INFORMATION HANDOUT

For Contract No. 04-235844
At 04-SM-101- 16.3/16.9

Identified by
Project ID 0400000684

PERMITS

San Francisco Bay Conservation and Development Commission dated October 23, 2013

United States Army Corps of Engineers

Non-Reporting Nationwide 404, dated October 24, 2013

WATER QUALITY

San Francisco Bay Regional Water Quality Control Board 401 Certification dated October 22, 2013

Storm Water Information Handout

AGREEMENTS

California Department of Fish and Wildlife dated October 22, 2013

Notification No. 1600-2012-0036-R3

Biological Opinion issued by United States Fish and Wildlife Service

MATERIALS INFORMATION

Foundation Report for Br. No. 35-0351, and 35-0352k

Foundation Report dated November 16, 2012 for Retaining Walls 15, 38, 39, 205, 209, 314, 315, and 316

Geotechnical Design and Materials Report dated April 19,2013

Lead Concentration Data and Sample Location Maps

Drainage Report, dated April 17, 2013

Non-storm Water Information Handout April 17, 2013

Cal/OSHA Underground Classifications

Making San Francisco Bay Better

October 23, 2013

California Department of Transportation
P.O. Box 23660
Oakland, California 94623-0660

ATTENTION: Hardeep S. Takhar, Acting Office Chief of Biological Sciences and Permits

SUBJECT: Amendment No. Two to BCDC Permit No. 2004.007.02

Dear Mr. Takhar:

Enclosed please find an original of amended BCDC Permit No. Permit No. 2004.007.02, formerly know as Permit No. 7-04, stamped "BCDC Original," and two copies stamped "Permittee's Copy," all executed by the Executive Director, incorporating the amendment requested in the letter dated July 15, 2013, and filed on October 21, 2013. In the amended permit, deleted language has been ~~struck through~~ and added language has been <u>underlined</u>.

I am issuing the amendment, which is included in the attached amended permit, on behalf of the Commission and upon the following findings and declarations:

1. This amendment to the permit is issued pursuant to Regulation Section 10820 upon the same criteria provided for the issuance of administrative permits in that the project, installing improvements associated with the US Highway 101/Broadway, Burlingame Interchange Reconstruction Project, is a "minor repair or improvement" consistent with Regulation Section 10601(b)(1), for which the Executive Director may issue an amendment to a permit, pursuant to Government Code Section 66632(f) and Regulation Section 10622(a).

2. The amendment to the permit is consistent with the San Francisco Bay Plan and the McAteer-Petris Act because the proposed project will not adversely affect the Bay nor public access to and enjoyment of the Bay consistent with the project.

Mr. Takhar, please: (1) **complete** the acknowledgment section of the permit stamped "BCDC Original," which indicates that you have read and that you understand all of the terms and conditions of the amended permit; (2) **forward** the signed "BCDC Original" to Mr. James McKim of San Mateo County Transportation Authority, for his signature and acknowledgement; and (3) **return** the "BCDC Original" to our office within the ten-day time period. The copies stamped "Permittee's Copy" should be retained by you and Mr. McKim for your records. The enclosed Notice of Completion and Declaration of Compliance must be signed and return to us upon project completion.

Furthermore, your permit contains special conditions which require you to take certain specific actions. Attached is a checklist to assist you in following the correct procedures. Please understand that **no** work may commence on the project until the permit stamped "BCDC Original" is executed and returned to us. Until the Commission receives the executed amended permit, the California Department of Transportation and the San Mateo County Transportation Authority do not have the necessary authorization for the work authorized under the amended permit. The commencement of any work within the Commission's jurisdiction without the necessary authorization from the Commission is a violation of the McAteer-Petris Act and could subject you to substantial fines.

If you should have any questions regarding the amended permit or the procedure outlined above, please contact Michelle Burt Levenson of our staff at 415/352-3618 or michellel@bcdc.ca.gov.

Very truly yours,

BRAD McCREA
Director of Regulatory Affairs
San Francisco Bay Conservation and
Development Commission

BM/MBL/ra
Enc.
cc: Mr. James McKim, San Mateo County Transportation Authority

CHECKLIST
For Permit Compliance

Permit No.: 2004.007.002
Permittee: Department of Transportation and the San Mateo County Transportation Authority
Date Issued: October 23, 2013
Analyst: Michelle Burt Levenson

PERMITTEE CHECKLIST	FOR BCDC USE
Within 10 Days of the Issuance of this Permit	
☐ Return the fully executed **BCDC Original** copy of the permit to the Commission's office.	Received_____
Prior to the Commencement of Construction	
☐ Submit and receive approval of project plans in accord with Special Condition II-A.	Received_____
☐ Submit Notice of Completion within 30 days of completing the permit requirements.	Received_____

PERMIT NO. 2004.007.02
(Originally Issued on December 30, 2005, as
Permit No. 7-04, and
Amended Through October 23, 2013)

**California Department of Transportation and
the San Mateo County Transportation Authority**

NOTICE OF COMPLETION AND DECLARATION OF COMPLIANCE

San Francisco Bay Conservation
and Development Commission
Fifty California Street, Suite 2600
San Francisco, CA 94111

Ladies and Gentlemen:

You are hereby informed that the work authorized by the above-referenced amended permit was completed on _____.

I have personally reviewed the terms and conditions of the amended permit, the final plans approved by or on behalf of the Commission, and the completed project and hereby certify that the project is in compliance with all terms and conditions of the amended permit and conforms to the plans previously reviewed and approved by or on behalf of the Commission. I further certify that all conditions of the amended permit, particularly with regard to plan review, public access areas and improvements, recordation, open space restrictions and other special conditions have been met.

I, _____, hereby declare under penalty of perjury that the foregoing is true and correct and that if called upon to testify to the contents of this notice, I would so testify.

Executed on this _____ day of _____, 20_____,

at _____, California.

_____
(Permittee)

_____
(Title)

Making San Francisco Bay Better

PERMIT NO. 2004.007.02
(Originally Issued on December 30, 2005, as
Permit No. 7-04, and
Amended Through October 23, 2013)

California Department of Transportation
P.O. Box 23660
Oakland, California 94623-0660

ATTENTION: Mr. Hardeep S. Takhar, Acting Office Chief of
Biological Sciences and Permits

AND

San Mateo County Transportation Authority
1250 San Carlos Avenue
San Carlos, California 94070

ATTENTION: Mr. James McKim

Ladies and Gentlemen:

On December 15, 2005, the San Francisco Bay Conservation and Development Commission, by a vote of 20 affirmative, 0 negative, and 0 abstentions, approved the resolution pursuant to which this the original permit ~~is hereby~~ was issued. Moreover, on January 10, 2007, and on October 23, 2013, the Executive Director issued Amendment Nos. One and Two, respectively, pursuant to which this amended permit is hereby issued:

I. Authorization

A. Subject to the conditions stated below, the permittees, the California Department of Transportation (Caltrans) and the San Mateo County Transportation Authority, are granted permission to do the following along northbound U. S. Highway 101, adjacent to the Burlingame Recreation Lagoon:

In the Bay:

1. **Easton Creek.** Extend an existing double box culvert by doing the following:

   (a) Excavate 74 cubic yards of sediment and remove 16 cubic yards of concrete and dispose of the material at a location located outside of the Commission's jurisdiction;

   (b) Install and remove, upon the completion of construction activities, two temporary (approximately 4 months) sand bag coffer dams at the down- and upstream ends of the creek;

   (c) Install and remove, upon project completion, a 70-foot-long, 12-inch-in-diameter pipe that will convey water through the area during construction activities; and

(d) Extend the existing culvert 42 feet towards the Bay (east) by placing 65 cubic yards of concrete that will result in the placement of 799 square feet (.018 acre) of Bay fill (Amendment No. Two).

2. **Unnamed Drainage Channel.** Construct a retaining wall that will aid in supporting the reconstructed Bayshore Highway by doing the following:

(a) Remove an existing 18-inch-in diameter culvert pipe at the west end of the channel, just east of the Bayshore Highway;

(b) Increase the depth of the channel by excavating 33 cubic yards of sediment from the channel and dispose of the material at a location outside of the Commission's jurisdiction;

(c) Remove an existing 900-square-foot berm and dispose of the material at a location outside of the Commission's jurisdiction;

(d) Remove and temporarily stockpile a total of 4,548 square feet of tidal marsh vegetation and replant the area at the completion of construction activities;

(e) Construct, use and maintain a concrete retaining wall that will result in the placement of 38 square feet of Bay fill;

(f) Relocate existing utility lines (e.g., electric cables, gas and sewer lines) within the work area; and

(g) Construct, use and maintain a 266-square-foot utility access road that will be used to access and service the relocated utility lines (Amendment No. Two).

In the Bay and within the 100-foot shoreline band:

1. **Burlingame Recreation Lagoon.** Temporarily remove existing rock riprap ~~along the~~ to facilitate construction of a retaining wall to support the widened freeway, and replace the riprap, in-kind, with no overall change in volume or square footage of Bay fill, following project construction.

Within the 100-foot shoreline band:~~, along 4,822 linear feet of the shoreline:~~

1. **Along 4,822 feet of the Burlingame Recreation Lagoon Shoreline:**

~~1.~~ (a) Construct, use and maintain an approximately 14,755-square-foot (0.33 acre) portion of a new, vehicular auxiliary lane;

~~2.~~ (b) Construct, use and maintain approximately 42,859-square-foot (0.98 acre) portions of a new vehicular shoulder;

~~3.~~ (c) Reconstruct, use and maintain an approximately 49,044-square-foot (1.12 acre) portion of an existing travel lane;

~~4.~~ (d) Resurface, use and maintain an approximately 193,866 square feet (4.45 acres) of existing pavement by applying an overlay of asphalt; and

~~5.~~ (e) Construct, use and maintain an approximately 2,156-foot-long, steel, soldier pile retaining wall with a type-80 "see through" vehicle barrier along the lagoon. The vehicle barrier would be 2.7 feet high with 5.3-foot-long, approximately 1-foot-wide openings that would allow for views to the lagoon by travelers on the highway.

2. **At the northeast corner of Bayshore Highway and Airport Boulevard:**

(a) Demolish an exiting gas station by removing all above ground structures and below ground storage tanks, monitoring wells and associated underground structures and removing and capping lateral utility connections; and

(b) Remediate 200 cubic feet of contaminated soils at the site and dispose of the material at a location outside of the Commission's jurisdiction (Amendment No. Two).

3. **Along the east side of the Bayshore Highway, near its intersection with Airport Boulevard:**

(a) Construct, use and maintain a 189-foot-long, 3-to 12-foot-tall retaining wall that will be used to support the reconstructed Bayshore Highway;

(b) Remediate contaminated soils at various locations and dispose of the material outside of the Commission's jurisdiction; and

(c) Improve existing sidewalks by increasing the width of approximately 1,056 linear feet of sidewalk on the east side of Bayshore Highway to a finished width ranging from 5.5 to 7 feet. A total of 4,969 linear feet of sidewalks will be improved with the project (Amendment No. Two).

B. This authority is generally pursuant to and limited by the permittees' original application received on August 5, 2004, and filed on November 17, 2005, the permittees' request for Amendment No. One received on December 18, 2006, and the request for Amendment No. Two received on July 15, 2013, including all accompanying and subsequent exhibits and correspondence, but subject to the modifications required by the conditions herein.

C. The work authorized by ~~this~~ the original permit ~~must~~ was required to commence by January 1, 2007, and ~~must~~ be diligently pursued to completion and ~~must~~ be completed by January 1, 2014, unless the terms of ~~this~~ the original authorization ~~are~~ were changed by amendment of this the original permit. Amendment No. One, issued on January 10, 2007, authorized an extension of commencement time, until September 1, 2007, to begin construction of the project. The work authorized under Amendment No. Two, improvements associated with the U.S. Highway 101 Broadway, Burlingame Interchange Project, must commence by April 30, 2014, and must be diligently pursued to completion and completed by May 30, 2017, unless an extensionof time is granted by further amendment of this amended permit.

D. The original project ~~will~~ resulted in the installation of approximately 57,614 square feet of new paved surfaces for an auxiliary lane and vehicle shoulder, the reconstruction and/or resurfacing of approximately 242,910 square feet of existing paved surfaces, the installation of a 2,156-foot-long retaining wall with a type-80, "see-through" vehicle

barrier on the top of the wall and the removal and replacement, in-kind, of existing rock riprap along the Burlingame Recreation Lagoon. The project will provide maximum feasible public access consistent with the project by providing and maintaining a new, non-motorized, twelve-foot-wide pedestrian/bicycle overcrossing just south of the existing Broadway Avenue, Burlingame interchange and improving existing pedestrian access and providing new bicycle access along the Peninsula Avenue overcrossing.

Amendment No. Two authorizes the reconstruction of the U.S. Highway 101/Broadway, Burlingame Interchange Reconstruction Project. The project will result in the reconstruction of a wider interchange structure, reconfiguration of the ramp connections to U.S. Highway 101 and installation of ramp meters on both north- and south-bound ramps. Components of the project that will be constructed in the Commission's 100-foot shoreline band consist of demolition of an existing gas station, remediation of soils, and construction of a retaining wall. Project components that will be constructed in the Bay include the extension of an existing culvert in an unnamed drainage channel, and installation of a concrete barrier, relocation of existing utilities and the construction of a new utility access road at Easton Creek. A total of 1,603 square feet of fill would be placed with the project and a total of 900 square feet of fill would be removed. In total the project would result in the net placement of 703 square feet of Bay fill to construct the project.

II. Special Conditions

The amended authorization made herein shall be subject to the following special conditions, in addition to the standard conditions in Part IV:

A. Specific Plans and Plan Review

1. **Plan Review.** No work whatsoever shall be commenced pursuant to this amended authorization until final precise site, engineering, grading and architectural plans and any other relevant criteria, specifications, and plan information for that portion of the work have been submitted to, reviewed, and approved in writing by or on behalf of the Commission. The specific drawings and information required will be determined by the staff. To save time, preliminary drawings should be submitted and approved prior to final drawings.

   Final plans submitted pursuant to this condition for the original project authorized herein shall generally conform to the plans entitled, "Retaining Wall No. 1 (Soldier Pile)" Sheets 1-16, dated January 25, 2004 and "Layout", Sheets L-9 through L14, both sets prepared by Caltrans.

   a. **Site, Grading and Architectural Plans.** Site, grading and architectural plans shall include and clearly label the Bay shoreline, the Mean High Tide Line or five feet above Mean Sea Level in marshlands, the line 100 feet inland from the Bay shoreline, property lines, grading, details showing the location, types, dimensions, and materials to be used for all structures, irrigation, landscaping, drainage, parking, signs, lighting, fences, utilities, and other proposed improvements.

b. **Engineering Plans.** Engineering plans shall include a complete set of contract drawings and specifications and design criteria. The design criteria shall be appropriate to the nature of the project, the use of any structures, soil and foundation conditions at the site, and potential earthquake-induced forces. Final plans shall be signed by the professionals of record and be accompanied by:

(1) Evidence that the design complies with all applicable codes; and

(2) Evidence that a thorough and independent review of the design details, calculations, and construction drawings has been made.

Plans submitted shall be accompanied by a letter requesting plan approval, identifying the type of plans submitted, the portion of the project involved, and indicating whether the plans are final or preliminary. Approval or disapproval shall be based upon:

a. Completeness and accuracy of the plans in showing the features required above, particularly the Bay shoreline, the Mean High Tide Line or inland edge of tidal marsh vegetation, property lines, and the line 100 feet inland of the Bay shoreline, and any other criteria required by this authorization;

b. Consistency of the plans with the terms and conditions of this authorization;

c. Assuring that any fill in the Bay does not exceed this authorization and will consist of appropriate shoreline protection materials as determined by or on behalf of the Commission; and

d. Assuring that appropriate provisions have been incorporated for safety in case of seismic event.

Plan review shall be completed by or on behalf of the Commission within 45 days after receipt of the plans to be reviewed.

2. **Conformity with Final Approved Plans.** All work, improvements, and uses shall conform to the final approved plans. Prior to any use of the facilities authorized herein, the appropriate design professional(s) of record shall certify in writing that, through personal knowledge, the work covered by the authorization has been performed in accordance with the approved design criteria and in substantial conformance with the approved plans. No noticeable changes shall be made thereafter to any final plans or to the exterior of any constructed structure, outside fixture, lighting, signage or shoreline protection work without first obtaining written approval of the change(s) by or on behalf of the Commission.

3. **Discrepancies between Approved Plans and Special Conditions.** In case of any discrepancy between final approved plans and Special Conditions of this authorization or legal instruments approved pursuant to this authorization, the Special Condition or the legal instrument shall prevail. The permittees are responsible for assuring that all plans accurately and fully reflect the Special Conditions of this authorization and any legal instruments submitted pursuant to this authorization.

Final plans for the shoreline protection improvements shall be prepared and submitted for BCDC review in accordance with Special Condition II-D, below. No changes to the design of the project shall be made without the prior written approval of the BCDC staff.

B. **Public Access**

~~1.~~ a. **Improvements Within the Total Public Access Area-Auxiliary Lanes Project.** Prior to the use of any portion of the auxiliary lanes authorized herein, the permittees shall install and make available for public use for as long as the auxiliary lanes authorized herein remain in place, the following public access improvements, as described below:

~~a.~~ i. **Broadway Avenue, Burlingame Pedestrian and Bicycle Overcrossing.** Construct a separate, non-motorized overcrossing to the south of the Broadway Avenue, Burlingame Interchange, providing a connection for communities west of the highway, over U.S. Highway 101 to existing Bay shoreline access. The overcrossing shall include a twelve-foot-wide, standard Class I, pedestrian and bicycle pathway with non-glare paving; lighting; ADA-compliant access ramps; and signage;

~~b.~~ ii. **Pedestrian and Bicycle Improvements on the Peninsula Avenue, Burlingame Overcrossing**. Construct sidewalks, bike lanes and connections to existing pedestrian/bicycle access on the reconstructed overcrossing, providing an improved connection over U.S. Highway 101 to existing Bay shoreline access and the Coyote Point Recreation Area. Improvements include five-foot-wide, pedestrian sidewalks on both the north and south sides of the reconstructed overcrossing, four-foot-wide, painted Class II bikeways on both the north and south sides of the reconstructed overcrossing; signalized cross walks, lighting and signage;

~~c.~~ iii. **Public Access Signs.** At lease twelve public access signs identifying the public access and nearby shoreline connections placed at the entrances to the over crossings and at existing access areas.

Such improvements shall be consistent with the plans approved pursuant to Condition II-A of this authorization and be based on the plans entitled "Broadway Avenue POC-General Plan" and "Peninsula Avenue Overcrossing (Replace)-General Plan", both dated January 26, 2004, and prepared by Caltrans and the plans entitled, "Existing, Proposed and Future Public Access-Broadway Pedestrian/Bicycle Overcrossing" and "Existing, Proposed and Future Public Access-Peninsula Avenue Overcrossing Reconstruction", both dated July 19, 2005 and prepared by LSA Associates, Inc.

b. **Improvements within the Total Public Access Area-Bayshore Highway and Airport Boulevard.** Prior to the use of the reconstructed U.S. Highway 101/Broadway Interchange Project authorized herein, the permittees shall install and make available for public access the following public access improvements as generally shown on Exhibit A (Amendment No. Two):

i. Broadway Overcrossing. Replace existing 2-foot-wide sidewalks with a 10-foot-wide sidewalk on the north side of the overcrossing and install a Class II, striped bike lane of the westbound side and a Class III bicycle lane on the eastbound side;

ii. Airport Boulevard. Install a Bay Trail Class I and a 5-foot-wide sidewalk along the northside and Class II striped bicycle lanes on both side of Airport Boulevard; and

iii. Bayshore Highway. Install a 5.5- to 7-foot-wide sidewalk on the east side and a 6- to10-foot-wide sidewalk on the west side and install 700 feet of Class II, striped bicycle lanes on both sides of Bayshore Highway.

Such improvements shall be consistent with the plans approved pursuant to Special Condition II-A of this amended authorization and be based on the plan entitled, "Figure 3B, US 101/Broadway Interchange Reconstruction Project, Proposed Public Access Map, Pedestrian and Bicycle Access," Sheet 1, prepared by URS and dated March 11, 2013.

2. **Maintenance.** The public access areas described above shall be permanently maintained by and at the expense of the permittees or their assignees. Such maintenance shall include, but is not limited to, repairs to all path surfaces; repairs or replacement as needed of any public access amenities such as signs, paving, railings, access ramps, trash containers and lights; periodic cleanup of litter and other materials deposited within the access areas or within trash containers; removal of any encroachments into the access areas; and assuring that the public access signs remain in place and visible. Within 30 days after notification by staff, the permittees shall correct any maintenance deficiency noted in a staff inspection of the site.

3. **Assignment.** The permittees may transfer maintenance responsibility of the public access areas required herein to a public agency or another party acceptable to the Commission provided that the transferee(s) agrees in writing, acceptable to counsel for the Commission, to be bound by all terms and conditions of this permit.

4. **Reasonable Rules and Restrictions.** The permittees may impose reasonable rules and restrictions for the use of the public access areas to correct particular problems that may arise. Such limitations, rules, and restrictions shall have first been approved in writing by or on behalf of the Commission upon a finding that the proposed rules would not significantly affect the public nature of the area, would not unduly interfere with reasonable public use of the public access areas, and would tend to correct a specific problem that the permittees have both identified and substantiated. Rules may include restricting hours of use and delineating appropriate behavior. Temporary, short-term (less than 24 hours) closures due to maintenance activities do not require prior written approval by or on behalf of the Commission. The permittees shall notify the Commission of any closures as a result of maintenance activities that last longer than 24 hours, 14 days prior to implementing such closures. For closures greater than 72 hours, the permittees shall provide signs informing the public of existing alternative routes over the highway and shall indicate when the areas will be open for use.

C. **Visual Access.** To ensure that visual access to the Bay is provided with the project, the permittees shall install a type-80 vehicle barrier approved pursuant to Special Condition II-A along 2,156 feet of the Burlingame Recreation Lagoon, in general conformance with the plans entitled, "Retaining Wall No. 1 (Soldier Pile) General Plan No. 2", dated January 25, 2004, and prepared by Caltrans. The type-80 vehicle barrier shall include 5.3-foot-long, 1-foot wide visual openings and the retaining wall/vehicle barrier structure shall not exceed 2.7 feet in height from the road surface.

D. **Riprap Conditions**

1. **Riprap Material.** Riprap material shall be either quarry rock or specially cast or carefully selected concrete pieces free of reinforcing steel and other extraneous material and conforming to quality requirements for specific gravity, absorption, and durability specified by the California Department of Transportation or the U. S. Army Corps of Engineers. The material shall be generally spheroid-shaped. The overall thickness of the slope protection shall be no more than three feet measured perpendicular to the slope. Use of dirt, small concrete rubble, concrete pieces with exposed rebar, large or odd shaped pieces of concrete, or asphalt concrete as riprap is prohibited.

2. **Riprap Placement.** Riprap material shall be placed so that a permanent shoreline with a minimum amount of fill is established by means of an engineered slope. The slope shall be created by the placement of a filter layer protected by riprap material of sufficient size to withstand wind and wave generated forces at the site.

3. **Riprap Plans**

a. **Design.** Professionals knowledgeable of the Commission's concerns, such as civil engineers experienced in coastal processes, should participate in the design of the shoreline protection improvements authorized herein.

b. **Plan Review.** No work whatsoever shall be commenced on the shoreline protection improvements authorized herein until final riprap plans have been submitted to, reviewed, and approved in writing by or on behalf of the Commission. The plans shall consist of appropriate diagrams and cross-sections that (1) show and clearly label the Bay shoreline (either the Mean High Tide Line or five feet above Mean Sea Level in marshlands), property lines, grading limits, and details showing the location, types, and dimensions of all materials to be used, (2) indicate the source of all materials to be used, and (3) indicate who designed the proposed shoreline protection improvements and their background in coastal engineering and familiarity with the Commission's concerns. Approval or disapproval of the plans shall be based upon (1) completeness and accuracy of the plans in showing the features required above, (2) consistency of the plans with the terms and conditions of this permit, (3) assuring that the proposed fill material does not exceed this permit, (4) the appropriateness of the types of fill material and their proposed manner of placement, and (5) the preparation of the plans by professionals knowledgeable of the Commission's concerns, such as civil engineers experienced in coastal processes. All improvements constructed pursuant to this permit shall conform to the final approved plans. No changes

shall be made thereafter to any final plans or to the constructed shoreline protection improvements without first obtaining written approval of the change(s) by or on behalf of the Commission.

4. **Maintenance.** The shoreline protection improvements authorized herein shall be regularly maintained by, and at the expense of the permittees, any assignees, lessees, sublessees, or other successors in interest to the project. Maintenance shall include, but not be limited to, collecting any riprap materials that become dislodged and repositioning them in appropriate locations within the riprap covered areas, replacing in-kind riprap material that is lost, repairing the required filter fabric as needed, and removing debris that collects on top of the riprap. Within 30 days after notification by the staff of the Commission, the permittees or any successors or assignees shall correct any maintenance deficiency noted by the staff.

E. **Water Quality.** Consistent with the Environmental Assessment/Initial Study prepared and certified for the project, the following measures shall be implemented to ensure that potential impacts to water quality are minimized:

1. All active and paved construction areas shall be swept and washed daily;
2. Silt fencing shall be used to retain sediment on the project site;
3. Temporary cover of all disturbed surfaces shall be provided to help control erosion. Permanent cover/revegetation shall be provided to stabilize the disturbed surfaces after construction has been completed; and
4. Best Management Practices (BMP's) shall be utilized during construction.

F. **Debris Removal.** All construction debris shall be removed to an authorized location outside the jurisdiction of the Commission. In the event that any such material is placed in any area within the Commission's jurisdiction, the permittees, their assignees, or successors in interest, or the owners of the improvements, shall remove such material, at their expense, within ten days after they have been notified by the Executive Director of such placement.

G. **Construction Operations.** All construction operations shall be performed to prevent construction materials from falling into the Bay. In the event that such material escapes or is placed in an area subject to tidal action of the Bay, the permittees shall immediately retrieve and remove such material at their expense.

H. **Notice to Contractor.** The permittees shall provide a copy of this permit to any contractor or person working in concert with the permittees to carry out the activities authorized herein and shall point out the special conditions contained herein.

I. **Creosote Treated Wood.** No new pilings or other wood structures that have been pressure treated with creosote shall be used in any area subject to tidal action in the Bay or any certain waterway, in any salt pond, or in any managed wetland within the Commission's jurisdiction as part of the project authorized herein.

III. Findings and Declarations

This amended authorization is given on the basis of the Commission's findings and declarations that the work authorized herein is consistent with the McAteer-Petris Act, the *San Francisco Bay Plan*, the California Environmental Quality Act, and the Commission's amended coastal zone management program for San Francisco Bay for the following reasons:

A. Original Authorization

1. **Bay Fill.** Section 66605 of the McAteer-Petris Act states that fill in the Bay should only be authorized if it would serve a water-oriented purpose, there is no alternative location for the fill, the fill that would be placed is the minimum amount necessary to achieve the purpose of the fill, that harmful effects from its placement would be minimized and the fill would establish a permanent shoreline, among other things.

   The original project ~~will~~ involves the removal and in-kind replacement of existing rock riprap that will result in no new increase in fill at the site. The rock riprap that will be placed is the minimum necessary to protect the toe of the new retaining wall while stabilizing and providing a permanent shoreline. The harmful effects of the placement of the riprap will be minimized because the riprap will be placed in locations where riprap currently exists and best management practices will be employed during construction to ensure that materials associated with the riprap installation do not enter the Bay.

   Because the amount of rock riprap that will be placed with the original project is the minimum amount necessary, will provide a permanent shoreline and the effects of its placement will be minimized, the Commission finds that the riprap removal and replacement is consistent with the McAteer-Petris Act and the Commission's policies on fill in the Bay.

~~B.~~ 2. **Maximum Feasible Public Access.** Section 66602 of the McAteer-Petris Act states that existing public access to the shoreline and waters of San Francisco Bay is inadequate and that maximum feasible public access, consistent with a proposed project, should be provided.

   The Bay Plan policies on public access state that, "...maximum feasible public access to and along the waterfront and on any permitted fills should be provided in and through every new development in the Bay or on the shoreline...." The policies go on to state, "...[P]ublic access improvements provided as a condition of any approval should be consistent with the project and the physical environment...and provide for the public's safety and convenience. The improvements should be designed and built to encourage diverse Bay-related activities and movement to and along the shoreline, should permit barrier free access for the physically handicapped to the maximum feasible extent, should include an ongoing maintenance program, and should be identified with appropriate signs...."

   With regard to visual access to the Bay, the Bay Plan policies on public access state that, "Roads near the edge of the water should be designed as scenic parkways...The roadway and right-of-way should maintain and enhance visual access for the traveler...."

In determining whether a proposed project meets the public access requirements of the McAteer-Petris Act and the San Francisco Bay Plan, the Commission must determine what constitutes maximum feasible public access consistent with the proposed project. In making this determination, the Commission is guided by informal written advice from the Attorney General's Office dated May 16, 2000. In this letter the Attorney General's office states that in determining feasibility, the Commission should consider and weigh a number of factors that will allow it to evaluate the policy goals of public access with a measure of what is probable and what is practicable. The letter further states that, "...Without purporting to limit BCDC's discretion in identifying and weighing these factors, the following types of concerns could be relevant in determining whether access would be feasible: (1) whether the public access deemed to be the maximum feasible is physically and technologically possible; (2) whether the public access under consideration is consistent with public health and safety; (3) the length of time needed to implement the public access under consideration; and (4) the cost associated with providing the public access under consideration...."

The work within the Commission's jurisdiction involves the installation of an auxiliary lane, vehicle shoulder and a retaining wall with a vehicle barrier along 4,822 linear feet of the 100-foot shoreline band, located adjacent to the Burlingame Recreation Lagoon along northbound U. S. Highway 101. The project authorized herein is part of an overall project to install auxiliary lanes and associated improvements along 4.4 miles of U. S. Highway 101 between the Millbrae Avenue and Third Street interchanges. The permittees state that the project will have a direct and beneficial impact on freeway operations along U. S. Highway 101 affected by the project. The auxiliary lanes will substantially improve merging and weaving conditions, reducing congestion and peak-hour travel times.

Public access improvements associated with a project of this scale and magnitude would often involve the provision of new shoreline access located adjacent to or near the project. Such improvements would largely be located within the Commission's jurisdiction. However, in this instance, public access improvements located directly adjacent to the project site (i.e., along the freeway) are not particularly desirable because of their proximity to the freeway, because such access would duplicate existing access on the opposite shore of the Burlingame Recreation Lagoon and because the most suitable area for public access along this stretch of shoreline has already been developed as a small shoreline path. In addition, shoreline access along the entire length of the project segment within the Commission's jurisdiction would likely involve the placement of fill within the Commission's Bay jurisdiction. While these improvements are not located directly *on* the shoreline they will greatly improve existing access *to* the Bay. The Commission believes that these improvements are preferable to shoreline access that could be provided adjacent to the project site along the Burlingame Recreation Lagoon. The access will provide critical links to existing shoreline access and the Bay Trail from inland residential areas in the Cities of Burlingame and San Mateo.

Currently, pedestrians and bicyclists can cross Highway 101 at five locations along the 4.4-mile segment of the Highway affected by this project. Three of these overcrossings will be rebuilt as part of this project and the public access on them will be significantly improved. In order for the Commission to make its required public access findings, this authorization requires the construction and maintenance of two of these public amenities. A new, separate pedestrian/bicycle, non-motorized overcrossing will be constructed just south of the existing Broadway Avenue, Burlingame overcrossing. This overcrossing will contain a Class I, twelve-foot-wide, shared pedestrian and bicycle pathway that will link residential communities on the west side of the highway with existing shoreline access on the east side of the highway. The Broadway Avenue, Burlingame overcrossing is expected to cost $1.5 million. In addition, existing pedestrian access will be improved on the Peninsula Avenue, Burlingame overcrossing by providing five-foot-wide sidewalks on both the north and south sides of the overcrossing. Additionally, new, four-foot-wide, Class II bicycle lanes will be provided on both the north and south sides of the overcrossing. The Peninsula Avenue improvements will enhance both the access and safety of users from nearby residential areas to existing shoreline access and the Coyote Point Recreation Area. The Peninsula Avenue, Burlingame improvements are expected to cost $1.1 million. Both the Peninsula Avenue and Broadway improvements will provide better connections to the Bay Trail. The third public access component that will be constructed by the permittees, the reconstruction of an existing pedestrian/bicycle overcrossing with a wider, ADA-compliant structure at the Monte Diablo exit in San Mateo, has not been required in this authorization as discussed in more detail below. The Monte Diablo improvements are expected to cost $2 million.

Requiring just two of the three public access components proposed with the project is the maximum feasible consistent with the project because, among other important criteria: (1) while the entire project encompasses a 4.4-mile area, just 0.91 mile (4,822 linear feet) of the project will be constructed within the Commission's shoreline band; and (2) the costs associated with the two public access improvements ($2.6 million) is appropriate in relation to the costs associated with the portion of project that will be built within the Commission's jurisdiction ($5 million). While the access improvements are not located directly *on* the shoreline, they will greatly improve existing access *to* the Bay and are preferable to shoreline access that could be provided adjacent to the project site along the Burlingame Recreation Lagoon. The access required herein will provide critical links to the existing shoreline access from inland residential areas in the Cities of Burlingame and San Mateo and the San Francisco Bay Trail Project.

This authorization does not require the construction and maintenance of the new Monte Diablo overcrossing. While the Monte Diablo improvements provide a link for communities on the west and east sides of the highway, the improvements will be located a significant distance (approximately 0.5 mile) from the Commission's jurisdiction and are further away from the shoreline than the other two crossings. Due to agreements the permittees have entered into with various local agencies and the strong demand for such facilities by adjacent communities, these improvements will be constructed whether or not they are required by this Commission

authorization. Additionally, when examining the costs associated with the project, the extent of the project within the Commission's jurisdiction and the high public access values associated with the Broadway, Burlingame and Peninsula Avenue, Burlingame overcrossing improvements, requiring the Monte Diablo improvements is not necessary for the Commission to determine that public access associated with the project is the maximum feasible consistent with the project.

With regard to the project's effect on visual access to the Bay, the type-80 vehicle barrier that will be installed with the project has been designed with visual openings to allow for views through the structure to the lagoon by passing motorists. The new vehicle barrier will not only maintain but will enhance visual access to the Bay from the highway.

In conclusion, the Commission finds that the bicycle and pedestrian improvements required herein should be considered as the public access component of the project. In addition, the Commission finds that the public access required herein is the maximum feasible, consistent with the project because the required public access will greatly improve pedestrian and bicycle access to existing shoreline access.

In addition, the Commission finds that the design and location of the vehicle barrier will maintain and enhance visual access to the Bay.

~~C.~~ 3. **Appearance, Design and Scenic Views.** The Bay Plan policies on appearance, design and scenic views state that, "All bayfront development should be designed to enhance the pleasure of the user or viewer of the Bay. Maximum efforts should be made to provide, enhance, or preserve views of the Bay and shoreline..." and "Access routes to Bay crossings should be designed so as to orient the traveler to the Bay...Guardrails, fences, landscaping, and other structures related to such routes should be designed and located so as to maintain and to take advantage of Bay views...."

Along the northbound section of the highway adjacent to the lagoon, partial views of the lagoon are achieved over an existing vehicle barrier for the majority of the length of the lagoon. As part of the project, a 2,156-foot-long retaining wall with a type 80, "see through" barrier will be constructed. The structure will contain 5.3-foot-long, approximately 1-foot-wide openings that will allow for views to the lagoon by travelers on the highway. The new vehicle barrier will allow for improved views to the lagoon over existing conditions because the visual openings will be provided at appropriate heights for travelers along the highway. The type-80 barrier was specifically chosen along the lagoon to take advantage of views to the water, while still providing a safe vehicle barrier.

The Commission finds that the type-80 vehicle barrier that will be installed with the project has been designed to maintain and take advantage of Bay views, consistent with the Bay Plan policies.

~~D.~~ 4. **Transportation.** The Bay Plan policies on transportation primarily address transportation projects that involve fill in the Bay, such as bridges and associated facilities (e.g., toll plazas, etc). Since the project authorized herein does not involve the placement of new Bay fill except for placing riprap removed to facilitate construction of the retaining wall, there are no transportation policies that are

directly applicable to this project. However, other Bay Plan policies on appearance, design and scenic views (discussed above) do address elements of roadways along the Bay. As conditioned, the project is consistent with these policies. Therefore, the Commission finds that the project is consistent with the Bay Plan policies on transportation.

B. **Amendment No. Two.** Amendment No. Two authorizes the construction of several improvements that are part of the U.S. Highway 101/Broadway, Burlingame Interchanged Reconstruction Project. The project will result in the construction of a new, seven-lane Broadway Overcrossing and the realignment of Broadway such that the roadway will extend straight across US 101 from the Broadway/Rollins Road intersection on the west to Bayshore Highway on the east, eliminating the existing curvilinear alignment. The project elements proposed in the Commission's 100-shoreline band jurisdiction include the demolition of an existing gas station, construction of a retaining wall, remediation of soils and improvements to sidewalks and bike lanes. These improvements consist of the placement of inert, inorganic material with no overall effect on present or future maximum feasible public access to the Bay or Bay resources, consistent with Regulation Section 10601(b)(1).

Project components proposed in the Bay include the extension of a culvert, the construction of a barrier wall, relocation of utilities and the construction of a utility access road. The improvements proposed in the Bay would result in the net placement of 703 square feet of Bay fill. The improvements authorized in the Bay are necessary to construct the overall project and have been designed to be the minimum necessary to safely and adequately accomplish the goals of the project. The overall reconstruction will aid in relieving congestion on U.S. Highway 101 and nearby city streets and will provide an overcrossing that is much safer than the existing curvilinear structure. The improvements proposed in the Bay are similar in nature and effect on Bay, consistent with Regulation Section 10601(e)(3), as the placement of 1,000 square feet of fill for the installation of protective works that are the minimum necessary and that cover less than 10,000 square feet, consistent with Regulation Section 10601(a)(2).

All of the improvements authorized under Amendment No. Two are considered "minor repairs or improvements" for which the Executive Director may issue an amendment to a permit consistent with Regulation Section 10820 and Government Code Section 66632(f).

The project authorized under Amendment No. Two is consistent with McAteer Petris Act and San Francisco Bay Plan. The project will improve existing public access by providing new sidewalks, improving existing sidewalks and providing new bicycle lanes along the Broadway Overcrossing, Airport Boulevard and Bayshore Highway. A total of 33,802 square feet of improved sidewalks and 47,801 square feet of new and improved bicycle access will be provided with the project.

~~E.~~ C. **Environmental Review.** On February 23, 2004, the Federal Highway Administration, the NEPA lead agency for the original project, determined that the Environmental Assessment prepared for the original project would not have a significant impact on the human environment. On January 30, 2004, Caltrans, the CEQA lead agency for the

project, certified the Negative Declaration prepared for the project. Caltrans prepared and completed an Initial Study/Mitigated Negative Declaration and an Environmental Assessment with a finding of no significant impact for the project authorized in Amendment No. Two. The document was completed and signed on March 18, 2011.

~~F.~~ D. **Conclusion**. For all the above reasons, the Commission finds, declares, and certifies that, subject to the Special Conditions stated herein, the project authorized herein is consistent with the *San Francisco Bay Plan*, the McAteer-Petris Act, the Commission's Regulations, the California Environmental Quality Act, and the Commission's Amended Management Program for the San Francisco Bay segment of the California coastal zone.

IV. Standard Conditions

~~A. This permit shall not take effect unless the permittees execute the original of this permit and return it to the Commission within ten days after the date of the issuance of the permit. No work shall be done until the acknowledgment is duly executed and returned to the Commission.~~

~~B. The attached Notice of Completion and Declaration of Compliance form shall be returned to the Commission within 30 days following completion of the work.~~

~~C. The rights, duties, and obligations contained in this permit are assignable. When the permittees transfer any interest in any property either on which the authorized activity will occur or which is necessary to the full compliance of one or more conditions to this permit, the permittees/transferors and the transferees shall execute and submit to the Commission a permit assignment form acceptable to the Executive Director (*call for a copy of the form or download it from our website*). An assignment shall not be effective until the assignees execute and the Executive Director receives an acknowledgment that the assignees have read and understand the permit and agree to be bound by the terms and conditions of the permit, and the assignees are accepted by the Executive Director as being reasonably capable of complying with the terms and conditions of the permit.~~

~~D. Unless otherwise provided in this permit, the terms and conditions of this permit shall bind all future owners and future possessors of any legal interest in the land and shall run with the land.~~

~~E. Unless otherwise provided in this permit, any work authorized herein shall be completed within the time limits specified in this permit, or, if no time limits are specified in the permit, within three years. If the work is not completed by the date specified in the permit, or, if no date is specified, within three years from the date of the permit, the permit shall become null and void. If a permit becomes null and void for a failure to comply with these time limitations, any fill placed in reliance on this permit shall be removed by the permittees or their assignees upon receiving written notification by or on behalf of the Commission to remove the fill.~~

~~F. All required permissions from governmental bodies must be obtained before the commencement of work; these bodies include, but are not limited to, the U. S. Army Corps of Engineers, the State Lands Commission, the Regional Water Quality Control Board, and the city and/or county in which the work is to be performed, whenever any of these may be required. This permit does not relieve the permittees of any obligations imposed by State or Federal law, either statutory or otherwise.~~

~~G. Work must be performed in the precise manner and at the precise locations indicated in your application, as such may have been modified by the terms of the permit and any plans approved in writing by or on behalf of the Commission.~~

~~H. Work must be performed in a manner so as to minimize muddying of waters, and if diking is involved, dikes shall be waterproof. If any seepage returns to the Bay, the permittees will be subject to the regulations of the Regional Water Quality Control Board in that region.~~

~~I. Unless otherwise provided in this permit, all the terms and conditions of this permit shall remain effective for so long as the permit remains in effect or for so long as any use or construction authorized by this permit exists, whichever is longer.~~

~~J. Any area subject to the jurisdiction of the San Francisco Bay Conservation and Development Commission under either the McAteer-Petris Act or the Suisun Marsh Preservation Act at the time the permit is granted or thereafter shall remain subject to that jurisdiction notwithstanding the placement of any fill or the implementation of any substantial change in use authorized by this permit.~~

~~K. Any area not subject to the jurisdiction of the San Francisco Bay Conservation and Development Commission that becomes, as a result of any work or project authorized in this permit, subject to tidal action shall become subject to the Commission's "bay" jurisdiction.~~

~~L. This permit reflects the location of the shoreline of San Francisco Bay when the permit was issued. Over time, erosion, avulsion, accretion, subsidence, relative sea level change, and other factors may change the location of the shoreline, which may, in turn, change the extent of the Commission's regulatory jurisdiction. Therefore, the issuance of this permit does not guarantee that the Commission's jurisdiction will not change in the future.~~

~~M. Except as otherwise noted, violation of any of the terms of this permit shall be grounds for revocation. The Commission may revoke any permit for such violation after a public hearing held on reasonable notice to the permittees or their assignees if the permit has been effectively assigned. If the permit is revoked, the Commission may determine, if it deems appropriate, that all or part of any fill or structure placed pursuant to this permit shall be removed by the permittees or their assignees if the permit has been assigned.~~

~~N. Unless the Commission directs otherwise, this permit shall become null and void if any term, standard condition, or special condition of this permit shall be found illegal or unenforceable through the application of statute, administrative ruling, or court determination. If this permit becomes null and void, any fill or structures placed in reliance on this permit shall be subject to removal by the permittees or their assignees if the permit has been assigned to the extent that the Commission determines that such removal is appropriate. Any uses authorized shall be terminated to the extent that the Commission determines that such uses should be terminated.~~

A. **Permit Execution**. This amended permit shall not take effect unless the permittees execute the original of this amended permit and return it to the Commission within ten days after the date of the issuance of the amended permit. No work shall be done until the acknowledgment is duly executed and returned to the Commission.

B. **Notice of Completion**. The attached Notice of Completion and Declaration of Compliance form shall be returned to the Commission within 30 days following completion of the work.

C. **Permit Assignment**. The rights, duties, and obligations contained in this amended permit are assignable. When the permittees transfer any interest in any property either on which the activity is authorized to occur or which is necessary to achieve full compliance of one or more conditions to this amended permit, the permittees/transferors and the transferees shall execute and submit to the Commission a permit assignment form acceptable to the Executive Director. An assignment shall not be effective until the assignees execute and the Executive Director receives an acknowledgment that the assignees have read and understand the amended permit and agree to be bound by the terms and conditions of the amended permit, and the assignees are accepted by the Executive Director as being reasonably capable of complying with the terms and conditions of the amended permit.

D. **Permit Runs With the Land**. Unless otherwise provided in this amended permit, the terms and conditions of this amended permit shall bind all future owners and future possessors of any legal interest in the land and shall run with the land.

E. **Other Government Approvals**. All required permissions from governmental bodies must be obtained before the commencement of work; these bodies include, but are not limited to, the U. S. Army Corps of Engineers, the State Lands Commission, the Regional Water Quality Control Board, and the city or county in which the work is to be performed, whenever any of these may be required. This amended permit does not relieve the permittees of any obligations imposed by State or Federal law, either statutory or otherwise.

F. **Built Project must be Consistent with Application**. Work must be performed in the precise manner and at the precise locations indicated in your application, as such may have been modified by the terms of the amended permit and any plans approved in writing by or on behalf of the Commission.

G. **Life of Authorization**. Unless otherwise provided in this amended permit, all the terms and conditions of this amended permit shall remain effective for so long as the amended permit remains in effect or for so long as any use or construction authorized by this amended permit exists, whichever is longer.

H. **Commission Jurisdiction**. Any area subject to the jurisdiction of the San Francisco Bay Conservation and Development Commission under either the McAteer-Petris Act or the Suisun Marsh Preservation Act at the time the amended permit is granted or thereafter shall remain subject to that jurisdiction notwithstanding the placement of any fill or the implementation of any substantial change in use authorized by this amended permit. Any area not subject to the jurisdiction of the San Francisco Bay Conservation and Development Commission that becomes, as a result of any work or project authorized in this amended permit, subject to tidal action shall become subject to the Commission's "bay" jurisdiction.

I. **Changes to the Commission's Jurisdiction as a Result of Natural Processes**. This amended permit reflects the location of the shoreline of San Francisco Bay when the amended permit was issued. Over time, erosion, avulsion, accretion, subsidence, relative sea level change, and other factors may change the location of the shoreline, which may, in turn, change the extent of the Commission's regulatory jurisdiction. Therefore, the issuance of this amended permit does not guarantee that the Commission's jurisdiction will not change in the future.

J. **Violation of Permit May Lead to Permit Revocation**. Except as otherwise noted, violation of any of the terms of this amended permit shall be grounds for revocation. The Commission may revoke any amended permit for such violation after a public hearing held on reasonable notice to the permittees or their assignees if the amended permit has been effectively assigned. If the amended permit is revoked, the Commission may determine, if it deems appropriate, that all or part of any fill or structure placed pursuant to this amended permit shall be removed by the permittees or their assignees if the amended permit has been assigned.

K. **Should Permit Conditions Be Found to be Illegal or Unenforceable**. Unless the Commission directs otherwise, this amended permit shall become null and void if any term, standard condition, or special condition of this amended permit shall be found illegal or unenforceable through the application of statute, administrative ruling, or court determination. If this amended permit becomes null and void, any fill or structures placed in reliance on this amended permit shall be subject to removal by the permittees or their assignees if the amended permit has been assigned to the extent that the Commission determines that such removal is appropriate. Any uses authorized shall be terminated to the extent that the Commission determines that such uses should be terminated.

L. **Permission to Conduct Site Visit**. The permittees shall grant permission to any member of the Commission's staff to conduct a site visit at the subject property during and after construction to verify that the project is being and has been constructed in compliance with the authorization and conditions contained herein. Site visits may occur during business hours without prior notice and after business hours with 24-hour notice.

Executed at San Francisco, California, on behalf of the San Francisco Bay Conservation and Development Commission on the date first above written.

LAWRENCE J. GOLDZBAND
Executive Director
San Francisco Bay Conservation and
Development Commission

By: _____
BRAD McCREA
Director of Regulatory Affairs
San Francisco Bay Conservation and
Development Commission

BM/MBL/ra

cc: U. S. Army Corps of Engineers, Attn.: Regulatory Functions Branch
San Francisco Bay Regional Water Quality Control Board,
Attn.: Certification Section
Environmental Protection Agency
Joe Bandel, Biologist, URS Corporation

* *

Receipt acknowledged, contents understood and agreed to:

Executed at_____ California Department of Transportation
Applicant

On _____ By: _____

_____
Title

* *

Receipt acknowledged, contents understood and agreed to:

Executed at_____ San Mateo County Transportation Authority
Applicant

On _____ By: _____

_____
Title

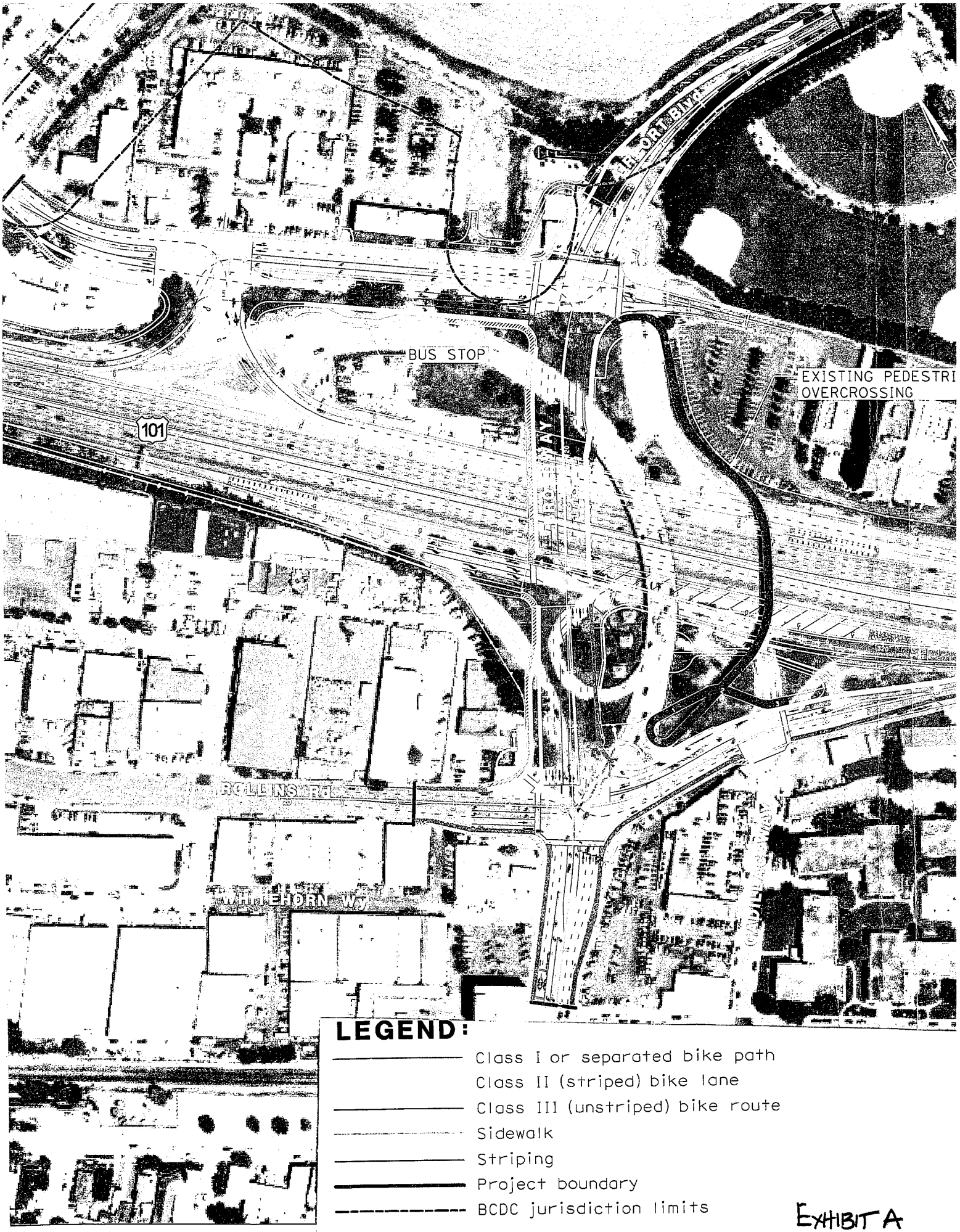
BUS STOP
EXISTING PEDESTRI
OVERCROSSING
101
ROLLINS RD
WHITEHORN WY
LEGEND:
Class I or separated bike path
Class II (striped) bike lane
Class III (unstriped) bike route
Sidewalk
Striping
Project boundary
BCDC jurisdiction limits

EXHIBIT A

DEPARTMENT OF THE ARMY PERMIT

PERMITTEE: California Department of Transportation, District 4

PERMIT NO.: 2010-00334S

ISSUING OFFICE: San Francisco District

NOTE: The term "you" and its derivatives, as used in this permit, means the permittee or any future transferee. The term "this office" refers to the appropriate District or Division office of the Corps of Engineers having jurisdiction over the permitted activity or the appropriate official of that office acting under the authority of the commanding officer.

You are authorized to perform work in accordance with the terms and conditions specified below:

PROJECT DESCRIPTION: The California Department of Transportation (Caltrans) is seeking Department the Army authorization to reconstruct the U.S. 101/Broadway interchange in the City of Burlingame. Work will include replacement of the Broadway overcrossing with a new structure (208 feet long, 110 feet wide, and 22.5 feet high), reconfiguration of all ramp connections to U.S. 101, and installation of ramp meters on northbound and southbound on-ramps. The project will construct a new seven-lane Broadway overcrossing approximately 100 feet to the north of the existing four-lane structure. Overcrossing replacement will require pile driving and new abutment installation. Broadway will be re-aligned to extend straight across U.S. 101 from the Broadway/Rollins Road intersection on the west to Bayshore highway on the east, eliminating the existing curvilinear alignment. The northern terminus of Airport Boulevard will be shifted approximately 100 feet to the north to meet the new eastern touchdown of the overcrossing and maintain a four-leg intersection with Broadway, Bayshore Highway, and the access road for the Crowne Plaza Hotel. New traffic signals and streetlights will be installed as part of the project. A landscaping project will also be completed. In total, work will include soil treatment, building demolition (Union 76 Gas Station), overcrossing construction, freeway on-ramp and off-ramp changes, pedestrian and bicycle facilities, ramp metering system installation, retaining wall and concrete barrier installation, utility work, drainage system work, and creek crossings. Work will require temporary diversion of Easton Creek during installation of a 42-foot six foot by six foot double box culvert extension. Additionally, 74 cubic yards of sediment will be removed from the East Creek box culvert. Ground water dewatering may be required throughout the project site.

In total work will result in the permanent placement of fill in 0.850 acre of Waters of the U.S. (0.648 acre of wetland and 0.202acre of other waters of the U.S.) and temporary placement of fill in 0.170 acre of waters of the U.S. (0.177 acre of wetland and 0.053 acre of other waters of the U.S.). All work shall be completed in accordance with the plans and drawings titled "*USACE File #2013-00334S, San Mateo U.S. 101 / Broadway Interchange Reconstruction Project, October 18, 2013, Figures 1 to 11*" provided as enclosure 1. Discharge of fill material for project implementation is depicted in drawings titled, "*USACE File #2013-00334S, San Mateo U.S. 101 / Broadway Interchange Reconstruction Project, October 18, 2013, Figures 1 to 6*" provided as enclosure 2.

PROJECT LOCATION: The project is located between post miles 16.3 to 17.1 along U.S. 101 at the Broadway interchange in the City of Burlingame, San Mateo County, California.

PERMIT CONDITIONS:

GENERAL CONDITIONS:

1. The time limit for completing the work authorized ends on December 1, 2018. If you find that you need more time to complete the authorized activity, submit your request for a time extension to this office for consideration at least one month before the above date is reached.

2. You must maintain the activity authorized by this permit in good condition and in conformance with the terms and conditions of this permit. You are not relieved of this requirement if you abandon the permitted activity, although you may make a good faith transfer to a third party in compliance with General Condition 4 below. Should you wish to cease to maintain the authorized activity or should you desire to abandon it without a good faith transfer, you must obtain a modification of this permit from this office, which may require restoration of the area.

3. If you discover any previously unknown historic or archeological remains while accomplishing the activity authorized by this permit, you must immediately notify this office of what you have found. We will initiate the Federal and State coordination required to determine if the remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

4. If you sell the property associated with this permit, you must obtain the signature of the new owner in the space provided and forward a copy of the permit to this office to validate the transfer of this authorization.

5. A conditioned water quality certification has been issued for your project you must comply with the conditions specified in the certification as special conditions to this permit. For your convenience, a copy of the certification is attached if it contains such conditions (enclosure 3).

6. You must allow representatives from this office to inspect the authorized activity at any time deemed necessary to ensure that it is being or has been accomplished in accordance with the terms and conditions of your permit.

7. You understand and agree that, if future operations by the United States require the removal, relocation or other alteration of the structure or work authorized herein, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, you will be required, upon due notice from the Corps of Engineers, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the United States. No claim shall be made against the United States on account of any such removal or alteration.

SPECIAL CONDITIONS:

1. You shall purchase and submit confirmation of the purchase of credits equivalent to at least 0.65 acre of tidal wetland and 0.20 acre of other waters of the U.S. from an approved wetland creation mitigation bank. The project site must occur within the Service area of the mitigation bank. Confirmation of the purchase of credits shall be provided prior to the initiation of impact (temporary or permanent) to a jurisdictional feature. The purchase of credits shall satisfy the mitigation requirement for fill of 0.850 acre of waters of the U.S. which will be filled by this project.

2. The Permittee retains ultimate legal responsibility for meeting the mitigation requirements and compliance with all terms and conditions of this permit.

3. Within 1-year of initiation of temporary impact to a jurisdictional feature, you shall re-contour the temporarily impacted area (0.117 acre of wetland and 0.170 acre of other waters of the U.S.) and replant, as appropriate, with soil-stabilizing native species. You shall monitor each re-vegetated area for 5 years. At the end of the fifth year, re-vegetated areas shall provide 75% absolute vegetative cover. In re-vegetated wetlands, the number of dominant species must be greater than 51% absolute cover (having a facultative (FAC) or wetter indicator status). You shall submit a monitoring report for the re-vegetated areas at the end of years 1, 3, and 5. The reports shall include representative photos of the re-vegetated areas. If the cover requirements for the re-vegetated areas are not met, the Corps may require further monitoring, re-vegetation, and/or off-site mitigation.

4. This Corps permit does not authorize you to 'take' a federally listed species. In order to legally 'take' a listed species, you must have a separate authorization under the Endangered Species Act (ESA) (e.g., an ESA Section 10 permit or a Biological Opinion (BO) under ESA Section 7 with "incidental take" provisions with which you must comply). The enclosed U.S. Fish and Wildlife Service (USFWS) BO titled "*Biological Opinion on the*

Effects of the United States Highway 101/Broadway Interchange Reconstruction Project in the City of Burlingame, San Mateo County, California (Caltrans EA 235840)" dated March 9, 2011 (enclosure 4) contains mandatory terms and conditions to implement the reasonable and prudent measures that are associated with "incidental take" that are also specified in the BOs. Your authorization under this Corps permit is conditional upon your compliance with all of the mandatory terms and conditions associated with incidental take authorized by the attached BOs, whose terms and conditions are incorporated by reference in this permit. Failure to comply with the terms and conditions associated with incidental take of the BOs, where a 'take' of the listed species occurs, would constitute an unauthorized take and it would also constitute non-compliance with this Corps permit. The USFWS is the appropriate authorities to determine compliance with the terms and conditions of their BOs and with the ESA.

5. The NMFS concurred with the determination that the project was not likely to adversely affect North American green sturgeon (*Acipenser medirostris*). This concurrence was premised, in part, on project work restrictions outlined in the December 7, 2010, letter from NMFS provided as enclosure 5. These work restrictions are incorporated to ensure unauthorized incidental take of species and loss of critical habitat does not occur.

6. Work in drainages and wetlands are restricted to the dry season (April 15 to October 15). To the extent possible, vegetation removal will be limited to between September 1 and January 31 to minimize adverse effects to migratory birds.

7. You shall employ sediment and erosion control best management practices as needed throughout the project area. No objects or fill shall be placed where they can be eroded or washed into drainage systems in the project area. All debris generated as a result of the project, shall be removed from the site and disposed of at an approved location outside of Corps jurisdiction. All project staging and equipment storage areas shall be located away from areas subject to the jurisdiction of the Corps. After construction, any materials used to dewater areas within the creeks shall be removed in their entirety.

8. While temporary creek diversions are in place, appropriate measures must be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable.

9. Temporary fills must consist of materials, and be placed in a manner, that will not be eroded by expected high flows.

10. Temporary fills must be removed at the end of each construction season in their entirety. The affected area must be returned to pre-construction elevations post-construction.

FURTHER INFORMATION:

1. Congressional Authorities: You have been authorized to undertake the activity described above pursuant to:

(x) Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. Section 403).
(x) Section 404 of the Clean Water Act (33 U.S.C. Section 1344).
( ) Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (33 U.S.C. Section 1413).

2. Limits of this authorization:

a. This permit does not obviate the need to obtain other Federal, State, or local authorizations required by law.

b. This permit does not grant any property rights or exclusive privileges.

c. This permit does not authorize any injury to the property or rights of others.

d. This permit does not authorize interference with any existing or proposed Federal project.

3. Limits of Federal Liability: In issuing this permit, the Federal Government does not assume any liability for the following:

   a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes.

   b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the United States in the public interest.

   c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit.

   d. Design or construction deficiencies associated with the permitted work.

   e. Damage claims associated with any future modification, suspension, or revocation of this permit.

4. Reliance on Applicant's Data: The determination of this office that issuance of this permit is not contrary to the public interest was made in reliance on the information you provided.

5. Reevaluation of Permit Decision: This office may reevaluate its decision on this permit at any time the circumstances warrant. Circumstances that could require a reevaluation include, but are not limited to, the following:

   a. You fail to comply with the terms and conditions of this permit.

   b. The information provided by you in support of your permit application proves to have been false, incomplete, or inaccurate. (See Item 4 above.)

   c. Significant new information surfaces which this office did not consider in reaching the original public interest decision.

Such a reevaluation may result in a determination that it is appropriate to use the suspension, modification, and revocation procedures contained in 33 C.F.R. Section 325.7 or enforcement procedures such as those contained in 33 C.F.R. Sections 326.4 and 326.5. The referenced enforcement procedures provide for the issuance of an administrative order requiring you to comply with the terms and conditions of your permit and for the initiation of legal action where appropriate. You will be required to pay for any corrective measures ordered by this office, and if you fail to comply with such directive, this office may in certain situations (such as those specified in 33 C.F.R. Section 209.170) accomplish the corrective measures by contract or otherwise and bill you for the cost.

6. Extensions: General Condition 1 establishes a time limit for the completion of the activity authorized by this permit. Unless there are circumstances requiring either a prompt completion of the authorized activity or a reevaluation of the public interest decision, the Corps will normally give favorable consideration to a request for an extension of this time limit.

Your signature below, as permittee, indicates that you accept and agree to comply with the terms and conditions of this permit.

Frances Malaund Rosa 10/24/2013

(PERMITTEE) (DATE)

This permit becomes effective when the Federal official, designated to act for the Secretary of the Army, has signed below.

Jane M. Hicks 10/24/13

(DATE)

for John K. Baker, P.E.
Lieutenant Colonel, US Army
District Engineer

When the structures or work authorized by this permit are still in existence at the time the property is transferred, the terms and conditions of this permit will continue to be binding on the new owner(s) of the property. To validate the transfer of this permit and the associated liabilities associated with compliance with its terms and conditions, have the transferee sign and date below.

(TRANSFEREE) (DATE)

October 21, 2013
CIWQS Place No. 757450

Sent via electronic mail--no hard copy to follow

California Department of Transportation
Attn: Al B. Lee
Al.B.Lee@dot.ca.gov
111 Grand Ave.
Oakland, CA 94612-3717

Subject: Water Quality Certification for the US 101/Broadway Interchange Reconstruction Project, City of Burlingame, San Mateo County

Department Project No.: EA 04-23584

Dear Mr. Lee:

We have reviewed and hereby issue water quality certification (Certification) to the California Department of Transportation (Department) for the U.S. 101/Broadway Interchange Reconstruction Project (Project). The Department is seeking an Individual Permit from the U.S. Army Corps of Engineers pursuant to Section 404 of the Clean Water Act (33 U.S.C. § 1344). As such, the Department has applied to the San Francisco Bay Regional Water Quality Control Board (Water Board) for a Clean Water Act Section 401 water quality certification that the Project will not violate State water quality standards.

Project: The Department proposes to reconstruct the U.S. 101/Broadway interchange. The Project will replace the Broadway overcrossing with a wider structure, reconfigure all ramp connections to U.S. 101, and install ramp meters on northbound and southbound on-ramps. The Project will construct a realigned seven-lane Broadway overcrossing approximately 100 feet to the north of the existing four-lane structure. Broadway will be realigned to extend straight across U.S. 101 from the Broadway/Rollins Road intersection on the west to Bayshore Highway on the east.

The proposed project elements include:

- Temporary diversion of Easton Creek to allow for the extension of the six foot by six foot double box culvert by 42 feet to accommodate the construction of the new northbound U.S. 101 on-ramp,
- Removal of approximately 74 cubic yards of sediment from the Easton Creek box culvert,

- Groundwater dewatering,
- Cement Deep Soil Mixing (CDSM) to reduce the magnitude of long-term settlement,
- Building demolition,
- Replacement of the existing Broadway overcrossing which would include pile driving and new abutments,
- Freeway on-ramp and off-ramp replacement and construction which would include construction of Mechanically Stabilized Earth walls,
- Installation of ramp metering systems,
- Addition of pedestrian facilities to the new Broadway overcrossing and bicycle lanes on Airport Boulevard, Bayshore Highway, and Broadway,
- Retaining wall construction,
- Concrete safety barrier construction on the east side of U.S. 101, and
- Utility relocations.

Impacts: Project implementation would permanently impact approximately 0.850 acre of tidal and estuarine wetlands and 982 linear feet of jurisdictional waters. Permanent impacts to wetlands and jurisdictional waters would occur due to construction of the Broadway overcrossing, extension of the Easton Creek culvert, construction of U.S. 101 ramps, construction of retaining walls, and installation of drainage features.

Project implementation would temporarily impact approximately 0.170 acre of wetlands and 446 linear feet of jurisdictional waters. Temporary impacts would occur due to temporary diversion of Easton Creek, alteration of an unnamed drainage channel, and ditch regrading.

See Impact Summary Table and Impact Maps in the Attachment for locations of permanent and temporary impacts.

Roadway Pollutant Impacts: Project implementation would result in approximately 1.67 acres of new and 6.02 acres of reworked impervious area. Stormwater runoff from impervious areas may contain hydrocarbons, metals, volatile organic compounds, trash, and sediment at levels that may significantly impact waters of the State if left untreated.

Hydromodification Impacts: Added impervious areas may result in alterations to existing hydrologic regimes, resulting in erosion and/or changes of sediment transport in receiving waters (hydromodification). Because stormwater runoff from the project area discharges to Easton Creek and Sanchez Creek, which are tidally influenced, hydromodification mitigation is not required for this Project.

Avoidance and Minimization: The Department has avoided and minimized impacts to wetlands and jurisdictional waters by: constructing biofiltration swales to treat stormwater runoff prior to discharge to surface waters; selecting a project alternative with fewer impacts to wetlands and jurisdictional waters; adjusting the project limits to avoid

construction in the vicinity of Mills Creek; adjusting the project limits to minimize the project footprint at Burlingame Lagoon along the northbound shoulder of U.S. 101.

Mitigation: To mitigate for permanent impacts to tidal and estuarine wetlands the Department shall purchase 0.85 acres of credits at the San Francisco Bay Wetland Mitigation Bank in Redwood City (see Condition no. 2).

To mitigate for temporary impacts to wetlands and jurisdictional waters, the Department shall restore temporarily impacted areas to previous or enhanced condition (see Condition no. 3).

Roadway Pollutant Mitigation: As mitigation for increased pollutant loads associated with 7.69 acres of added and reworked impervious area for this Project, the Department shall construct 8 biofiltration swales to treat 10.35 acres of impervious area. The biofiltration swales shall be constructed as shown in the plans, details, and Bioswale Summary Table in the Attachment (see Condition no. 1).

CEQA Compliance: The Department evaluated the Project pursuant to the requirements of the California Environmental Quality Act (CEQA) in a Negative Declaration. The Department filed a Notice of Determination on October 26, 2011 (SCH No. 2010082077).

EcoAtlas: It has been determined through regional, state, and national studies that tracking of mitigation/restoration projects must be improved to better assess the performance of these projects, following monitoring periods that last several years. In addition, to effectively carry out the State's Wetlands Conservation Policy of no net loss to wetlands, the State needs to closely track both wetland losses and mitigation/restoration project success. Therefore, we require that the applicant use the California Wetlands Form to provide Project information related to impacts and mitigation/restoration measures (see Condition No. 2 of this Certification). An electronic copy of the form and instructions can be downloaded at: http://www.waterboards.ca.gov/sanfranciscobay/certs.shtml. Project information concerning impacts and mitigation/restoration will be made available at the web link: http://ecoatlas.org.

Certification: I hereby issue an order certifying that any discharge from the referenced Project will comply with the applicable provisions of sections 301 (Effluent Limitations), 302 (Water Quality Related Effluent Limitations), 303 (Water Quality Standards and Implementation Plans), 306 (National Standards of Performance), and 307 (Toxic and Pretreatment Effluent Standards) of the Clean Water Act, and with other applicable requirements of State law. This discharge is also regulated under State Water Resources Control Board Order No. 2003 - 0017 – DWQ, "General Waste Discharge Requirements for Dredge and Fill Discharges That Have Received State Water Quality Certification" which requires compliance with all conditions of this Certification. The following conditions are associated with this Certification:

1. As mitigation for increased pollutant loads associated with impervious surface added and reworked with the Project, the Department shall provide treatment of stormwater runoff from no less than 10.35 acres of impervious area using biofiltration swales. The biofiltration swales shall be installed concurrent with the project and consistent with the plans and details in the Attachment of this Certification. Any revisions to the biofiltration swale design details shall be subject to the acceptance of Water Board staff.

2. As mitigation for permanent impacts to wetlands and jurisdictional waters, the Department shall purchase 0.850 wetland mitigation credits from the San Francisco Bay Wetland Mitigation Bank in Redwood City, San Mateo County.

3. The Department shall restore all jurisdictional wetlands and waters to their pre-project or improved conditions, within the first growing season following cessation of construction activity in those areas. All temporarily disturbed areas shall be re-vegetated using only native plant species. The Department shall not cause, through operation of heavy machinery, or any other construction activity, compaction of wetlands or waters. Any compaction of wetlands or waters shall require mitigation.

4. The Resident Engineer (or appropriately authorized agent) shall hold onsite water quality permit compliance meetings (similar to tailgate safety meetings) to discuss permit compliance, including instructions on violation avoidance and violation reporting procedures. The meetings shall be held at least every other week, before forecasted storm events, and when a new contractor or subcontractor arrives to begin work at the site. The contractors, subcontractors and their employees, as well as any inspectors or monitors assigned to the Project, shall be present at the meetings. The Department shall maintain dated sign-in sheets for attendees at these meetings, and shall make them available to the Water Board on request;

5. The Department is required to use the standard California Wetlands Form to provide Project information describing impacts and restoration measures within 14 days from the date of this certification. An electronic copy of the form can be downloaded at: http://www.waterboards.ca.gov/sanfranciscobay/certs.shtml. The completed form shall be submitted electronically to habitatdata@waterboards.ca.gov or shall be submitted as a hard copy to both (1) the Water Board (see the address on the letterhead), to the attention of EcoAtlas and (2) the San Francisco Estuary Institute, 4911 Central Avenue, Richmond, CA 94804, to the attention of EcoAtlas;

6. The Project shall be constructed in conformance with the Project Description described in this Certification and certification application materials. Any change in the Project that could impact State waters may require compensatory mitigation and shall first be reported to and found acceptable by the Water Board Executive Officer;

7. Concrete shall be excluded from surface water for a period of 30 days after it is poured/sprayed. During that time the concrete shall be kept moist and runoff from the concrete shall not be allowed to enter State waters. Commercial sealants may be applied to the concrete surface in instances where 30 days of water exclusion is infeasible. If sealant is used, water shall be excluded from the site until the sealant is cured. If groundwater comes into contact with fresh concrete, it shall be prevented from flowing towards surface water;

8. If, at any time, an unauthorized discharge to surface water (including wetlands, rivers or streams) occurs, or any other water quality problem arises, the associated Project activities shall immediately cease until adequate BMPs are implemented. The Water Board shall be notified promptly within 24 hours after the unauthorized discharge or water quality problem arises;

9. The Department shall adhere to the conditions imposed by the Individual Permit issued to the Department by the U.S. Army Corps of Engineers, the Streambed Alteration Agreement issued to the Department by the California Department of Fish and Wildlife, and the Biological Opinion issued to the Department by the USFWS;

10. All activities and best management practices (BMPs) shall be implemented according to the submitted application materials and the findings and conditions of this Certification. BMPs for erosion, sediment, turbidity and pollutant control shall be implemented and in place at commencement of, during, and after any ground clearing activities, construction activities, or any other Project activities that could result in erosion, sediment, or other pollutant discharges to waters of the State. The BMPs shall be implemented in accordance with the Caltrans Construction Site Best Management Practice Manual (CCSBMPM) and all contractors and subcontractors shall comply with the CCSBMPM. BMPs for erosion and sediment control shall be utilized throughout all phases of construction, regardless of date, wherever sediment-laden runoff threatens to enter waters of the State. The Department shall stage erosion and sediment control materials at the work site. All BMPs shall be installed properly and in accordance with the manufacturer's specifications. If the Project Resident Engineer elects to install alternative BMPs for use on the project, the Department shall submit a proposal to Water Board staff for review and concurrence;

11. The Department shall not use or allow the use of erosion control products that contain synthetic materials within waters of the State at any time. The Department shall request approval from Water Board staff if an exception from this requirement is needed at a specific location. In upland and riparian areas, the Department shall prioritize the use of wildlife-friendly biodegradable (not photo-degradable) erosion control products. The Department shall not use or allow the use of erosion control products that contain synthetic netting for permanent erosion control (i.e. erosion

control materials to be left in place for two years or after the completion date of the Project).

If the Department finds that erosion control netting or products have entrapped or harmed wildlife, personnel shall remove the netting or product and replace it with wildlife-friendly biodegradable products;

12. Fueling, lubrication, maintenance, storage and staging of vehicles and equipment shall be prohibited within waters of the State. Fueling of individual equipment types within waters of the State may be authorized if the Department first prepares a fueling plan that:
    a. Identifies the specific piece of machinery that may require fueling within waters of the State;
    b. Provides justification for the need to refuel within State waters. The justification shall describe why fueling outside of jurisdictional waters is infeasible; and
    c. Includes a narrative of specific BMPs that shall be employed to prevent and capture fuel releases.

    Fueling of equipment within waters of the State shall be prohibited until the above mentioned plan has been approved by Water Board staff. The fueling plan may be submitted individually, included in the project Storm Water Pollution Prevention Plan (SWPPP), or submitted as a SWPPP amendment.

13. Fueling, lubrication, maintenance, storage and staging of vehicles and equipment shall not result in a discharge or a threatened discharge to any waters of the State. At no time shall the Department use any vehicle or equipment which leaks any substance that may impact water quality;

14. Except as expressly allowed in this Certification, the Department is prohibited from discharging waste to waters of the State. No debris, soil, silt, sand, bark, slash, sawdust, rubbish, cement or concrete or concrete washings, welding slag, oil or petroleum products, or other organic or earthen material from any construction or associated activity of whatever nature, other than that authorized by this Certification, shall be allowed to enter into waters of the State. Except for temporary stockpiling of waste generated during demolition operations (“temporary” in this instance means generated and removed during the same working day), waste materials shall not be placed where the materials may be washed by rainfall into waters of the State;

15. The Department shall provide analysis and verification that placement of non-hazardous waste or inert materials (which may include discarded product or recycled materials) will not result in degradation of water quality, human health, or the environment. All Project-generated waste shall be handled, transported, and

disposed in strict compliance with all applicable State and Federal laws and regulations. When construction is complete, any excess material or debris shall be removed from the work area and disposed of properly and in accordance with the State and Federal laws and regulations, the Department is liable and responsible for the proper disposal of waste generated by their Project;

16. All imported fill material shall be clean and free of pollutants. All fill material shall be imported from a source that has the appropriate environmental clearances and permits. The reuse of low-level contaminated solids as fill onsite shall be performed in accordance with all State and Federal policies and established guidelines; a plan for such re-use must first be submitted to Water Board staff for review and concurrence;

17. Work in flowing or standing surface waters is prohibited;

18. Caltrans shall submit, subject to the acceptance of Water Board staff, a dewatering and/or diversion plan that appropriately describes the dewatered or diverted areas and how those areas will be handled during construction. The diversion/dewatering plans shall be submitted no later than 30 days prior to conducting the proposed activity. Diversion/dewatering activities shall be prohibited until Water Board staff has accepted the dewatering/diversion plan for that specific water. Information submitted shall include the area or work to be diverted or dewatered and method of the proposed activity. All diversion or dewatering activities shall be designed to minimize the impact to waters of the State, avoid fish entrainment, and maintain natural flows upstream and downstream. All dewatering or diversion structures shall be installed in a manner that does not cause sedimentation, siltation or erosion upstream or downstream. All dewatering or diversion structures shall be removed immediately upon completion of Project activities;

19. This Certification does not allow for the take, or incidental take, of any special status species. The Department shall use the appropriate protocols, as approved by the California Department of Fish and Wildlife and the USFWS, to ensure that Project activities do not impact the Beneficial Use of the Preservation of Rare and Endangered Species, as described in the San Francisco Bay Regional Water Quality Control Plan;

20. The Department shall maintain a copy of this Certification at the Project site to be available at all times to Project personnel. It is the responsibility of the Department to assure that all personnel (employees, contractors, and subcontractors) are adequately informed and trained regarding the conditions of this Certification;

21. The Water Board may add to or modify the conditions of this Certification, as appropriate, to implement any new or revised water quality standards and implementation plans adopted or approved pursuant to the Porter-Cologne Water Quality Control Act or section 303 of the Clean Water Act;

22. This Certification action is subject to modification or revocation upon administrative or judicial review, including review and amendment pursuant to Section 13330 of the California Water Code and Title 23 of the California Code of Regulations, Section 3867;

23. This Certification action is not intended and shall not be construed to apply to any discharge from any activity involving a hydroelectric facility requiring a Federal Energy Regulatory Commission (FERC) license or an amendment to a FERC license, unless the pertinent certification application was filed pursuant to California Code of Regulations Title 23, Subsection 3855(b) and that application specifically identified that a FERC license or amendment to a FERC license for a hydroelectric facility was being sought; and

24. This Certification is conditioned upon total payment of the full fee required in State regulations (23 CCR Section 3833). The Water Board has received the full fee for this Certification.

We anticipate your cooperation in implementing these conditions. However, please be advised that any violation of water quality certification conditions is a violation of State law and subject to administrative civil liability pursuant to California Water Code, Section 13350. Failure to respond, inadequate response, late response, or failure to meet any condition of this Certification may subject you to civil liability imposed by the Water Board to a maximum of $5,000 per day per violation or $10 for each gallon of waste discharged in violation of this Certification.

This Certification includes requirements for information and reports. Any requirement for a report made as a condition to this action is a formal requirement pursuant to CWC section 13267, and failure or refusal to provide, or falsification of such required report is subject to civil liability as described in California Water Code, Section 13268.

If you have any question, please contact Derek Beauduy at (510) 622-2348, or via e-mail to derek.beauduy@waterboards.ca.gov.

Sincerely,

Bruce H. Wolfe
Executive Officer

Attachment

cc (via e-mail):

Mr. Bill Orme SWRCB-DWQ
Mr. Cameron Johnson, USACE
Ms. Jane Hicks, Regulatory Branch, USACE
Ms. Melissa Escaron, CDFW
Ms. Paula Gill, USACE
Mr. Dale Bowyer, Water Board
Mr. Cyrus Vafai, Caltrans
Mr. Hardeep Takhar, Caltrans
Mr. Jason Brush, USEPA
Mr. Ryan Olah, USFWS

N

0 1 2 MILES

USGS 30x60-minute topographic quadrangle, San Francisco and Palo Alto, CA

US 101/BROADWAY INTERCHANGE RECONSTRUCTION PROJECT

BURLINGAME, CA
EA 235841

URS PROJECT NO. 28645286

Figure 1
PROJECT VICINITY

May, 2012

URS Corp - Oakland CA - L:\Projects\VTA_US101_Express\US-101_Broadway_Interchange\Maps\401_Permit_Applications\Figure_1_Project_vicinity.mxd

Permanent and Temporary Impact Table

Feature ID (as provided in application materials)	Feature Type	Reason for Impact	Acreage and/or Linear Footage of Permanent Impact	Acreage and/or Linear Footage of Temporary Impact
WWUS 3c	Estuarine marsh north of Easton Creek	Construction of northbound U.S 101 on-ramp and drainage features	0.130 acre	0.015 acre
WUS 3b	Easton Creek	Culvert extension	46 linear feet; 0.018 acre	6 linear feet; <0.001 acre
WWUS 5	Estuarine marsh south of Easton Creek	Construction of northbound U.S. 101 on-ramp and drainage features	0.088 acre	
WWUS 6	Seasonal cattail wetland ditch	Regraded ditch behind concrete barrier	0.002 acre	0.004 acre
WUS 6	Estuarine ditch	Construction of northbound U.S. 101 on-ramp and drainage features	115 linear feet; 0.020 acre	
WUS 7	Ephemeral ditch	Regraded ditch behind concrete barrier	354 linear feet; 0.014 acre	0.053 acre; 440 linear feet
WUS 10	Ephemeral ditch	Construction of northbound U.S. 101 on-ramp and northbound off-ramp and drainage features	32 linear feet; 0.001 acre	
WWUS 1	Saltwater marsh near SF Bay	Grade and contour drainage channel	0.007 acre	0.098 acre
WWUS 5a	Estuarine marsh	Construction of Broadway overcrossing roadway and embankments	0.125 acre	
WWUS 5b	Estuarine marsh	Construction of Broadway overcrossing roadway and embankments	0.197 acre	
WUS 5a	Seasonal ponding	Construction of Broadway overcrossing roadway and embankments	0.039 acre; 61 linear feet	
WUS 5b	Seasonal ponding	Construction of Broadway overcrossing roadway and embankments	0.015 acre; 92 linear feet	
WWUS 7	Estuarine wetland north of Sanchez Creek	Construction of embankment and drainage features for northbound U.S. 101 off-ramp	0.086 acre	
WWUS 7b	Estuarine wetland	Construction of embankment and drainage features for northbound U.S. 101 off-ramp	0.013 acre	
WUS 9	Seasonal ponding	Construction of Broadway overcrossing roadway and embankments	0.008 acre; 44 linear feet	
WUS 8	Seasonal ponding	Construction of embankment behind retaining wall	0.088 acre; 238 linear feet	
		Totals:	0.850 acre of permanent impact to wetlands; 982 linear feet of permanent impact to jurisdictional waters	0.170 acre of temporary impact to wetlands; 446 linear feet of temporary impact to jurisdictional waters

0 500 1,000 FEET

Imagery source: Microsoft Bing Maps, 2012

US 101/BROADWAY INTERCHANGE
RECONSTRUCTION PROJECT

BURLINGAME, CA
EA 235841

URS PROJECT NO. 28645286

Figure 2
PROPOSED PROJECT AND BIOLOGICAL STUDY AREA

May, 2012

URS Corp - Oakland CA - L:\Projects\VTA_US101_Express\US_101_Broadway_Interchange\Maps\401_Permit_Applications\Figure_2_Project_area_BSA.mxd

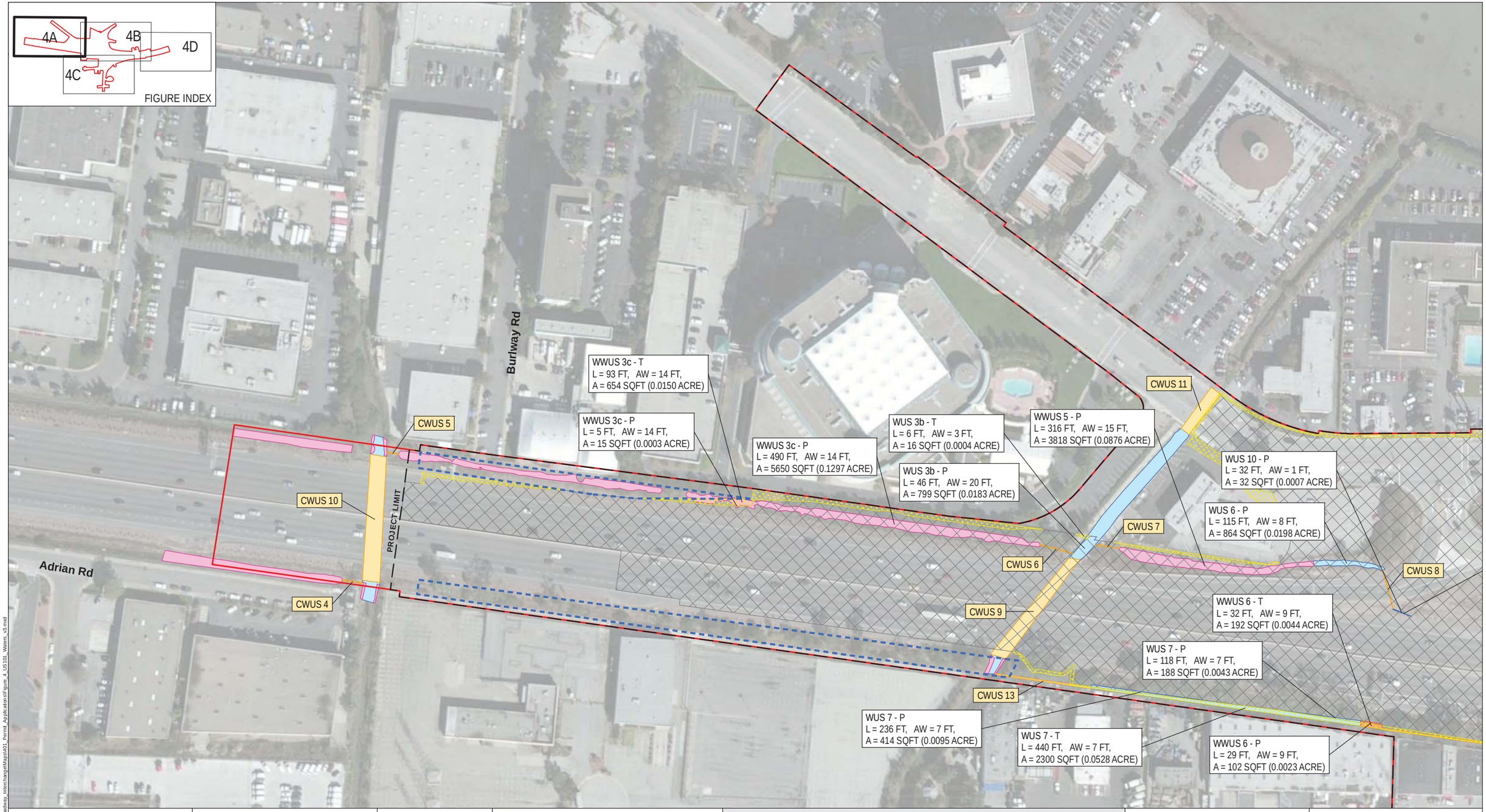

FIGURE 4A SUBTOTAL

WETLANDS IMPACTS:
PERMANENT = 9585 SQFT (0.2200 ACRE)
TEMPORARY = 846 SQFT (0.0194 ACRE)

OTHER WATERS IMPACTS:
PERMANENT = 2296 SQFT (0.0524 ACRE)
TEMPORARY = 2318 SQFT (0.0531 ACRE)

PROJECT TOTAL

WETLANDS IMPACTS:
PERMANENT = 28216 SQFT (0.6478 ACRE)
TEMPORARY = 5092 SQFT (0.1169 ACRE)

OTHER WATERS IMPACTS:
PERMANENT = 8825 SQFT (0.2023 ACRE)
TEMPORARY = 2318 SQFT (0.0531 ACRE)

LABELING NOTES:
T = TEMPORARY
P = PERMANENT
L = LENGTH
AW = AVERAGE WIDTH
A = AREA

N

0 150 300 FEET

1 INCH = 150 FEET AT 11x17-INCH PAGE SIZE

Imagery source: Microsoft Bing Maps

- WETLAND STUDY AREA
- PROJECT LIMIT
- ESA FENCING
- TEMPORARY IMPACTS (T)
- PERMANENT IMPACTS (P)
- CWUS - CULVERTED WATERS OF THE US
- OWUS - OTHER WATERS OF THE US
- WETLAND, ESTUARINE
- WETLAND, SALTMARSH
- WETLAND, SEASONAL CATTAIL

US 101/BROADWAY INTERCHANGE
RECONSTRUCTION PROJECT

BURLINGAME, CA
ESA 235841

URS PROJECT NO. 28645286

FIGURE 4A
IMPACTS TO WETLANDS AND
OTHER WATERS OF THE U.S.
IN THE STUDY AREA

NOVEMBER 2012

URS Corp - Oakland CA - I:\Projects\US-101_Broadway_Interchange\Maps\401_Permit_Application\Figure_4_US101_Waters_v3.mxd

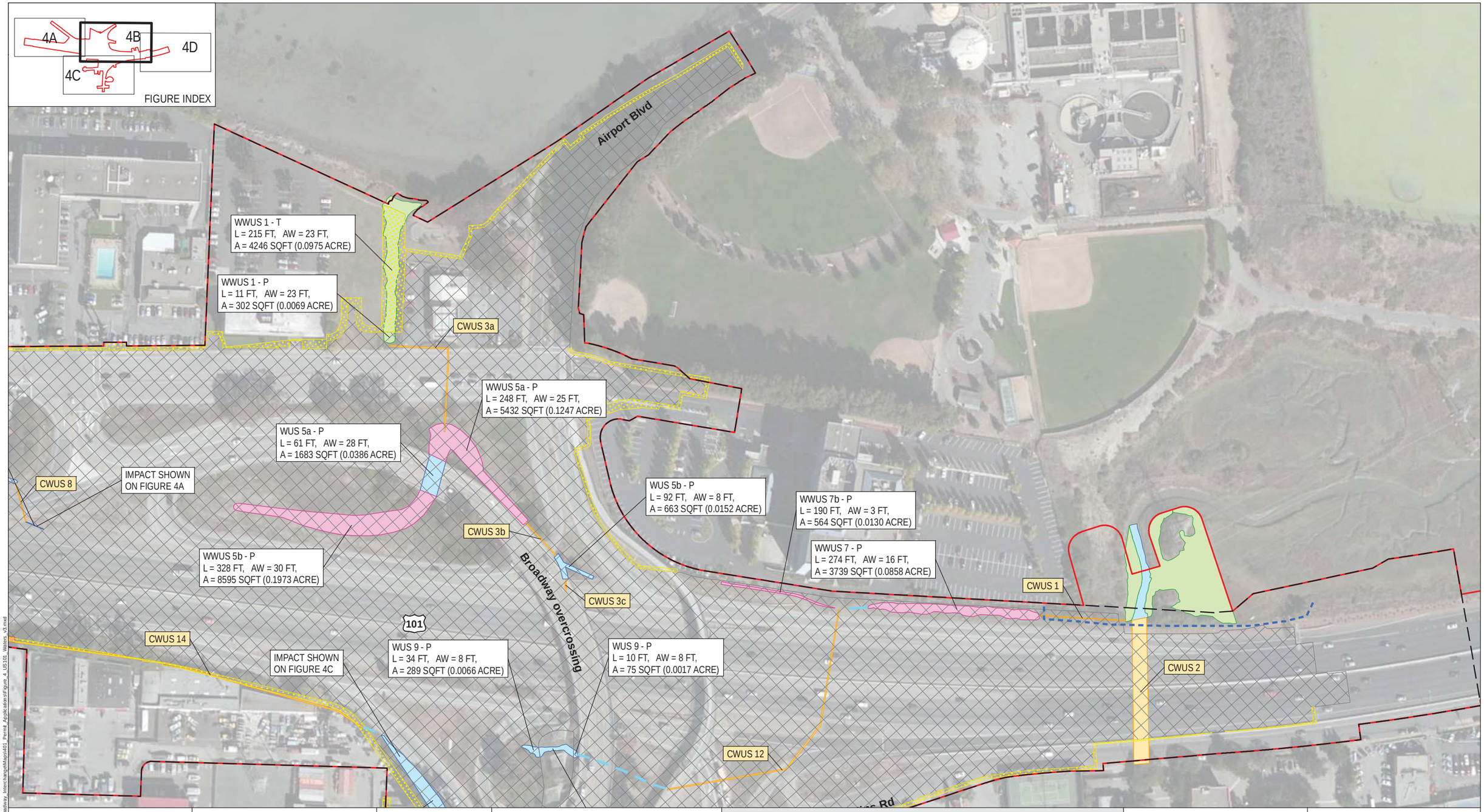

FIGURE 4B SUBTOTAL

WETLANDS IMPACTS:
PERMANENT = 18632 SQFT (0.4277 ACRE)
TEMPORARY = 4246 SQFT (0.0975 ACRE)

OTHER WATERS IMPACTS:
PERMANENT = 2710 SQFT (0.0622 ACRE)
TEMPORARY = 0 SQFT (0 ACRE)

PROJECT TOTAL

WETLANDS IMPACTS:
PERMANENT = 28216 SQFT (0.6478 ACRE)
TEMPORARY = 5092 SQFT (0.1169 ACRE)

OTHER WATERS IMPACTS:
PERMANENT = 8825 SQFT (0.2023 ACRE)
TEMPORARY = 2318 SQFT (0.0531 ACRE)

LABELING NOTES:
T = TEMPORARY
P = PERMANENT
L = LENGTH
AW = AVERAGE WIDTH
A = AREA

0 150 300 FEET

1 INCH = 150 FEET AT 11x17-INCH PAGE SIZE

Imagery source: Microsoft Bing Maps

WETLAND STUDY AREA
PROJECT LIMIT
ESA FENCING
TEMPORARY IMPACTS (T)
PERMANENT IMPACTS (P)
CWUS - CULVERTED WATERS OF THE US
OWUS - OTHER WATERS OF THE US
WETLAND, ESTUARINE
WETLAND, SALTMARSH
WETLAND, SEASONAL CATTAIL

US 101/BROADWAY INTERCHANGE
RECONSTRUCTION PROJECT

BURLINGAME, CA
ESA 235841

URS PROJECT NO. 28645286

FIGURE 4B
IMPACTS TO WETLANDS AND
OTHER WATERS OF THE U.S.
IN THE STUDY AREA

NOVEMBER 2012

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FIGURE 4C SUBTOTAL

WETLANDS IMPACTS:
PERMANENT = 0 SQFT (0 ACRE)
TEMPORARY = 0 SQFT (0 ACRE)

OTHER WATERS IMPACTS:
PERMANENT = 3820 SQFT (0.0877 ACRE)
TEMPORARY = 0 SQFT (0 ACRE)

PROJECT TOTAL

WETLANDS IMPACTS:
PERMANENT = 28216 SQFT (0.6478 ACRE)
TEMPORARY = 5092 SQFT (0.1169 ACRE)

OTHER WATERS IMPACTS:
PERMANENT = 8825 SQFT (0.2023 ACRE)
TEMPORARY = 2318 SQFT (0.0531 ACRE)

LABELING NOTES:
T = TEMPORARY
P = PERMANENT
L = LENGTH
AW = AVERAGE WIDTH
A = AREA

0 150 300 FEET

1 INCH = 150 FEET AT 11x17-INCH PAGE SIZE

Imagery source: Microsoft Bing Maps

WETLAND STUDY AREA
PROJECT LIMIT
ESA FENCING
TEMPORARY IMPACTS (T)
PERMANENT IMPACTS (P)
CWUS - CULVERTED WATERS OF THE US
OWUS - OTHER WATERS OF THE US
WETLAND, ESTUARINE
WETLAND, SALTMARSH
WETLAND, SEASONAL CATTAIL

US 101/BROADWAY INTERCHANGE
RECONSTRUCTION PROJECT

BURLINGAME, CA
ESA 235841

URS PROJECT NO. 28645286

FIGURE 4C
IMPACTS TO WETLANDS AND
OTHER WATERS OF THE U.S.
IN THE STUDY AREA

NOVEMBER 2012

URS Corp - Oakland CA - I:\Projects\US-101_Broadway_Interchange\Maps\401_Permit_Application\Figure_4_US101_Waters_v3.mxd

FIGURE 4D SUBTOTAL

WETLANDS IMPACTS:
PERMANENT = 0 SQFT (0 ACRE)
TEMPORARY = 0 SQFT (0 ACRE)

OTHER WATERS IMPACTS:
PERMANENT = 0 SQFT (0 ACRE)
TEMPORARY = 0 SQFT (0 ACRE)

PROJECT TOTAL

WETLANDS IMPACTS:
PERMANENT = 28216 SQFT (0.6478 ACRE)
TEMPORARY = 5092 SQFT (0.1169 ACRE)

OTHER WATERS IMPACTS:
PERMANENT = 8825 SQFT (0.2023 ACRE)
TEMPORARY = 2318 SQFT (0.0531 ACRE)

LABELING NOTES:
T = TEMPORARY
P = PERMANENT
L = LENGTH
AW = AVERAGE WIDTH
A = AREA

0 150 300 FEET

1 INCH = 150 FEET AT 11x17-INCH PAGE SIZE

Imagery source: Microsoft Bing Maps

- WETLAND STUDY AREA
- PROJECT LIMIT
- ESA FENCING
- TEMPORARY IMPACTS (T)
- PERMANENT IMPACTS (P)
- CWUS - CULVERTED WATERS OF THE US
- OWUS - OTHER WATERS OF THE US
- WETLAND, ESTUARINE
- WETLAND, SALTMARSH
- WETLAND, SEASONAL CATTAIL

US 101/BROADWAY INTERCHANGE
RECONSTRUCTION PROJECT

BURLINGAME, CA
ESA 235841

URS PROJECT NO. 28645286

FIGURE 4D
IMPACTS TO WETLANDS AND
OTHER WATERS OF THE U.S.
IN THE STUDY AREA

NOVEMBER 2012

URS Corp - Oakland CA - I:\Projects\US-101_Broadway_Interchange\Maps\401_Permit_Application\Figure_4_US101_Waters_v3.mxd

Bioswale Summary Table

Bioswale ID	Beginning Station (as shown in drainage plans)	Ending Station (as shown in drainage plans)	Swale Bottom Area (ft^2)	Treated Impervious Area (acre)
1	B1 Rt 206+38.48	B1 Rt 207+39.43	2,050	1.00
2	B4 Lt 407+46.21	B1 Rt 207+39.43	1,125	0.44
3	B4 Lt 410+03.92	BYSH Rt 37+17.86	5,000	2.24
4	HTL Rt 52+39.84	B4 Lt 416+26.65	4,628	0.48
5	B4 Lt 414+45.04	B4 Lt 422+87.35	7,314	0.9
6	B3 Rt 316+33.71	B3 Rt 318+80.01	5,228	4.46
7	RLN Lt 23+18.54	BWY Lt 15+16.92	1,399	0.44
8	B3 Rt 318+73.44	B3 Rt 319+34.82	695	0.39
			Total:	10.35 acres

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER 6/21/13 DATE

PLANS APPROVAL DATE

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SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
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SAN CARLOS, CA 94070-1306

NOTES:

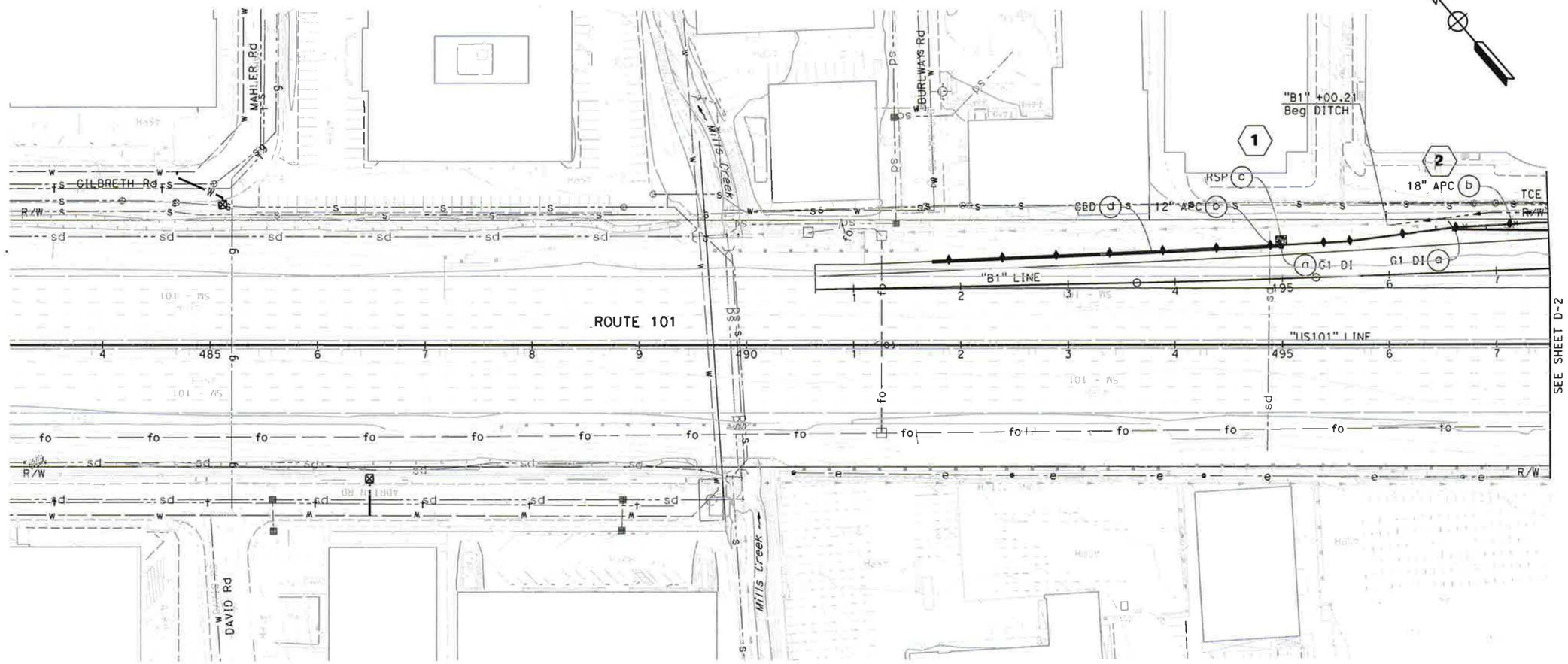
1. FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.
2. FOR GLD DETAILS, SEE STANDARD PLANS D98C.
3. STATION AND OFFSET REFERENCE LOCATIONS FOR DRAINAGE STRUCTURES ARE SHOWN ON DRAINAGE DETAIL SHEET DD-1.
4. LOCATIONS OF EXISTING DRAINAGE FACILITIES SHOWN ON THE PLANS ARE APPROXIMATE. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL FIELD VERIFY THE LOCATIONS AND FLOW LINES OF EXISTING DRAINAGE FACILITIES. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER.
5. FOR ALL DRAINAGE DITCH LOCATIONS AND ELEVATIONS, SEE DRAINAGE DETAIL PLAN.

LEGEND:

- # — DRAINAGE SYSTEM No.
- a — DRAINAGE SYSTEM UNIT
- RSP
- FLOW DIRECTION
- ——- - sd ——— EXISTING STORM DRAIN LINE
- ✕-✕-✕ sd ✕-✕-✕ EXISTING CULVERT TO BE REMOVED
- #-#-# sd #-#-# EXISTING CULVERT TO BE ABANDONED
- ——→- - - ——→ DITCH

ABBREVIATION:

GLD GRATED LINE DRAIN



DRAINAGE PLAN

SCALE: 1" = 50'

D-1

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BORDER LAST REVISED 7/2/2010

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DGN FILE => 04000006841a001.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

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04	SM	101	16.3/17.1	.	.

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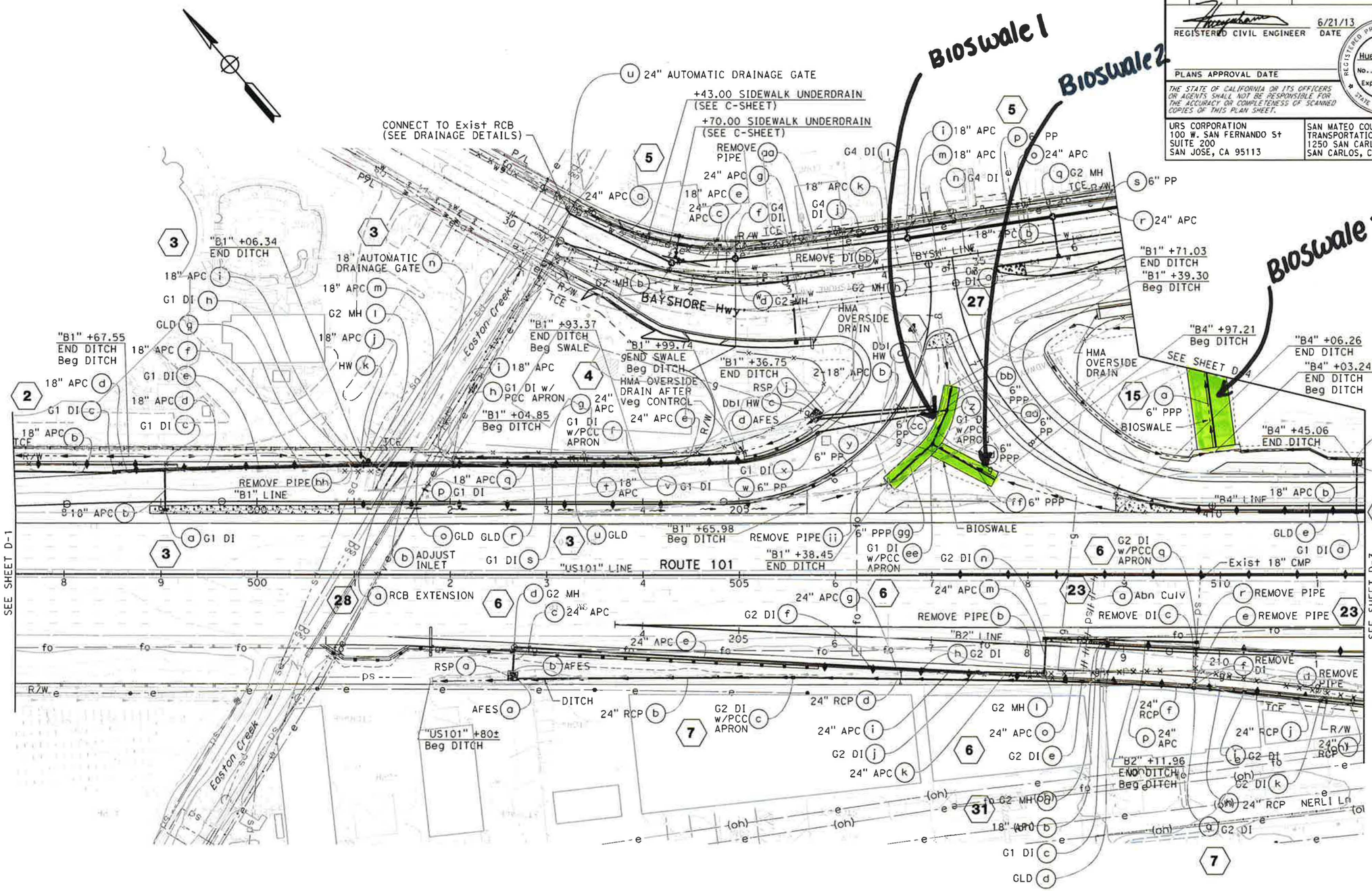

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET D-1

DRAINAGE PLAN

SCALE: 1" = 50'

D-2

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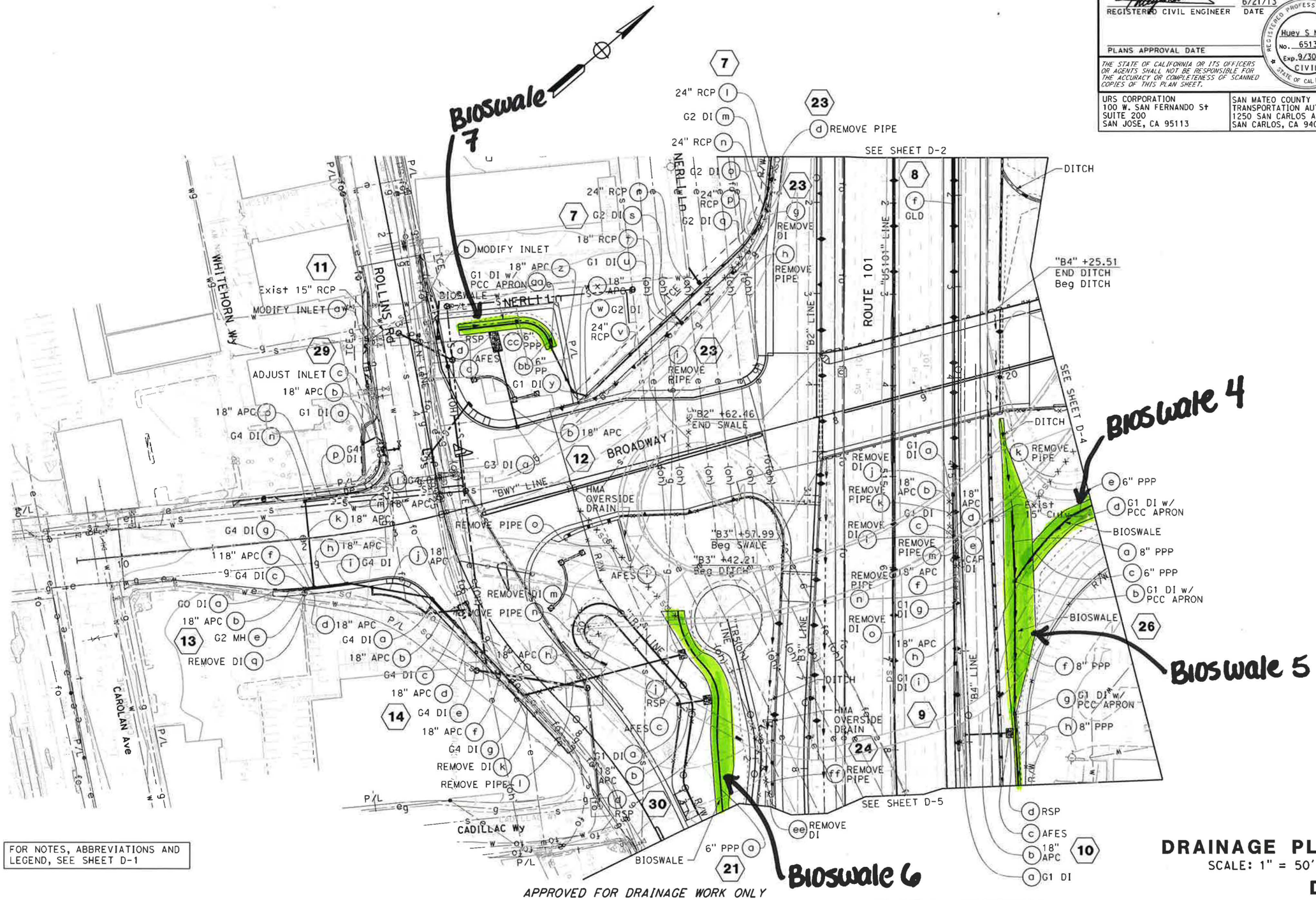

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SCALE: 1" = 50'

D-3

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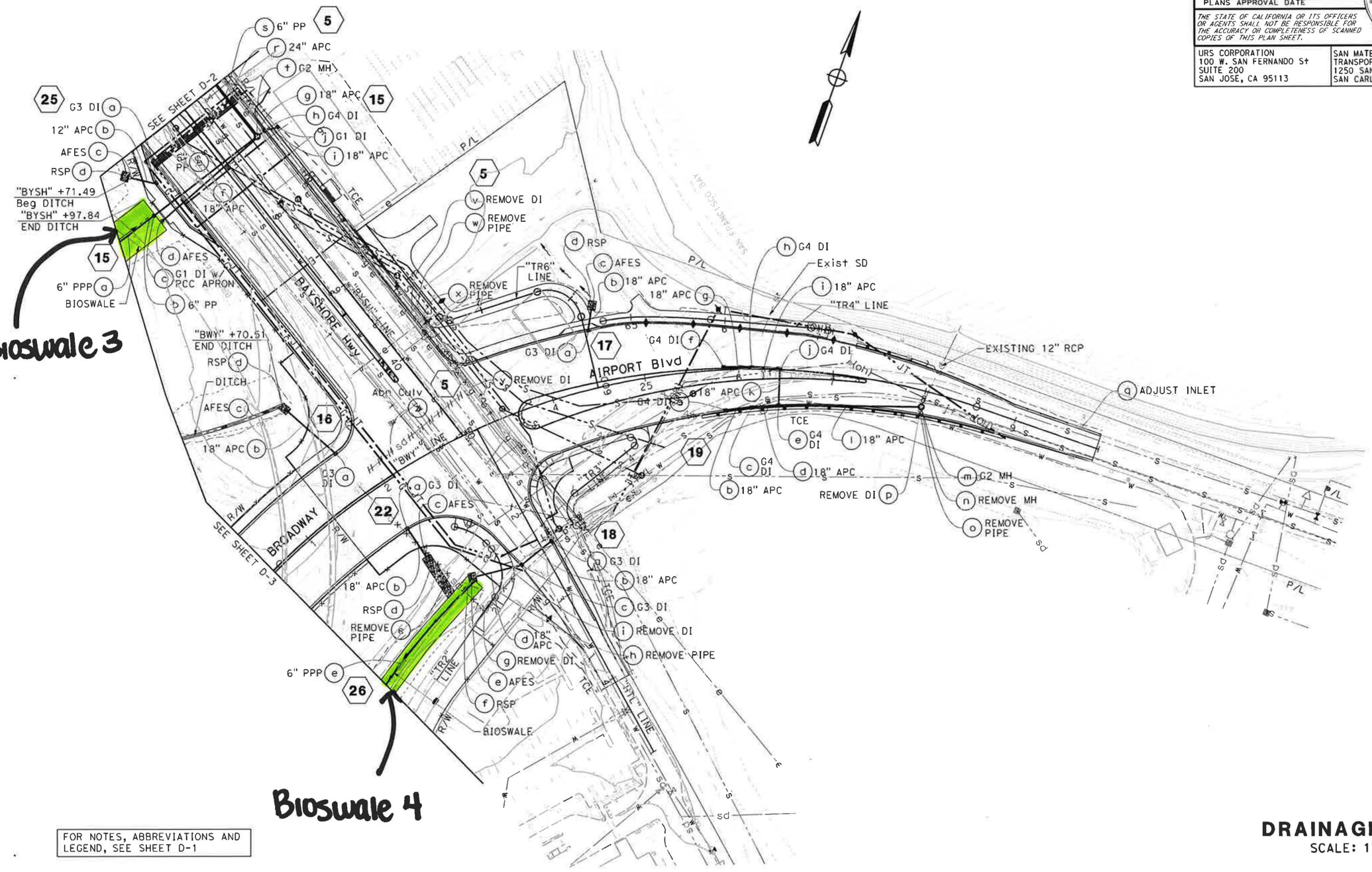

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DRAINAGE PLAN

SCALE: 1" = 50'

D-4

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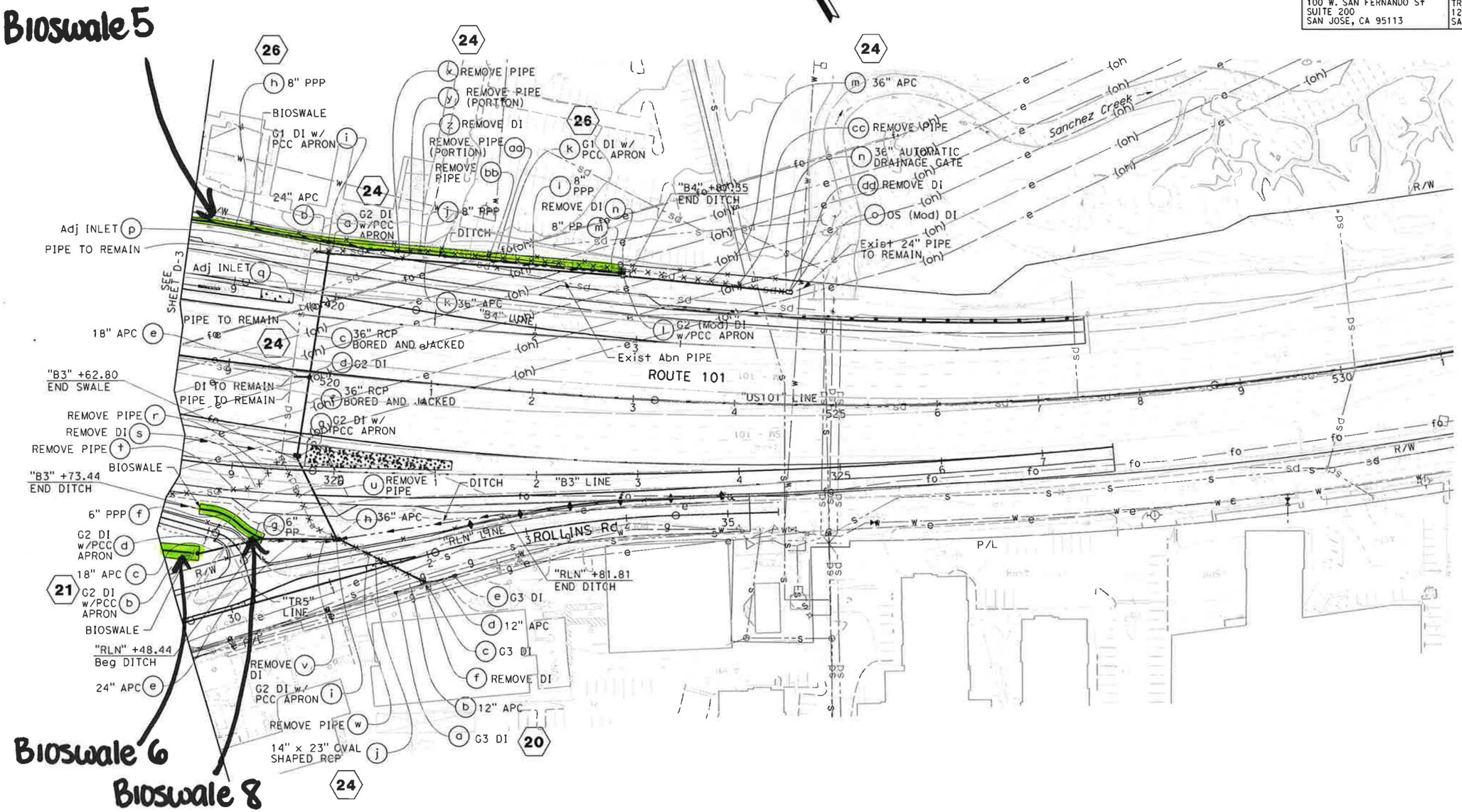

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET D-1

DRAINAGE PLAN

SCALE: 1" = 50'

D-5

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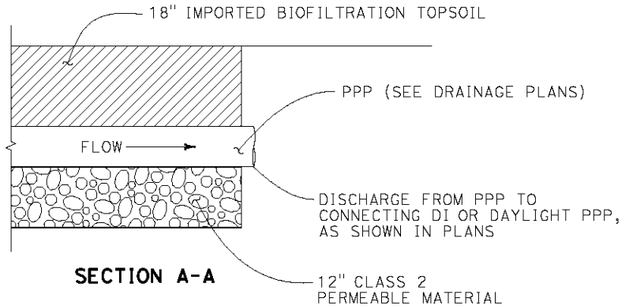

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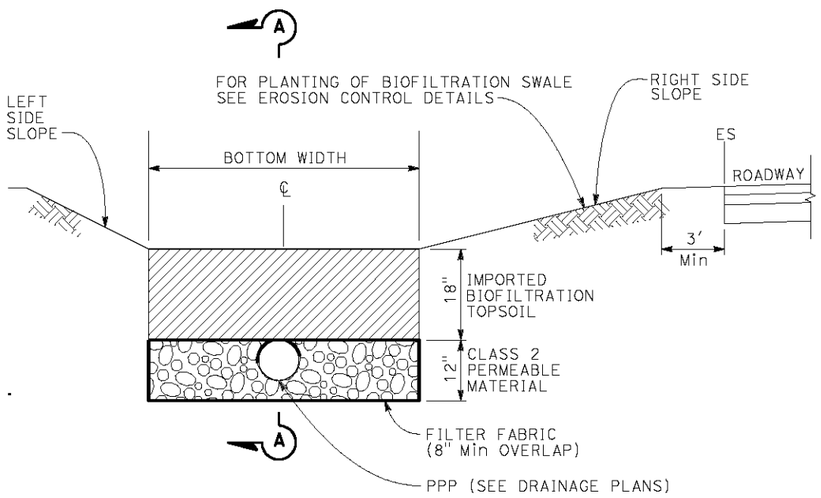
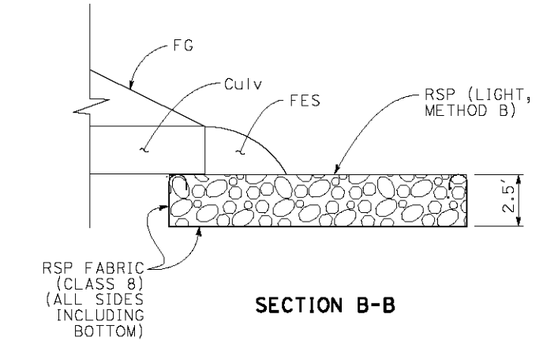


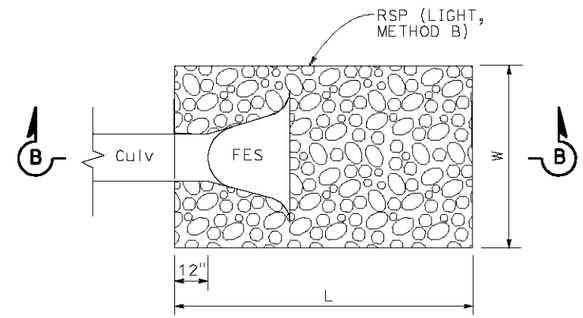
BIOFILTRATION SWALE DETAIL

RSP AT AFES

SYSTEM No.	AFES	L	W
1 (c)	NONE	10'	8'
4 (j)	HW	10'	12'
6 (a), 7 (a)	24"	10'	10'
8 (d)	18"	10'	8'
10 (d)	18"	8'	10'
12 (d)	18"	24'	10'
14 (j)	18"	8'	10'
16 (d)	18"	10'	8'
17 (d)	18"	10'	8'
18 (f)	18"	8'	10'
22 (d)	18"	10'	50'
25 (d)	12"	8'	10'
30 (d)	18"	8'	10'

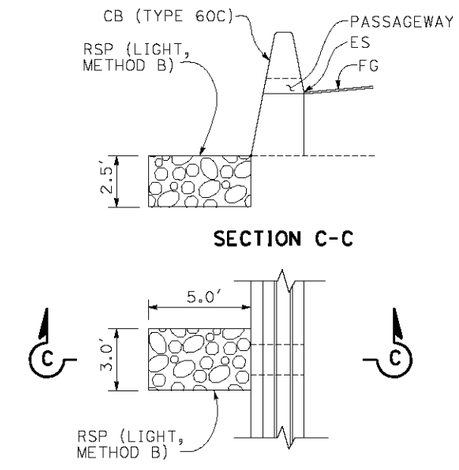


SECTION B-B



PLAN

RSP AT AFES DETAIL



SECTION C-C

PLAN

RSP AT CONCRETE BARRIER WILDLIFE PASSAGEWAY (TYPE S) DETAIL

BIOFILTRATION SWALE

DRAINAGE SYSTEM	APPROXIMATE ℄ LOCATION	LENGTH	BEGIN FLOWLINE	END FLOWLINE	LEFT SIDE SLOPE	RIGHT SIDE SLOPE	BOTTOM WIDTH	IMPORTED BIOFILTRATION TOPSOIL	CLASS 2 PERMEABLE MATERIAL (N)	PPP
		ft	ft	ft	H:V	H:V	ft	CY	CY	
3	45.64' Rt "B1" 206+38.48 TO 40.41' Rt "B1" 207+39.43	125	8.62	8.40	4:1 OR FLATTER	4:1 OR FLATTER	16	114	76	6"
3	87.37' Rt "B4" 407+46.21 TO 61.95' Rt "B4" 407+97.75	75	8.44	9.23	4:1 OR FLATTER	4:1 OR FLATTER	16	63	42	6"
7	54.83' Lt "RLN" 23+18.54 TO 146.97' Lt "BWY" 15+16.92	114	10.35	10.00	4:1 OR FLATTER	4:1 OR FLATTER	12	78	52	6"
15	60.47' Lt "B4" 410+03.92 TO 109.92' Rt "BYSH" 37+17.86	125	7.41	7.54	4:1 OR FLATTER	4:1 OR FLATTER	40	278	185	6"
21	145.27' Rt "B3" 316+33.71 TO 89.43' Rt "B3" 318+80.01	266	8.96	8.13	2:1 OR FLATTER	2:1 OR FLATTER	14 TO 24	288	192	6"
21	45.94' Rt "B3" 318+73.44 TO 69.47' Rt "B3" 319+34.82	66	11.06	10.84	4:1 OR FLATTER	2:1 OR FLATTER	10	39	26	6"
26	78.67' Rt "HTL" 52+39.84 TO 57.97' Lt "B4" 416+26.65	262	8.56	7.09	4:1 OR FLATTER	4:1 OR FLATTER	20	256	171	6"
26	47.74' Lt "B4" 414+45.04 TO 63.07' Lt "B4" 422+87.35	738	7.16	6.35	4:1 OR FLATTER	4:1 OR FLATTER	5 TO 35	575	383	8"
	TOTAL	N/A						1691	1127	N/A

(N) - NOT A SEPARATE PAY ITEM, FOR INFORMATION ONLY

LOCATION	QUANTITY
	CY
"B1" 193+17.91	1.4
"B1" 193+77.93	1.4
"B1" 194+38.10	1.4
"B1" 194+98.28	1.4
"B1" 195+58.38	1.4
"B1" 196+18.10	1.4
"B1" 196+77.93	1.4
"B1" 197+37.91	1.4
"B1" 197+97.87	1.4
"B1" 198+57.35	1.4
"B1" 198+80.11	1.4
"B1" 199+39.63	1.4
"B1" 199+99.42	1.4
"B1" 200+59.41	1.4
"B1" 201+19.47	1.4
"B1" 201+79.47	1.4
"B1" 202+39.47	1.4
"B1" 202+99.47	1.4
"B1" 203+59.47	1.4
"B1" 204+19.36	1.4
TOTAL	27.8

*SEE "SHEET DQ-37" FOR TOTAL.

DRAINAGE DETAILS

NO SCALE

DD-6

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HUEY S. NHAM — ELIE-ABI-JAOUDE

CALCULATED-DESIGNED BY — CHECKED BY

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Replace "Reserved" in section 21-1.02N with:

21-1.02N Imported Biofiltration Soil

Section 21-1.02(N) includes specifications for furnishing and placing imported biofiltration soil.

Submit a certificate of compliance for imported biofiltration soil before mixing compost with sand and topsoil, The certificate must comply with the provisions in Section 6-3.05E "Certificates of Compliance," A copy of the compost producer's compost technical data sheet. The compost technical data sheet must include:

2.1. Laboratory analytical test results

2.2. List of product ingredients

3. A copy of the compost producers Seal of Testing Assurance certification.

Imported biofiltration soil must be accompanied by a Certificate of Compliance, from the soil supplier, in conformance with the provisions in Section 6-3.05E "Certificates of Compliance," of the Standard Specifications.

Saturated hydraulic conductivity for imported biofiltration soil must be at least 5 inches per hour.

Imported biofiltration soil must be a uniform mixture of the following types of materials: Volumetric proportion of the mixture by volume must be: four-parts sand; two-parts compost; one-part topsoil.

1. Sand

Sand must be free of wood, waste, coating such as clay, stone dust, carbonate, or any other deleterious material. All aggregate passing No. 200 sieve size must be non-plastic. Sand must be graded within the following limits:

Sieve Size	Percentage Passing
3/8"	100
No. 4	90 - 100
No. 8	70 - 100
No. 16	40 - 95
No. 30	15 - 70
No. 40	5 - 55
No. 100	0 - 15
No. 200	0 - 5

Grain size analysis results of the sand component must be performed and comply with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.

2. Compost

Compost must comply with section 21-1.02M.

3. **Topsoil**

Topsoil must comply with section 21-1.02D.

Add to section 21-1:

21-1.03R Imported Biofiltration Soil

Construction of imported biofiltration soil must comply with section 21-1.03B.

Place imported biofiltration soil in lifts 8 to 12 inch lifts. Do not compact the lifts.

Payment for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in imported biofiltration soil, complete in place, including testing is included in the payment for imported biofiltration soil.

US101/BROADWAY INTERCHANGE RECONSTRUCTION PROJECT

PS&E Phase

STORM WATER INFORMATION HANDOUT

April 17, 2013

THE CITY OF BURLINGAME INCORPORATED 1908

SAN MATEO COUNTY Transportation Authority

Caltrans

WRECO

URS

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2.2 Major Engineering Features 2
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Appendices

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Appendix B Conceptual Sampling Plan
Appendix C Conceptual Water Pollution Control Plan

Disclaimer

A "Disclaimer" is required specifying that the information provided in the Storm Water Information Handout is just a guideline and is to be used for information purposes only and should not be considered a sole source document to adhere to the requirements of the new National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP), Number CAS000002, adopted on September 2, 2009. The contractor is required to provide water quality monitoring, sampling and implement best management practices (BMPs) based on standard industry operations, field conditions and conditions encountered based on the contractor's means and methods. The information in this handout is not to be construed in any way as a waiver of the provisions in the CGP. Bidders and contractors are cautioned to make independent investigations and examinations as they deem necessary to satisfy the conditions encountered in performance of work, with respect to the following: sampling and monitoring locations, distribution of watershed areas for sizing of BMPs, and selection of BMPs in order to conform to the requirement of the contract documents and the CGP.

1 OVERVIEW

1.1 Intent of this Document

The objectives of this Water Quality Information Handout are as follows:

- to summarize general water quality information of the Project;
- to summarize updated requirements per the new Construction General Permit (CGP), which became effective as of July 1, 2010;
- to aid in developing the Storm Water Pollution Prevention Plan (SWPPP) of the project;
- to highlight information necessary to file Permit Registration Documents (PRDs) to the State Water Resources Control Board via the Stormwater Multi Application Reporting and Tracking System (SMARTS)
- file the Notice of Intent (NOI) at the start of construction.

The information in this handout will guide the Resident Engineer (RE) through the process of submitting PRDs. A Storm Water Information Handout (SWIH) will be provided to the Contractor with a disclaimer that Conceptual SWPPP and cost estimate are not attached.

1.2 Summary of New Requirements

The "National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activities" (NPDES Number CAS000002), or CGP, regulates discharges from construction activities within the Project area.

The CGP is based on a risk level (RL) permitting approach. The RL is calculated by project sediment risk and receiving water risk. See the risk assessment calculations in Section 3.1 of this document for details.

A risk assessment was done for the **US 101/Broadway Interchange Reconstruction Project** (Project), and the Project was determined to be **RL 2.**

RL 2 projects will be subject to monitoring and sampling requirements, plus Numeric Action Levels (NALs) for pH and turbidity.

All projects will have to upload stormwater data into SMARTS, such as Notices of Intent (NOIs), SWPPPs, annual reports, and monitoring data, as applicable.

2 GENERAL PROJECT INFORMATION

2.1 Location

The Project is located along US 101 from Post Mile (PM) 16.3 to 17.1 in the City of Burlingame in San Mateo County, see Figure 1.

2.2 Major Engineering Features

The California Department of Transportation (Caltrans), in cooperation with the San Mateo County Transportation Authority (SMTA) proposes to reconstruct the United States Highway 101 (US 101)/Broadway Interchange. The Project replaces the existing Broadway overcrossing with a new wider structure, reconfigures all northbound and southbound ramp connections to US 101, and installs ramp meters on the northbound and southbound on-ramps.

2.3 Receiving Water Bodies

The Project area drains to five waterways: Mills Creek, Easton Creek, the unlined channel near the intersection of Airport Boulevard and Bayshore Highway, Sanchez Creek and San Francisco Bay Lower are all part of hydrologic sub area 204.40. Most of the runoff from southbound (SB) US 101 within the Project limits, north of the Broadway overcrossing, drains to Easton Creek through a series of open channels and roadside culverts along US 101. The area to the east of Rollins Road, north of the Broadway overcrossing, drains to Easton Creek. The area to the east of Rollins Road, south of the Broadway overcrossing, drains in an easterly direction under US 101 to an open ditch adjacent to the northdbound (NB) US 101 off-ramp, which drains into Sanchez Creek and ultimately into Burlingame Lagoon. The area surrounding and beneath the eastern landing of the Broadway overcrossing between US 101 and Airport Boulevard drains to a culvert beneath Bayshore Highway, which drains into an unlined channel whose outlet to the bay has been blocked by a berm. Bayshore Highway drains to the east into Easton Creek. A portion of NB US 101 north of Easton Creek drains to an open ditch along NB US 101 that eventually drains to Mills Creek located just north of the Project's northern limit.

The San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) *Water Quality Control Plan (Basin Plan)* does not designate beneficial uses for Mills Creek, Easton Creek and Sanchez Creek. The San Francisco Bay, Lower is the only receiving water body with identified beneficial uses shown in the San Francisco Bay RWQCB Basin Plan, these beneficial uses are:

- Potential Beneficial Uses:
  - Fish Spawning (SPWN)
  - Industrial Service Supply (IND)
  - Ocean, Commercial and Sport Fishing (COMM)
  - Shellfish Harvesting (SHELL)
  - Estuarine Habitat (EST)
  - Fish Migration (MIGR)

- Preservation of Rare and Endangered Species (RARE)
- Wildlife Habitat (WILD)
- Water Contact Recreation (REC-1)
- Non Contact Recreation (REC-2)
- Navigation (NAV)

2.4 Creek Crossings

US 101 crosses two named creeks, Easton Creek and Sanchez Creek, within the Project limits. A portion of NB US 101 north of Easton Creek drains to Mill Creek, located just outside the northern Project limit.

Table 1. Stream Crossing in Project Area

Waterway	Culvert Size	Approximate Station
Sanchez Creek	Triple 8'x 10' RCB	"US101" 525+00
Easton Creek	Double 5.5'x 6' RCB	"US101" 500+30 ~ 501+30

Sanchez Creek crosses beneath US 101 near the southern limit of the Project through a triple reinforced concrete box culvert (RCB) that drains into Burlingame Lagoon. Easton Creek crosses beneath US 101 near the northern limit of the Project through a double RCB. A concrete-lined rectangular channel conveys Easton Creek to another double RCB beneath Bayshore Highway. In this reach of channel, the southern bank is lower than the northern bank, but a channel wall extends above the adjacent grade on the southern side, making the confining bank heights on both sides of the channel approximately level. Downstream of Bayshore Highway, the creek drains into a straight trapezoidal earthen channel that discharges directly into San Francisco Bay.

2.5 Climate and Rainfall

A National Oceanic and Atmospheric Administration (NOAA) weather station located at the San Francisco International airport was used to obtain the anticipated number of rainy days per year and qualifying rain events. The compliance storm event was determined from NOAA's online Atlas 14, Volume 6, Version 2 (http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ca).

Rainy days per year (assumed equal to precipitation 0.10 inches or greater): 38.8 days

Qualifying rain events per year (precipitation 0.5 inches or greater): 13.6 days

Compliance Storm Event (rainfall total for the 5 year, 24 hour storm) 2.84 inches

2.6 Soils and Geology

Soil information was obtained from a 2005 geotechnical report by Parikh Consultants, Inc., and from the Natural Resources Conservation Service (NRCS) Web Soil Survey. Project site soils generally consist of up to 10 feet of dense clayey well compacted artificial fill underlain by 5 to 10 feet of soft organic clay (Bay Mud). Historic borings at the interchange did not encounter

bedrock to a maximum depth of 85 feet. It should also be noted that both groundwater and soils at the site are corrosive (Parikh, 2005). The lack of slopes and the fact that the Project area is predominantly paved reduces the potential for erosion.

The NRCS Web Soil Survey identifies the soils within the Project as within hydrologic soil group D. Soils within group D generally have very slow infiltration rates and high runoff potential.

Erosion factor K indicates the erodibility of the fine-earth fraction of the soil. The factor is given as a percentage or fraction ranging from 0.02 to 0.69; the higher the value, the more susceptible the soil is to sheet and rill erosion by water. The NRCS Web Soil Survey does not provide K factor information for soils within the Project area, so the State Water Resources Control Board "Stormwater Multiple Application and Report Tracking System" (SMARTS) was used to identify the K factor. This K factor was verified using the Caltrans "2009 Construction General Permit Info" web tool. The K factor within the Project area is 0.32; this K factor value suggests a moderate erosion potential.

2.7 Hazardous Waste

A *Hazardous Materials Site Investigation Report* was conducted, and it was determined that there is aerially deposited lead (ADL) present within the Project limits (URS, 2013). The soils in the upper1.5 ft are considered soil type Y-2 under the Caltrans ADL variance. In these areas, the reuse of soil containing ADL is restricted to heights of 5 feet above the highest ground water level. ADL plans are included in the appendices.

Several nearby sites have leaking underground storage tanks (LUSTs) and/or other hazardous material contamination that could potentially impact soil and groundwater within the Project area (Powers & Associates, 2002). In the Project area, there have been past releases of contaminants to groundwater from some land uses; the *Initial Site Assessment* (URS, 2009) provides detailed discussion of these releases. Caltrans Standard Specs and SSP's cover soils, paints and other hazmat materials.

2.8 Existing (Pre-Construction) Control Practices

There are no existing treatment BMPs currently present within the Project Limits..

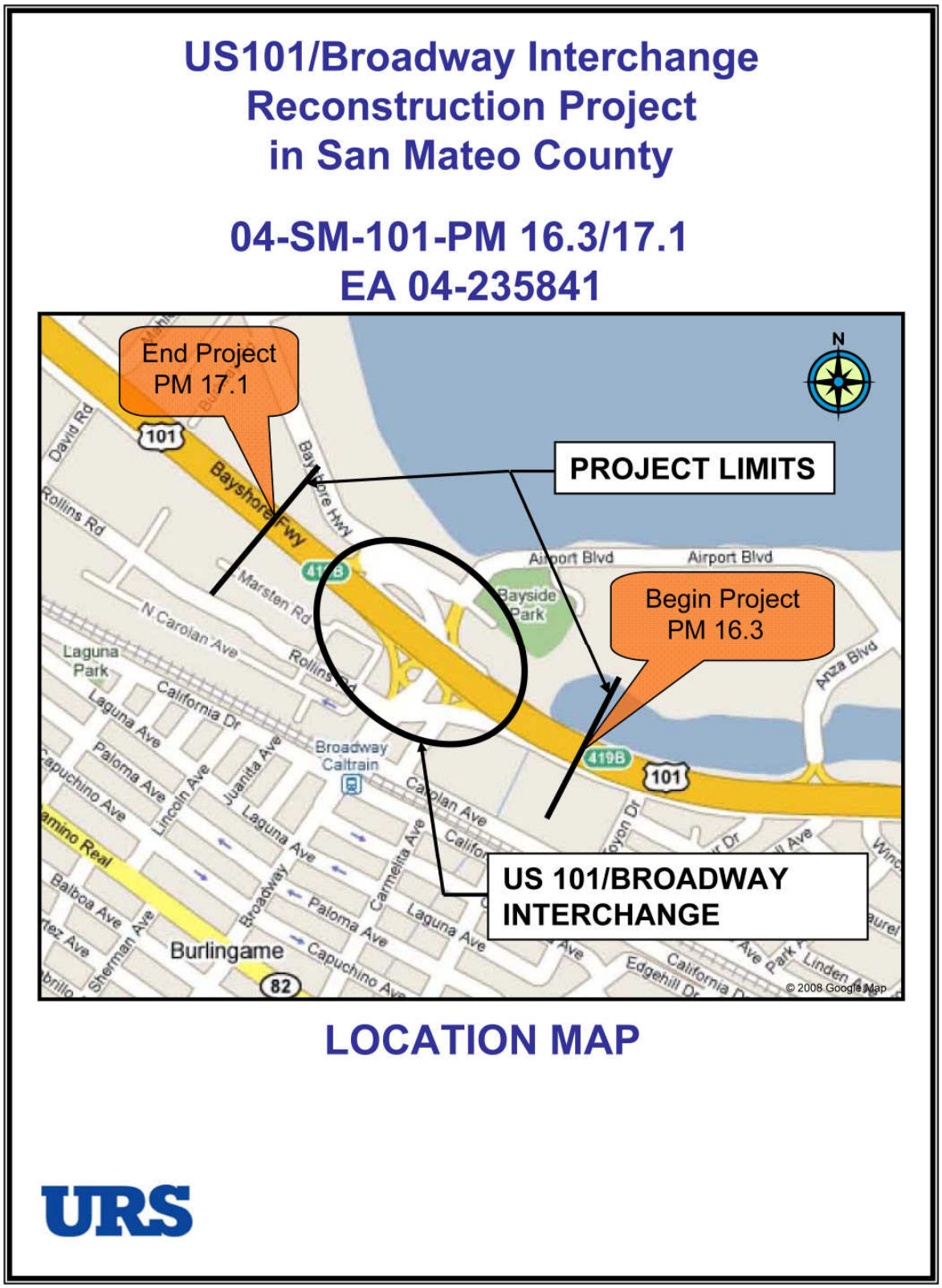


Figure 1 . Location Map

3 CONSTRUCTION GENERAL PERMIT

To minimize the potential effects of construction runoff on the quality of the receiving water bodies, any construction activity affecting one acre or more must obtain coverage under the CGP. Permit applicants are required to prepare a SWPPP and implement BMPs to reduce construction effects on receiving water quality.

3.1 Risk Assessment

The new CGP requirements include a risk assessment to determine the Project's impact risk to receiving water bodies. The risk assessment uses measurements of the Project's potential sediment risk and the sensitivity of the receiving water bodies to sediment to determine the risk level of the Project. This Project has a **Low Site Sediment Risk Factor** and a **High Receiving Water Risk Factor**; the combined risk is **Level 2**. The risk factors are detailed in the following sections.

3.1.1 Sediment Risk

The sediment risk is based on the following equation from the adopted NPDES permit "Fact Sheet" (Section J.1.a pg. 28):

Equation 1. Sediment Risk Equation

$$A = (R)(K)(LS)(C)(P)$$

Where:

R = Runoff erosivity factor
K = Soil erodibility factor
LS = Length-slope
C = Cover
P = Management operations and support practices
A = Rate of sheet and rill erosion (tons per acre)

The rainfall runoff erosivity factor (R) of **82.76** was determined from the United States Environmental Protection Agency (EPA) "Rainfall Erosivity Factor Calculator for Small Construction Sites."

The soil erodibility factor (K) of **0.32** was determined from the StateWater Resource Control Board. The United States Department of Agriculture Natural Resources Conservation Services "Web Soil Survey" did not provide K factors.

The length-slope factor (LS) of **0.35** was determined by examining the original grade delineated on the Typical Cross Sections included in the Contract Project Plans.

The cover factor (C) and management operations and support practices (P) are given values of 1.0 by the adopted NPDES permit to simulate bare ground conditions.

	A	B	C
1	**Sediment Risk Factor Worksheet**		**Entry**
2	**A) R Factor**		
3	Analyses of data indicated that when factors other than rainfall are held constant, soil loss is directly proportional to a rainfall factor composed of total storm kinetic energy (E) times the maximum 30-min intensity (I30) (Wischmeier and Smith, 1958). T		
4	http://cfpub.epa.gov/npdes/stormwater/LEW/lewCalculator.cfm		
5	**R Factor Value**		82.76
6	**B) K Factor (weighted average, by area, for all site soils)**		
7	The soil-erodibility factor K represents: (1) susceptibility of soil or surface material to erosion, (2) transportability of the sediment, and (3) the amount and rate of runoff given a particular rainfall input, as measured under a standard condition. Fin		
8	Site-specific K factor guidance		
9	**K Factor Value**		0.32
10	**C) LS Factor (weighted average, by area, for all slopes)**		
11	The effect of topography on erosion is accounted for by the LS factor, which combines the effects of a hillslope-length factor, L, and a hillslope-gradient factor, S. Generally speaking, as hillslope length and/or hillslope gradient increase, soil loss in		
12	LS Table		
13	**LS Factor Value**		0.35
14			
15	**Watershed Erosion Estimate (=RxKxLS) in tons/acre**	9	
16	**Site Sediment Risk Factor**	**Low**	
17	Low Sediment Risk: < 15 tons/acre		
18	Medium Sediment Risk: >=15 and <75 tons/acre		
19	High Sediment Risk: >= 75 tons/acre		
20			

Figure 2. Sediment Risk Factor Worksheet

Based on these factors, the rate of sheet and rill erosion (A) is **9** tons per acre. Because the value is less than 15, the Project is classified as having a low sediment risk.

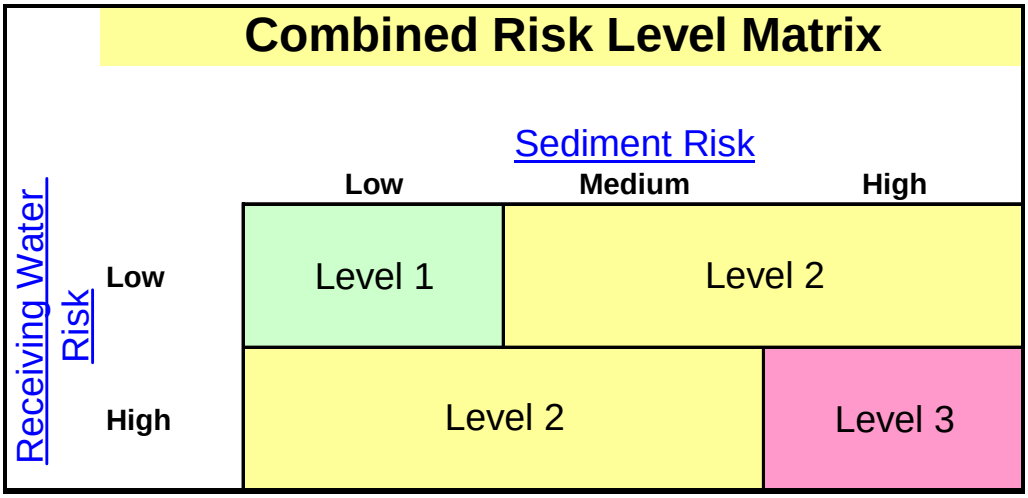
3.1.2 Receiving Water Body Risk

None of the receiving water bodies have the combined existing beneficial uses of MIGR, SPWN, and cold freshwater habitat, nor are any of the water bodies on the 303(d) List impaired for sediment. However, the receiving water risk is classified as high because the Caltrans Water Quality Planning Tools website has the Project within the high risk receiving water area (see Figure 4).

Receiving Water (RW) Risk Factor Worksheet	**Entry**	**Score**
A. Watershed Characteristics	**yes/no**	
A.1. Does the disturbed area discharge (either directly or indirectly) to a **303(d)-listed waterbody impaired by sediment**? For help with impaired waterbodies please check the attached worksheet or visit the link below: 2006 Approved Sediment-impared WBs Worksheet http://www.waterboards.ca.gov/water_issues/programs/tmdl/303d_lists2006_epa.shtml **OR**	**Yes**	**High**
A.2. Does the disturbed area discharge to a waterbody with designated beneficial uses of SPAWN & COLD & MIGRATORY? http://www.ice.ucdavis.edu/geowbs/asp/wbquse.asp		

Figure 3. Receiving Water Body Risk Assessment

With a low sediment risk and high receiving water body risk, the combined RL is **2** as shown in Figure 4



Project Sediment Risk: Low
Project RW Risk: High
Project Combined Risk: Level 2

Figure 4. Combined Risk Level Matrix

3.2 Notice of Termination (NOT)

The CGP provides both revised and new requirements for completion and approval of the NOT. The NOT requirements are presented in Section II.D of the new CGP permit "Order." These requirements include demonstrating through photos, computational proof or other "custom methods," such as results of testing and analysis, that the terms of the NOT have been satisfied.

While these methods of demonstrating compliance are at the option of the contractor, should the RWQCB determine that the visual photos do not adequately show compliance, further computational efforts may be required. This computational proof is obtained through the use of the Revised Universal Soil Loss Equation 2 (RUSLE2) program.

4 RUN-ON DISCHARGES

There are minimal anticipated run-on discharges within the Project limits. The Project primarily consists of placing fill or has existing or proposed retaining walls that should prevent any run-on based on the existing and proposed contour grading. While the run-on is anticipated to be minimal, the contractor is responsible for determining any actual run-on discharges based on anticipated in-field work and document measures to address run-on discharges in the SWPPP.

Generally, the Rational Method is used to calculate the run-on discharges.

Equation 1. Rational Method for run-on discharge

$$Q = CiA$$

Where:

Q = Run-on discharge (cubic feet per second)
C = Runoff coefficient = **0.8**
i = 2-year, 24-hour rainfall intensity (inches/hour) = **0.096**
A = Drainage area (acre)

5 PERMIT REGISTRATION DOCUMENTS

To obtain permit coverage under the CGP, all dischargers must electronically file PRDs, NOTs, changes of information, sampling and monitoring information, annual reporting, and other compliance documents required by this CGP through the SWRCB's SMARTS. The contractor will have to coordinate these submittals with Caltrans within the timeframe allotted in the contract special provisions and as specified in the permit. SMARTS is found under the following website:

https://smarts.waterboards.ca.gov

PRDs include the following information:

1. Notice of Intent (NOI)
2. Site Map(s) Includes:
    a. The project's surrounding area (vicinity)
    b. Site layout
    c. Construction site boundaries
    d. Drainage areas
    e. Discharge locations
    f. Sampling locations
    g. Areas of soil disturbance (temporary or permanent)
    h. Active areas of soil disturbance (cut or fill)
    i. Locations of all runoff BMPs
    j. Locations of all erosion control BMPs
    k. Locations of all sediment control BMPs
    l. Active Treatment System (ATS) location (if applicable)
    m. Locations of sensitive habitats, watercourses, or other features which are not to be disturbed
    n. Locations of all post-construction BMPs
    o. Locations of storage areas for waste, vehicles, service, loading/unloading of materials, access (entrance/exits) points to construction site, fueling and water storage, water transfer for dust control and compaction practices

3. SWPPPs

The contractor for the Project is required to prepare a SWPPP because the Project involves disturbing more than 1 acre of soil. The SWPPP must include the following information:

- Active areas of cut and fill
- Areas of soil disturbance (temporary and permanent)
- Locations of storage areas for waste, vehicles, access, etc.
- Locations of all runoff BMPs
- Locations of all erosion control BMPs
- Locations of all sediment control BMPs

The SWPPP should be submitted with the PRDs and will be forthcoming from the Contractor.

4. Risk Assessment
    a. The Standard Risk Assessment includes utilization of the following:
        i. Receiving water Risk Assessment interactive map
        ii. EPA Rainfall Erosivity Factor Calculator Website
        iii. Sediment Risk interactive map
        iv. Sediment sensitive water bodies list
    b. The Site-Specific Risk Assessment includes the completion of the hand calculated R value Risk Calculator

5.1 General Information Included

The following is a list of information included in this Storm Water Information Handout that can be used for the PRDs:

- Vicinity Map
- Risk Assessment

5.2 Storm Water Pollution Prevention Plan

The contractor for the Project is required to prepare a SWPPP because the Project involves disturbing more than 1 ac of soil. The SWPPP must include the following information:

- Active areas of cut and fill
- Areas of soil disturbance (temporary and permanent)
- Locations of storage areas for waste, vehicles, access, etc.
- Locations of all runoff BMPs
- Locations of all erosion control BMPs
- Locations of all sediment control BMPs

The SWPPP should be submitted with the PRDs and will be forthcoming from the Contractor.

5.3 Notice of Intent (NOI)

The NOI must be submitted once the Contractor submits the SWPPP. This document is included in Appendix A.

5.4 Site Maps

Registration requirements can be met by the inclusion of the following plans, which can be found in the appendices.

- Conceptual Sampling Plan (Appendix B)
  - Discharge Locations (Subject to changes by the Contractor and approved by the Resident Engineer)
  - Sampling Locations (Subject to changes by the Contractor and approved by the Resident Engineer)
- Conceptual Water Pollution Control Plans (For Resident Engineer reference only)
  - Conceptual drawings of temporary storm water BMP locations
  - Locations of sediment control BMPs

Appendix A Notice of Intent (NOI)

Attachment 2

State Water Resources Control Board

NOTICE OF INTENT

TO COMPLY WITH THE TERMS OF THE
GENERAL PERMIT TO DISCHARGE STORM WATER
ASSOCIATED WITH CONSTRUCTION ACTIVITY (WQ ORDER No. 99-08-DWQ)

I. NOI STATUS (SEE INSTRUCTIONS)

MARK ONLY ONE ITEM 1. ☐ New Construction 2. ☐ Change of Information for WDID#

II. PROPERTY OWNER

Name: California Department of Transportation		Contact Person: Bijan Sartipi	
Mailing Address: 111 Grand Ave.		Title: District Director	
City: Oakland	State: CA	Zip: 94623	Phone: (510) 286-5900

Owner Type (*check one*) 1.[ ] Private Individual 2.[ ]Business 3.[ ]Municipal 4.[X]State 5.[ ]Federal 6.[ ]Other

III. DEVELOPER/CONTRACTOR INFORMATION

Developer/Contractor		Contact Person	
Mailing Address		Title	
City	State	Zip	Phone

IV. CONSTRUCTION PROJECT INFORMATION

Site/Project Name: US 101 / Broadway Interchange Reconstruction Project		Site Contact Person	
Physical Address/Location: US 101 and Broadway Interchange	Latitude: 37.59 °	Longitude: 122.36 °	County: San Mateo
City (or nearest City): Burlingame	Zip: 94010	Site Phone Number	Emergency Phone Number

A. Total size of construction site area: 36.27 Acres

B. Total area to be disturbed: 10.78 Acres (% of total 29.7)

C. Percent of site imperviousness (including rooftops):
Before Construction: _____%
After Construction: _____%

D. Tract Number(s): _____, _____

E. Mile Post Marker: 16.3/17.1

F. Is the construction site part of a larger common plan of development or sale?
☐ YES ☒ NO

G. Name of plan or development:

H. Construction commencement date: 02 / ___ / 14

I. % of site to be mass graded: _____

J. Projected construction dates:
Complete grading: ___/___/___ Complete project: 10 / ___ / 16

K. Type of Construction (Check all that apply):
1. ☐ Residential 2. ☐ Commercial 3. ☐ Industrial 4. ☒ Reconstruction 5. ☒ Transportation
6. ☐ Utility Description: _____ 7. ☐ Other (Please List): _____

V. BILLING INFORMATION

SEND BILL TO: ☒ OWNER (as in II. above)	Name	Contact Person	
☐ DEVELOPER (as in III. above)	Mailing Address	Phone/Fax	
☐ OTHER (enter information at right)	City	State	Zip

VI. REGULATORY STATUS

A. Has a local agency approved a required erosion/sediment control plan? ☒ YES ☐ NO

Does the erosion/sediment control plan address construction activities such as infrastructure and structures? ☒ YES ☐ NO

Name of local agency: California Department of Transportation Phone: (510) 286-5900

B. Is this project or any part thereof, subject to conditions imposed under a CWA Section 404 permit of 401 Water Quality Certification? ☒ YES ☐ No

If yes, provide details: 401 from SFBRWQCB; 404 from USACOE

VII. RECEIVING WATER INFORMATION

A. Does the storm water runoff from the construction site discharge to (Check all that apply):

1. ☐ **Indirectly to waters of the U.S.**
2. ☒ **Storm drain system - Enter owner's name:** California Department of Transportation, City of Burlingame
3. ☒ **Directly to waters of U.S. (e.g. , river, lake, creek, stream, bay, ocean, etc.)**

B. Name of receiving water: (river, lake, creek, stream, bay, ocean): Easton Creek, Sanchez Creek, Mills Creek, San Francisco Bay, Lower, unnamed channel

VIII. IMPLEMENTATION OF NPDES PERMIT REQUIREMENTS

A. STORM WATER POLLUTION PREVENTION PLAN (SWPPP) (check one)

☐ A SWPPP has been prepared for this facility and is available for review: Date Prepared: ____/____/____ Date Amended: ____/____/____

☐ A SWPPP will be prepared and ready for review by (enter date): ____/____/____

☐ A tentative schedule has been included in the SWPPP for activities such as grading, street construction, home construction, etc.

B. MONITORING PROGRAM

☐ A monitoring and maintenance schedule has been developed that includes inspection of the construction BMPs before anticipated storm events and after actual storm events and is available for review.

If checked above: A qualified person has been assigned responsibility for pre-storm and post-storm BMP inspections to identify effectiveness and necessary repairs or design changes ☐ YES ☐ NO

Name: _____ Phone: _____

C. PERMIT COMPLIANCE RESPONSIBILITY

A qualified person has been assigned responsibility to ensure full compliance with the Permit, and to implement all elements of the Storm Water Pollution Prevention Plan including:

1. Preparing an annual compliance evaluation ☐ YES ☐ NO

Name: _____ Phone: _____

2. Eliminating all unauthorized discharges ☐ YES ☐ NO

IX. VICINITY MAP AND FEE (must show site location in relation to nearest named streets, intersections, etc.)

Have you included a vicinity map with this submittal? ☒ YES ☐ NO

Have you included payment of the annual fee with this submittal? ☐ YES ☐ NO

X. CERTIFICATIONS

"I certify under penalty of law that this document and all attachments were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine or imprisonment. In addition, I certify that I have read the entire General Permit, including all attachments, and agree to comply with and be bound by all of the provisions, requirements, and prohibitions of the permit, including the development and implementation of a Storm Water Pollution Prevention Plan and a Monitoring Program Plan will be complied with."

Printed Name: _____

Signature: _____ **Date:** _____

Title: _____

Appendix B Conceptual Sampling Plan

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

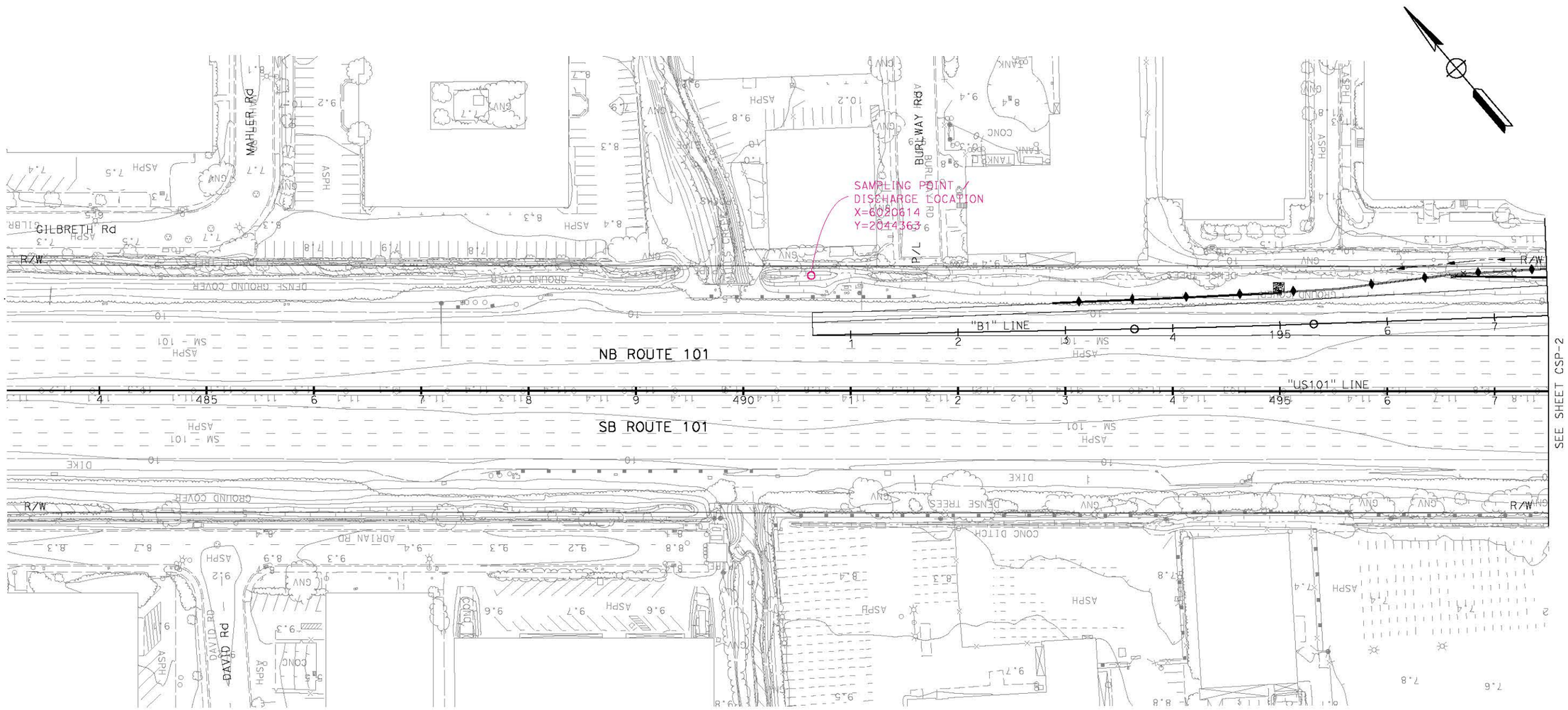
THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

WRECO
1814 FRANKLIN STREET
SUITE 608
OAKLAND, CA 94612

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:

FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



CONCEPTUAL SAMPLING PLAN

SCALE: 1"=50'

CSP-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: HAN-BIN LIANG

CALCULATED-DESIGNED BY: TERENCE XIAO

CHECKED BY: ANDREW SEKIOKA

REVISED BY: . DATE REVISED: .

LAST REVISION 00-00-00 DATE PLOTTED => 1/14/2013 TIME PLOTTED => 3:00:54 PM

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

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PLANS APPROVAL DATE

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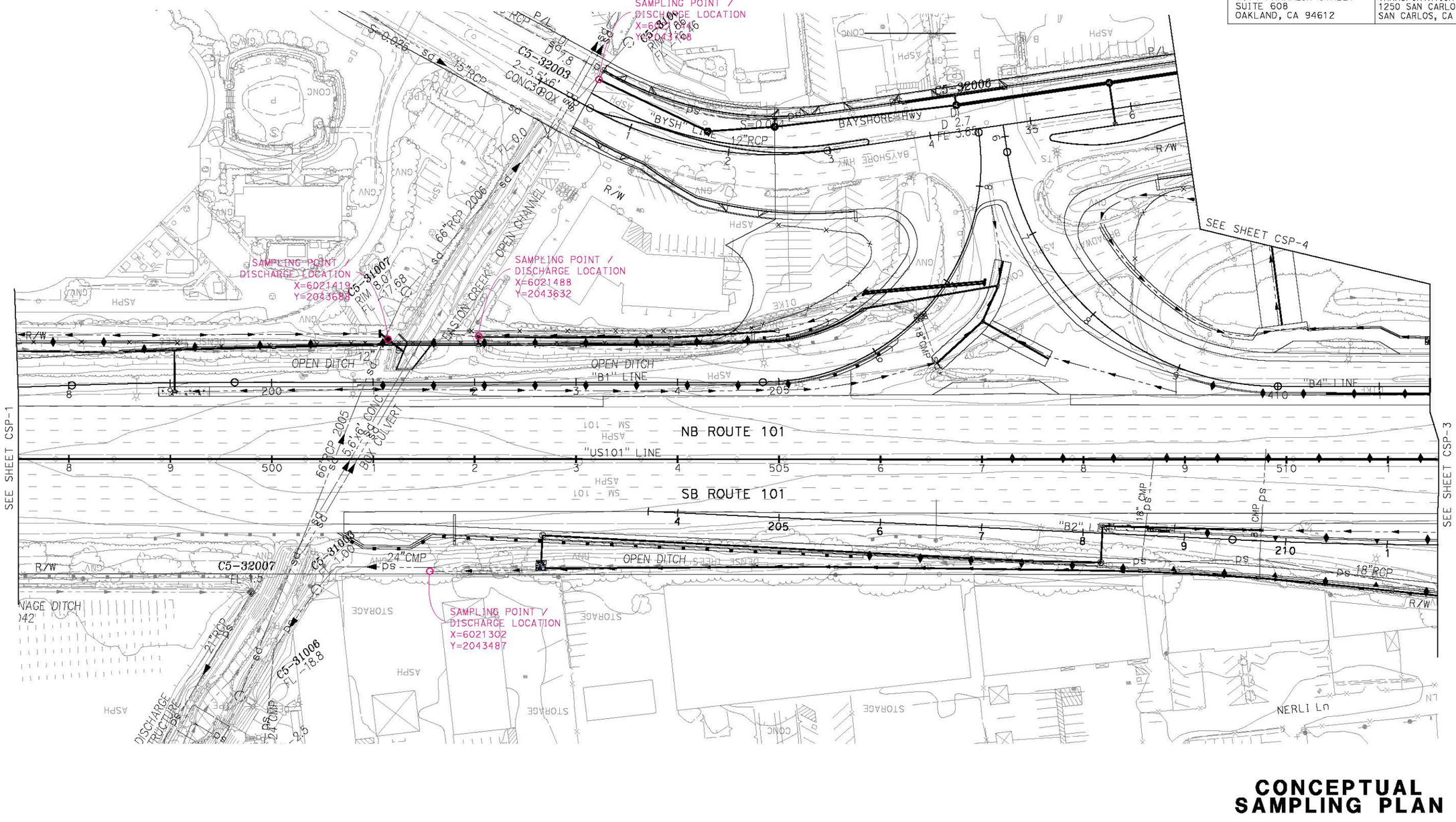

CONCEPTUAL SAMPLING PLAN

SCALE: 1"=50'

CSP-2

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: HAN-BIN LIANG

CALCULATED-DESIGNED BY: TERENCE XIAO

CHECKED BY: ANDREW SEKIOKA

REVISED BY: .

DATE REVISED: .

LAST REVISION 00-00-00

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TIME PLOTTED => 3:01:19 PM

BORDER LAST REVISED 7/2/2010

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DGN FILE => ...\Dwg\CSP\0400023584csp002.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Huey Nham
No. C65138
Exp. 9/30/13
CIVIL
STATE OF CALIFORNIA

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1814 FRANKLIN STREET
SUITE 608
OAKLAND, CA 94612

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

CONCEPTUAL SAMPLING PLAN

SCALE: 1"=50'

CSP-3

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: HAN-BIN LIANG

CALCULATED-DESIGNED BY: TERENCE XIAO

CHECKED BY: ANDREW SEKIOKA

REVISED BY: .

DATE REVISED: .

LAST REVISION: 00-00-00

DATE PLOTTED => 1/14/2013
TIME PLOTTED => 3:01:38 PM

BORDER LAST REVISED 7/2/2010

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RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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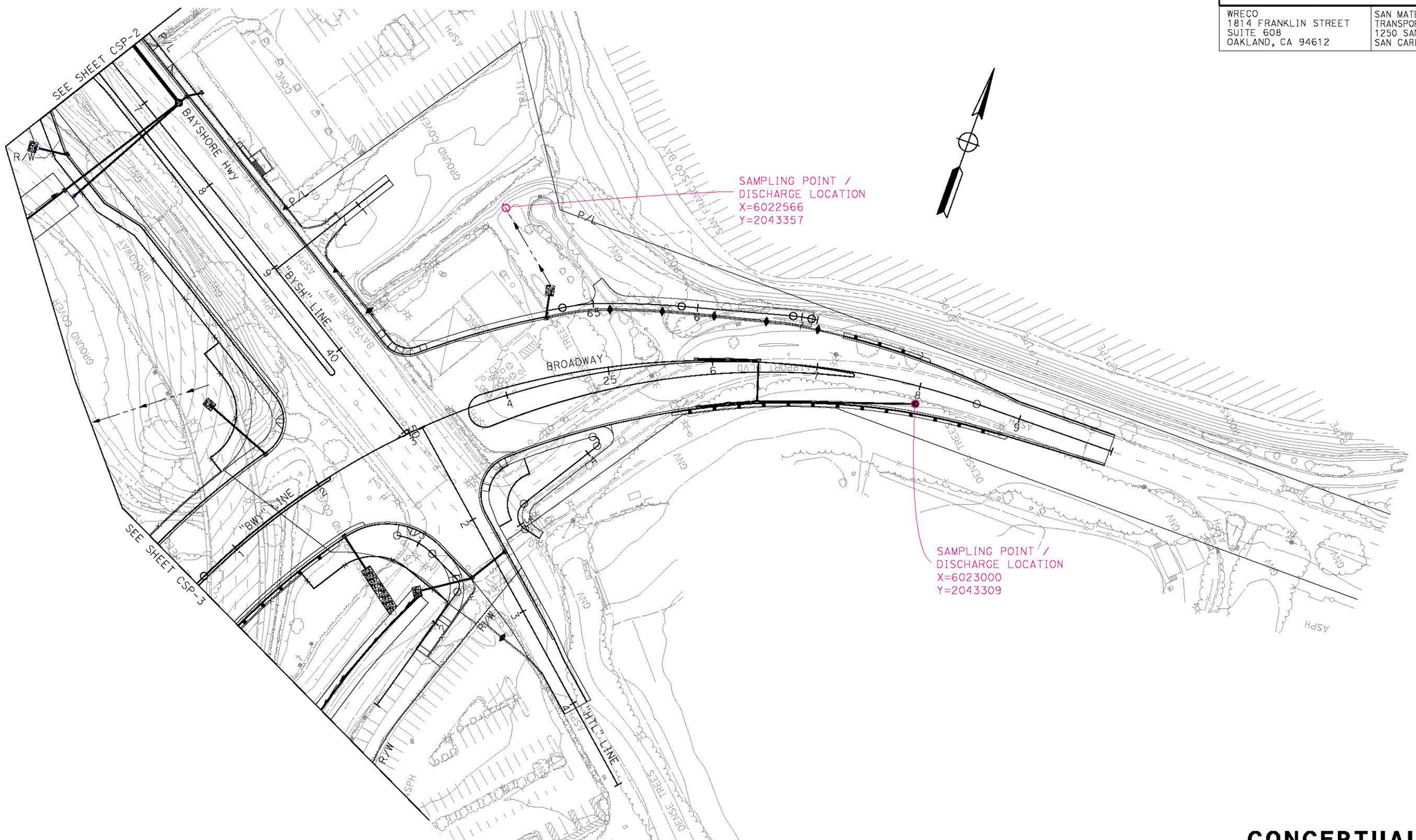

CONCEPTUAL SAMPLING PLAN

SCALE: 1"=50'

CSP-4

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: HAN-BIN LIANG

CALCULATED-DESIGNED BY: TERENCE XIAO

CHECKED BY: ANDREW SEKIOKA

REVISED BY: .

DATE REVISED: .

LAST REVISION 00-00-00

DATE PLOTTED => 1/14/2013
TIME PLOTTED => 3:02:28 PM

BORDER LAST REVISED 7/2/2010

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RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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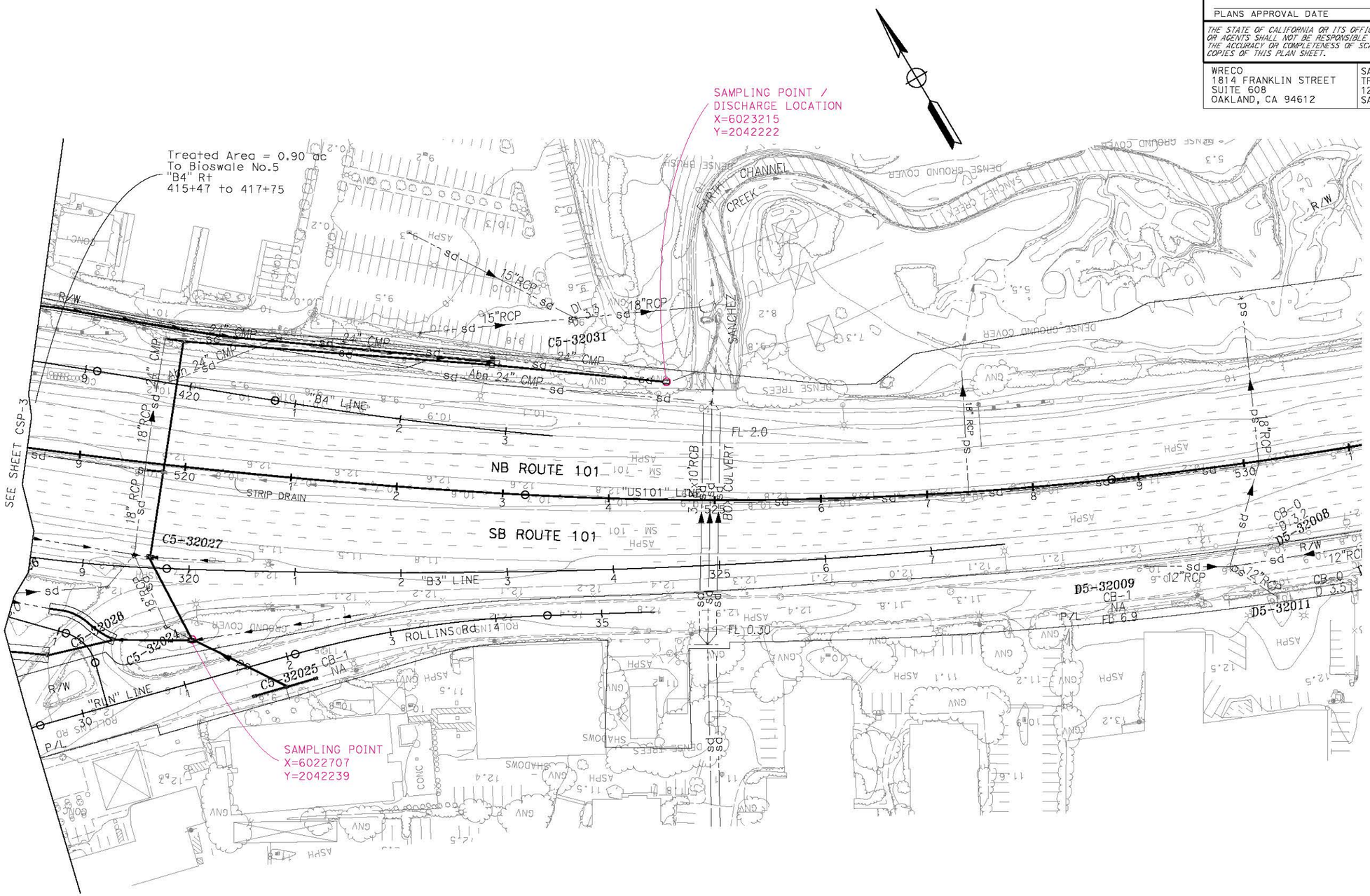

CONCEPTUAL SAMPLING PLAN

SCALE: 1"=50'

CSP-5

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: HAN-BIN LIANG

CALCULATED-DESIGNED BY: TERENCE XIAO

CHECKED BY: ANDREW SEKIOKA

REVISED BY: .

DATE REVISED: .

LAST REVISION: 00-00-00

DATE PLOTTED => 1/14/2013
TIME PLOTTED => 3:03:00 PM

BORDER LAST REVISED 7/2/2010

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RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Appendix C Conceptual Water Pollution Control Plan

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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NOTES:

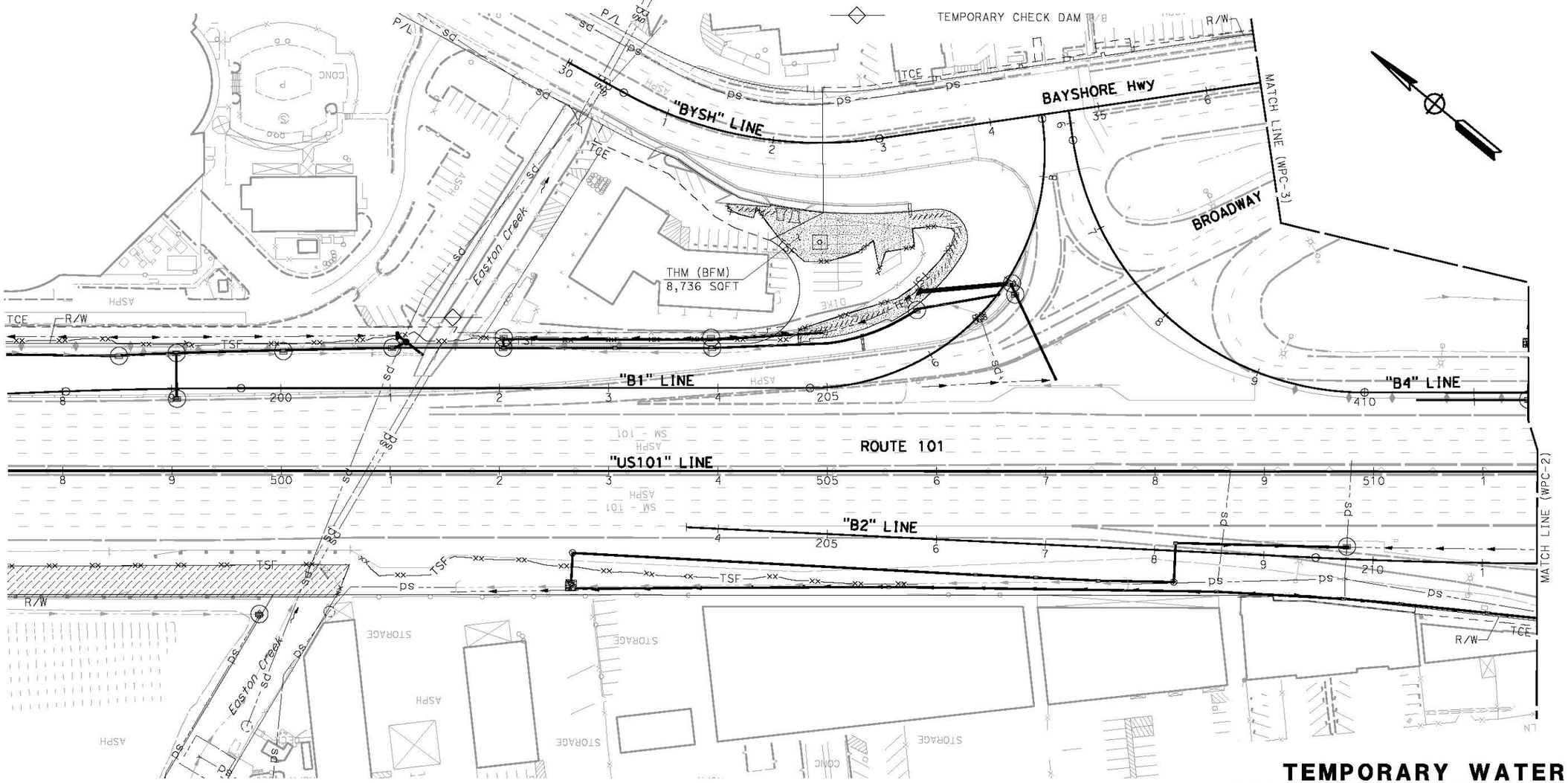
1. FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.
2. THESE PLANS PROVIDE MINIMUM LEVELS OF TEMPORARY WATER POLLUTION CONTROL DURING THE CONSTRUCTION OF PROJECT. ADJUSTMENT/MODIFICATIONS SHALL BE MADE IN REGARD TO ADDRESS ACTUAL SITE CONDITIONS AS DIRECTED BY THE ENGINEER.
3. SEE DRAINAGE PLANS FOR INLET TYPES AND SIZE OF DRAINAGE PIPES.
4. SEE STAGE CONSTRUCTION PLANS FOR SEQUENCE OF STAGING.

ABBREVIATION:

THM (BFM) TEMPORARY HYDRAULIC MULCH (BONDED FIBER MATRIX)

LEGEND:

- TEMPORARY DRAINAGE INLET PROTECTION
- DIRECTION OF FLOW
- STORM DRAIN INLET AND PIPE SYSTEM
- TSF — TEMPORARY SILT FENCE
- TFR — TEMPORARY FIBER ROLL
- TEMPORARY CONSTRUCTION ENTRANCE
- TEMPORARY CONCRETE WASHOUT FACILITY
- TEMPORARY HYDRAULIC MULCH (BONDED FIBER MATRIX)
- TEMPORARY COVER
- ENVIRONMENTALLY SENSITIVE AREA
- TEMPORARY CHECK DAM



TEMPORARY WATER POLLUTION CONTROL PLAN

STAGE 1 PHASE 1

SCALE 1" = 50'

WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

	REVISED BY	DATE REVISED
	JH	4/17/13

CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
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DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:26:52 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
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PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
Exp. 12-31-13
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STATE OF CALIFORNIA

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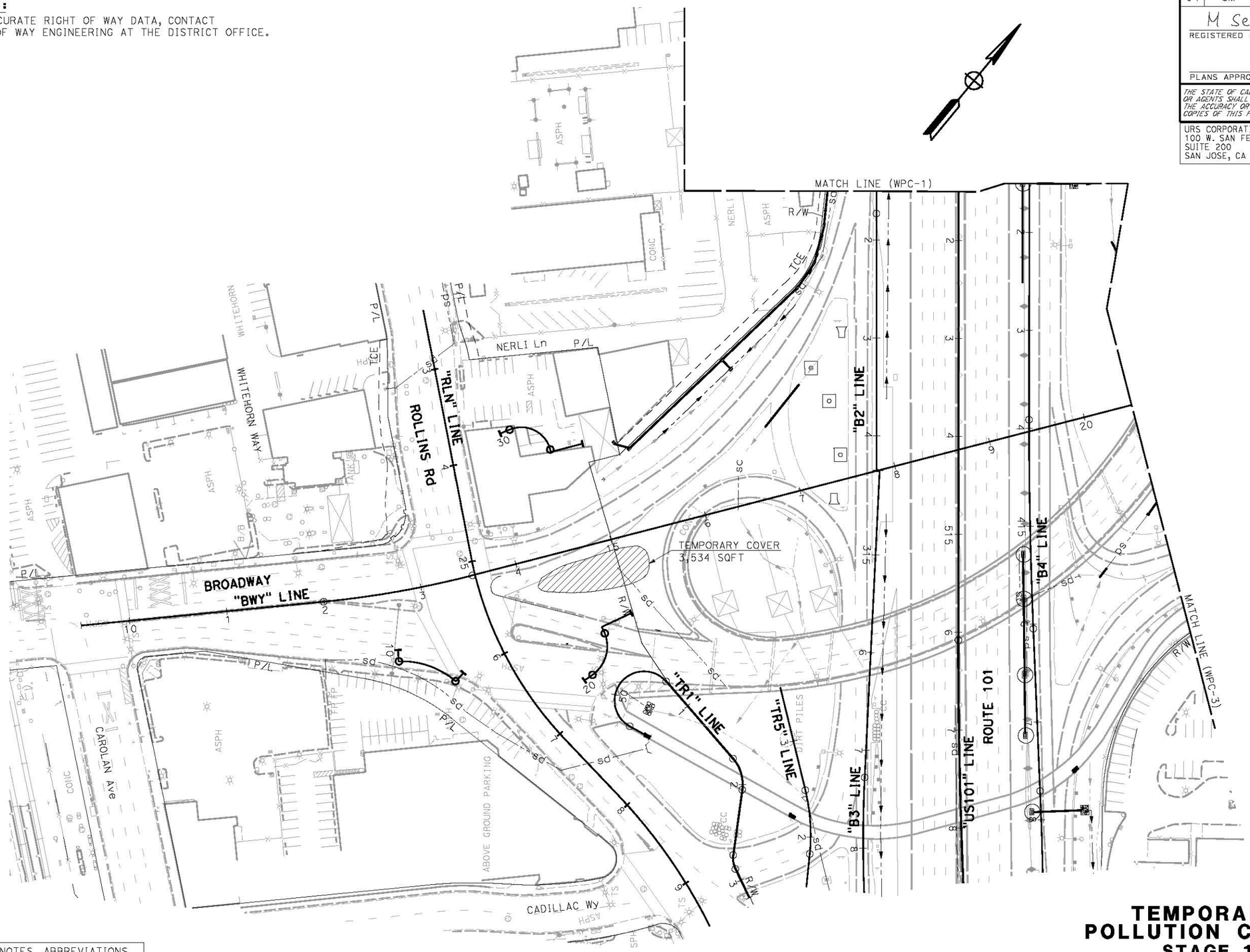
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 1 PHASE 1
SCALE 1" = 50'

WPC-2

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:26:57 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

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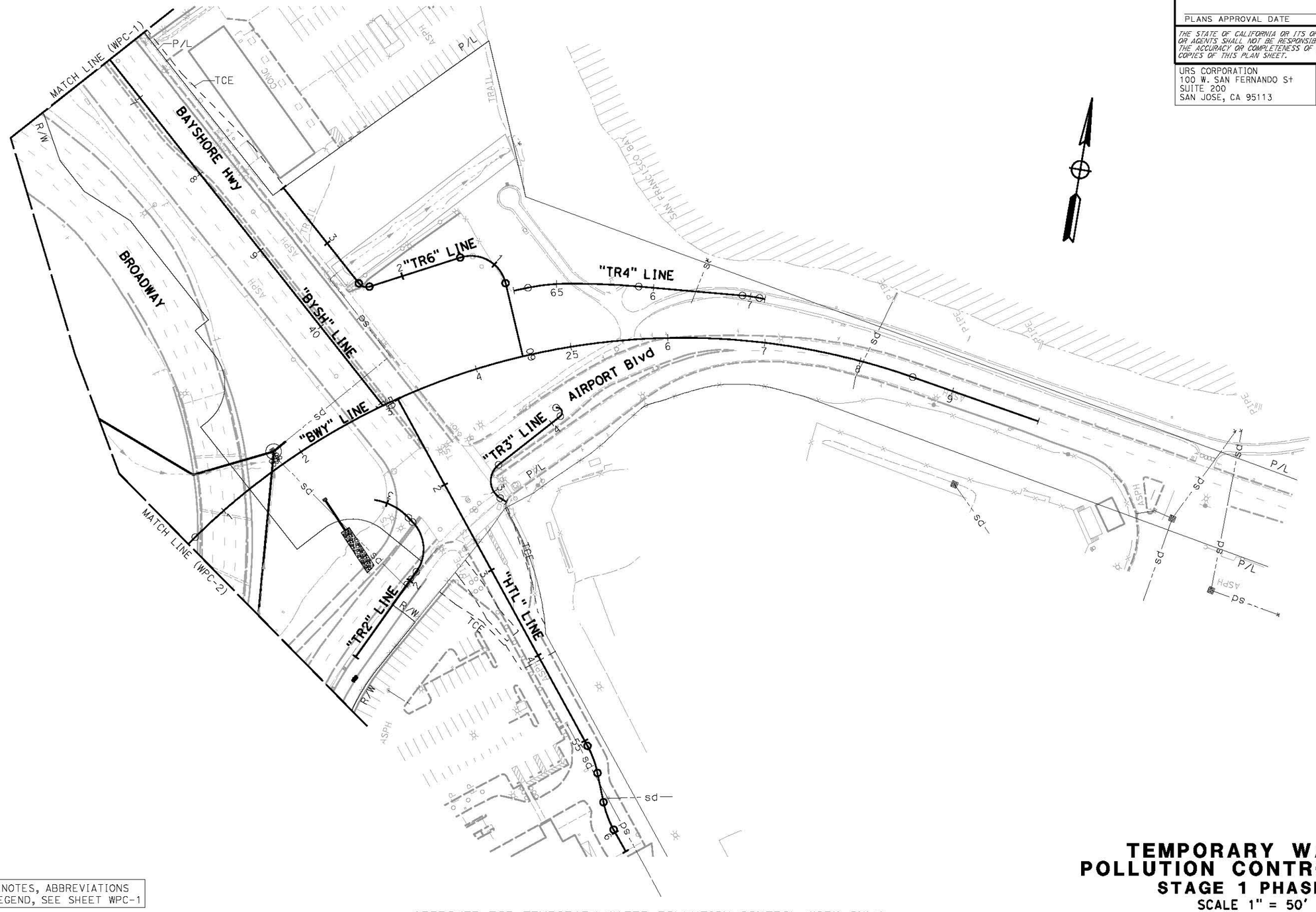

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 1 PHASE 1
SCALE 1" = 50'

WPC-3

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	CONSULTANT FUNCTIONAL SUPERVISOR	CALCULATED-DESIGNED BY	JASON HOM	REVISED BY	JH
Caltrans	RAMSEY J. HISSEN	CHECKED BY	MARIA SEDGHI	DATE REVISED	4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:27:01 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi — REGISTERED CIVIL ENGINEER — 4/17/13 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Maria Sedghi — No. C74619 — Exp. 12-31-13 — CIVIL — STATE OF CALIFORNIA

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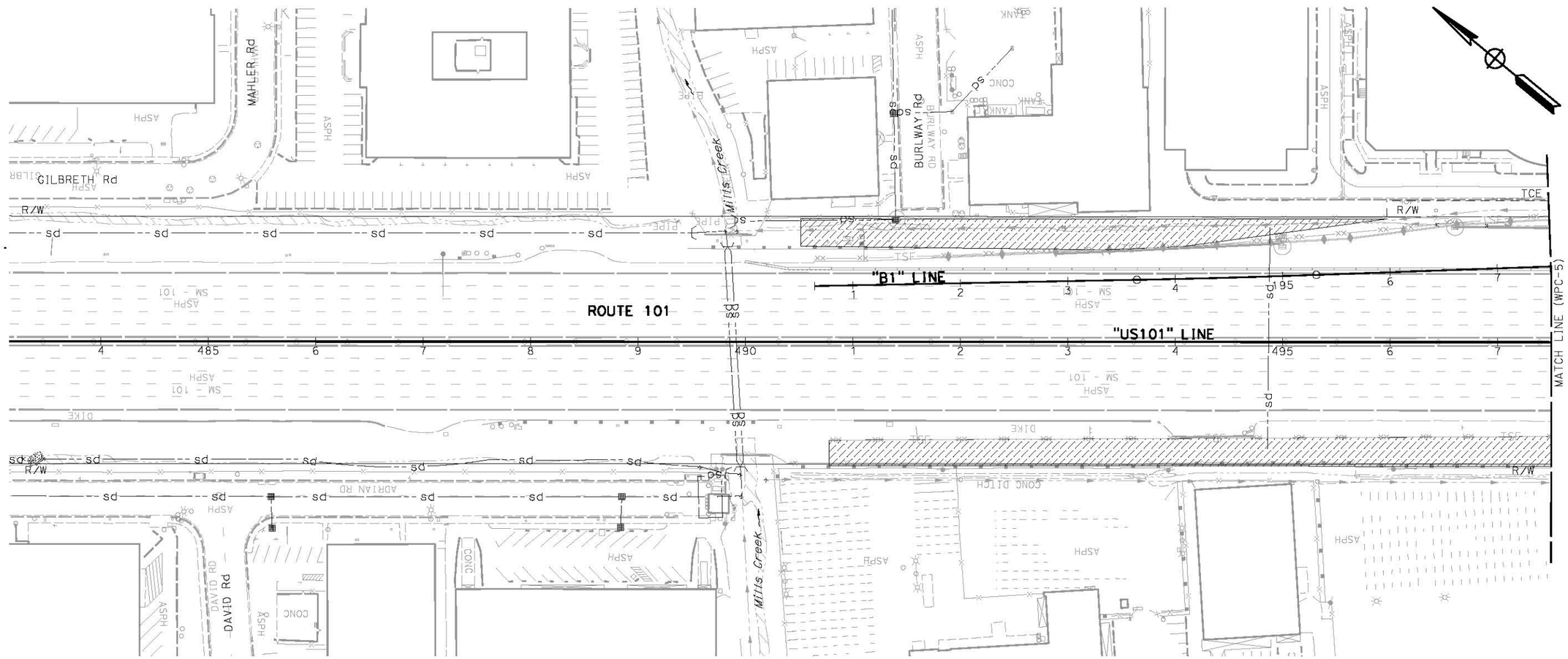

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 1 PHASE 2
SCALE 1" = 50'

WPC-4

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CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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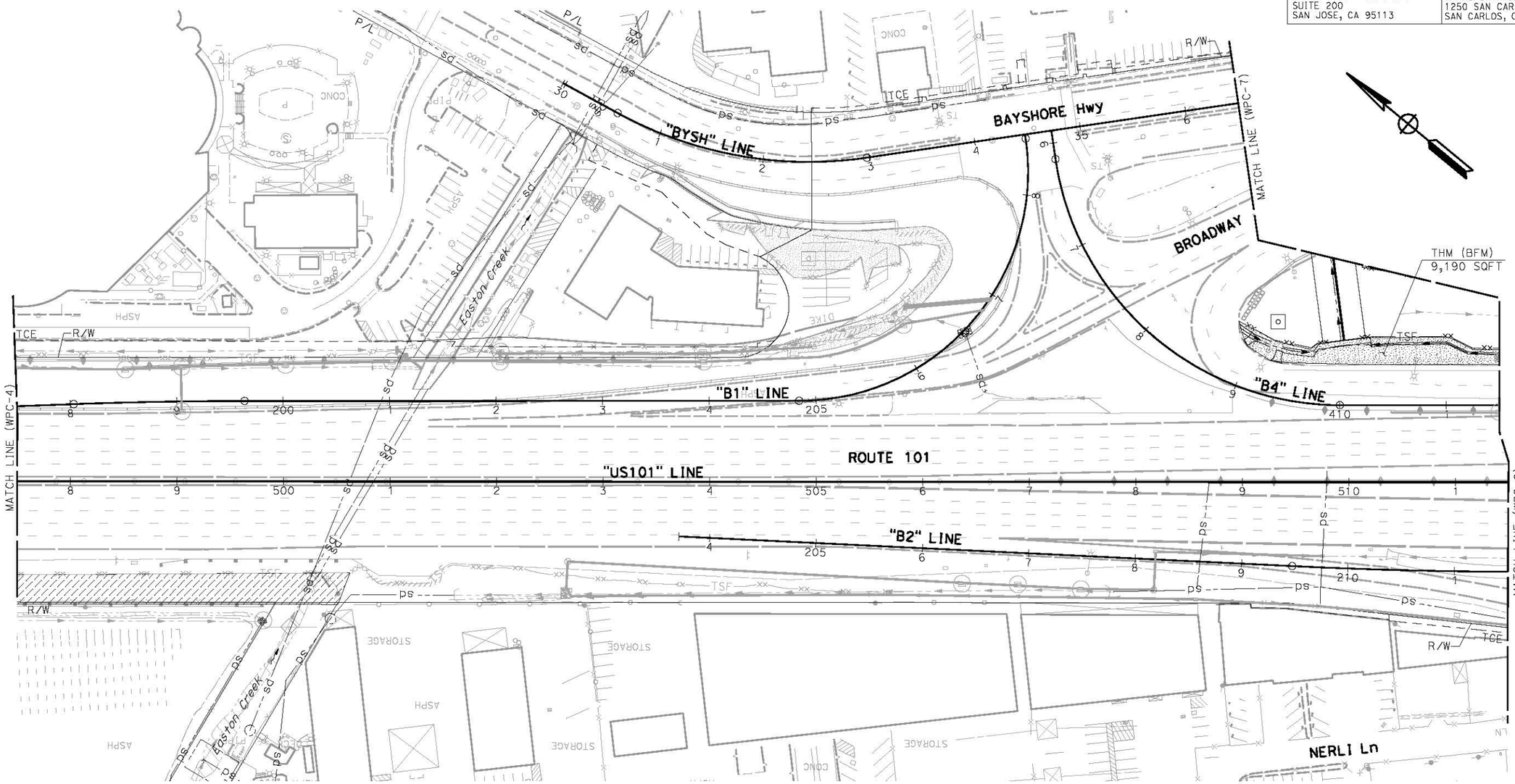

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 1 PHASE 2
SCALE 1" = 50'

WPC-5

		JH	4/17/13
		REVISED BY	DATE REVISED
CALCULATED-DESIGNED BY	JASON HOM		
CHECKED BY	MARIA SEDGHI		
CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN		

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LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:27:09 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

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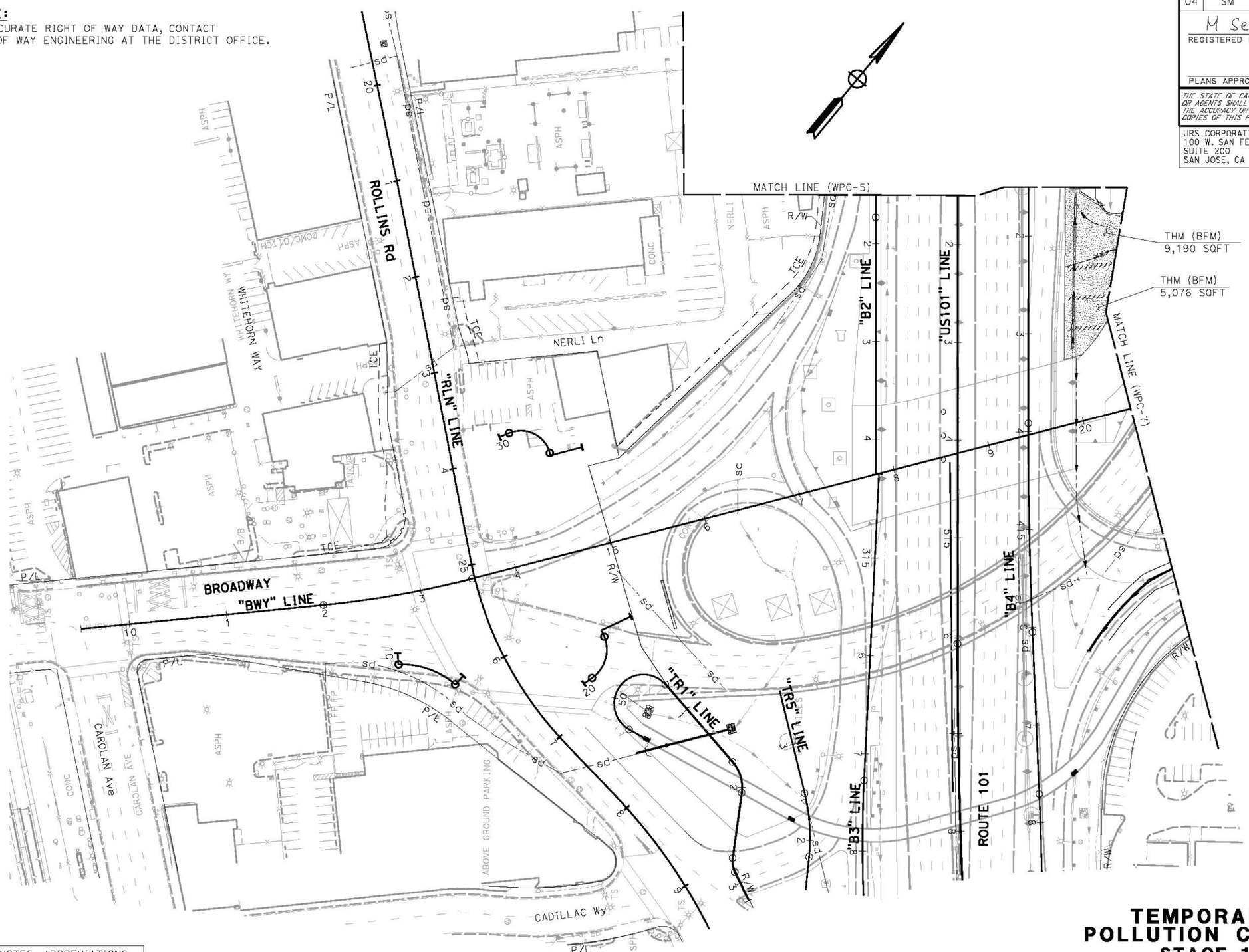

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 1 PHASE 2
SCALE 1" = 50'

WPC-6

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
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CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 11:27:15 PM

BORDER LAST REVISED 7/2/2010
USERNAME => shruti_shah
DGN FILE => 040000068 4gb006.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0703
PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
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SAN CARLOS, CA 94070-1306

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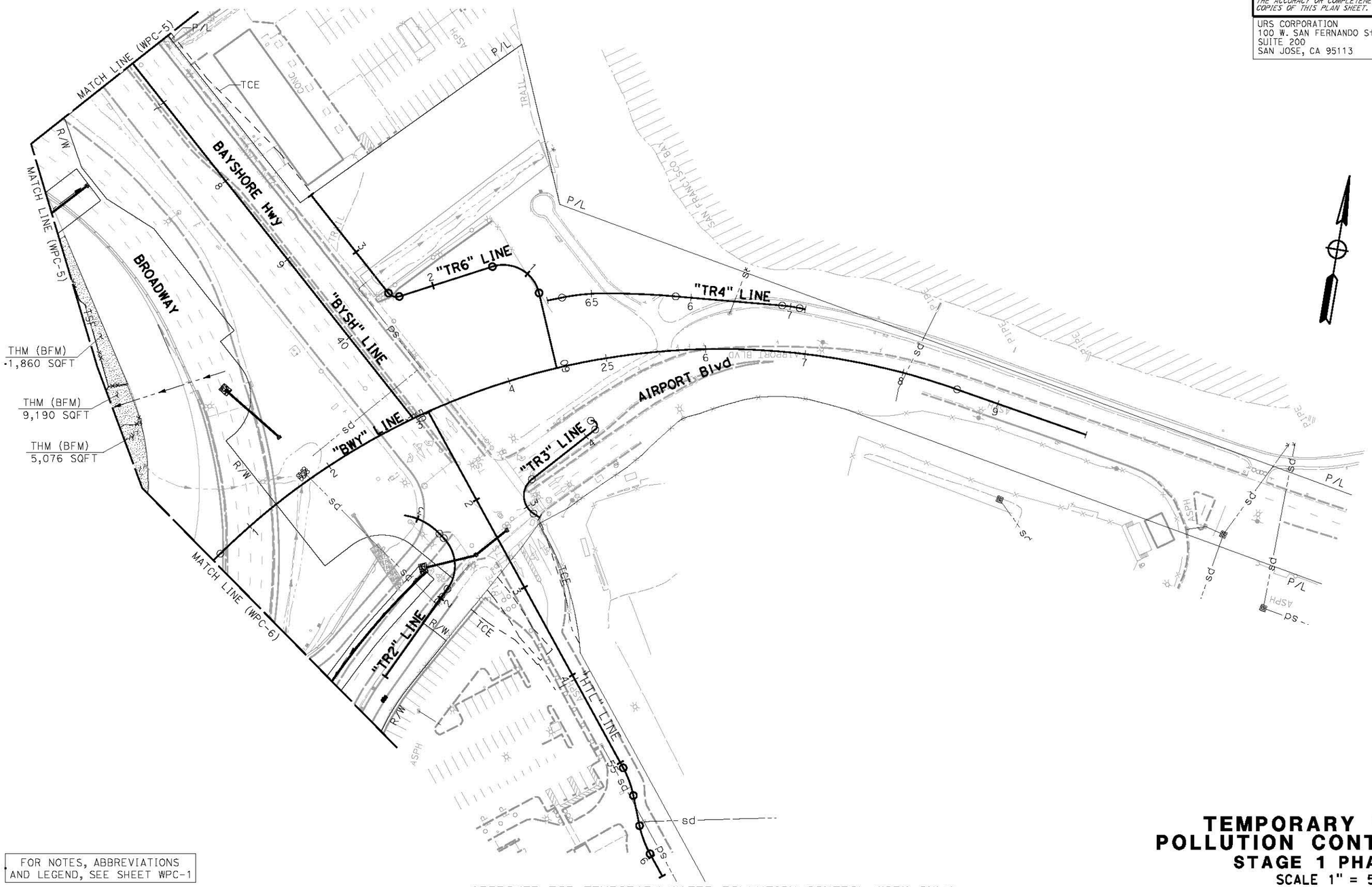

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 1 PHASE 2
SCALE 1" = 50'

WPC-7

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
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DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:27:21 PM

BORDER LAST REVISED 7/2/2010
USERNAME => shruti_shah
DGN FILE => 0400000684gb007.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0703
PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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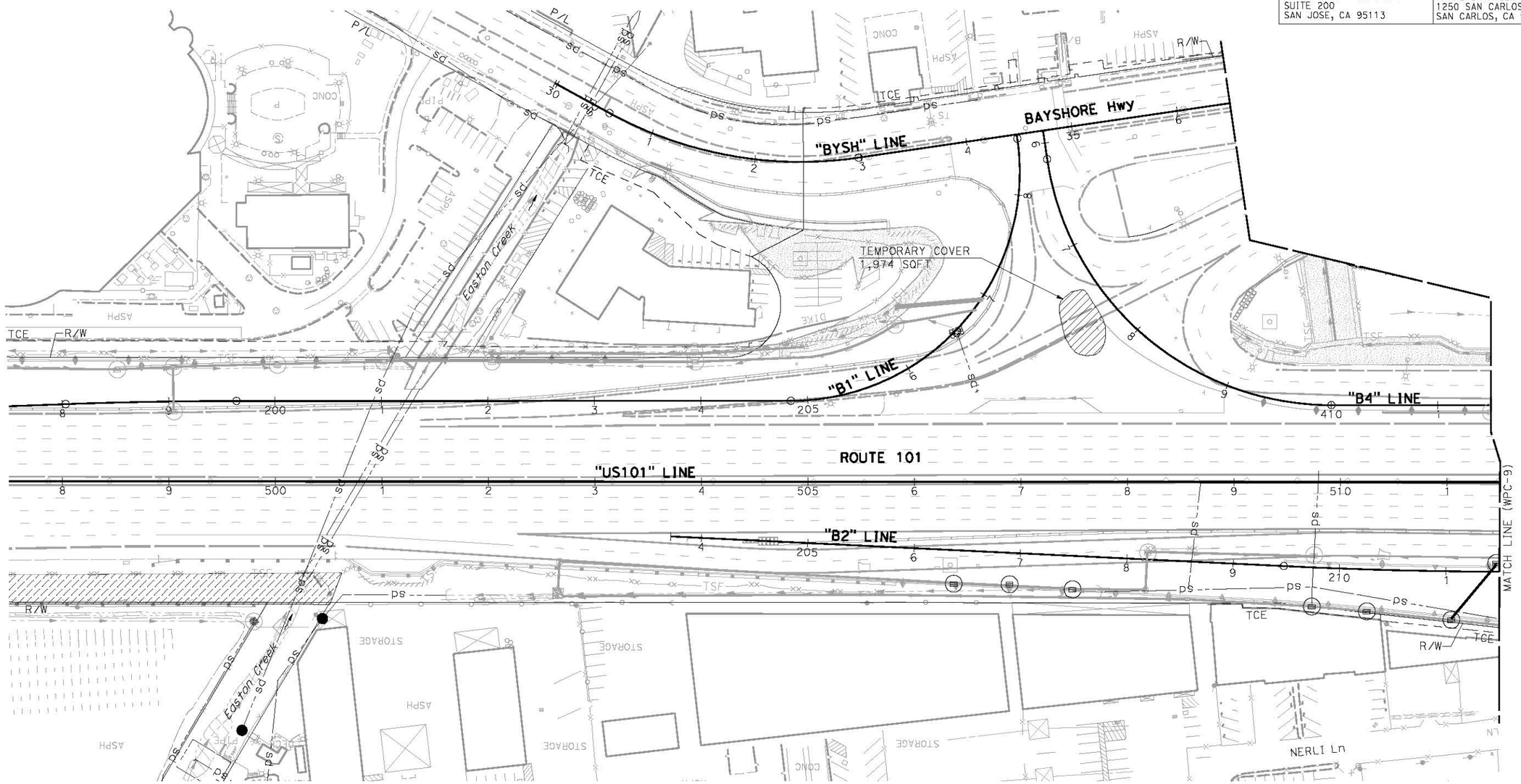

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 2 PHASE 1
SCALE 1" = 50'

WPC-8

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 11:27:27 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi — REGISTERED CIVIL ENGINEER — 4/17/13 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Maria Sedghi — No. C74619 — Exp. 12-31-13 — CIVIL — STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

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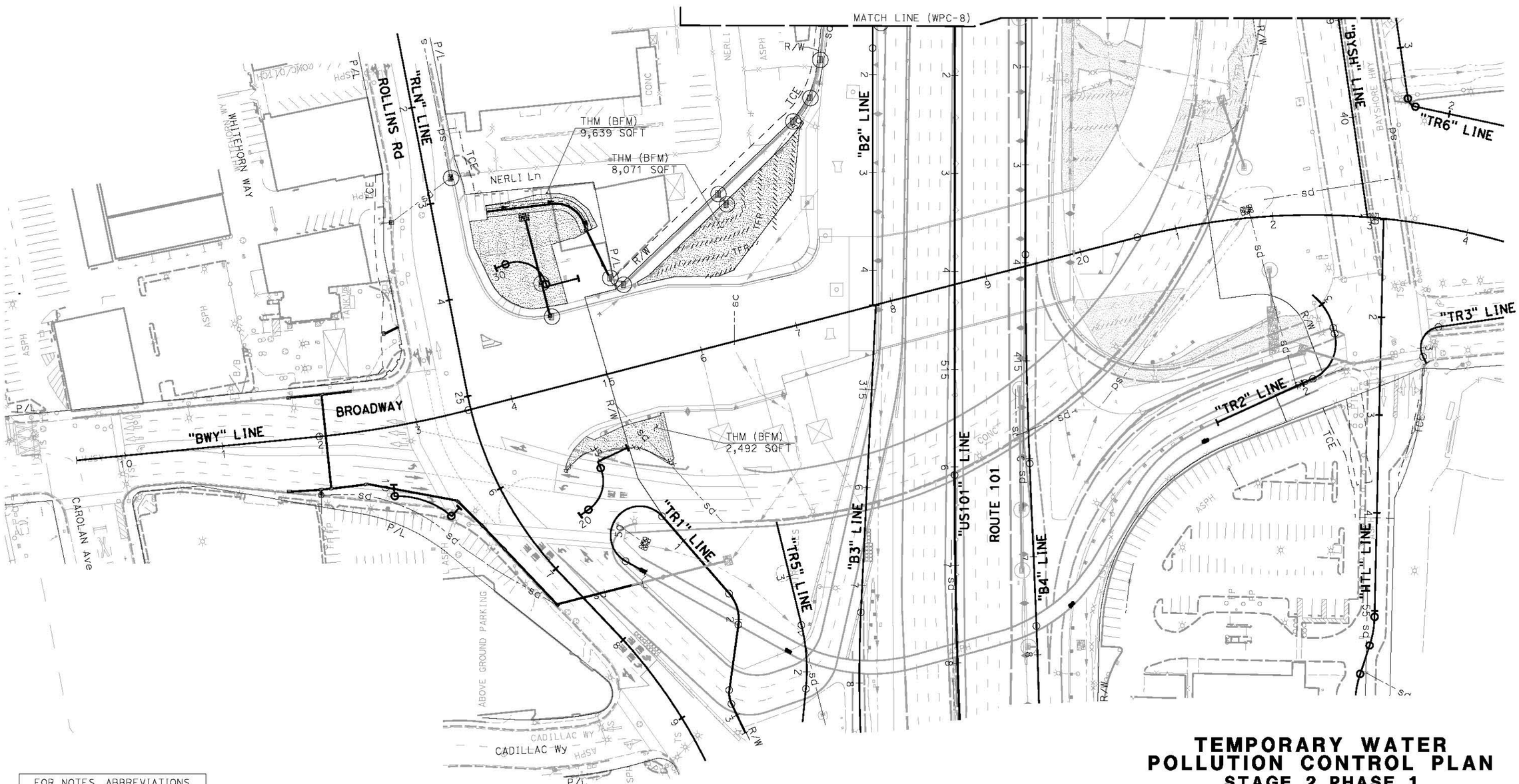

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 2 PHASE 1
SCALE 1" = 50'

WPC-9

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION — Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13 — DATE PLOTTED => 6/3/2013 — TIME PLOTTED => 1:27:33 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

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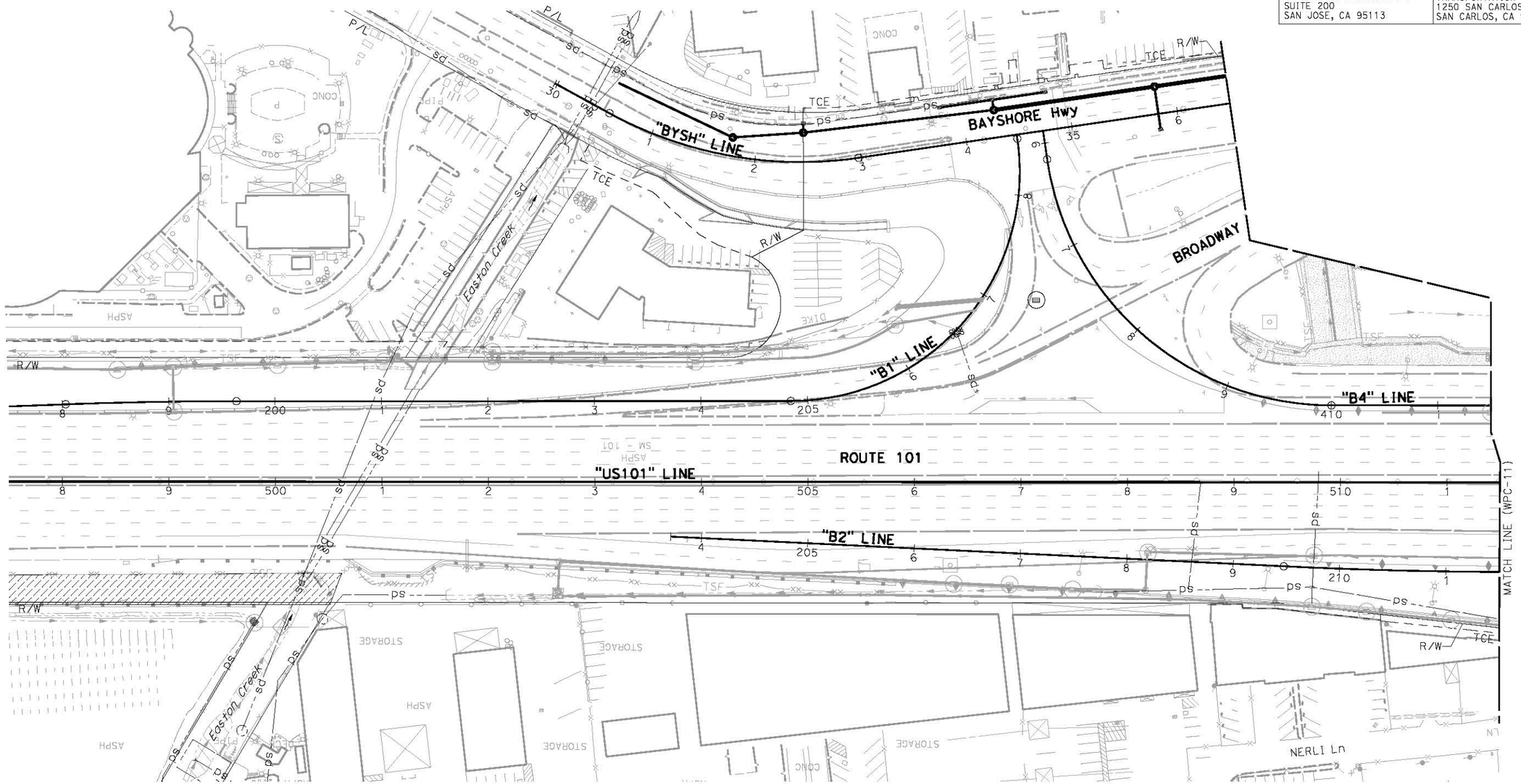

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 2 PHASE 2
SCALE 1" = 50'

WPC-10

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:27:43 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

NOTE:
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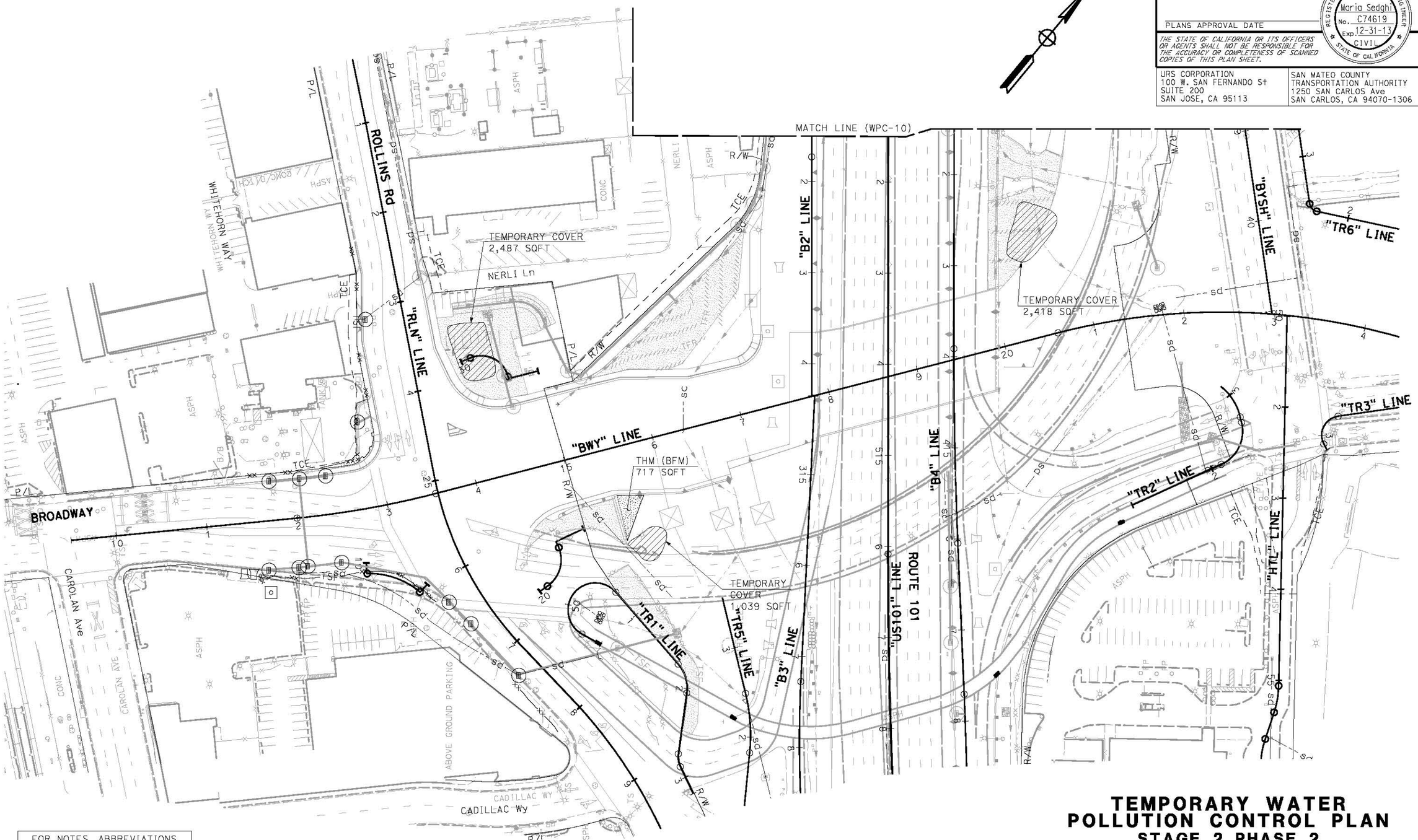
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 2 PHASE 2
SCALE 1" = 50'

WPC-11

REVISED BY	DATE REVISED
JH	4/17/13

CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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Caltrans

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:27:48 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
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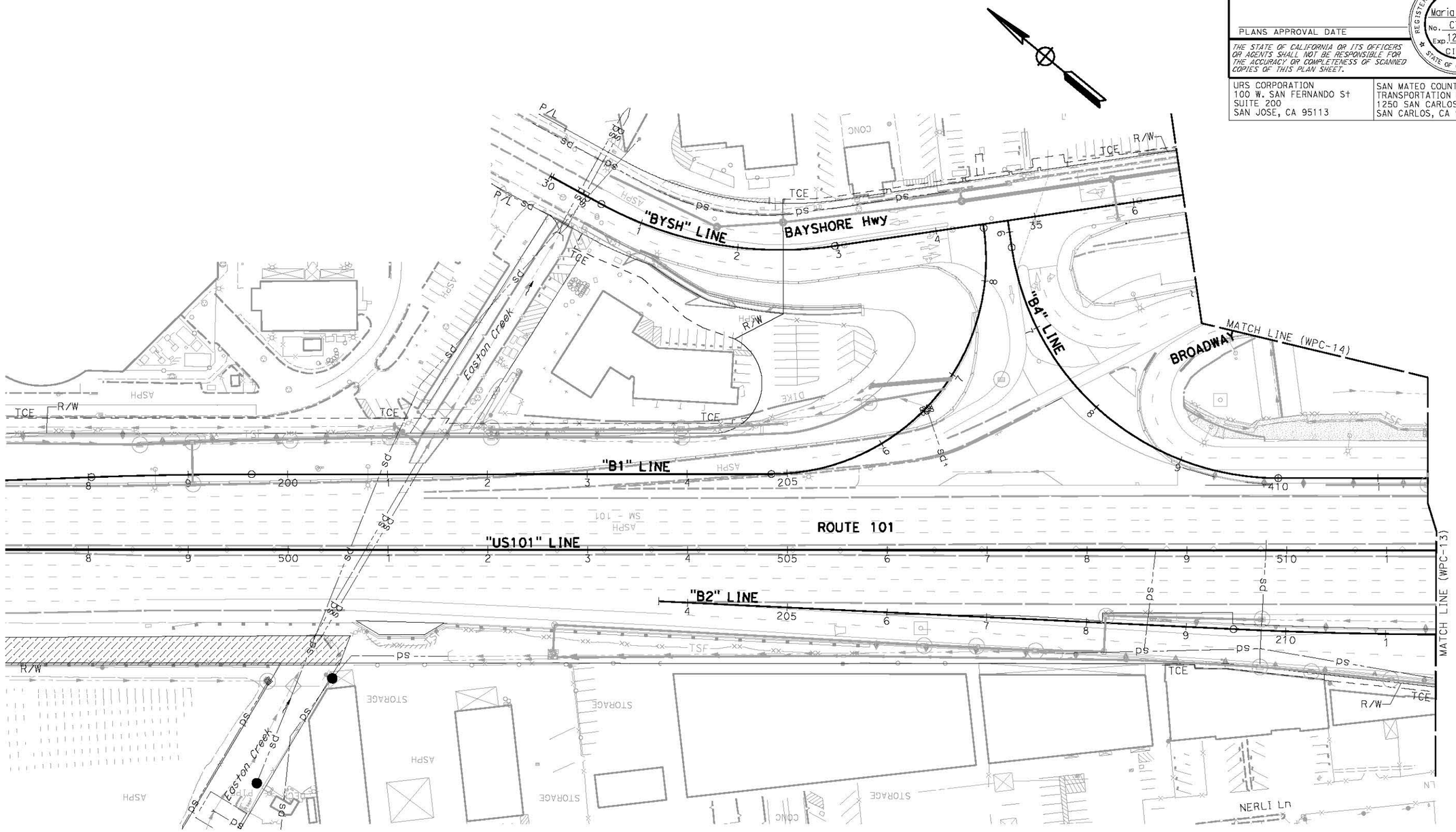
SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 1A
SCALE 1" = 50'

WPC-12

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:27:58 PM

BORDER LAST REVISED 7/2/2010
USERNAME => shruti_shah
DGN FILE => 0400000684gb012.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0703
PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
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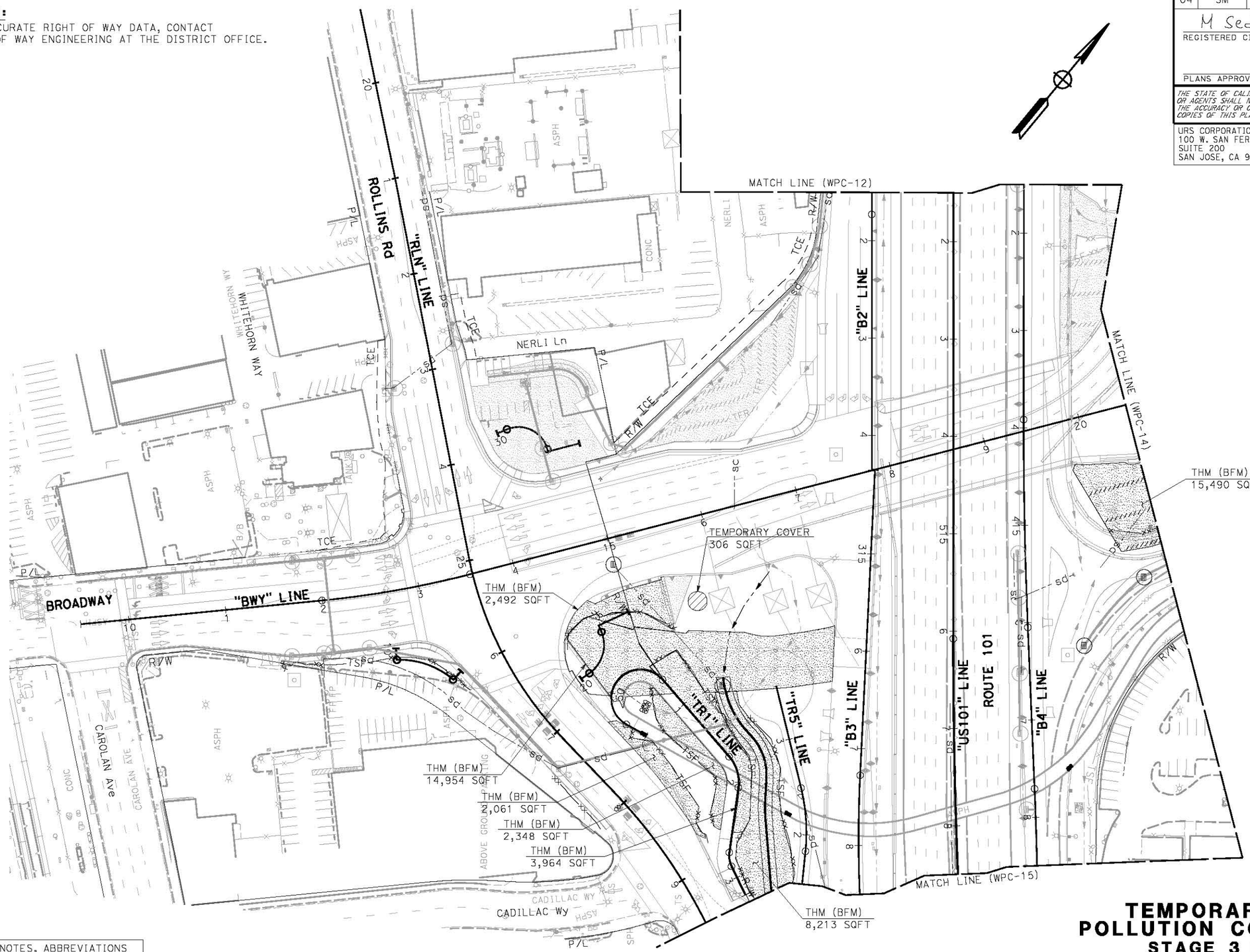

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 1A
SCALE 1" = 50'

WPC-13

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:28:03 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN MATEO COUNTY
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1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
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RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 1A
SCALE 1" = 50'

WPC-14

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:28:16 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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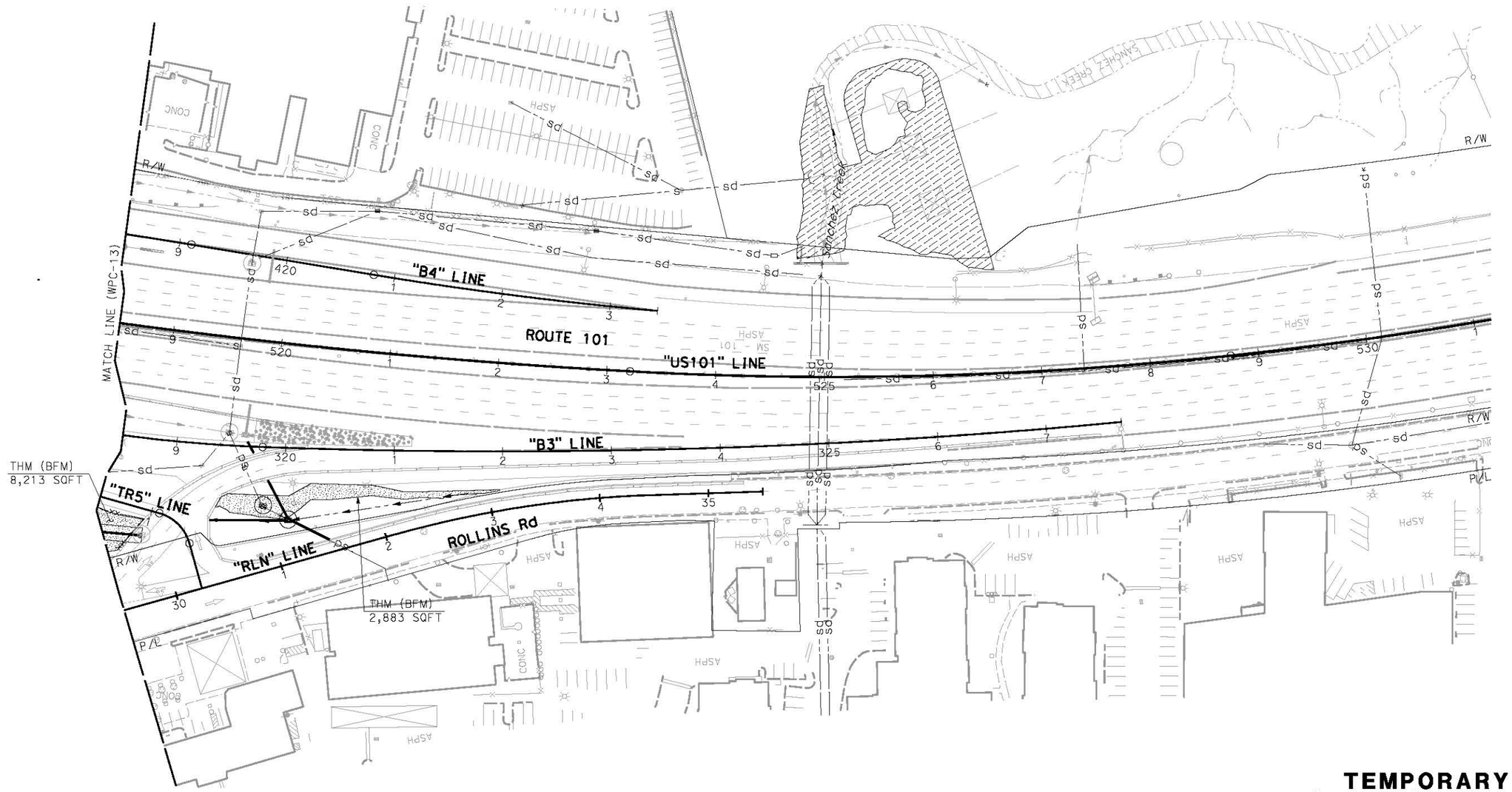
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 1A
SCALE 1" = 50'

WPC-15

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

CALCULATED-DESIGNED BY: JASON HOM

CHECKED BY: MARIA SEDGHI

REVISED BY: JH

DATE REVISED: 4/17/13

LAST REVISION 04-17-13 DATE PLOTTED => 6/3/2013 TIME PLOTTED => 1:28:24 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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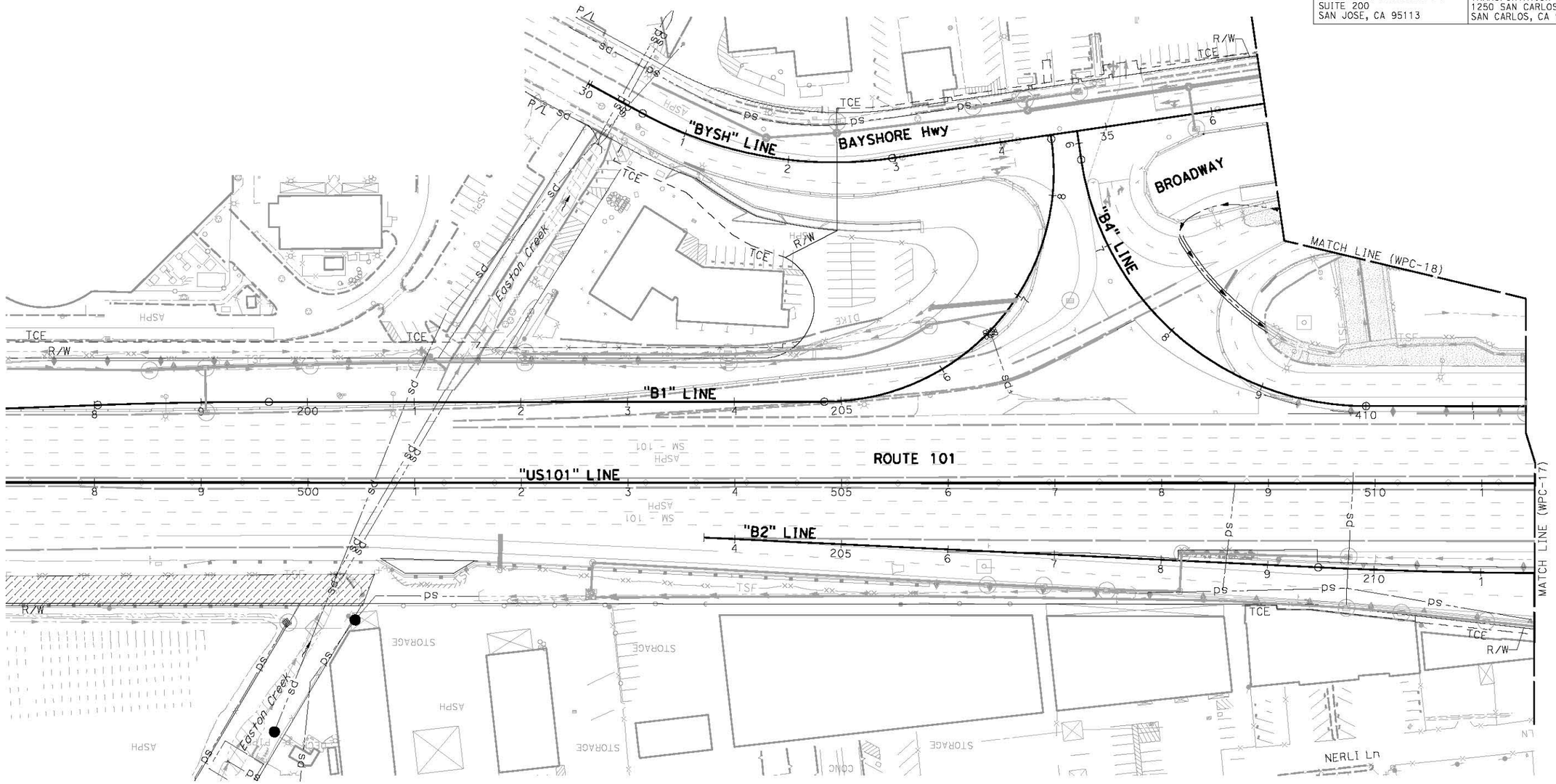
SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 1B
SCALE 1" = 50'

WPC-16

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:28:30 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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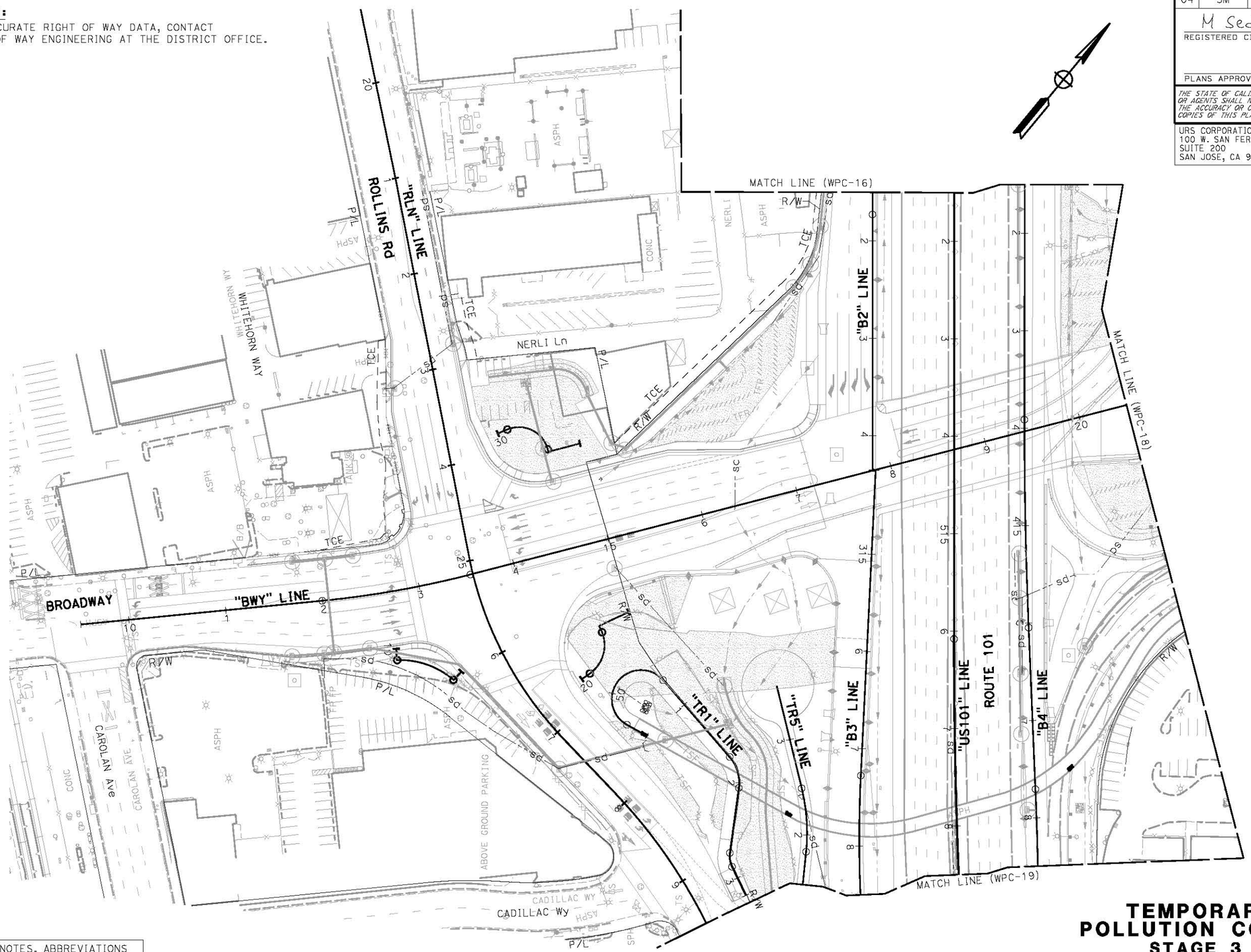
SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 1B
SCALE 1" = 50'

WPC-17

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:28:35 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
Exp. 12-31-13
CIVIL
STATE OF CALIFORNIA

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1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
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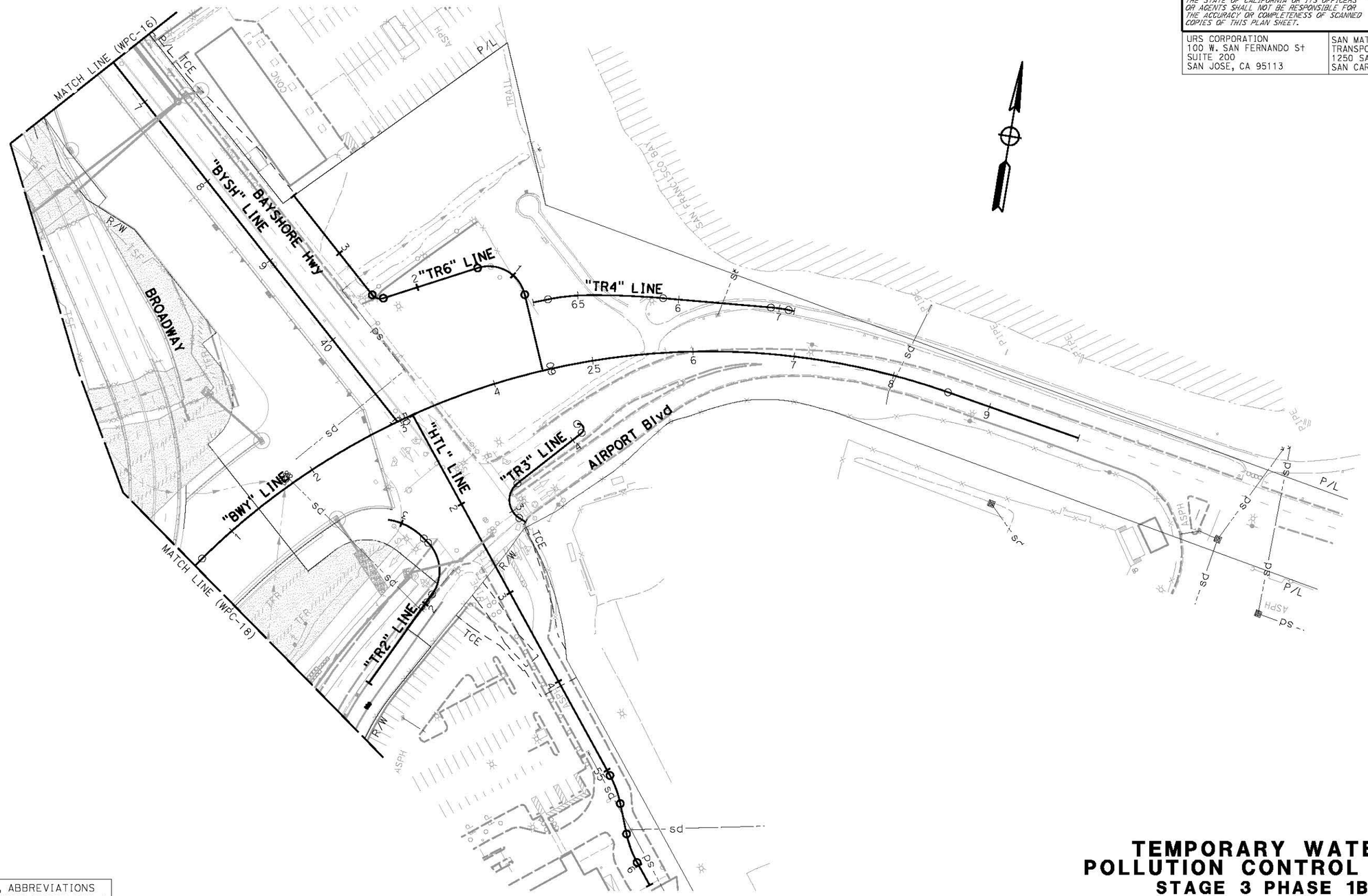

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 1B
SCALE 1" = 50'

WPC-18

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:28:48 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
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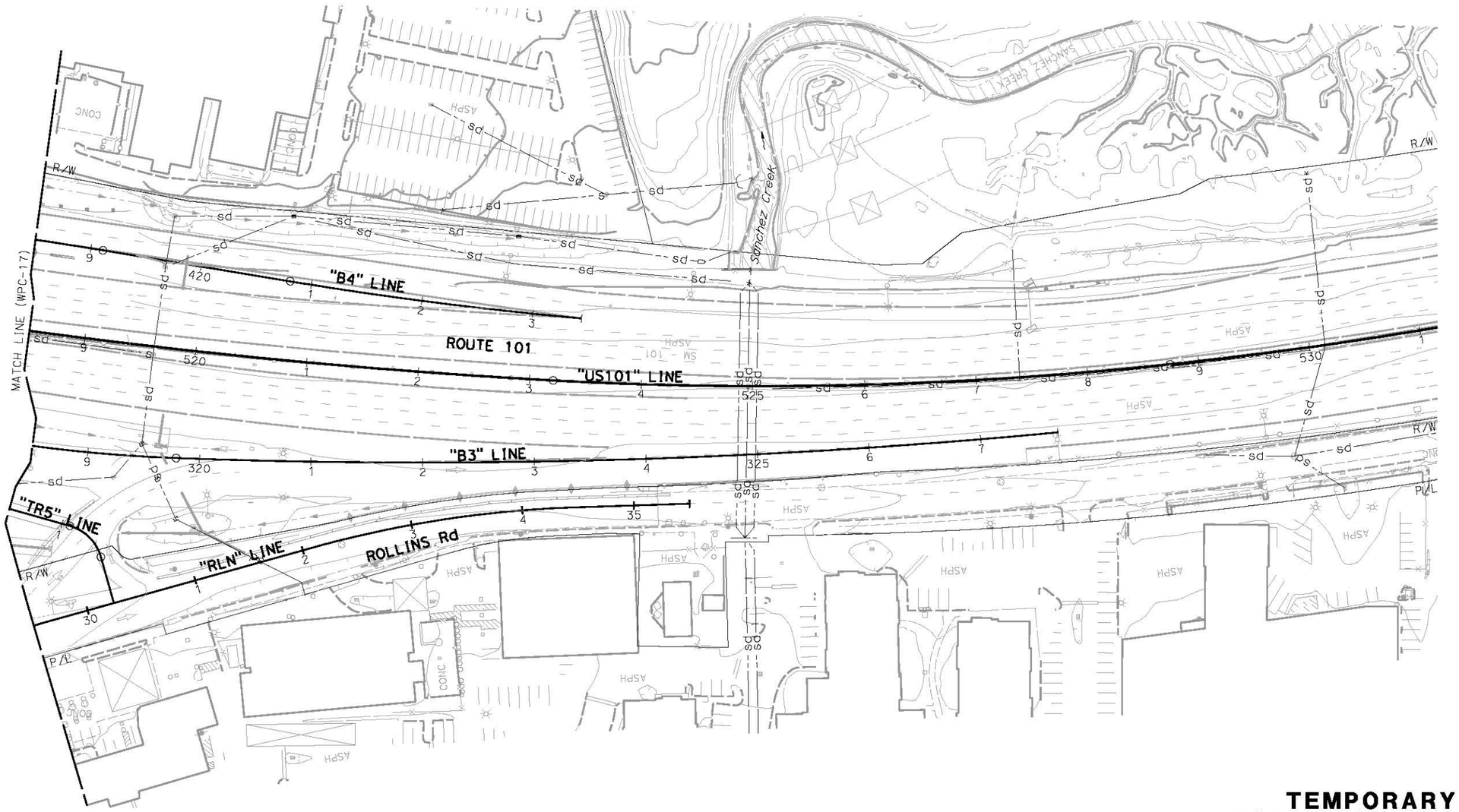
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 1B
SCALE 1" = 50'

WPC-19

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	CONSULTANT FUNCTIONAL SUPERVISOR	CALCULATED-DESIGNED BY	JASON HOM	REVISED BY	JH
	RAMSEY J. HISSEN	CHECKED BY	MARIA SEDGHI	DATE REVISED	4/17/13

LAST REVISION 04-17-13 | DATE PLOTTED => 6/3/2013 | TIME PLOTTED => 1:28:57 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN MATEO COUNTY
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1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

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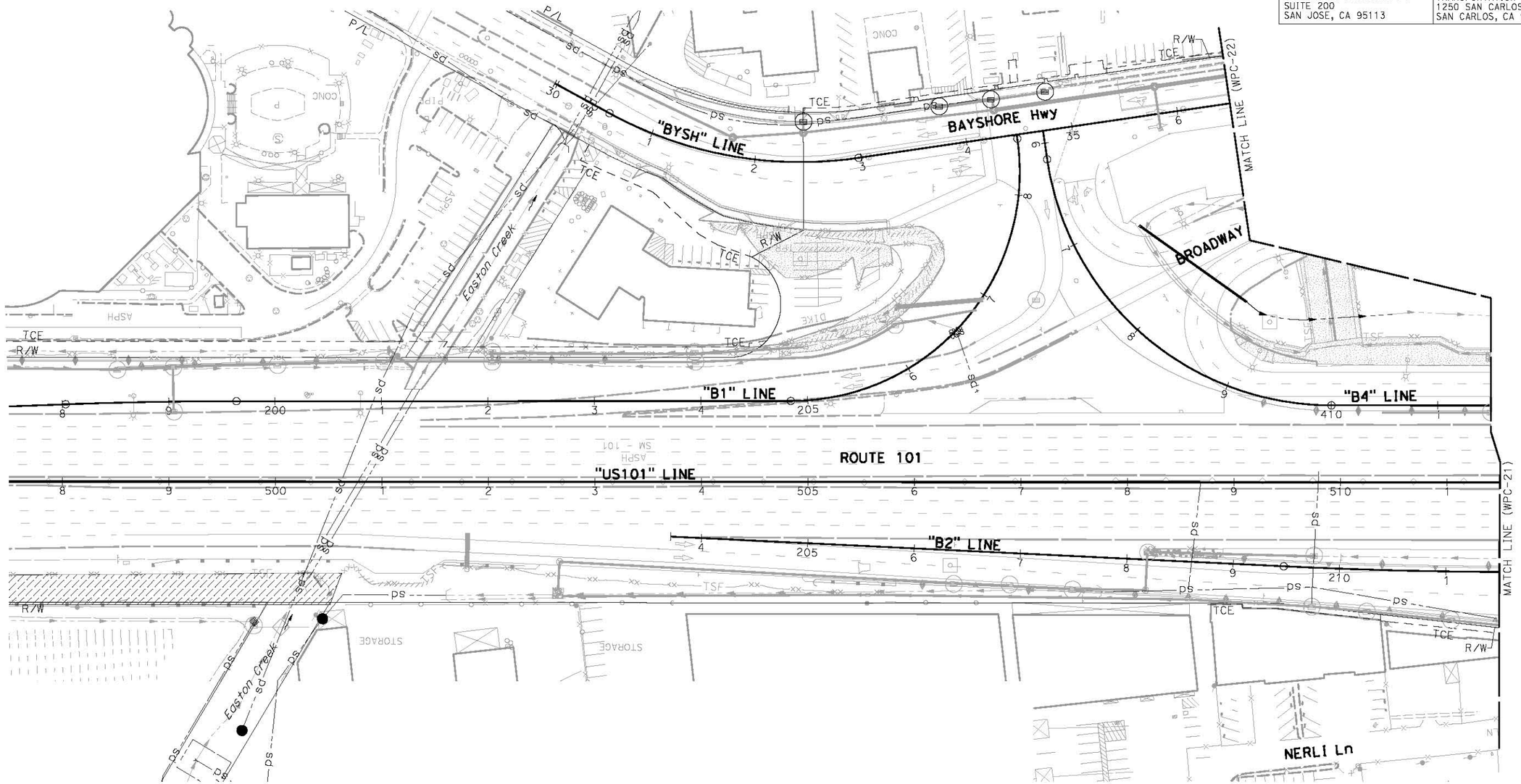

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 2
SCALE 1" = 50'

WPC-20

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:29:02 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

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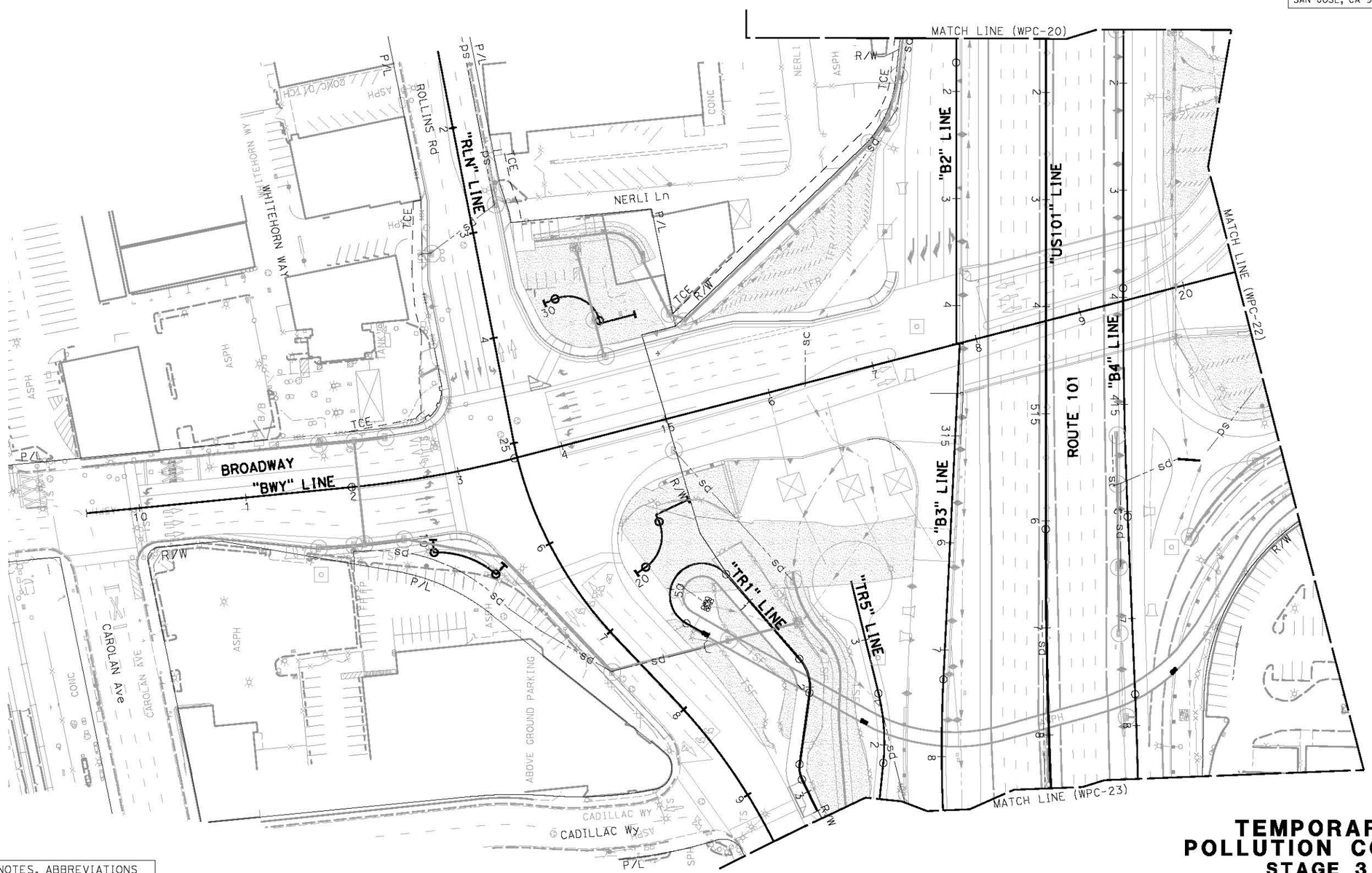

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 2
SCALE 1" = 50'

WPC-21

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:29:08 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
Exp. 12-31-13
CIVIL
STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

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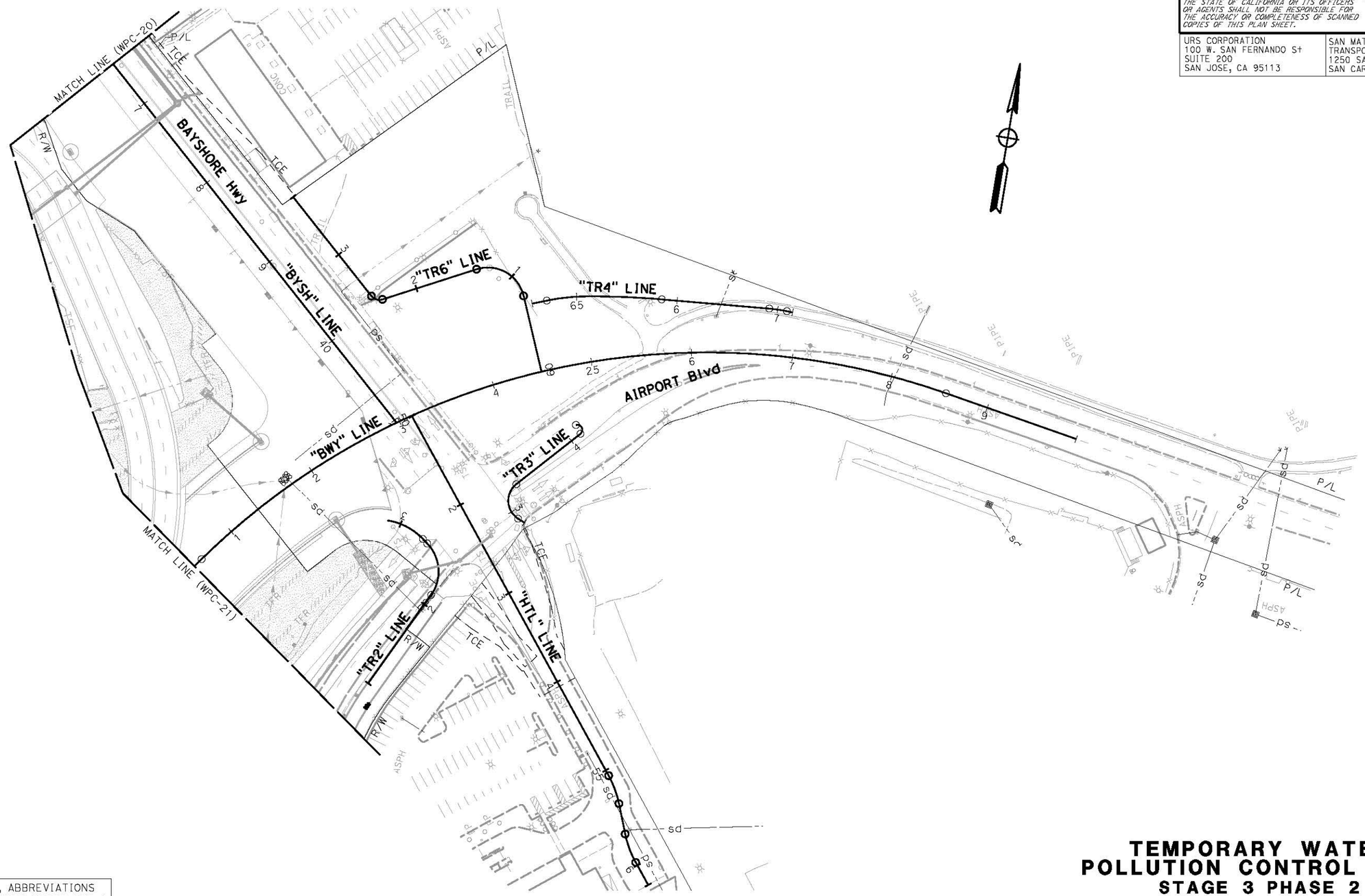

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 2
SCALE 1" = 50'

WPC-22

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:29:20 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

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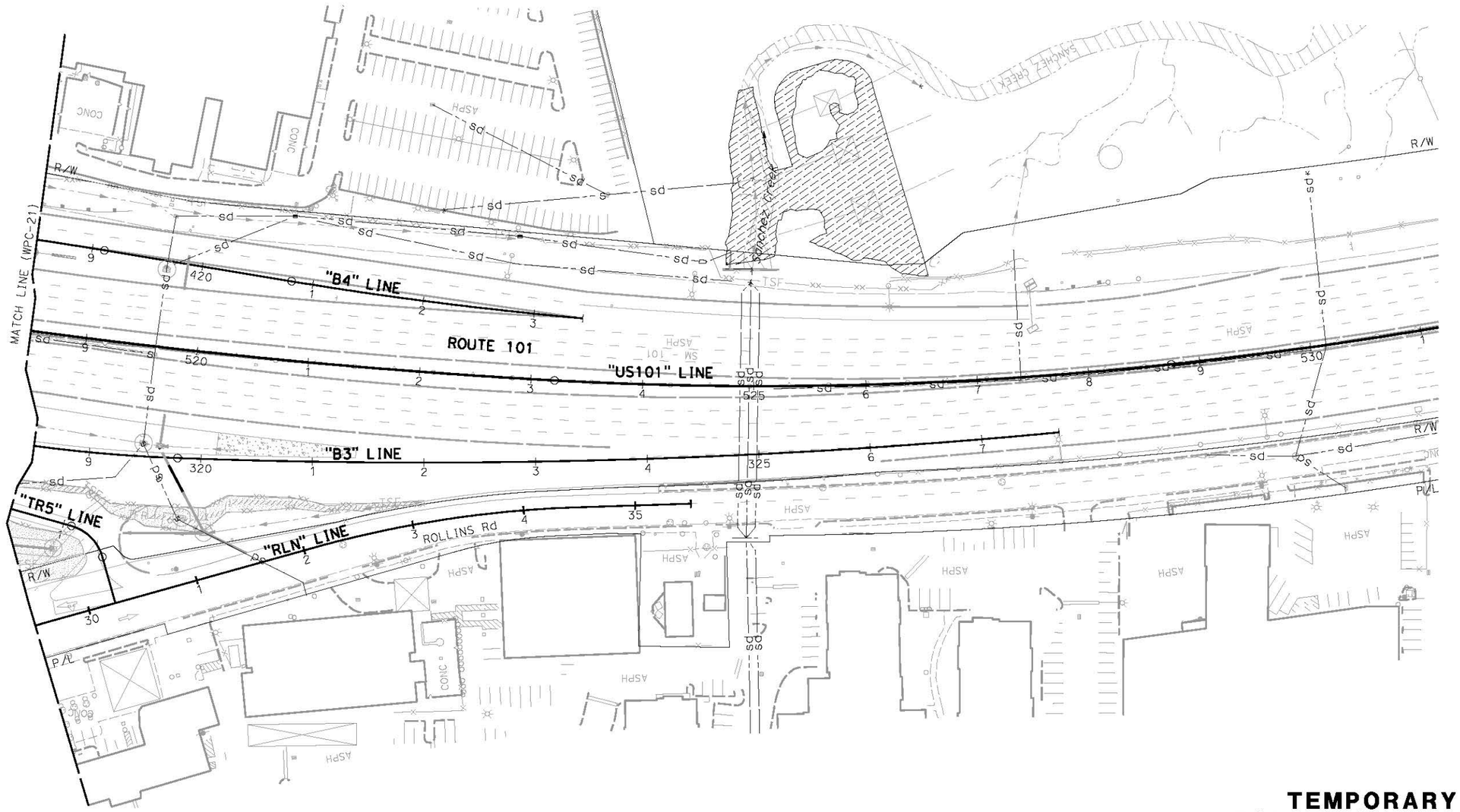

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 3 PHASE 2
SCALE 1" = 50'

WPC-23

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:29:28 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
Exp. 12-31-13
CIVIL
STATE OF CALIFORNIA

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SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
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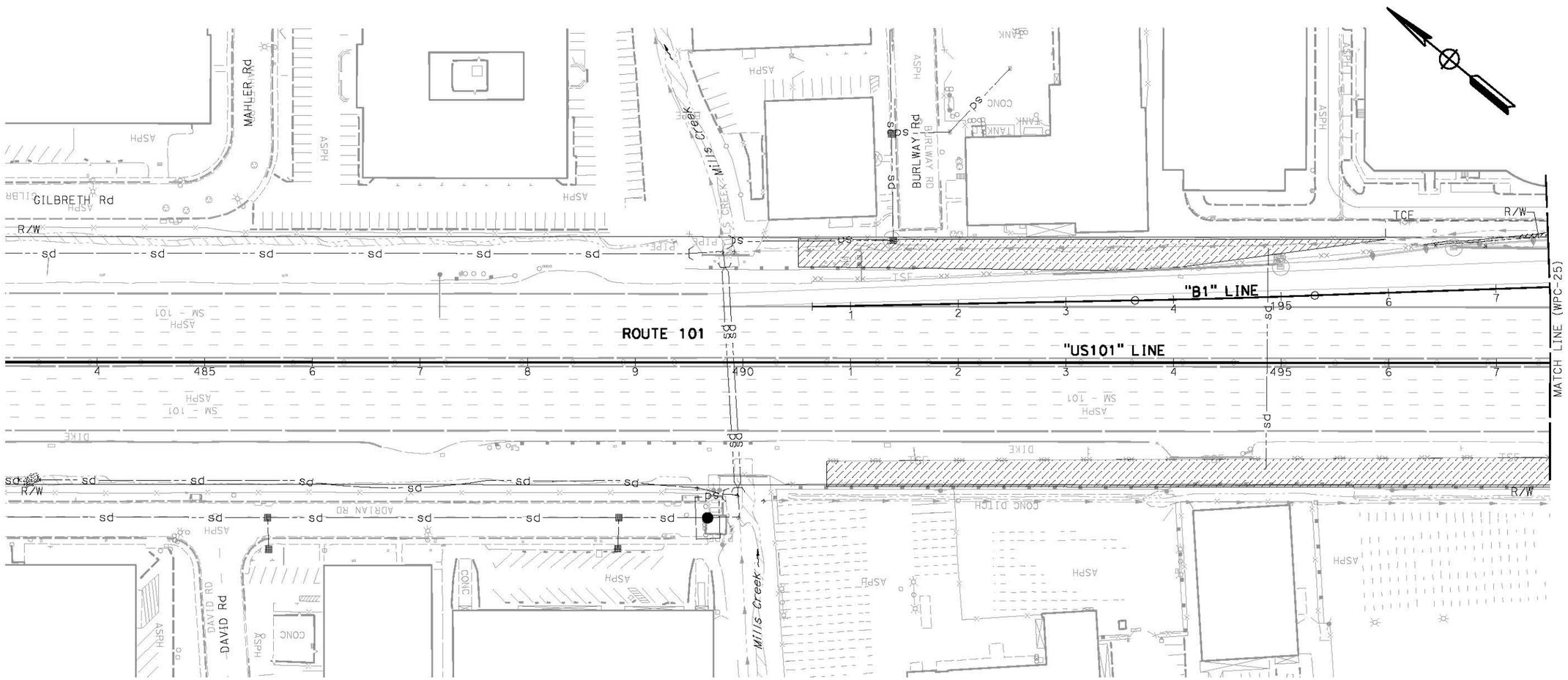

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 4 PHASE 1
SCALE 1" = 50'

WPC-24

CALCULATED-DESIGNED BY	JASON HOM	REVISED BY	JH
CHECKED BY	MARIA SEDGHI	DATE REVISED	4/17/13

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 04-17-13 | DATE PLOTTED => 6/3/2013 | TIME PLOTTED => 1:29:33 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

NOTE:
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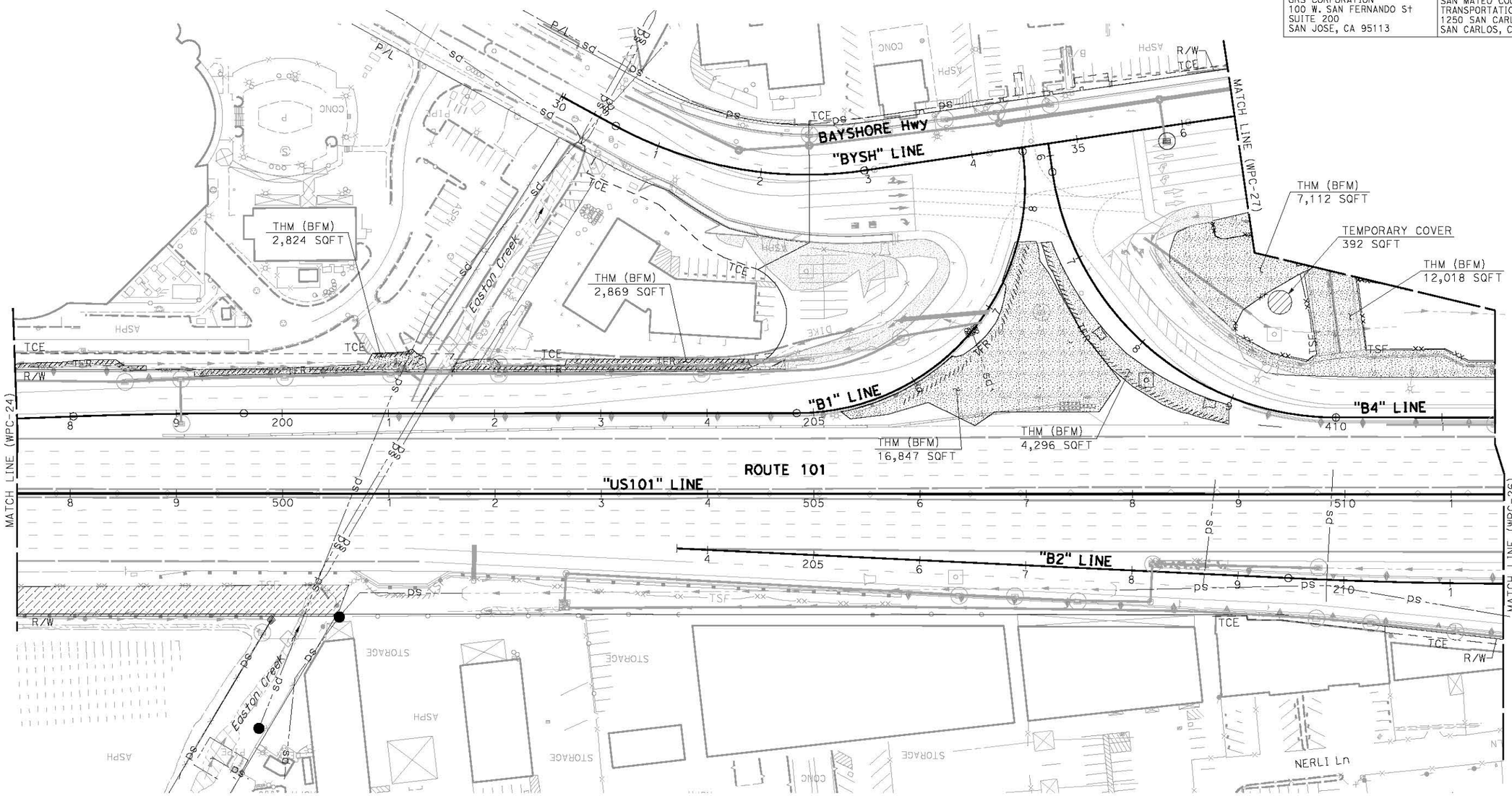

FOR NOTES AND LEGEND,
SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 4 PHASE 1
SCALE 1" = 50'

WPC-25

REVISED BY	JH
DATE REVISED	4/17/13
CALCULATED-DESIGNED BY	JASON HOM
CHECKED BY	MARIA SEDGHI
CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:29:37 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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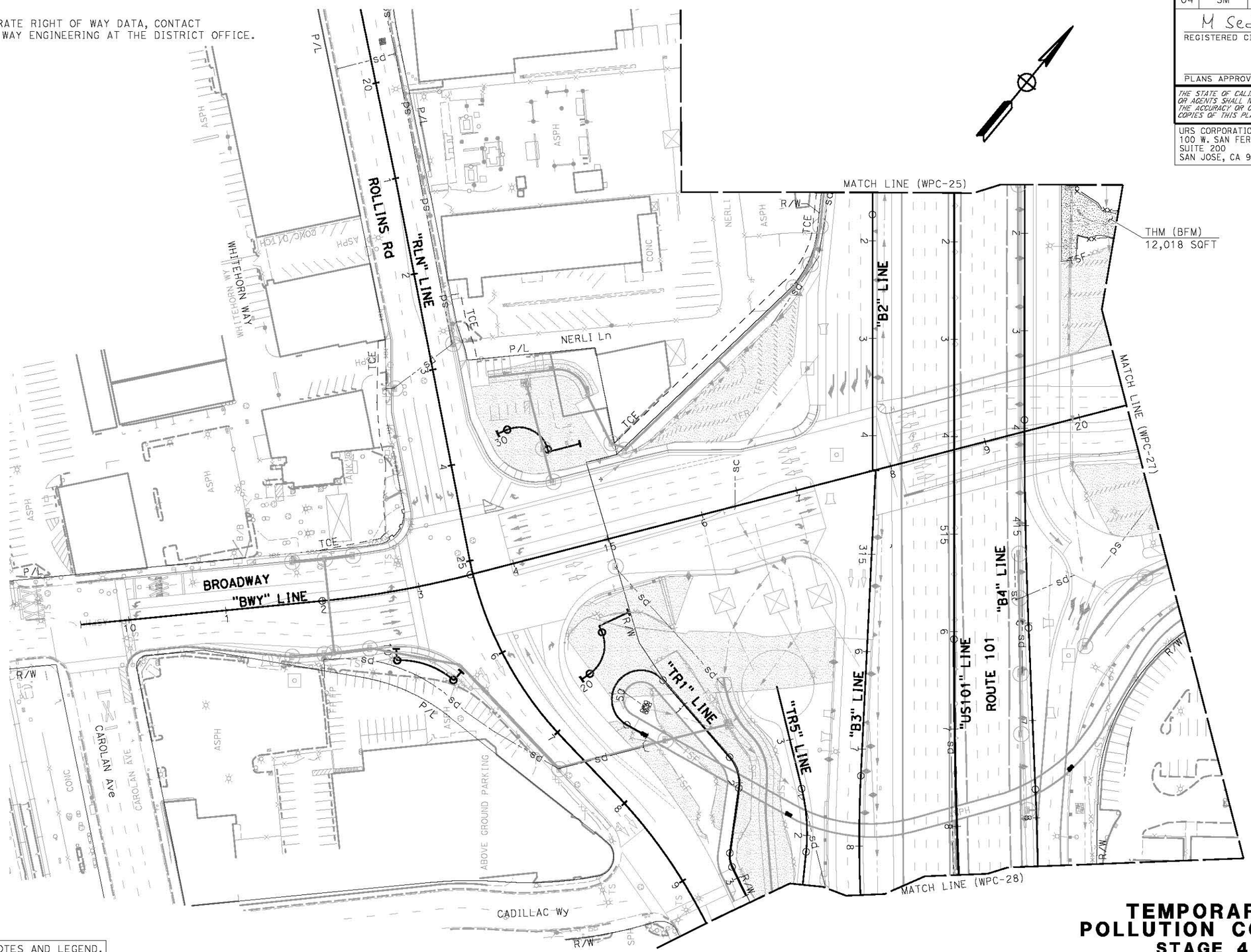
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 4 PHASE 1
SCALE 1" = 50'

WPC-26

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:29:49 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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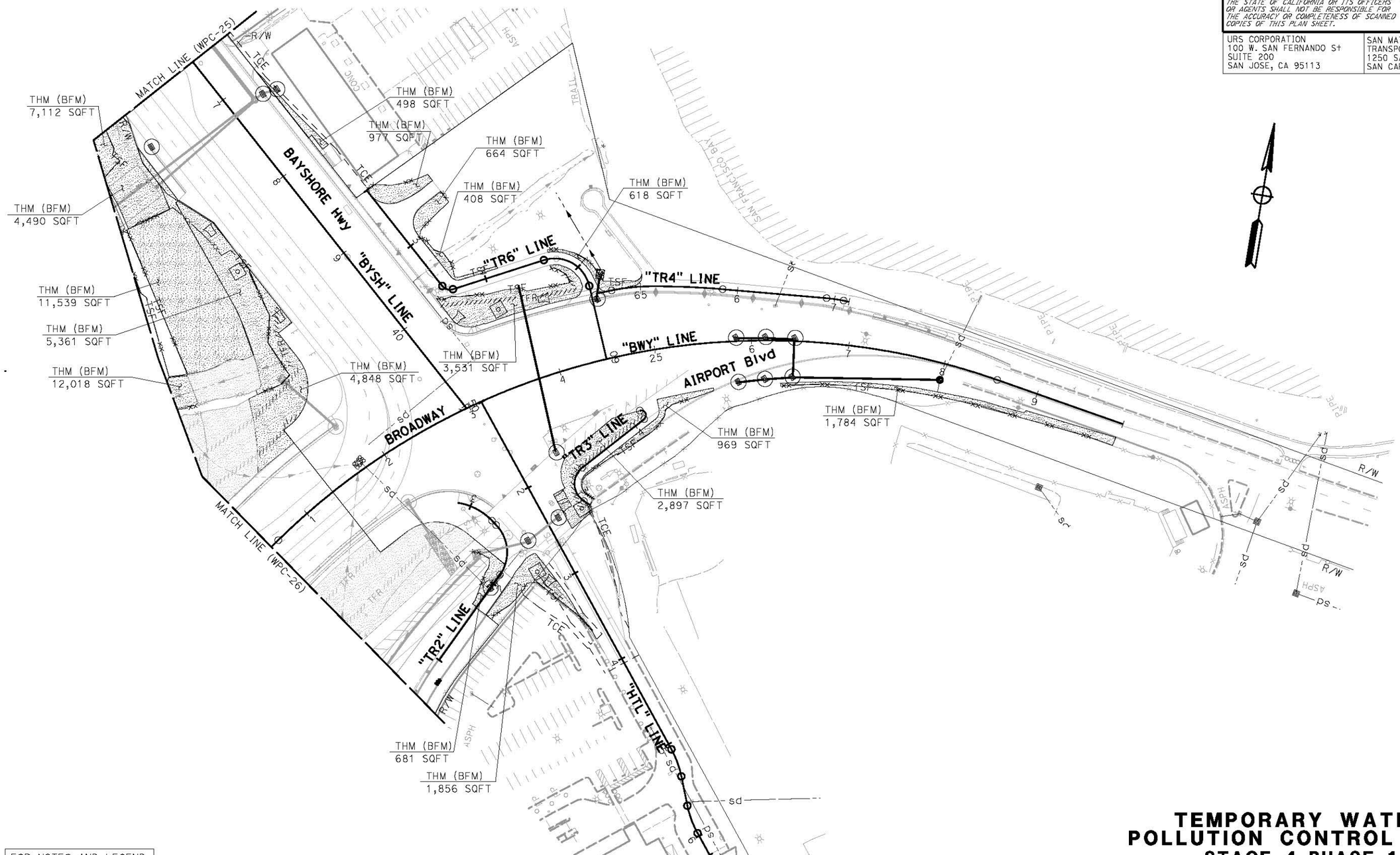
SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 4 PHASE 1
SCALE 1" = 50'

WPC-27

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:30:01 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
Exp. 12-31-13
CIVIL
STATE OF CALIFORNIA

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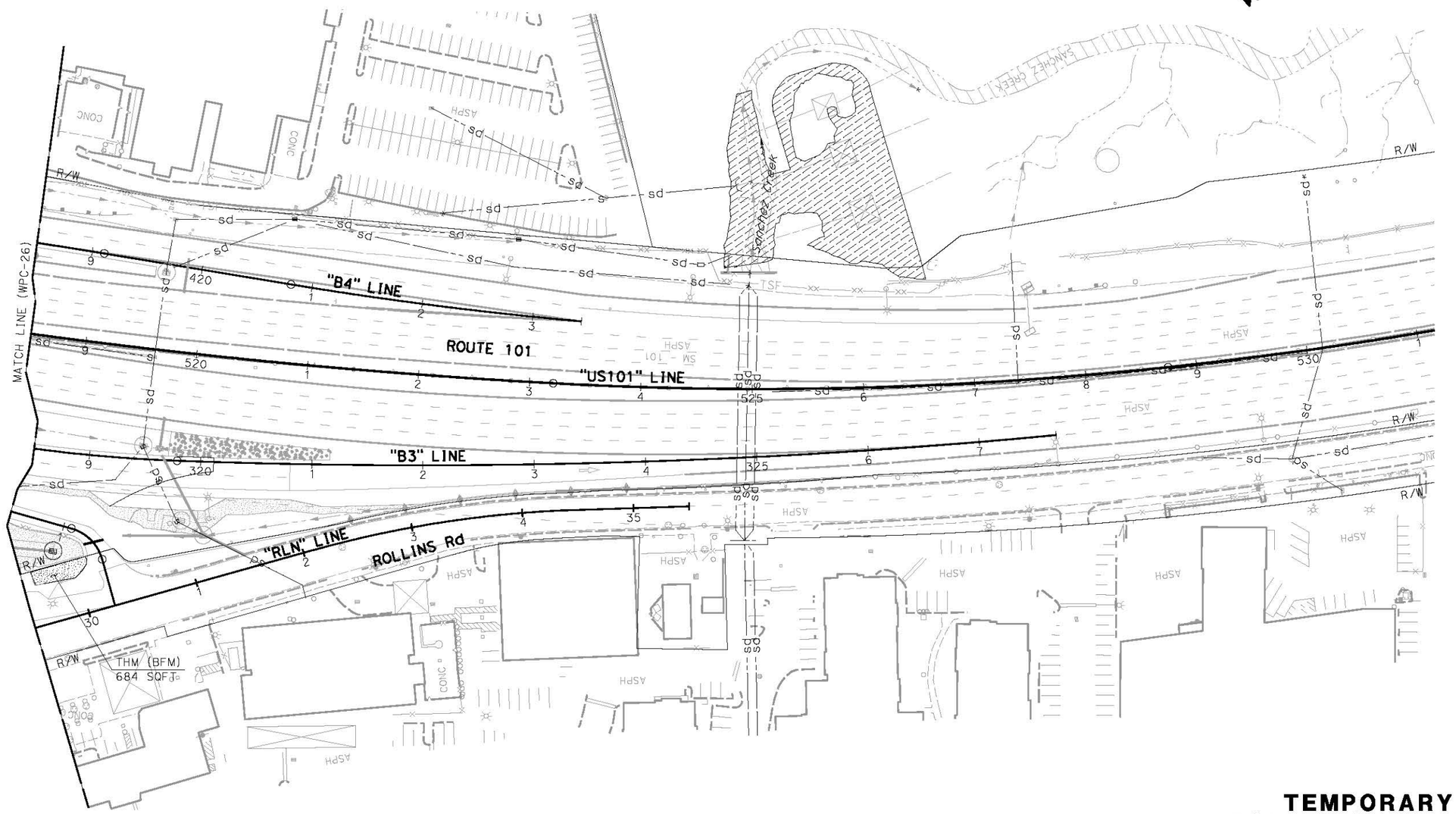
SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 4 PHASE 1
SCALE 1" = 50'

WPC-28

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:30:12 PM

BORDER LAST REVISED 7/2/2010
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DGN FILE => 0400000684gb028.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0703
PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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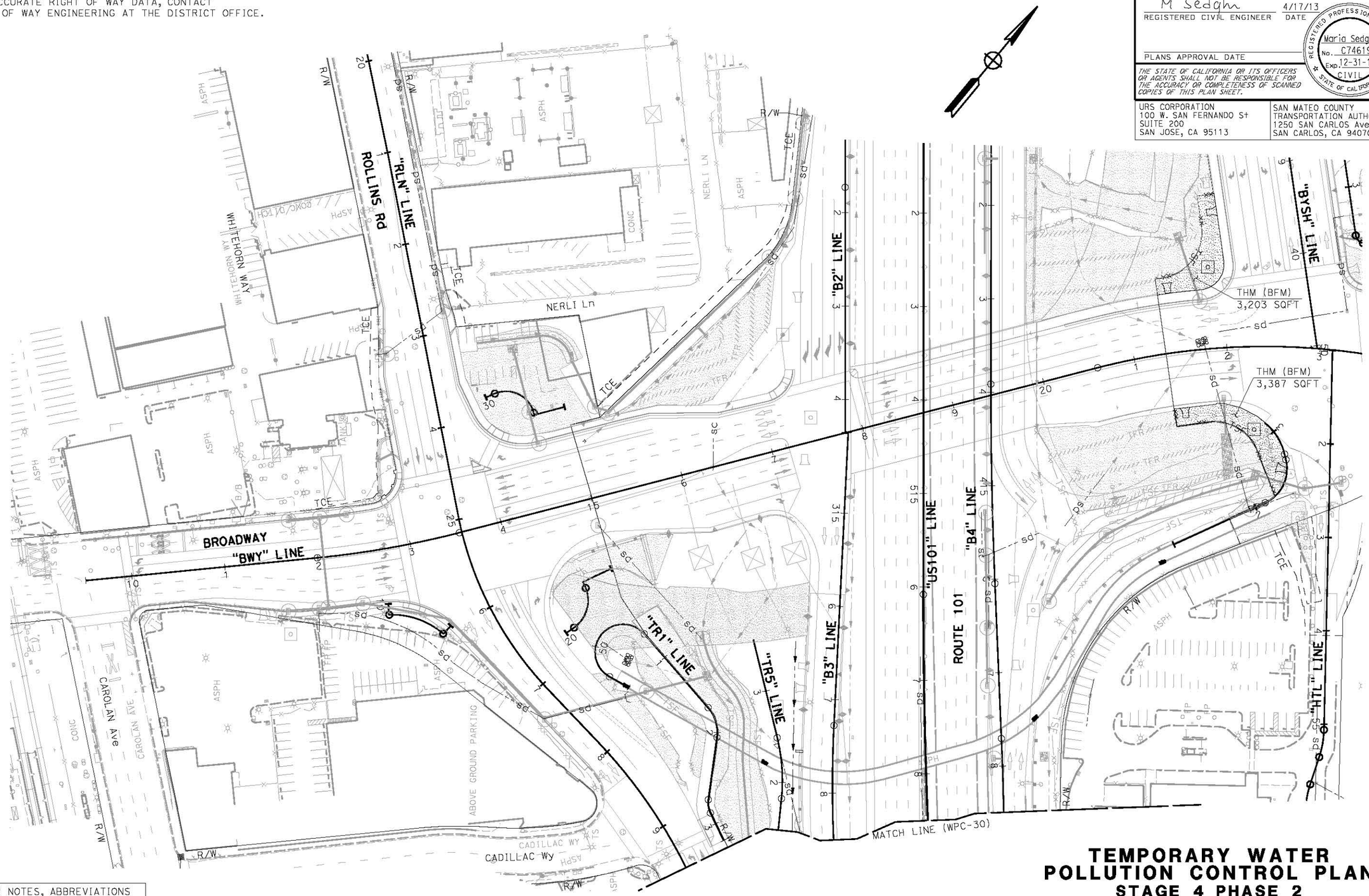
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 4 PHASE 2
SCALE 1" = 50'

WPC-29

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	CONSULTANT FUNCTIONAL SUPERVISOR	CALCULATED-DESIGNED BY	JASON HOM
Caltrans	RAMSEY J. HISSEN	CHECKED BY	MARIA SEDGHI

REVISED BY	DATE REVISED
JH	4/17/13

LAST REVISION 04-17-13 DATE PLOTTED => 6/3/2013 TIME PLOTTED => 11:30:20 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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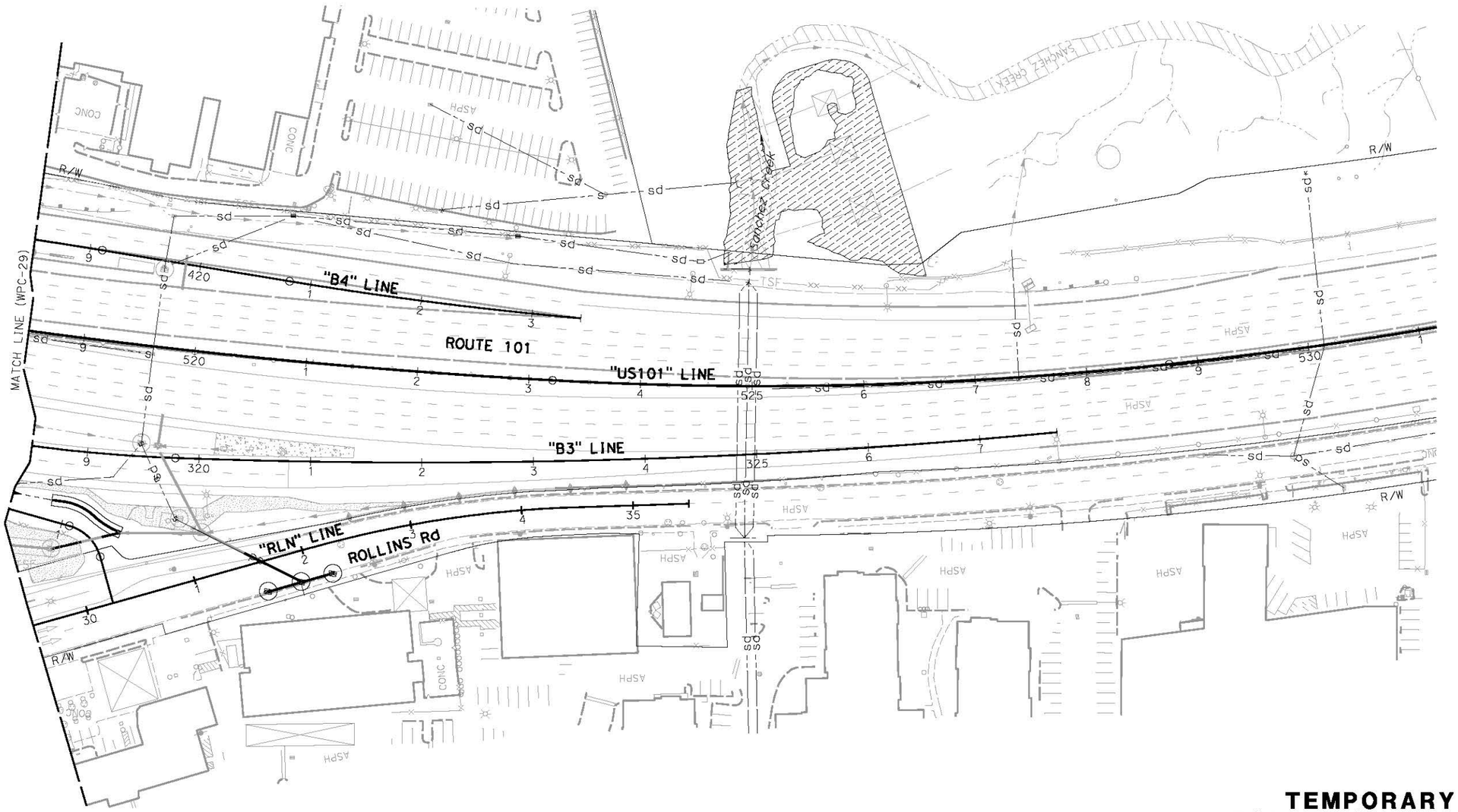
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 4 PHASE 2
SCALE 1" = 50'

WPC-30

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

		REVISED BY	JH
		DATE REVISED	4/17/13
CALCULATED-DESIGNED BY	JASON HOM		
CHECKED BY	MARIA SEDGHI		
CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN		

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
Exp. 12-31-13
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SAN CARLOS, CA 94070-1306

NOTE:
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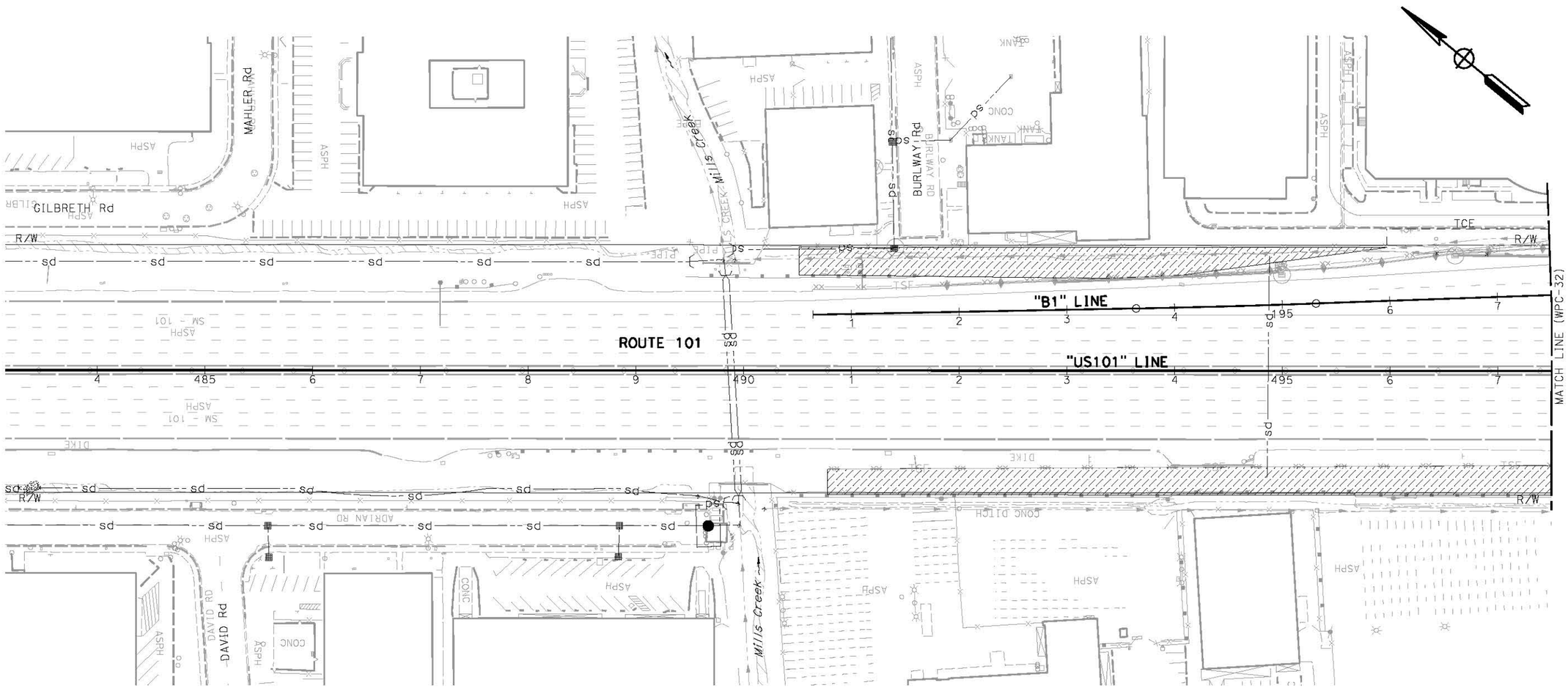
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 5 PHASE 1
SCALE 1" = 50'

WPC-31

CALCULATED-DESIGNED BY	JASON HOM	REVISED BY	JH
CHECKED BY	MARIA SEDGHI	DATE REVISED	4/17/13

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

LAST REVISION 04-17-13 | DATE PLOTTED => 6/3/2013 | TIME PLOTTED => 1:30:42 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

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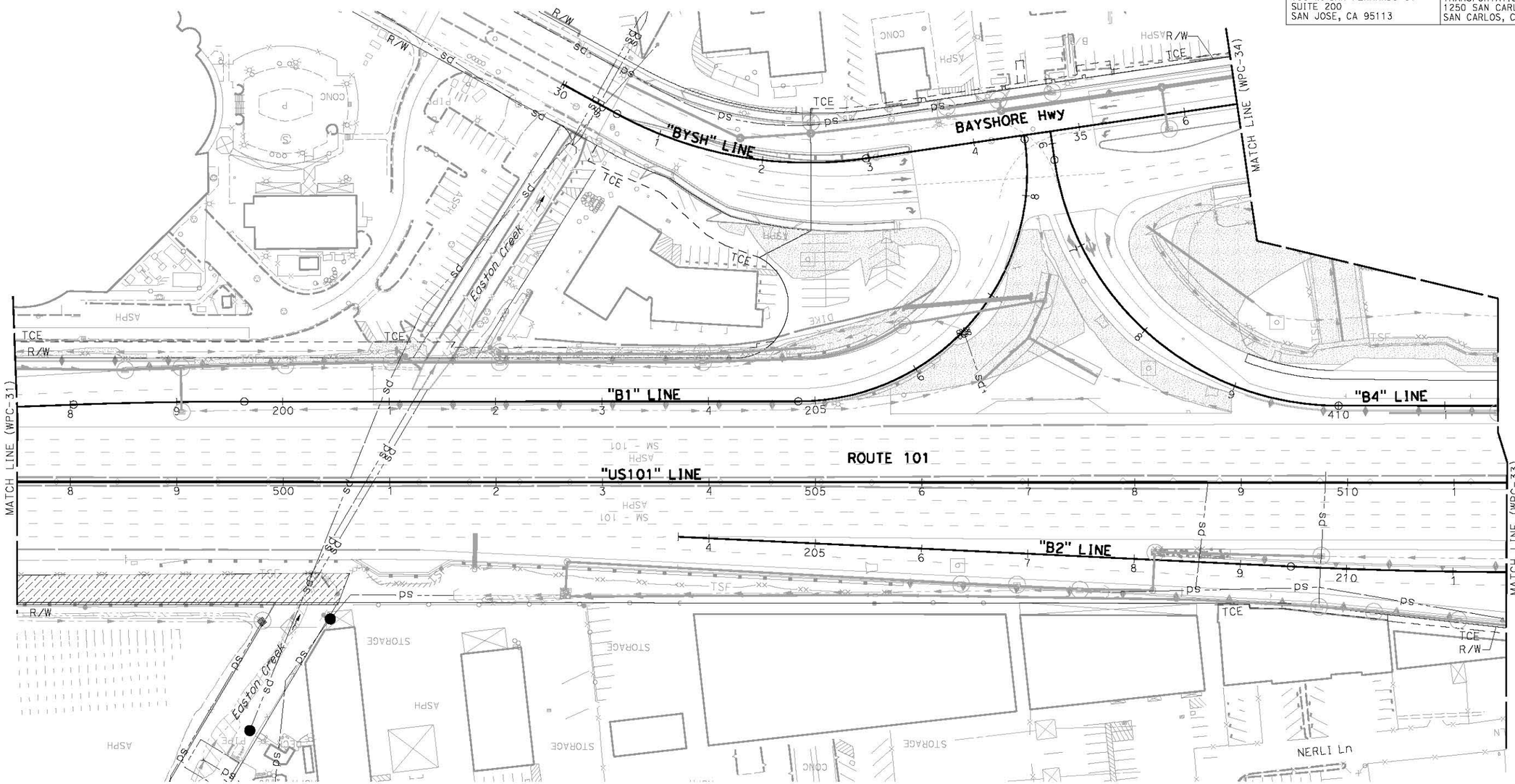
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 5 PHASE 1
SCALE 1" = 50'

WPC-32

REVISED BY	JH
DATE REVISED	4/17/13
JASON HOM	
MARIA SEDGHI	
CALCULATED-DESIGNED BY	
CHECKED BY	
CONSULTANT FUNCTIONAL SUPERVISOR	
RAMSEY J. HISSEN	

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
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LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:30:46 PM

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi — REGISTERED CIVIL ENGINEER — DATE 4/17/13

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Maria Sedghi — No. C74619 — Exp. 12-31-13 — CIVIL — STATE OF CALIFORNIA

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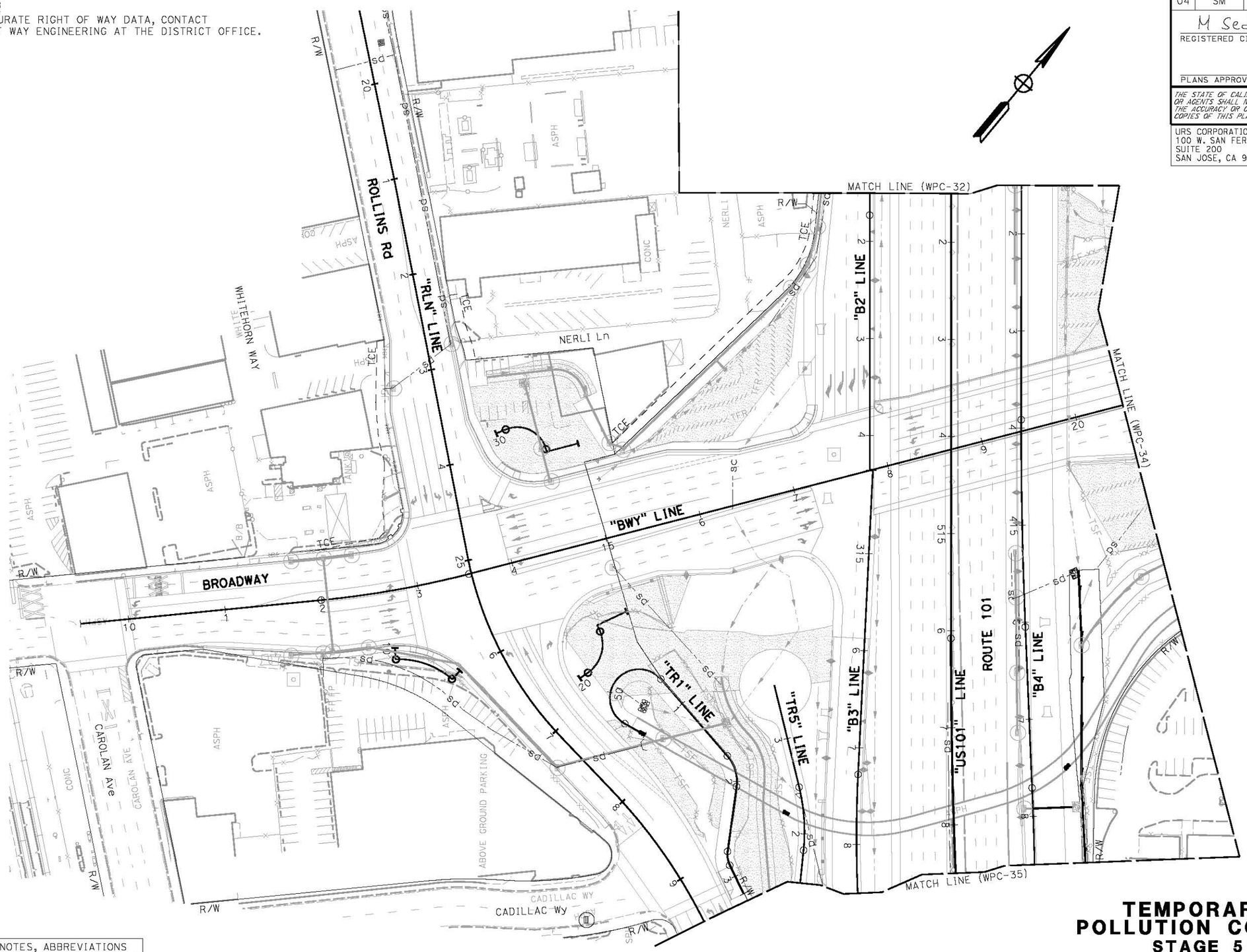
SAN CARLOS, CA 94070-1306



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 5 PHASE 1
SCALE 1" = 50'

WPC-33

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION — Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13 — DATE PLOTTED => 6/3/2013 — TIME PLOTTED => 1:30:57 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
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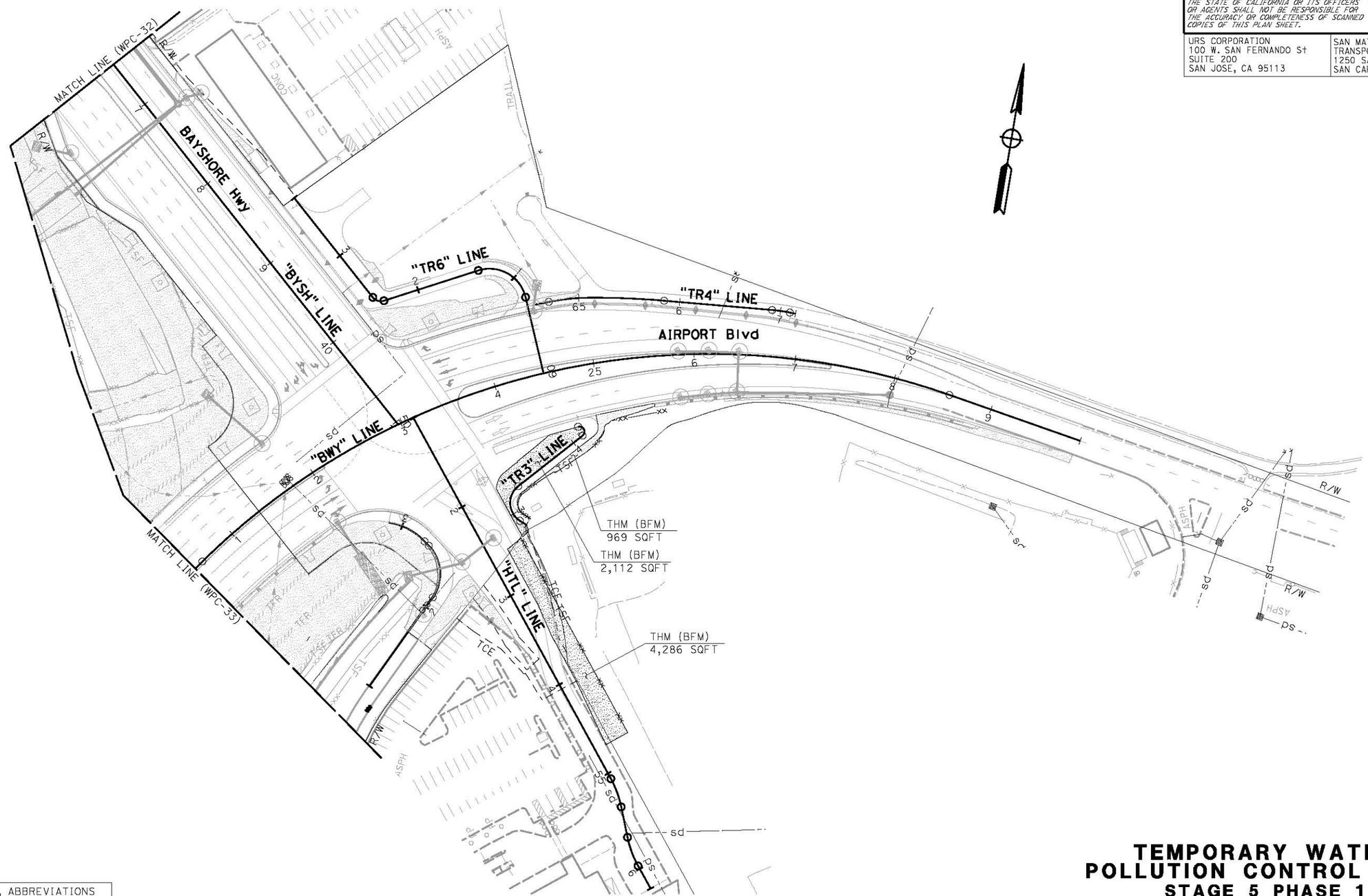
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 5 PHASE 1
SCALE 1" = 50'

WPC-34

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:31:10 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
Exp. 12-31-13
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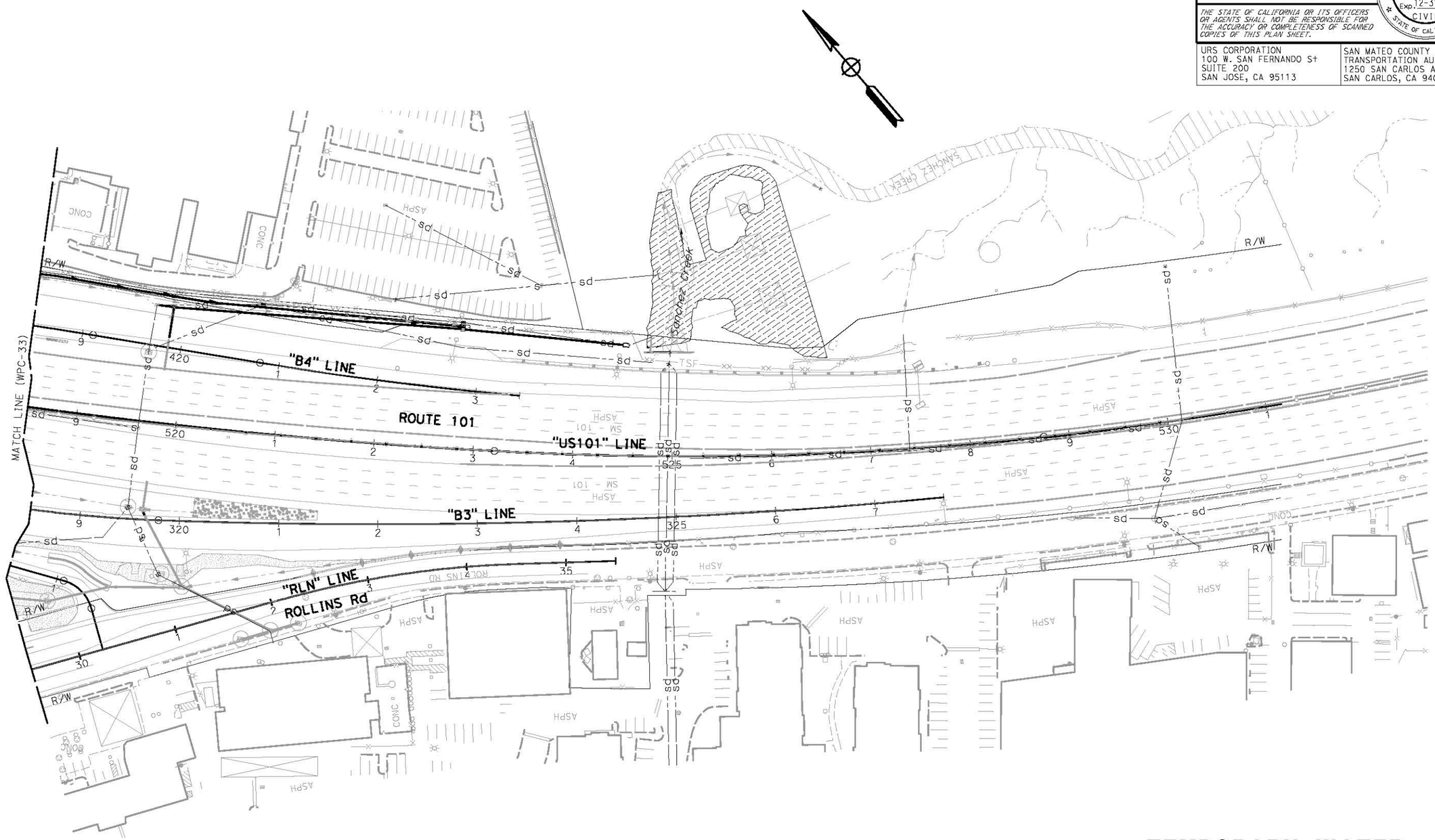
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 5 PHASE 1
SCALE 1" = 50'

WPC-35

REVISED BY	DATE REVISED
JH	4/17/13

CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:31:19 PM

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
Exp. 12-31-13
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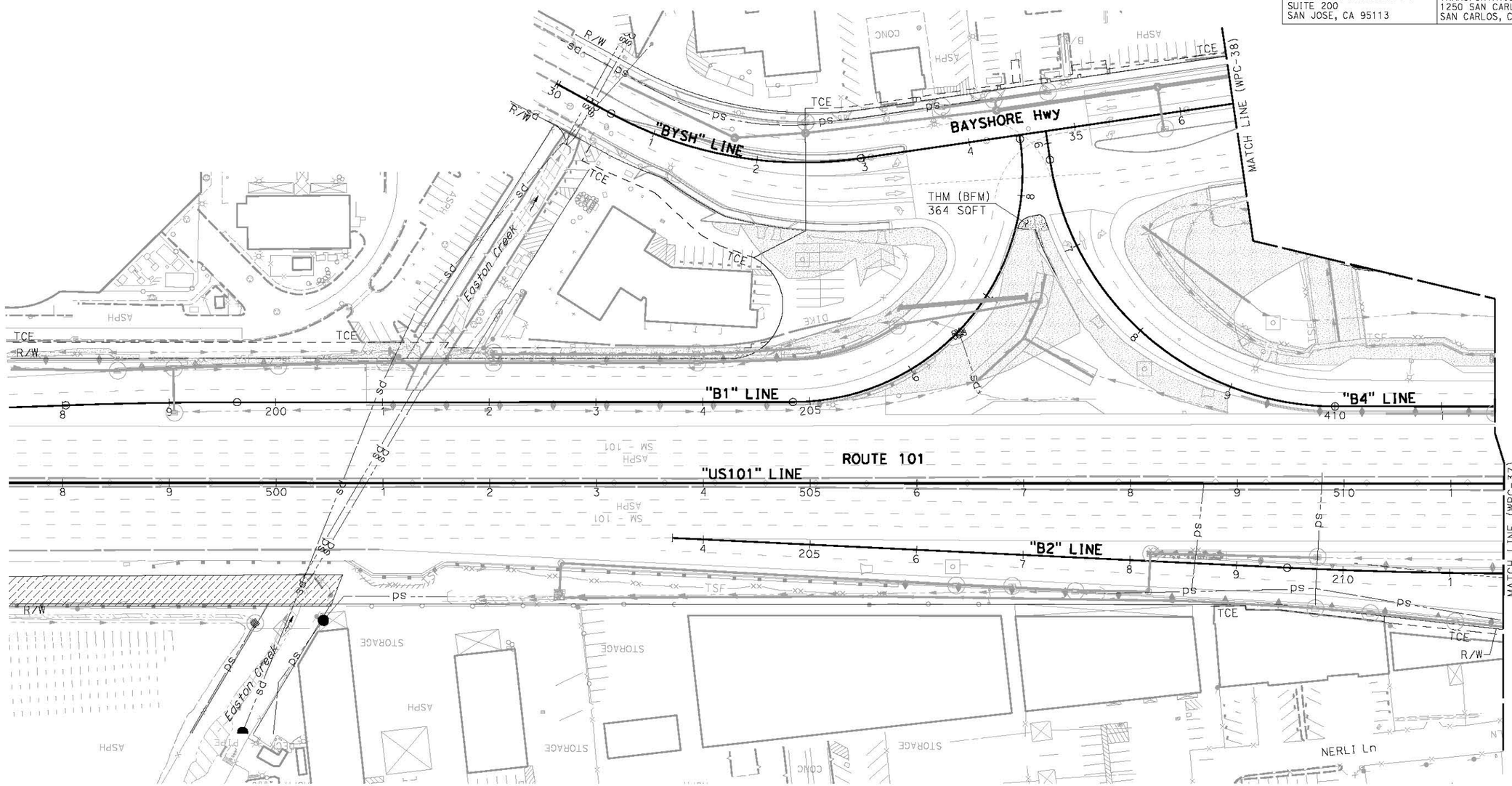
SAN CARLOS, CA 94070-1306



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 5 PHASE 2
SCALE 1" = 50'

WPC-36

REVISED BY	DATE REVISED
JH	4/17/13

CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:31:27 PM

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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SAN MATEO COUNTY
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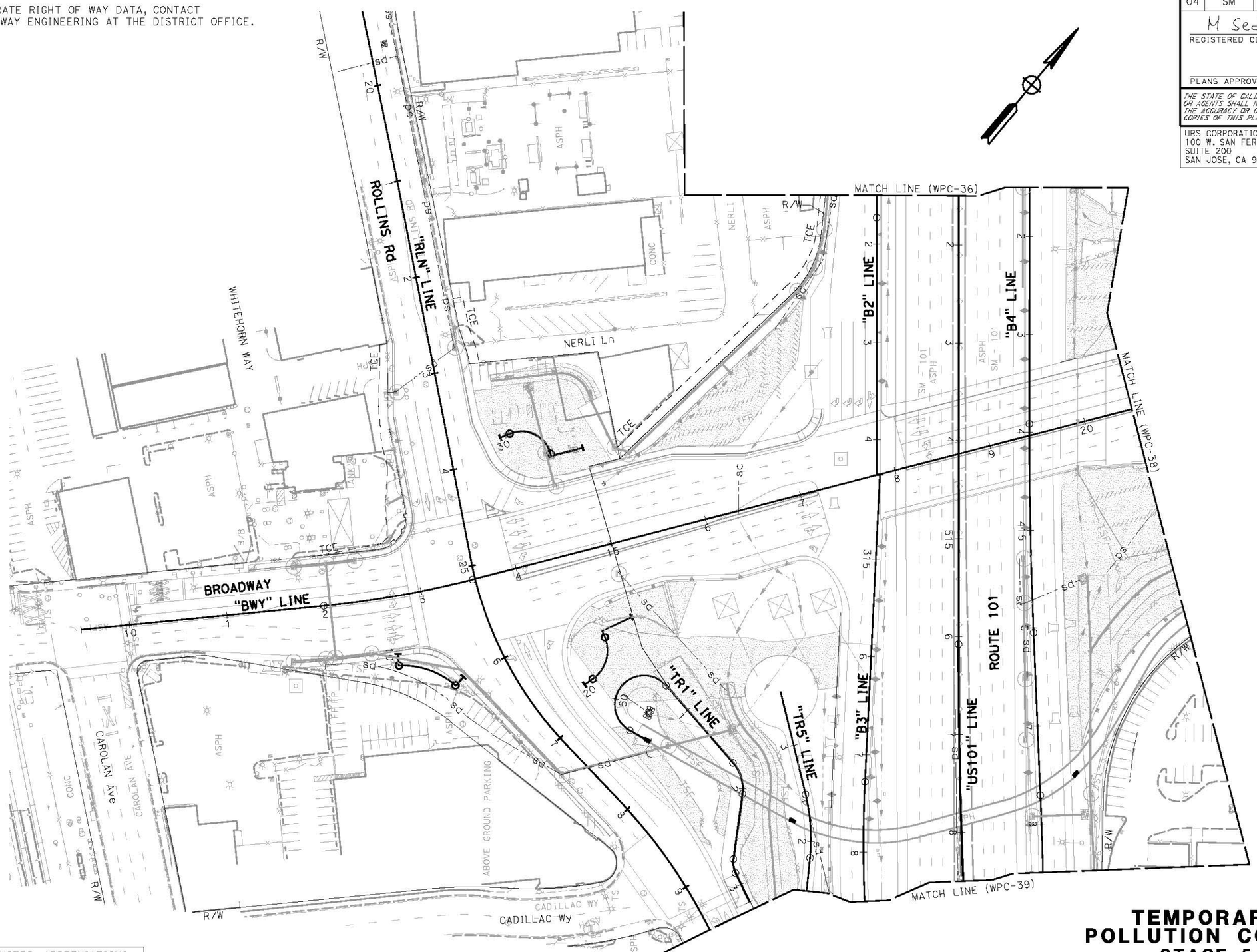
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 5 PHASE 2
SCALE 1" = 50'

WPC-37

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	CONSULTANT FUNCTIONAL SUPERVISOR	CALCULATED-DESIGNED BY	JASON HOM
Caltrans	RAMSEY J. HISSEN	CHECKED BY	MARIA SEDGHI
		REVISED BY	JH
		DATE REVISED	4/17/13

LAST REVISION 04-17-13 DATE PLOTTED => 6/3/2013 TIME PLOTTED => 11:31:38 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

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NOTE:
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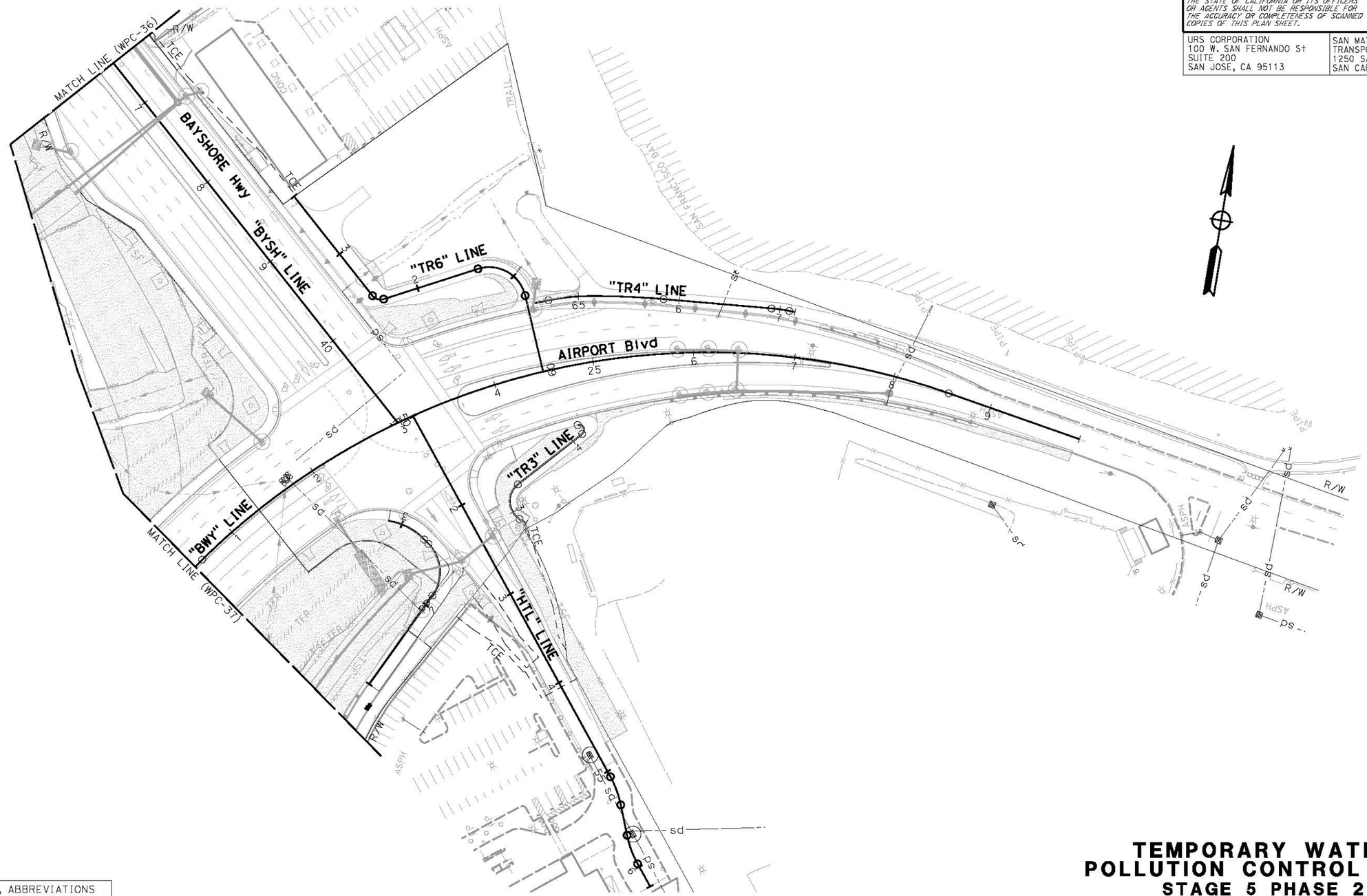


FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 5 PHASE 2
SCALE 1" = 50'

WPC-38

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1:31:53 PM

BORDER LAST REVISED 7/2/2010
USERNAME => shruti_shah
DGN FILE => 0400000684gb038.dgn
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0703
PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

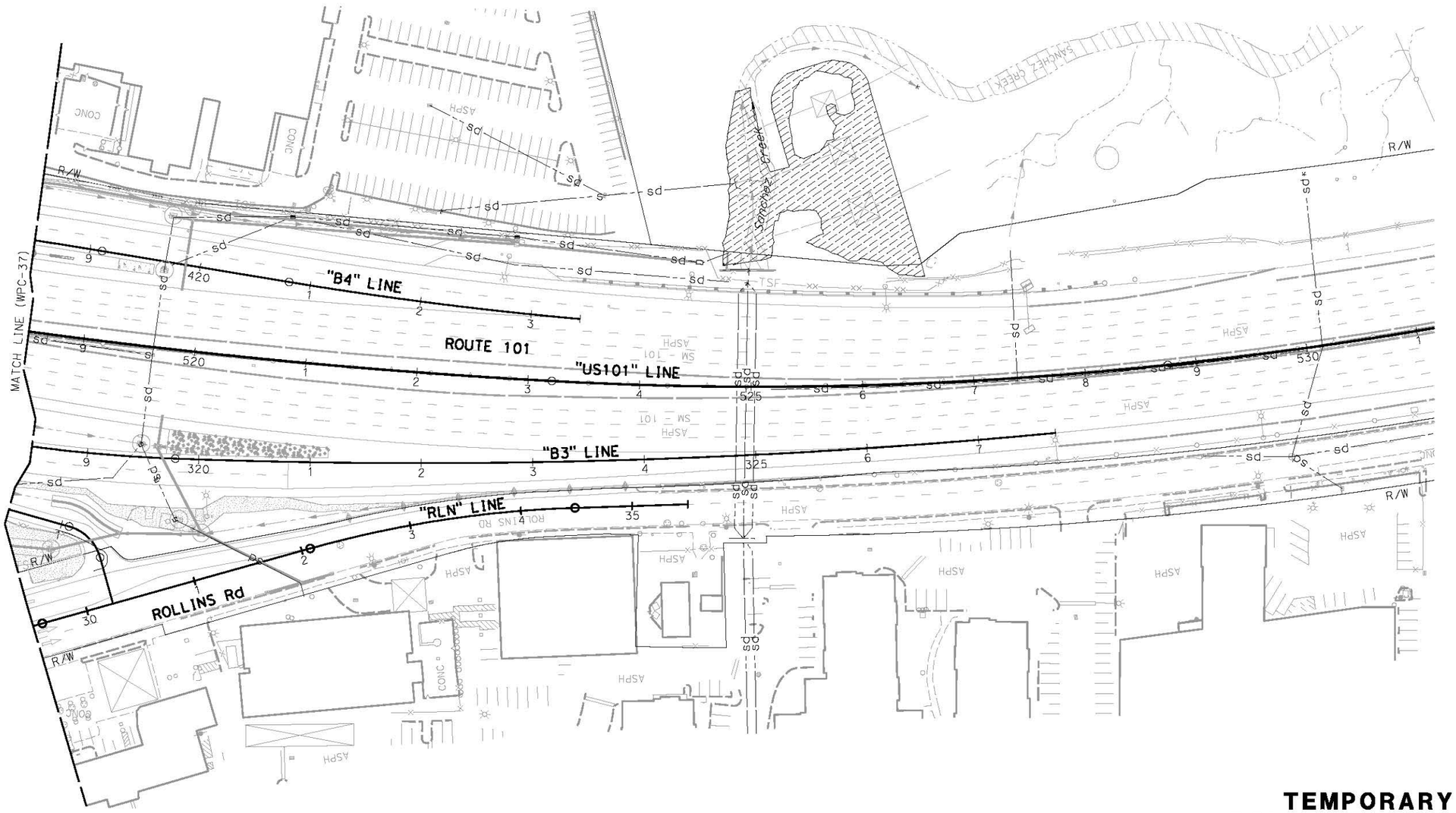
REGISTERED PROFESSIONAL ENGINEER Maria Sedghi No. C74619 Exp. 12-31-13 CIVIL STATE OF CALIFORNIA

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

URS CORPORATION
100 W. SAN FERNANDO St
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WPC-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

TEMPORARY WATER POLLUTION CONTROL PLAN
STAGE 5 PHASE 2
SCALE 1" = 50'

WPC-39

CALCULATED-DESIGNED BY	JASON HOM
CHECKED BY	MARIA SEDGHI
CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN
REVISED BY	JH
DATE REVISED	4/17/13

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 1132:05 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

M Sedghi 4/17/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER
Maria Sedghi
No. C74619
Exp. 12-31-13
CIVIL
STATE OF CALIFORNIA

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URS CORPORATION
100 W. SAN FERNANDO St
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

TEMPORARY WATER POLLUTION CONTROL

STAGE No.	TEMPORARY FIBER ROLL	TEMPORARY SILT FENCE	TEMPORARY CONSTRUCTION ENTRANCE	TEMPORARY COVER	TEMPORARY CHECK DAM	TEMPORARY DRAINAGE INLET PROTECTION	TEMPORARY HYDRAULIC MULCH (BONDED FIBER MATRIX)
	LF	LF	EA	SQYD	LF	EA	SQYD
STAGE 1 (PHASE 1)	340	340	5	393	100	**25**	971
STAGE 1 (PHASE 2)	259	259	3			**1**	2794
STAGE 2 (PHASE 1)	398	398		219		**21**	2245
STAGE 2 (PHASE 2)			2	660		**13**	80
STAGE 3 (PHASE 1A)	682	682	2	34		**5**	6787
STAGE 3 (PHASE 1B)							
STAGE 3 (PHASE 2)						**4**	
STAGE 4 (PHASE 1)	1649	1649	9	44		**15**	9064
STAGE 4 (PHASE 2)			4			**3**	1074
STAGE 5 (PHASE 1)						**1**	819
STAGE 5 (PHASE 2)			2			**7**	2640
TOTAL	3328	3328	27	1350	100	**95**	26473

(N) = NOT A SEPARATE PAY ITEM, FOR INFORMATION ONLY

TEMPORARY WATER POLLUTION CONTROL
QUANTITIES
NO SCALE

WPCQ-1

APPROVED FOR TEMPORARY WATER POLLUTION CONTROL WORK ONLY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: JASON HOM
CHECKED BY: MARIA SEDGHI
REVISED BY: JH
DATE REVISED: 4/17/13

LAST REVISION 04-17-13
DATE PLOTTED => 6/3/2013
TIME PLOTTED => 11:32:08 PM

State of California – The Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Bay Delta Region
7329 Silverado Trail
Napa, CA 94558
(707) 944-5500
www.wildlife.ca.gov

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

October 22, 2013

Hardeep Takhar
California Department of Transportation
111 Grand Avenue
Oakland, CA 94623

Subject: Final Lake or Streambed Alteration Agreement
Notification No. 1600-2013-0036-R3
US 101 BROADWAY INTERCHANGE RECONSTRUCTION PROJECT

Dear Mr. Takhar:

Enclosed is the final Streambed Alteration Agreement ("Agreement") for the California Department of Transportation US 101/Broadway Interchange Reconstruction Project ("Project"). Before the Department may issue an Agreement, it must comply with the California Environmental Quality Act ("CEQA"). In this case, the Department, acting as a responsible agency, filed a notice of determination ("NOD") on October 22, 2013 based on information contained in the Mitigated Negative Declaration the lead agency prepared for the Project.

Under CEQA, filing a NOD starts a 30-day period within which a party may challenge the filing agency's approval of the project. You may begin your project before the 30-day period expires if you have obtained all necessary local, state, and federal permits or other authorizations. However, if you elect to do so, it will be at your own risk.

If you have any questions regarding this matter, please contact Melissa Escaron, Staff Environmental Scientist, at (925)786-3045 or Melissa.escaron@wildlife.ca.gov.

Sincerely,

Karen Weiss for

Craig J. Weightman
Environmental Program Manager
Bay Delta Region

cc: Michael Baker
Lieutenant Joe
Warden Ober

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
BAY DELTA REGION
7329 SILVERADO TRAIL
NAPA, CALIFORNIA 94558
(707) 944-5500
WWW.WILDLIFE.CA.GOV

STREAMBED ALTERATION AGREEMENT
NOTIFICATION NO. 1600-2013-0036-R3
Easton Creek Culvert Extension

CALIFORNIA DEPARTMENT OF TRANSPORTATION
US 101/BROADWAY INTERCHANGE RECONSTRUCTION PROJECT

This Streambed Alteration Agreement (Agreement) is entered into between the California Department of Fish and Wildlife (CDFW) and the California Department of Transportation (Permittee), as represented by Mr. Hardeep Takhar.

RECITALS

WHEREAS, pursuant to Fish and Game Code (FGC) section 1602, Permittee notified CDFW on February 4, 2013 that Permittee intends to complete the project described herein.

WHEREAS, pursuant to FGC section 1603, CDFW has determined that the project could substantially adversely affect existing fish or wildlife resources and has included measures in the Agreement necessary to protect those resources.

WHEREAS, Permittee has reviewed the Agreement and accepts its terms and conditions, including the measures to protect fish and wildlife resources.

NOW THEREFORE, Permittee agrees to complete the project in accordance with the Agreement

PROJECT LOCATION

The project is in Easton Creek at the Interstate 101 culvert, in the City of Burlingame, in San Mateo County.

PROJECT DESCRIPTION

The proposed project is part of a larger Caltrans project that will reconstruct the Interstate 101/Broadway Interchange. The larger project will replace the Broadway overcrossing with a wider structure and reconfigure all ramp connections to Interstate 101. To accommodate this work, construction within CDFW 1602 jurisdiction will be necessary as described below.

The double box culvert at Easton Creek will be extended by 42 feet on the east side of Interstate 101. To divert flow from the upper reaches of Easton Creek around the work area, a gravelbag cofferdam will be constructed inside of the existing concrete double box culvert under Interstate 101. At least one 12-inch diameter plastic pipe will be placed within the gravelbag cofferdam to allow creek and tidal water to pass around the work area. The cofferdam will be sized to withstand the hydrostatic and hydrodynamic pressure from tidal flows. Prior to construction of the culvert extension, approximately 74 cubic yards of sediment will be removed from the stream channel and box culvert. The existing channel and bank is concrete lined. No trees will be removed.

An unnamed channel lies between Bayshore Highway and the San Francisco Bay, between a vacant lot and a gas station. The unnamed channel drains roadside runoff. To prevent ongoing flooding, the channel will be excavated to increase its depth and the berm across the channel will be removed during low tide, allowing for tidal exchange. A sewer line and utility access road will be constructed at the western end of the unnamed channel. The access road will impact an area approximately 38 feet long, 27 feet wide and 15 feet deep. Native salt marsh vegetation along the channel will be removed before construction, preserved in a nursery, and replanted after channel work is concluded.

PROJECT IMPACTS

Existing fish or wildlife resources the project could substantially adversely affect include:

- California red legged frogs (CRLF) and habitat
- San Francisco garter snakes (SFGS) and habitat
- Aquatic invertebrates
- Nesting birds

The adverse effects the project could have on the fish or wildlife resources identified above include:

- Sensitive species mortality
- Disruption of bird nesting
- Water quality degradation
- Short-term release of contaminants

MEASURES TO PROTECT FISH AND WILDLIFE RESOURCES

1. Administrative Measures

Permittee shall meet each administrative requirement described below.

1.1 Documentation at Project Site. Permittee shall make the Agreement, any extensions and amendments to the Agreement, and all related

notification materials and California Environmental Quality Act (CEQA) documents, readily available at the project site at all times and shall be presented to CDFW personnel, or personnel from another state, federal, or local agency upon request.

1.2 Providing Agreement to Persons at Project Site. Permittee shall maintain onsite at all times, a copy of the Agreement and any extensions and amendments to the Agreement.

1.3 Notification of Conflicting Provisions. Permittee shall notify CDFW if Permittee determines or learns that a provision in the Agreement might conflict with a provision imposed on the project by another local, state, or federal agency. In that event, CDFW shall contact Permittee to resolve any conflict.

1.4 Project Site Entry. Permittee agrees that CDFW personnel may, with notification of the Resident Engineer, enter the project site at any time to verify compliance with the Agreement.

2. Avoidance and Minimization Measures

To avoid or minimize adverse impacts to fish and wildlife resources identified above, Permittee shall implement each measure listed below. These conditions apply only to CDFW jurisdiction as described in the Project Description above.

2.1 To minimize adverse impacts to fish and wildlife all work within the bed, bank, and channel shall be confined to the period of April15 to October 15. Revegetation work is not confined to this time period.

2.2 No trees within CDFW 1602 jurisdiction will be removed.

2.3 Stream diversions shall be installed during low tide.

2.4 At least 30-days prior to commencing project activities covered by this Agreement, the Permittee shall submit to CDFW, for review and approval, the qualifications for a number of biologists (Qualified Biologist) that shall oversee the implementation of the conditions in this Agreement. At a minimum, the Qualified Biologists shall have a combination of academic training and professional experience in biological sciences and related resource management activities. The Qualified Biologists shall communicate to the Resident Engineer when any activity is not in compliance with this Agreement and the Resident Engineer shall immediately stop the activity that is not in compliance with this Agreement.

2.5 Before the onset of construction activities, a Qualified Biologist shall conduct an education program for all construction personnel. At a minimum the training will include

a description of CRLF; SFGS; migratory birds and their habitats; the occurrence of these species within the Project site; avoidance and minimization measures; and boundaries within which construction may occur. A fact sheet conveying this information will be prepared and distributed to all construction crews and Project personnel entering the Project site. Upon completion of the program, personnel will sign a form stating that they attended the program and understand all the avoidance and minimization measures.

2.6 If Project activities will occur between February 15 and September 1, a Qualified Biologist shall conduct pre-construction surveys for nesting birds no more than one week prior to construction. Surveys shall consist of multiple days of observations. If nests are found the Qualified Biologist shall establish an appropriate buffer to be in compliance with Migratory Bird Treaty Act (MBTA) and Fish and Game Code 3503. The Qualified Biologist shall perform at least two hours of pre-construction monitoring of the nest to characterize "typical" bird behavior. The Qualified Biologist shall monitor the nesting birds and shall increase the buffer if the Qualified Biologist determines the birds are showing signs of unusual or distressed behavior by Project activities. Atypical nesting behaviors which may cause reproductive harm include, but are not limited to, defensive flights/vocalizations directed towards Project personnel, standing up from a brooding position, and flying away from the nest. The Qualified Biologist shall have authority, through the Resident Engineer, to order the cessation of all Project activities if the nesting birds exhibit atypical behavior which may cause reproductive failure (nest abandonment and loss of eggs and/or young) until an appropriate buffer is established. To prevent encroachment, the established buffer(s) shall be clearly marked by high visibility material. The established buffer(s) shall remain in effect until the young have fledged or the nest has been abandoned as confirmed by the Qualified Biologist. Any sign of nest abandonment shall be reported to CDFW within 48 hours.

2.7 The creek diversion system shall be constructed using sandbags filled with clean gravel or sand, or water filled bladders. The downstream outlet of the diversion pump shall be screened with 1/4-inch mesh during all dewatering in accordance with NOAA Fisheries Fish Screening Criteria (NMFS 1997).

2.8 A Qualified Biologist shall conduct Pre-construction surveys immediately prior to the initiation of any ground disturbing activities within or adjacent to suitable California red-legged frog (CRLF) and San Francisco garter snake (SFGS) habitat. These surveys will comprise walking transects while conducting visual encounter surveys within areas that will be subject to staging, vegetation clearing, grubbing, grading, cut and fill, or other ground disturbing activities. All mammal burrows shall be inspected to the maximum extent practicable.

2.9 A Qualified Biologist shall be present onsite to monitor for CRLF and SFGS during construction activities located within suitable CRLF and SFGS habitat. Through communication with the Resident Engineer, a Qualified Biologist may stop work if deemed necessary for any reason to protect CRLF and SFGS. A Qualified Biologist will

conduct clearance surveys at the beginning of each day within or adjacent to suitable CRLF and SFGS habitat and regularly throughout the workday when construction is occurring within or adjacent to suitable CRLF and SFGS habitat. If CRLF or SFGS are encountered, work within 50 feet of the animal shall cease immediately and the Resident Engineer and a Qualified Biologist shall be notified. At no time shall work occur within 50 feet of a CRLF or SFGS without a Qualified Biologist present.

2.10 Prior to handling or relocation of CRLF, a Qualified Biologist will take precaution to prevent introduction of amphibian diseases in accordance with the Revised Guidance on Site Assessments and Field Surveys for the California Red-legged Frog (USFWS 2005). CRLF will be captured by hand, dipnet, or other USFWS-approved methodology, transported by hand, dipnet or temporary holding container, and release as soon as practicable the same day of capture. Handling of CRLF will be minimized to the maximum extent practicable. Holding/transporting containers and dipnets will be thoroughly cleaned and disinfected and will be rinsed with freshwater onsite immediately prior to usage unless doing so would result in the injury or death of the animal due to the time delay. CRLF will be relocated to the nearest suitable habitat outside of the area where actions would not result in harm or harassment. The individual(s) will be released within suitable habitat. If suitable habitat cannot be identified, the USFWS and CDFW shall be contacted to determine an acceptable location.

2.11 To prevent inadvertent entrapment of sensitive species during construction, all excavated, steep-walled holes or trenches more than 2 feet deep will be covered with plywood or similar materials at the end of each workday or the holes or trenches will contain one or more escape ramps constructed of earth fill or wooden planks. Before such holes or trenches are filled, they will be thoroughly inspected for trapped animals.

2.12 To the extent practicable, Permittee shall leave the root masses of shrubs in place. Disturbance or removal of vegetation shall not exceed the minimum necessary to complete operations.

2.13 All slopes or unpaved areas temporarily affected will be restored to pre-project conditions to the maximum extent practicable. Slopes and bare ground will be reseeded with native grasses and shrubs to stabilize and prevent erosion. Hydroseed mixes shall not contain exotic plant species. Prohibited exotic plant species include those identified in the California Exotic Pest Plant Council's database, which is accessible at: http://www.cal-ipc.org/ip/inventory/weedlist.php.

2.14 Permittee shall comply with all applicable state and federal laws, including the California and Federal Endangered Species Act. This Agreement does not authorize the take of any state or federally endangered listed species. Liability for any take or incidental take of such species remains the responsibility of the Permittee for the duration of the project. Any unauthorized take of listed species may result in

prosecution and nullification of the Agreement. This Agreement does not authorize take of Fully Protected Species.

2.15 Wildlife encountered during the course of project activities shall be allowed to leave the area unharmed and on their own volition.

2.16 The perimeter of the work site shall be adequately fenced using high visibility Environmentally Sensitive Area (ESA) fencing to prevent damage to adjacent riparian habitat. No construction activities, within the riparian zone, will be allowed within the habitat protected by the ESA fencing.

2.17 Prior to the start of construction, Wildlife Exclusion Fencing (WEF) shall be installed in all areas where sensitive species could enter the work site. The location of the WEF shall be determined by the Qualified Biologist, in consultation with the Resident Engineer. Prior to beginning construction CDFW will be provided plans showing where and how the WEF will be installed.

2.18 Permittee shall conduct work defined in the above project description, and within the project area, during periods of dry weather. The project area is defined as the bed, bank, channel, and associated riparian habitat. The Permittee shall monitor forecasted precipitation. When ¼ inch or more of precipitation is forecasted to occur, the Permittee shall stop work before precipitation commences. No activity of the project may be started if its associated erosion control measures cannot be completed prior to the onset of precipitation. After any storm event, the Permittee shall inspect all sites currently under construction and all sites scheduled to begin construction within the next 72 hours for erosion and sediment problems and take corrective action as needed. Seventy-two hour weather forecasts from National Weather Service shall be consulted and work shall not start back up until runoff ceases and there is less than a 30% forecast for precipitation for the following 24-hour period.

2.19 Permittee shall utilize erosion control measures throughout all phases of operation where sediment runoff from exposed slopes threatens to enter waterways. At no time shall silt laden runoff be allowed to enter the stream or directed to where it may enter the stream. Erosion control installations shall be monitored for effectiveness and shall be repaired or replaced as recommended by a Water Quality Monitor to the Resident Engineer or designated representative. As needed to prevent sediment transport, Permittee shall deploy soil stabilizer such as hydroseeding, netting, erosion control mats, mulch, fiber rolls, silt fences, check dams, and flow velocity dissipation devices. Permittee shall stabilize and equip construction site entrances and exits with tire washing capability. Materials containing monofilament or plastic shall not be used. Erosion and sediment control measures shall be installed prior to unseasonable rain storms.

2.20 Staging and storage areas for equipment, materials, fuels, lubricants and solvents, shall be located outside of the creek channel and banks. Stationary equipment such as

motors, pumps, generators, compressors and welders, located within or adjacent to the creek shall be positioned over drip pans. Any equipment or vehicles driven and/or operated above or adjacent to the stream must be checked and maintained daily, to prevent leaks of materials that if introduced to water could be deleterious to aquatic life.

2.21 Refueling of mobile construction equipment and vehicles shall not occur within 50 feet of any water body, or anywhere that spilled fuel could drain to a water body. Refueling of stationary equipment requiring breakdown and setup to move will remain in place. All equipment shall be refueled with appropriate drip pans, absorbent pads, and water quality Best Management Practices. Equipment and vehicles operating in the project area shall be checked and maintained daily to prevent leaks of fuels, lubricants, or other liquids.

2.22 If work is conducted at the unnamed drainage ditch other than the construction of the maintenance road or the sewer relocation, then native salt marsh vegetation at the unnamed drainage shall be surveyed prior to disturbance to document plant species distribution and percent cover. Native salt marsh vegetation shall be removed prior to construction, preserved in a nursery, and replanted after channel work is concluded. The Permittee shall monitor the survival and vigor of onsite replantings for a period of 5 years to ensure attainment of 75% survivorship. Permittee shall control invasive species as needed to ensure attainment of 75% survivorship at 5 years. Permittee shall submit a year 3 and year 5 monitoring report to CDFW for review and approval by December 31st. In the event that success criteria are not met after year 5, Permittee shall implement CDFW-approved corrective actions to attain 75% survivorship.

CONTACT INFORMATION

Any communication that Permittee or CDFW submits to the other shall be in writing and any communication or documentation shall be delivered to the address below by U.S. mail, fax, or email, or to such other address as Permittee or CDFW specifies by written notice to the other.

To Permittee:

California Department of Transportation
Mr. Hardeep Takhar
111 Grand Ave.
Oakland, Ca 94623
Hardeep.takhar@dot.ca.gov

To CDFW:

California Department of Fish and Wildlife
Bay Delta Region

7329 Silverado Trail
Napa, California 94558
Attn: Lake and Streambed Alteration Program – Melissa Escaron
Notification #1600-2013-0036-R3
Fax (707) 944-5553
Melissa.escaron@wildlife.ca.gov

LIABILITY

Permittee shall be solely liable for any violations of the Agreement, whether committed by Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents or contractors and subcontractors, to complete the project or any activity related to it that the Agreement authorizes.

This Agreement does not constitute CDFW's endorsement of, or require Permittee to proceed with the project. The decision to proceed with the project is Permittee's alone.

SUSPENSION AND REVOCATION

CDFW may suspend or revoke in its entirety the Agreement if it determines that Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, is not in compliance with the Agreement.

Before CDFW suspends or revokes the Agreement, it shall provide Permittee written notice by certified or registered mail that it intends to suspend or revoke. The notice shall state the reason(s) for the proposed suspension or revocation, provide Permittee an opportunity to correct any deficiency before CDFW suspends or revokes the Agreement, and include instructions to Permittee, if necessary, including but not limited to a directive to immediately cease the specific activity or activities that caused CDFW to issue the notice.

ENFORCEMENT

Nothing in the Agreement precludes CDFW from pursuing an enforcement action against Permittee instead of, or in addition to, suspending or revoking the Agreement.

Nothing in the Agreement limits or otherwise affects CDFW's enforcement authority or that of its enforcement personnel.

OTHER LEGAL OBLIGATIONS

This Agreement does not relieve Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, from obtaining any other permits or authorizations that might be

required under other federal, state, or local laws or regulations before beginning the project or an activity related to it.

This Agreement does not relieve Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, from complying with other applicable statutes in the FGC including, but not limited to, FGC sections 2050 et seq. (threatened and endangered species), 3503 (bird nests and eggs), 3503.5 (birds of prey), 5650 (water pollution), 5652 (refuse disposal into water), 5901 (fish passage), 5937 (sufficient water for fish), and 5948 (obstruction of stream).

Nothing in the Agreement authorizes Permittee or any person acting on behalf of Permittee, including its officers, employees, representatives, agents, or contractors and subcontractors, to trespass.

AMENDMENT

CDFW may amend the Agreement at any time during its term if CDFW determines the amendment is necessary to protect an existing fish or wildlife resource.

Permittee may amend the Agreement at any time during its term, provided the amendment is mutually agreed to in writing by CDFW and Permittee. To request an amendment, Permittee shall submit to CDFW a completed CDFW "Request to Amend Lake or Streambed Alteration" form and include with the completed form payment of the corresponding amendment fee identified in CDFW's current fee schedule (see Cal. Code Regs., tit. 14, § 699.5).

TRANSFER AND ASSIGNMENT

This Agreement may not be transferred or assigned to another entity, and any purported transfer or assignment of the Agreement to another entity shall not be valid or effective, unless the transfer or assignment is requested by Permittee in writing, as specified below, and thereafter CDFW approves the transfer or assignment in writing.

The transfer or assignment of the Agreement to another entity shall constitute a minor amendment, and therefore to request a transfer or assignment, Permittee shall submit to CDFW a completed CDFW "Request to Amend Lake or Streambed Alteration" form and include with the completed form payment of the minor amendment fee identified in CDFW's current fee schedule (see Cal. Code Regs., tit. 14, § 699.5).

EXTENSIONS

In accordance with FGC section 1605(b), Permittee may request one extension of the Agreement, provided the request is made prior to the expiration of the Agreement's term. To request an extension, Permittee shall submit to CDFW a completed CDFW

"Request to Extend Lake or Streambed Alteration" form and include with the completed form payment of the extension fee identified in CDFW's current fee schedule (see Cal. Code Regs., tit. 14, § 699.5). CDFW shall process the extension request in accordance with FGC 1605(b) through (e).

If Permittee fails to submit a request to extend the Agreement prior to its expiration, Permittee must submit a new notification and notification fee before beginning or continuing the project the Agreement covers (Fish & G. Code, § 1605, subd. (f)). .

EFFECTIVE DATE

The Agreement becomes effective on the date of CDFW's signature, which shall be: 1) after Permittee's signature; 2) after CDFW complies with all applicable requirements under the California Environmental Quality Act (CEQA); and 3) after payment of the applicable FGC section 711.4 filing fee listed at http://www.wildlife.ca.gov/habcon/ceqa/ceqa_changes.html.

TERM

This Agreement shall expire on December 31, 2017, unless it is terminated or extended before then. All provisions in the Agreement shall remain in force throughout its term. Permittee shall remain responsible for implementing any provisions specified herein to protect fish and wildlife resources after the Agreement expires or is terminated, as FGC section 1605(a)(2) requires.

AUTHORITY

If the person signing the Agreement (signatory) is doing so as a representative of Permittee, the signatory hereby acknowledges that he or she is doing so on Permittee's behalf and represents and warrants that he or she has the authority to legally bind Permittee to the provisions herein.

AUTHORIZATION

This Agreement authorizes only the project described herein. If Permittee begins or completes a project different from the project the Agreement authorizes, Permittee may be subject to civil or criminal prosecution for failing to notify CDFW in accordance with FGC section 1602.

CONCURRENCE

The undersigned accepts and agrees to comply with all provisions contained herein.

FOR CALIFORNIA DEPARTMENT OF TRANSPORTATION

Hardeep Takhar
Office Chief

10.21.13
Date

FOR DEPARTMENT OF FISH AND WILDLIFE

Karen Weiss for
Craig Weightman
Environmental Program Manager

10/22/13
Date

Prepared by: Melissa Escaron
Staff Environmental Scientist

Date Sent: August 23, 2013
Revision Sent: October 18, 2013

-Revised-

FOR DEPARTMENT USE ONLY				
Date Received	Amount Received	Amount Due	Date Complete	Notification No.
2/4/13	$ 123325	$		1600-2013-0036-3

#00305356
URS
rec'd 2/27/13

Escaron
Kt Joe

STATE OF CALIFORNIA
DEPARTMENT OF FISH AND WILDLIFE

NOTIFICATION OF LAKE OR STREAMBED ALTERATION

Complete EACH field, unless otherwise indicated, following the enclosed instructions and submit ALL required enclosures. Attach additional pages, if necessary.

1. APPLICANT PROPOSING PROJECT

Name	Hardeep Takhar		Fish & Game
Business/Agency	California Department of Transportation		
Street Address	111 Grand Avenue		AUG 12 2013
City, State, Zip	Oakland, CA 94612		
Telephone	510-286-7182	Fax	Yountville
Email	Hardeep.Takhar@dot.ca.gov		

2. CONTACT PERSON (*Complete only if different from applicant*)

Name	Michael Baker		
Street Address	111 Grand Avenue		
City, State, Zip	Oakland, CA 94612		
Telephone	510-622-1771	Fax	
Email	Michael.Baker@dot.ca.gov		

3. PROPERTY OWNER (*Complete only if different from applicant*)

Name			
Street Address			
City, State, Zip			
Telephone		Fax	
Email			

4. PROJECT NAME AND AGREEMENT TERM

A. Project Name	US 101 Broadway Interchange Reconstruction Project, EA 04-235840			
B. Agreement Term Requested	☑ Regular (*5 years or less*) ☐ Long-term (*greater than 5 years*)			
C. Project Term		D. Seasonal Work Period		E. Number of Work Days
Beginning (*year*)	Ending (*year*)	Start Date (*month/day*)	End Date (*month/day*)	
2014	2015	04/15	10/15	50.00

NOTIFICATION OF LAKE OR STREAMBED ALTERATION

5. AGREEMENT TYPE

- Revised

Check the applicable box. If box B, C, D, or E is checked, complete the specified attachment.		
A.	☑ Standard *(Most construction projects, excluding the categories listed below)*	
B.	☐ Gravel/Sand/Rock Extraction (*Attachment A*)	*Mine I.D. Number:* _____
C.	☐ Timber Harvesting (*Attachment B*)	THP *Number:* _____
D.	☐ Water Diversion/Extraction/Impoundment (*Attachment C*)	*SWRCB Number:* _____
E.	☐ Routine Maintenance (*Attachment D*)	
F.	☐ DFG Fisheries Restoration Grant Program (FRGP)	*FRGP Contract Number:* _____
G.	☐ Master	
H.	☐ Master Timber Harvesting	

6. FEES

Please see the current fee schedule to determine the appropriate notification fee. Itemize each project's estimated cost and corresponding fee. ***Note: The Department may not process this notification until the correct fee has been received.***

	A. Project	B. Project Cost	C. Project Fee
1	Easton Creek culvert extension	$120,000.00	$1,233.25
2	Unnamed Drainage Channel	$50,000.00	$840.25
3			
4			
5			
		D. Base Fee *(if applicable)*	
		E. TOTAL FEE ENCLOSED	$1,233.25

7. PRIOR NOTIFICATION OR ORDER

A. Has a notification previously been submitted to, or a Lake or Streambed Alteration Agreement previously been issued by, the Department for the project described in this notification?

☐ Yes (*Provide the information below*) ☑ No

Applicant: _____ Notification Number: _____ Date: _____

B. Is this notification being submitted in response to an order, notice, or other directive ("order") by a court or administrative agency (including the Department)?

☑ No ☐ Yes (*Enclose a copy of the order, notice, or other directive. If the directive is not in writing, identify the person who directed the applicant to submit this notification and the agency he or she represents, and describe the circumstances relating to the order.*)

☐ *Continued on additional page(s)*

8. PROJECT LOCATION

A. Address or description of project location.

(*Include a map that marks the location of the project with a reference to the nearest city or town, and provide driving directions from a major road or highway*)

The proposed project is located in Burlingame, California (Figure 1) at the northeastern side of San Mateo County. This location corresponds to unmarked sections in the northwestern portion of the San Mateo 7.5-minute U.S. Geological Survey (USGS) Quadrangle, Township 4 South, Range 5 West. Elevations in the area range from 0 to 10 ft. above mean sea level. The topography is relatively flat in this portion of the Peninsula, with elevations decreasing gradually toward the San Francisco Bay.

☐ *Continued on additional page(s)*

B. River, stream, or lake affected by the project.	Easton Creek
C. What water body is the river, stream, or lake tributary to?	San Francisco Bay
D. Is the river or stream segment affected by the project listed in the state or federal Wild and Scenic Rivers Acts?	☐ Yes ☑ No ☐ Unknown
E. County	San Mateo

F. USGS 7.5 Minute Quad Map Name	G. Township	H. Range	I. Section	J. ¼ Section
San Mateo	4S	5W		

☐ *Continued on additional page(s)*

K. Meridian (*check one*) ☐ Humboldt ☑ Mt. Diablo ☐ San Bernardino

L. Assessor's Parcel Number(s)

☐ *Continued on additional page(s)*

M. Coordinates (*If available, provide at least latitude/longitude or UTM coordinates and check appropriate boxes)*

Latitude/Longitude	*Latitude:* 37.59° N	*Longitude:* 122.36° W	
	☐ Degrees/Minutes/Seconds	☑ Decimal Degrees	☐ Decimal Minutes
UTM	*Easting:*	*Northing:*	☐ Zone 10 ☐ Zone 11
Datum used for Latitude/Longitude or UTM	☐ NAD 27	☑ NAD 83 or WGS 84	

9. PROJECT CATEGORY AND WORK TYPE *(Check each box that applies)*

PROJECT CATEGORY	NEW CONSTRUCTION	REPLACE EXISTING STRUCTURE	REPAIR/MAINTAIN EXISTING STRUCTURE
Bank stabilization – bioengineering/recontouring	☐	☐	☐
Bank stabilization – rip-rap/retaining wall/gabion	☐	☐	☐
Boat dock/pier	☐	☐	☐
Boat ramp	☐	☐	☐
Bridge	☐	☐	☐
Channel clearing/vegetation management	☐	☐	☐
Culvert	☑	☐	☐
Debris basin	☐	☐	☐
Dam	☐	☐	☐
Diversion structure – weir or pump intake	☑	☐	☐
Filling of wetland, river, stream, or lake	☑	☐	☐
Geotechnical survey	☐	☐	☐
Habitat enhancement – revegetation/mitigation	☐	☐	☐
Levee	☐	☐	☐
Low water crossing	☐	☐	☐
Road/trail	☑	☐	☐
Sediment removal – pond, stream, or marina	☐	☐	☐
Storm drain outfall structure	☐	☐	☐
Temporary stream crossing	☐	☐	☐
Utility crossing : Horizontal Directional Drilling	☐	☐	☐
Jack/bore	☐	☐	☐
Open trench	☐	☐	☐
Other *(specify)*:	☐	☐	☐

10. PROJECT DESCRIPTION

A. Describe the project in detail. Photographs of the project location and immediate surrounding area should be included.

- Include any structures (e.g., rip-rap, culverts, or channel clearing) that will be placed, built, or completed in or near the stream, river, or lake.
- Specify the type and volume of materials that will be used.
- If water will be diverted or drafted, specify the purpose or use.

Enclose diagrams, drawings, plans, and/or maps that provide all of the following: site specific construction details; the dimensions of each structure and/or extent of each activity in the bed, channel, bank or floodplain; an overview of the entire project area (i.e., "bird's-eye view") showing the location of each structure and/or activity, significant area features, and where the equipment/machinery will enter and exit the project area.

The proposed project will reconstruct the US 101/Broadway interchange. The project will replace the Broadway overcrossing with a wider structure, reconfigure all ramp connections to US 101, and install ramp meters on northbound and southbound on-ramps. The project will construct a new seven-lane Broadway overcrossing approximately 100 ft. to the north of the existing four-lane structure. Broadway will be realigned to extend straight across US 101 from the Broadway/Rollins Road intersection on the west to Bayshore Highway on the east, eliminating the existing curvilinear alignment. The northern terminus of Airport Boulevard will be shifted approximately 100 ft. to the north to meet the new eastern touchdown of the overcrossing and maintain a four-leg intersection with Broadway, Bayshore Highway, and the access road for the Crowne Plaza Hotel. New traffic signals and streetlights will be installed as part of the project. A landscaping project would be completed as a follow up to the roadway contract.

See Box 10A in the attached supplement for additional information.

☑ *Continued on additional page(s)*

B. Specify the equipment and machinery that will be used to complete the project.

Excavators, cranes, pile drivers, bulldozers, earth movers, compaction equipment, front loader, dump truck, back hoe, paver, graders, mixers

☐ *Continued on additional page(s)*

C. Will water be present during the proposed work period (specified in box 4.D) in the stream, river, or lake (specified in box 8.B).	☑ Yes ☐ No (*Skip to box 11*)
D. Will the proposed project require work in the wetted portion of the channel?	☑ Yes (*Enclose a plan to divert water around work site*) ☐ No

11. PROJECT IMPACTS

A. Describe impacts to the bed, channel, and bank of the river, stream, or lake, and the associated riparian habitat. Specify the dimensions of the modifications in length (linear feet) and area (square feet or acres) and the type and volume of material (cubic yards) that will be moved, displaced, or otherwise disturbed, if applicable.

The existing 6 ft-by-6-ft double box culvert at Easton Creek (WUS-3) on the east side of US 101 will be extended by approximately 42 ft to accommodate the construction of the new northbound US 101 on-ramp. Construction of the box culvert extension will have permanent and temporary impacts to the bed and bank of Easton Creek. More details on the impacts to the bed and bank are provided in the supplement.
See Box 11A in the attached supplement for additional information.

☑ *Continued on additional page(s)*

B. Will the project affect any vegetation? ☑ Yes (*Complete the tables below*) ☐ No

Vegetation Type	Temporary Impact	Permanent Impact
See Box 11B, Table 1 of attached supplement.	Linear feet: _____ Total area: _____	Linear feet: _____ Total area: _____
	Linear feet: _____ Total area: _____	Linear feet: _____ Total area: _____

Tree Species	Number of Trees to be Removed	Trunk Diameter (range)
Impacted trees are provided in table 2		
of the attached supplement		

☑ *Continued on additional page(s)*

C. Are any special status animal or plant species, or habitat that could support such species, known to be present on or near the project site?

☑ Yes *(List each species and/or describe the habitat below)* ☐ No ☐ Unknown

See Box 11C, Tables 3 through 4 of the attached supplement.

☑ *Continued on additional page(s)*

D. Identify the source(s) of information that supports a "yes" or "no" answer above in Box 11.C.

USFWS Biological Opinion (attached), NMFS Letter of Concurrence (attached)

☐ *Continued on additional page(s)*

E. Has a biological study been completed for the project site?

☑ Yes (*Enclose the biological study*) ☐ No

The Final Natural Environment Study is attached

Note: A biological assessment or study may be required to evaluate potential project impacts on biological resources.

F. Has a hydrological study been completed for the project or project site?

☑ Yes (*Enclose the hydrological study*) ☐ No Drainage Report is Appendix I

Note: A hydrological study or other information on site hydraulics (e.g., flows, channel characteristics, and/or flood recurrence intervals) may be required to evaluate potential project impacts on hydrology.

12. MEASURES TO PROTECT FISH, WILDIFE, AND PLANT RESOURCES

A. Describe the techniques that will be used to prevent sediment from entering watercourses during and after construction.

A variety of techniques will be implemented for the project to prevent sediment from entering the watercourse and to prevent erosion and degradation of water quality. Please see the avoidance and minimization measures in the supplement under Box 12A.

☑ *Continued on additional page(s)*

B. Describe project avoidance and/or minimization measures to protect fish, wildlife, and plant resources.

Avoidance and Minimization measures will be implemented as part of construction activities to minimize and avoid impacts to special status species and habitat, as well as common biological resources. Please see the avoidance and minimization measures in the supplement under Box 12B.

☑ *Continued on additional page(s)*

C. Describe any project mitigation and/or compensation measures to protect fish, wildlife, and plant resources.

No compensatory mitigation is proposed for impacts to fish, wildlife or plant species. However there will be compensatory mitigation for unavoidable permanent impacts to wetlands and other Waters of the U.S. which will be implemented at a minimum of a one to one ratio. The proposed project will impact approximately 0.65 acres of jurisdictional wetlands and 0.20 acre of other waters of the U.S. in the BSA, and therefore at a minimum compensatory mitigation will be provided for 0.85 acres of impacts. The supplement (see Box 12C in supplement) outlines how Caltrans and San Mateo County Transportation Authority plan to compensate for these impacts.

☑ *Continued on additional page(s)*

13. PERMITS

List any local, state, and federal permits required for the project and check the corresponding box(es). Enclose a copy of each permit that has been issued.

A. 401 Clean Water Certification with San Francisco RWQCB ☑ Applied ☐ Issued

B. USACE Clean Water Act 404 Permit Application ☑ Applied ☐ Issued

C. San Francisco Bay Conservation and Development Commission Application ☑ Applied ☐ Issued

D. Unknown whether ☐ local, ☐ state, or ☐ federal permit is needed for the project. (*Check each box that applies*)

☑ *Continued on additional page(s)*

14. ENVIRONMENTAL REVIEW

A. Has a draft or final document been prepared for the project pursuant to the California Environmental Quality Act (CEQA), National Environmental Protection Act (NEPA), California Endangered Species Act (CESA) and/or federal Endangered Species Act (ESA)?

☑ Yes (*Check the box for each CEQA, NEPA, CESA, and ESA document that has been prepared and enclose a copy of each*)

☐ No (*Check the box for each CEQA, NEPA, CESA, and ESA document listed below that will be or is being prepared*)

☐ Notice of Exemption	☑ Mitigated Negative Declaration	☑ NEPA document (*type*): EA/FONSI
☑ Initial Study	☐ Environmental Impact Report	☑ CESA document (*type*): IS/MND
☐ Negative Declaration	☑ Notice of Determination *(Enclose)*	☑ ESA document (*type*): Biological Opinion
☐ THP/ NTMP	☑ Mitigation, Monitoring, Reporting Plan	

B. State Clearinghouse Number (*if applicable*)	2010082077		
C. Has a CEQA lead agency been determined?	☑ Yes (*Complete boxes D, E, and F*)	☐ No (*Skip to box 14.G*)	
D. CEQA Lead Agency	California Department of Transportation		
E. Contact Person	Yolanda Rivas	F. Telephone Number	(510) 286-6215

G. If the project described in this notification is part of a larger project or plan, briefly describe that larger project or plan.

☐ *Continued on additional page(s)*

H. Has an environmental filing fee (Fish and Game Code section 711.4) been paid?

☑ Yes (*Enclose proof of payment*) ☐ No (*Briefly explain below the reason a filing fee has not been paid*)

Note: If a filing fee is required, the Department may not finalize a Lake or Streambed Alteration Agreement until the filing fee is paid.

15. SITE INSPECTION

Check one box only.

☑ In the event the Department determines that a site inspection is necessary, I hereby authorize a Department representative to enter the property where the project described in this notification will take place at any reasonable time, and hereby certify that I am authorized to grant the Department such entry.

☐ I request the Department to first contact (*insert name*) _____ at (*insert telephone number*) _____ to schedule a date and time to enter the property where the project described in this notification will take place. I understand that this may delay the Department's determination as to whether a Lake or Streambed Alteration Agreement is required and/or the Department's issuance of a draft agreement pursuant to this notification.

16. DIGITAL FORMAT

-Revised-

Is any of the information included as part of the notification available in digital format (i.e., CD, DVD, etc.)?

☑ Yes (Please enclose the information via digital media with the completed notification form)

☐ No

17. SIGNATURE

I hereby certify that to the best of my knowledge the information in this notification is true and correct and that I am authorized to sign this notification as, or on behalf of, the applicant. I understand that if any information in this notification is found to be untrue or incorrect, the Department may suspend processing this notification or suspend or revoke any draft or final Lake or Streambed Alteration Agreement issued pursuant to this notification. I understand also that if any information in this notification is found to be untrue or incorrect and the project described in this notification has already begun, I and/or the applicant may be subject to civil or criminal prosecution. I understand that this notification applies only to the project(s) described herein and that I and/or the applicant may be subject to civil or criminal prosecution for undertaking any project not described herein unless the Department has been separately notified of that project in accordance with Fish and Game Code section 1602 or 1611.

Signature of Applicant or Applicant's Authorized Representative

8/6/13

Date

Hardeep Takhar

Print Name

NOTICE OF DETERMINATION

TO: Office of Planning and Research
Post Office Box 3044
Sacramento, California 95812-3044

FROM: California Department of Fish and Wildlife
Bay Delta Region
7329 Silverado Trail
Napa, California 94558

SUBJECT: Filing of Notice of Determination in compliance with Section 21108 or 21152 of the Public Resources Code

PROJECT TITLE:

STATE CLEARINGHOUSE NUMBER: 2010082077

LEAD AGENCY: California Department of Transportation
CONTACT: Hardeep Takhar, (510)286-7182

RESPONSIBLE AGENCY: California Department of Fish and Wildlife
CONTACT: Melissa Escaron, Staff Environmental Scientist, (925)786-3045

PROJECT DESCRIPTION / LOCATION: The double box culvert at Easton Creek will be extended by 42 feet on the east side of Interstate 101. To divert flow from the upper reaches of Easton Creek around the work area, a gravelbag cofferdam will be constructed inside of the existing concrete double box culvert under Interstate 101. At least one 12-inch diameter plastic pipe will be placed within the gravelbag cofferdam to allow creek and tidal water to pass around the work area. The cofferdam will be sized to withstand the hydrostatic and hydrodynamic pressure from tidal flows. Prior to construction of the culvert extension, approximately 74 cubic yards of sediment will be removed from the stream channel and box culvert. The existing channel and bank is concrete lined. No trees will be removed The project is in Easton Creek at the Interstate 101 culvert, in the City of Burlingame, in San Mateo County. The California Department of Fish and Wildlife is executing a Lake and Streambed Alteration Agreement Number 1600-2013-0036-R3, pursuant to Section 1602 of the Fish and Game Code to the project Applicant, Mr. Hardeep Takhar, representing the California Department of Transportation.

This is to advise that the California Department of Fish and Wildlife as a Responsible Agency approved the project described above on October 22, 2013 and has made the following determinations regarding the above described project pursuant to section 15096 (i).

1. The project ***will not*** have a significant effect on the environment.
2. CDFW considered the Negative Declaration as previously prepared for this project by the Lead Agency.

This is to certify that a copy of the Negative Declaration prepared for this project is available to the general public and may be reviewed at: http://www.dot.ca.gov/dist4/envdocs.htm. Please contact the lead agency person specified above.

Karen Weiss for

Craig J. Weightman
Environmental Program Manager
Bay Delta Region

Date Received for Filing:_____

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In Reply Refer To:
81420-2010-F-0629-2

MAR 0 9 2011

Mr. Jim Richards
Attn: Laura Ivey
Office of Biological Sciences and Permits
California Department of Transportation
P.O. Box 23660
Oakland, California 94623-0660

Subject: Biological Opinion on the Effects of the United States Highway 101/Broadway Interchange Reconstruction Project in the City of Burlingame, San Mateo County, California (Caltrans EA 235840)

Dear Mr. Richards:

This letter responds to a letter from the California Department of Transportation (Caltrans), dated September 8, 2010, which requested formal consultation for the proposed United States Highway 101 (US 101)/Broadway Interchange Reconstruction Project in the City of Burlingame, San Mateo County, California. Your letter was received by the U.S. Fish and Wildlife Service (Service) on September 9, 2010 (Caltrans EA 235840). The proposed project is not located in proposed or designated critical habitat for any federally-listed species. Therefore, no critical habitat will be affected. This document represents the Service's biological opinion on the effects of the project on the threatened California red-legged frog (*Rana draytonii*), endangered San Francisco garter snake (*Thamnophis sirtalis tetrataenia*), and endangered California clapper rail (*Rallus longirostris obsoletus*). This letter issued under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (Act).

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users legislation (23 U.S.C. 327) allows the Secretary of the U.S. Department of Transportation acting through the Federal Highway Administration (FHWA) to establish a Surface Transportation Project Delivery Pilot Program, whereby a State may assume the FHWA responsibilities under the National Environmental Policy Act (NEPA) for environmental review, agency consultation and other action pertaining to the review or approval of a specific project. Caltrans assumed these responsibilities for the FHWA on July 1, 2007 through a Memorandum of Understanding (MOU) within the State of California (http://www.dot.ca.gov/ser/downloads/MOUs/nepa_delegation/sec6005mou.pdf).

Based on the information provided in the September 1, 2010, biological assessment, the letter from Caltrans to the Service dated September 9, 2010, and email correspondence from Caltrans on December 8, 2010, Caltrans determined that based on their findings the project is not likely to adversely affect the San Francisco garter snake and California clapper rail. Based on our review of the project as described herein and the information provided by Caltrans, the Service concurs with this determination. Therefore, the effects to these species are not addressed herein.

TAKE PRIDE IN AMERICA

This biological opinion is based on: (1) the *US 101/Broadway Interchange Reconstruction Project, Biological Assessment* dated September 1, 2010; (2) letter from Caltrans to the Service dated September 9, 2010; (3) email correspondence from Caltrans on December 8, 2010 and accompanying exhibits; (4) site visits conducted by the Service and Caltrans on February 23, 2010; (5) miscellaneous correspondence and electronic mail concerning the proposed action between Caltrans and the Service; and (6) other information available to the Service.

Consultation History

February 23, 2010	The Service attended a site visit with Caltrans District 4 staff, URS Corporation consultants, and Melissa Escaron of the California Department of Fish and Game to review the project, biological findings, effects determination, project timing and scheduling, and avoidance and minimization measures.
August 30, 2010	The Service received the Notice of Availability of Draft Environmental Document, Notice of Public Meeting for the US 101/Broadway Interchange Reconstruction Project and the Initial Study with Proposed Mitigated Negative Declaration/Environmental Assessment dated August 2010.
September 9, 2010	The Service received a letter requesting the initiation of formal consultation dated September 8, 2010, and a biological assessment for the US 101/Broadway Interchange Reconstruction project.
November 2, 2010	The Service sent an email to Caltrans requesting additional information with regards to noise attenuation buffers around pile driving locations, cofferdam installation and timing, revised conservation measures and California red-legged frog surveys.
December 8, 2010	The Serviced received an email from Caltrans responding to the request for additional information from Caltrans with regards to noise attenuation buffers around pile driving locations, cofferdam installation and timing, revised conservation measures and California red-legged frog surveys.
December 10, 2010	The Serviced received a letter from Caltrans dated December 8, 2010, requesting to receive the biological opinion by January 22, 2011.
February 2, 2011	The Service issued a draft biological opinion to Caltrans for their review and comment.
February 11, 2011	The Service received comments from Caltrans on the draft biological opinion.
February 4, 2010 - February 17, 2011	Electronic and phone correspondence between Caltrans, URS Corporation, California Department of Fish and Game, and the Service.

BIOLOGICAL OPINION

Description of the Proposed Action

The following is a summary of the project description, inclusive of the proposed conservation measures, provided by Caltrans in the September 2010 biological assessment (Caltrans 2010a) with modifications outlined in emails from Caltrans to the Service on December 8, 2010, and February 11, 2011. Any changes to the project description or project plans not provided to Service and evaluated in the preparation of this biological opinion are subject to the requirements of reinitiation of formal consultation.

Project History

The proposed action will reconstruct the US 101/Broadway interchange. The total length of the project is 0.76-mile (from post miles [PM] 16.30 to 17.06) and extends from East Millbrae Avenue south to Anza Boulevard. The project will replace the Broadway overcrossing with a wider structure, reconfigure all ramp connections to US 101, and install ramp meters on northbound and southbound on-ramps.

The existing US 101/Broadway interchange is a trumpet configuration composed of the four-lane Broadway overcrossing and a combination of diagonal and loop ramps. The short distance between the southbound on-ramp from westbound Broadway and the southbound off-ramp to eastbound Broadway (less than 200 feet) requires drivers to reduce their speed through the weaving section. At the Cadillac Way/US 101 southbound ramps/Rollins Road intersection, drivers making left turns from Rollins Road to US 101 and from US 101 to Rollins Road experience long delays during the afternoon peak hour. The radius of the loop ramp in the northwest quadrant of the US 101/Broadway interchange is below current design standards, which forces drivers to slow down and can cause backups on westbound Broadway during peak periods. The existing movement from southbound Bayshore Highway to westbound Broadway requires drivers to travel northbound at one point to cross US 101.

Project Description

The proposed action will construct a new seven-lane Broadway overcrossing approximately 170 feet to the north of the existing four-lane structure. Broadway will be realigned to extend straight across US 101 from the Broadway/Rollins Road intersection on the west to Bayshore Highway on the east, eliminating the existing curvilinear alignment. The northern terminus of Airport Boulevard will be shifted approximately 100 feet to the north to meet the new eastern touchdown of the overcrossing and maintain a four-leg intersection with Broadway, Bayshore Highway, and the access road for the Crowne Plaza Hotel. New traffic signals and streetlights will be installed as part of the project. The proposed action, as designed, is anticipated to take 2 to 2.5 years to construct.

Overcrossing Construction

Construction of the new overcrossing will require the installation of abutments on both ends of the structure and a support column in the US 101 median. Approximately 250 piles will be driven to permanently support the abutments and column. The piles will be Class 140, measuring 14 or 15 inches in diameter depending on the type used, and driven by an impact hammer. Approximately 12 to 15 piles will be driven per day. Pile driving for the overcrossing is expected to last between 2 and 4 weeks. As groundwater has been encountered at a depth of

approximately 4 feet in the project vicinity, dewatering at the abutment footings is anticipated. Tanker trucks will collect all extracted liquid and dispose of it at an appropriate off-site facility.

The new overcrossing's profile will be more than 2 feet higher than the existing structure to meet the current standard for vertical clearance. The southbound off- and on-ramps west of US 101 and Airport Boulevard, Bayshore Highway, and the Crowne Plaza Hotel access road east of US 101 will also be raised as they approach the Broadway overcrossing. Imported fill will be used for project-related grade changes as needed.

Freeway On-Ramp and Off-Ramp Changes

On the west side of US 101, the existing partial cloverleaf interchange with collector-distributor roads will be removed and replaced with a partial diamond interchange. The intersection of the southbound off- and on-ramps with Broadway will be elevated by up to 25 feet above the existing grade. Approximately 60 to 120 piles will be driven to permanently support the southbound off- and on-ramps. The piles will also be Class 140, measuring 14 or 15 inches in diameter depending on the type used, and driven by an impact hammer. Approximately 12 to 15 piles will be driven per day. Pile driving for the southbound off- and on-ramps is expected to last approximately 2 weeks. On the east side of the interchange, the existing trumpet-configuration ramps will be replaced with a partial buttonhook interchange. The two-lane northbound US 101 off-ramp will pass under the new overcrossing and curve west to form a T-intersection at Bayshore Highway. Bayshore Highway will be widened from four to eight lanes between the new overcrossing and the northbound US 101 ramps.

Pedestrian and Bicycle Facilities

Both ends of the pedestrian overcrossing located approximately 100 feet south of the existing Broadway overcrossing will be reconfigured to meet the increased profile grades of Rollins Road to the west and Bayshore Highway and the Crowne Plaza Hotel access road to the east. The new Broadway overcrossing will have a 10-foot sidewalk on the north side and Class II (striped) bike lanes on both sides. The project will also provide new Class II bike lanes on Airport Boulevard and Bayshore Highway and Class III (unstriped) bikeways on Broadway west of the overcrossing and Rollins Road.

Ramp Metering Systems

Ramp metering signals and equipment will be installed at both the northbound and southbound US 101 on-ramps.

Right-of-Way (ROW) Requirements

East of US 101, the realignment of Airport Boulevard at its intersection with Broadway and Bayshore Highway will require the acquisition of a gas station. West of US 101, an industrial property will be acquired to accommodate the northward realignment of Broadway just east of Rollins Road. Partial property acquisitions and temporary easements for construction access and staging could be necessary from commercial and industrial properties. No residential properties will be acquired for the proposed action.

The increased profile height of the new Broadway overcrossing will require adjacent approach roadways and parking lot driveways to be raised in elevation by 2 to 10 feet, depending on the distance from the overcrossing. Asphalt-concrete overlay will be added to increase roadway

elevations, and in some locations retaining walls will be constructed to minimize encroachment onto existing properties.

Utilities and Drainage

To meet Caltrans freeway design standards, utilities within the proposed action's state ROW will be relocated unless longitudinal encroachment variances are approved. A number of utilities are anticipated to be affected, including Pacific Gas and Electric Company (PG&E) electric cables and gas lines; Comcast and Sprint communication lines; and City of Burlingame sanitary sewer, storm water, and water lines. The project will avoid the three PG&E transmission towers in the northwest quadrant of the existing US 101/Broadway interchange. All potentially relocated utilities are within the areas studied for biological effects.

The existing drainage systems in the project limits consist of roadside ditches, cross culverts, longitudinal culverts, asphalt-concrete dikes, and concrete curbs with inlets to collect storm water at shoulders. The City of Burlingame also operates a pump station on the west side of US 101, which the project will not affect. The project will replace undersized culverts and install additional inlets and new longitudinal systems to meet current drainage design requirements.

An unnamed drainage channel lies just east of the project footprint between Bayshore Highway and San Francisco Bay near Airport Boulevard. The channel occupies a drainage easement between a vacant lot and a gas station. Roadway and roadside runoff from around the eastern landing of the Broadway overcrossing and Bayshore Highway flows into the drainage channel by way of 18 and 24 -inch pipe culverts under Bayshore Highway. The culvert outfall is flush with the bottom of the channel and routinely becomes clogged with sediment, restricting flows from draining into the channel. A low berm across the channel approximately 200 feet to the east of the outfall restricts the channel from draining into San Francisco Bay. Together, the clogged culvert and the berm result in localized flooding around the eastern landing of the Broadway overcrossing.

The project will restore the conveyance capacity of the unnamed drainage channel by cleaning the 24-inch culvert pipe that drains to the channel and determining if it has sufficient capacity to convey runoff. The project will also remove sediments from the channel to increase its capacity and remove the berm across the channel to allow surface water to drain to the Bay. All temporarily affected areas will be restored to approximately the original site conditions upon completion of work. Native salt marsh vegetation along the unnamed drainage channel will be removed and restored. Options for restoration may include preserving the native plants in a nursery and replanting them after construction is complete, or replanting using plugs from the surrounding remaining vegetation. The method and design of channel improvements and replanting options will include coordination with appropriate agency staff.

Creek Crossings

US 101 crosses Easton and Sanchez creeks within the action area. Easton Creek is located north of the proposed interchange. The existing 6 by 6 foot double box culvert at Easton Creek on the east side of US 101 will be extended by approximately 42 feet to accommodate the construction of the new northbound US 101 on-ramp. A temporary creek diversion system will be installed before culvert work in the creek commences. In-stream work will occur during the dry season from June 15 to October 15 when the water levels are at their lowest. The creek bottom will be dewatered at low tide in the portion of the creek isolated by one or more cofferdams, which will be in place for a maximum of 4 months. A temporary creek diversion bypass will be installed to

allow creek flow over or around the dewatered portion of the creek, either using a gravity flow system or pumping. On completion of the culvert extension, the cofferdam(s) and creek diversion bypass will be removed and the creek will be returned to preconstruction conditions. Neither the existing culvert nor the proposed extension will interfere with fish passage. No changes will be made to the segment of Easton Creek on the west side of US 101. Sanchez Creek crosses US 101 in a triple box culvert south of the proposed interchange and flows into the Burlingame Lagoon. No work will take place in Sanchez Creek or the lagoon. Project activities near Sanchez Creek and the Burlingame Lagoon will be limited to pavement restriping within the existing paved roadway. A third waterway, Mills Creek, is to the north and outside of the action area and will not be affected by project construction. The Burlingame Lagoon and Mills Creek will be designated as an environmentally sensitive area (ESA), and contractor access will be prohibited.

The cofferdams would be configured as follows.

1. To divert flow from the upper reaches of Easton Creek around the work area, a sandbag cofferdam would be constructed inside of the existing 6-ft-by-6-ft concrete double box culvert under US 101. The sandbags would be manually placed inside of the existing box culvert so as to not affect Easton Creek west of US 101. One or more plastic pipes would be placed within the sandbag cofferdam to allow creek and tidal waters to pass around the work area by gravity flow.

2. To divert tidal flow from the Bay around the work area, a gravel cofferdam would be constructed in the concrete-lined Easton Creek channel between US 101 and Bayshore Highway just east of the culvert extension area. The cofferdam would be sized to withstand the hydrostatic and hydrodynamic pressure from tidal flows. This cofferdam would also have one or more plastic pipes to allow tidal and creek waters to pass around the work area by gravity flow.

3. The downstream outlet of the diversion pipe will be screened with 1/4-inch mesh screen material during all dewatering in accordance with National Marine Fisheries Service (NMFS) Fish Screening Criteria (NMFS 1997) for fingerling-sized fish unless otherwise directed by NMFS. On completion of the culvert extension, the cofferdam(s) and creek diversion bypass will be removed and the creek will be restored to preconstruction conditions.

4. Most of the cofferdam work will be done manually because of the lack of construction equipment access to/in the channel. However, construction equipment such as a small pickup truck, backhoe and/or small crane will be used to mobilize the needed materials. The equipment and materials staging would be in one of the existing paved parking lots on either side of the creek channel between US 101 and Bayshore Highway.

Site Preparation

Site preparation activities will include:

- Installation of ESA fencing
- Installation of Wildlife Exclusion Fencing (WEF)
- Vegetation removal during the non-nesting season for migratory birds

Retaining Walls and Concrete Barriers

Retaining walls will be constructed in several locations within the action area to minimize ROW impacts to existing businesses and to support the ramp approaches and roadway embankments. Approximately 375 piles will be driven to permanently support retaining walls adjacent to the Broadway overcrossing and southbound off- and on-ramps. The piles will be Class 90, 14 or 15 inches in diameter depending on the type used, and driven by impact hammer. Approximately 12 to 15 piles will be driven per day. Pile driving for the retaining walls is expected to last between 4 and 5 weeks. Dewatering at retaining wall footings is anticipated and tanker trucks will collect all extracted liquid and dispose of it at an appropriate off-site facility.

Retaining walls will also be constructed along the Crowne Plaza Hotel access road, Bayshore Highway, and Rollins Road. These retaining walls will be supported on spread footings and will not require pile driving. Concrete safety barriers will be constructed on the east side of US 101 along the proposed northbound off-ramp and on the east side of the proposed northbound onramp. Soundwalls are present in the southern project limits (south of approximately Toyon Drive) along the west side of US 101 and will not be affected by the project.

General Construction Actions

The project footprint is the area subject to direct permanent and temporary construction effects. All construction activities, including site preparation, staging, access, and detours will take place in the project footprint. Construction will require work to be conducted during both day and night.

Contractor Access and Laydown

The proposed action will not require special haul roads. Caltrans will use one-way traffic control and lane closures to accomplish construction activities. Temporary K-rail will be used with other traffic control devices to close lanes, sidewalks, and trail areas, and the available paved surfaces behind the K-rail will provide temporary storage, staging, or laydown areas. Temporary detours and partial nighttime closures of US 101, Broadway, and Bayshore Highway will be required for safety reasons during interchange reconstruction. Some short-term closures of existing interchange ramps, pedestrian overcrossing, sidewalks, and trail segments may be necessary during construction.

Fill and Excavation

Segments of Broadway, Airport Boulevard, Bayshore Highway, and some on- and off-ramps would be raised using imported fill to conform to the grade of the new Broadway overcrossing. The type and quality of fill material would be selected during final design based on the findings of the geotechnical design report. The total quantity of fill placed in the project footprint as a result of project activities is estimated to be 90,000 cubic yards. About 85 percent of the fill will be placed in upland areas (76,500 cubic yards), and about 15 percent (13,500 cubic yards) will be placed in aquatic areas designated as estuarine wetlands and other waters of the U.S. Minor roadway excavation for proposed pavement sections would not exceed 3 feet in depth. Material removed during excavation would be disposed by the contractor at an appropriate offsite location.

Structure Type and Pile Driving

According to the Advanced Planning Study Design Memo (URS 2010), the replacement Broadway overcrossing would be one of the following structure types:

- A 5-foot-deep cast-in-place box girder structure with five 4-foot-diameter octagonal columns on pile footings
- A 6-foot-deep precast, prestressed California wide flange girder bridge with a continuous dropped bent cap supported on pile footings
- A 5-foot-deep precast, prestressed California wide flange girder bridge with an integral bent cap supported on pile footings

Approximately 250 piles would be driven to support the Broadway overcrossing, and approximately 60 to 120 piles would be driven to support the southbound off- and on-ramps. Class 140 precast, prestressed concrete piles are recommended; minimum 14-inch Alternative "X," minimum 15-inch Alternative "Y," piles, or steel pipe piles (Alternative "V," cast-in-steel shell) could be used at this location. While the Advanced Planning Study Design Memo (URS 2010) does not specify pile depths, the maximum estimated depth would be between 60 and 70 feet. Class 90 piles would be driven to support new retaining walls. These piles would also be 14 or 15 inches in diameter and would be driven to a shorter depth than the Class 140 piles.

Hammers used in pile installation would conform to Caltrans Standard Specifications (49-1.05). Impact hammers would be steam, hydraulic, air or diesel hammers sufficient to drive piles at a penetration rate of not less than 1/8 inch per strike at the specified nominal resistance. Vibratory hammers would be considered for use in the initial installation of permanent piles unless shown on the plans or specified in the special provisions, possibly followed by driving to a specified tip elevation with an impact hammer if a hard layer of soil exists at that level. The contractor may also use vibratory hammers to install shoring, cofferdam, or falsework piles unless otherwise restricted in the Contract Special Provisions or as listed in permits.

Sequence of Construction Actions

Caltrans anticipates that construction will begin in early 2014 and will be completed in 2016. The project is anticipated to involve seven stages of construction, which are summarized as follows. Construction staging may be further refined during the final design phase.

Stage 1:

- Partially detour southbound off-ramp
- Construct Bayshore Highway to Collector-Distributor Road detour connection
- Construct northbound off-ramp to northbound on-ramp direct connection
- Construct Broadway overcrossing
- Construct a portion of Airport Boulevard and relocate Bayshore Trail
- Extend Easton Creek culvert
- Partially construct northbound on-ramp
- Partially construct southbound off-ramp

Stage 2:

- Demolish existing southbound off-ramp detour and construct new southbound off-ramp detour
- Partially detour southbound off-ramp
- Partially construct Broadway
- Construct embankment and detour Broadway southbound traffic to new Broadway overcrossing

Stage 3:

- Close existing bus stop and establish up to two temporary bus stop locations.
- Detour two lanes of Broadway northbound traffic to new Broadway overcrossing
- Demolish existing Broadway overcrossing and embankment
- Partially construct Broadway and Bayshore Highway
- Widen and restripe Broadway and Rollins Road

Stage 4:

- Detour two lanes of Broadway northbound traffic to new Broadway alignment
- Partially construct Bayshore Highway
- Partially construct northbound off-ramp
- Temporarily restripe and detour Bayshore Highway

Stage 5:

- Partially construct southbound off-ramp and detour traffic
- Detour Airport Boulevard - Broadway traffic
- Partially construct Bayshore Highway and Crowne Plaza Hotel access road
- Construct temporary pavement (raised) for Airport Boulevard to Broadway connection
- Partially construct northwest portion of Bayshore Highway
- Partially construct northbound off-ramp
- Construct remaining portions of Broadway, Rollins Road, and access road to PG&E towers
- Demolish existing southbound off-ramp to southbound on-ramp connection

Stage 6:

- Detour Airport Boulevard to Broadway traffic
- Construct portion of Bayshore Highway
- Construct remaining portions of Airport Boulevard
- Partially construct northeast portion of Bayshore Highway
- Construct remaining portions of southbound on-ramp
- Construct remaining portions of northbound on- and off-ramp
- Demolish remaining portions of northbound on-ramp, and southbound off-ramp
- Remove temporary bus stops and establish new bus stop

Stage 7:

- Construct remaining portion of Crowne Plaza Hotel access road
- Construct pedestrian access to Bayside Park
- Construct POC landings
- Demolish existing northbound on- and off-ramp
- Construct remaining portion of northbound off-ramp

Site Clean-up and Restoration

Temporarily disturbed areas and staging areas will be cleaned up and recontoured to original grade. Permanent erosion control, including soil stabilization measures such as hydroseeding and coir netting, will be applied to all temporarily affected project areas to minimize erosion after construction. All construction-related materials, including ESA fencing and exclusion fencing, will be removed after construction, site clean-up, and restoration activities are complete.

Vegetation and trees removed by construction operations within the project limits will be replaced according to Caltrans policy. Appropriate native species will be used to the maximum extent possible, and trees, shrubs, and groundcover will be selected for drought tolerance and disease resistance. Mulch will be applied to planted areas to reduce weed growth, conserve moisture, and minimize maintenance operations. An automated electric remote irrigation control system will be installed and will include low-volume irrigation heads and limited overhead irrigation. Revegetation will take place under a separate landscape contract after completion of the roadway construction contract. The landscape contract will be funded by the parent project and will include a 3-year plant establishment period.

Post-Project Maintenance

When the project is completed, maintenance will be performed by Caltrans or by approved contractors hired by Caltrans for those tasks. Standard Caltrans practices for cleaning, repairing, and otherwise maintaining US 101 throughout the length of the project area will be followed.

Conservation Measures

The measures listed below will be implemented as part of construction to avoid and/or minimize effects to listed species and their habitats as well as to common biological resources.

1. **Construction Work, Access, and Staging Areas.** All proposed construction will be limited to the existing and proposed Caltrans ROW.

2. **Environmentally Sensitive Area Fencing.** ESAs are defined as the areas containing sensitive habitats within or adjacent to the construction work areas that are off-limits to construction personnel and will be conspicuously demarked to prevent any disturbance within these areas. Prior to the start of construction, all ESAs will be clearly demarked using high-visibility orange construction fencing. The ESA fencing will remain in place throughout the duration of the project, while construction activities are ongoing, and will be regularly inspected and fully maintained at all times. The final project plans will depict all locations where ESA fencing will be installed and will provide installation specifications. The bid solicitation package special provisions will clearly describe acceptable fencing material and prohibited construction-related activities including vehicle operation, material and equipment storage, access roads and other surface-disturbing activities within ESAs. In addition, hydrological features (i.e., topographic depressions, drainage ditches, culverts, etc.) outside of the project footprint will not be manipulated (i.e., re-routed, dredged, filled, graded, etc.). This will avoid potential effects to wetlands and waters outside of the project footprint that are hydrologically connected to aquatic features within the project footprint.

3. **Wildlife Exclusion Fencing**. Replaced by Term and Condition 1.f.

4. **Environmental Awareness Training.** Prior to the start of construction, a qualified biologist will conduct an educational training program for all construction personnel including contractors and subcontractors. The training will include, at a minimum, a description of the California red-legged frog, San Francisco garter snake, California clapper rail, salt marsh harvest mouse, California seablite, and migratory birds and their habitats; associated habitats of these species within the action area; an explanation of the status of these species and protection under state and federal laws; the avoidance and minimization measures to be implemented to reduce take of these species; communication and work stoppage procedures in case a listed species is observed onsite; and an explanation of the ESAs and WEF and the importance of maintaining these structures. A fact sheet conveying this information will be prepared and distributed to all construction personnel. Upon completion of the program, personnel will sign a form stating that they attended the program and understand all the avoidance and minimization measures and implications of Act.

5. **Vegetation Removal.** Replaced by Term and Condition 1.g.

6. **Work in Waterways.** One or more temporary cofferdam(s) will be required to install the Easton Creek culvert extension. Only sandbags filled with clean gravel or sand, i.e. gravel or sand substantially free of dirt, silt or other debris that would adversely affect water quality if released into the stream, will be used for construction of the cofferdams. The dewatering pump will be screened with 1/4-inch mesh screen material during all dewatering in accordance with NMFS Fish Screening Criteria (1997) for fingerling-sized fish unless otherwise directed by NMFS. Sediment removal in the unnamed drainage channel will take place after upstream culvert work is complete. The berm separating the unnamed drainage channel from San Francisco Bay will be removed after completion of the culvert work (including sediment removal) and during low tide.

7. **Construction Discharges.** No debris, soil, silt, sand, bark, slash, sawdust, cement, concrete, washings, petroleum products or other organic or earthen material shall be allowed to enter into or be placed where it may be washed by rainfall or runoff into waters of the U.S., non-jurisdictional drainages, or other suitable California red-legged frog habitat. No discharges of excessively turbid water will be allowed, and all equipment will be well-maintained and free of leaks.

8. **Best Management Practices (BMPs).** Storm Water Pollution Prevention Plans (SWPPP) and erosion control BMPs will be developed and implemented to minimize any wind or water-related erosion and will be in compliance with the requirements of the Regional Water Quality Control Board. The SWPPP will provide guidance for design staff to include provisions in construction contracts for measures to protect sensitive areas and prevent and minimize stormwater and non-stormwater discharges. Protective measures will include, at a minimum:

    a. No discharge of pollutants from vehicle and equipment cleaning is allowed into any storm drains or water courses.

b. Vehicle and equipment fueling and maintenance operations must be at least 50 feet away from watercourses, except at established commercial gas stations or established vehicle maintenance facility.

c. Concrete wastes are collected in washouts and water from curing operations is collected and disposed. Neither will be allowed into watercourses.

d. Spill containment kits will be maintained onsite at all times during construction operations and/or staging or fueling of equipment.

e. Dust control measures will include use of water trucks and dust palliatives to control dust in excavation-and-fill areas, covering temporary access road entrances and exits with rock (rocking), and covering of temporary stockpiles when weather conditions require.

f. Coir rolls or straw wattles will be installed along or at the base of slopes during construction to capture sediment.

g. Protection of graded areas from erosion using a combination of silt fences, fiber rolls along toes of slopes or along edges of designated staging areas, and erosion control netting (such as jute or coir) as appropriate on sloped areas. No erosion control materials that use plastic or synthetic mono-filament netting will be used.

h. Permanent erosion control measures such as bio-filtration strips and swales to receive storm water discharges from the highway, or other impervious surfaces will be incorporated to the maximum extent practicable.

9. **Construction Site Management Practices.** The following site restrictions will be implemented to avoid or minimize effects on listed species and their habitats:

a. A speed limit of 15 miles per hour in the project footprint in unpaved areas will be enforced to reduce dust and excessive soil disturbance.

b. Construction access, staging, storage, and parking areas, will be located within the Caltrans ROW outside of any designated ESA or outside of the Caltrans ROW in areas environmentally cleared by the contractor. Access routes and the number and size of staging and work areas will be limited to the minimum necessary to construct the proposed project. Routes and boundaries of roadwork will be clearly marked prior to initiating construction or grading.

c. To the maximum extent practicable, any borrow material will be certified to be non-toxic and weed free.

d. All food and food-related trash items will be enclosed in sealed trash containers and removed completely from the site at the end of each day.

e. No pets from project personnel will be allowed anywhere in the action area during construction.

f. No firearms will be allowed on the project site except for those carried by authorized security personnel, or local, State or Federal law enforcement officials.

g. All equipment will be maintained such that there will be no leaks of automotive fluids such as gasoline, oils or solvents and a Spill Response Plan will be prepared. Hazardous materials such as fuels, oils, solvents, etc. will be stored in sealable containers in a designated location that is at least 50 feet from wetlands and aquatic habitats.

h. Servicing of vehicles and construction equipment including fueling, cleaning, and maintenance will occur at least 50 feet from any aquatic habitat unless separated by topographic or drainage barrier or unless it is an already existing gas station. Staging areas may occur closer to the project activities as required.

10. **Reduce Spread of Invasive Species**. To reduce the spread of invasive non-native plant species and minimize the potential decrease of palatable vegetation for wildlife species, Caltrans will comply with Executive Order 13112. This order is provided to prevent the introduction of invasive species and provide for their control in order to minimize the economic, ecological, and human health impacts. In the event that high- or medium-priority noxious weeds, as defined by the California Department of Food and Agriculture or the California Invasive Plant Council, are disturbed or removed during construction-related activities, the contractor will contain the plant material associated with these noxious weeds and dispose of it in a manner that will not promote the spread of the species. The contractor will be responsible for obtaining all permits, licenses and environmental clearances for properly disposing of materials. Areas subject to noxious weed removal or disturbance will be replanted with fast-growing native grasses or a native erosion control seed mixture. If seeding is not possible, the area should be covered to the extent practicable with heavy black plastic solarization material until the end of the project.

11. **Restoration/Revegetation.** Replaced by Term and Condition 1.h.

Analytical Framework for Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this biological opinion relies on four components: (1) *Status of the Species*; (2) *Environmental Baseline*, which evaluates the California red-legged frog range-wide conditions, the factors responsible for that condition, and their survival and recovery needs; and evaluates the condition of this species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of this species; (3) *Effects of the Action*, which determines the direct and indirect effects of the proposed Federal action and the effects of any interrelated or interdependent activities on this species; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the California red-legged frog.

In accordance with policy and regulation, this jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the California red-legged frog current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of this species in the wild.

The jeopardy analysis in this biological opinion places an emphasis on consideration of the range-wide survival and recovery of the California red-legged frog and the role of the action area in the survival and recovery of species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the proposed action the Service considers the action area, comprising 50.48 acres, to encompass the project footprint, construction access and staging areas, traffic staging, parking areas, turnouts, borrow/disposal/stockpile sites, and utility relocation areas as specified by Caltrans and submitted to the Service in the September 1, 2010 biological assessment and described in the Project Description of this biological opinion. The action area extends 0.76-mile from PM 16.30 to PM 17.06 and includes portions of US 101, Rollins Road, Broadway, Airport Boulevard, Bayshore Highway and immediately surrounding areas. Habitat within the action area is comprised of California annual grassland, landscaped iceplant, eucalyptus forest, mixed non-native forest, mixed non-native shrubland, pickleweed wetland, alkali heath wetland, brackish cattail wetland and saltgrass wetland vegetation communities. However, the majority of the action area consists of paved hardscapes and urbanized/landscaped development. Hydrologic features within the action area includes estuarine wetlands, Easton and Sanchez creeks, roadside ditches, an unnamed drainage channel between Bayshore Highway and San Francisco Bay near Airport Boulevard; all of which are tidally influenced within the action area.

Status of the Species and Environmental Baseline

California Red-legged Frog

Listing Status: The California red-legged frog was listed as a threatened species on May 23, 1996 (61 FR 25813). Critical habitat was designated for this species on April 13, 2006 (71 FR 19244) and revisions to the critical habitat designation were published on March 17, 2010 (75 FR 12816). At this time, the Service recognized the taxonomic change from *Rana aurora draytonii* to *Rana draytonii* (Shaffer *et al.* 2010). A recovery plan was published for the California red-legged frog on September 12, 2002 (Service 2002).

Distribution: The historic range of the California red-legged frog extended from the vicinity of Elk Creek in Mendocino County, California, along the coast inland to the vicinity of Redding in Shasta County, California, and southward to northwestern Baja California, Mexico (Fellers 2005; Jennings and Hayes 1985; Hayes and Krempels 1986). The species was historically documented in 46 counties but the taxa now remains in 238 streams or drainages within 23 counties, representing a loss of 70 percent of its former range (Service 2002). California red-legged frogs are still locally abundant within portions of the San Francisco Bay area and the Central California Coast. Isolated populations have been documented in the Sierra Nevada, northern Coast, and northern Transverse Ranges. The species is believed to be extirpated from the southern Transverse and Peninsular ranges, but is still present in Baja California, Mexico (CDFG 2010).

Status and Natural History: California red-legged frogs predominately inhabit permanent water sources such as streams, lakes, marshes, natural and manmade ponds, and ephemeral drainages in valley bottoms and foothills up to 4,921 feet in elevation (Jennings and Hayes 1994,

Bulger *et al.* 2003, Stebbins 2003). However, they also inhabit ephemeral creeks, drainages and ponds with minimal riparian and emergent vegetation. California red-legged frogs breed from November to April, although earlier breeding records have been reported in southern localities. Breeding generally occurs in still or slow-moving water often associated with emergent vegetation, such as cattails, tules or overhanging willows (Storer 1925, Hayes and Jennings 1988). Female frogs deposit egg masses on emergent vegetation so that the egg mass floats on or near the surface of the water (Hayes and Miyamoto 1984).

Habitat includes nearly any area within 1-2 miles of a breeding site that stays moist and cool through the summer including vegetated areas with coyote brush, California blackberry thickets, and root masses associated with willow and California bay trees (Fellers 2005). Sheltering habitat for California red-legged frogs potentially includes all aquatic, riparian, and upland areas within the range of the species and includes any landscape feature that provide cover, such as animal burrows, boulders or rocks, organic debris such as downed trees or logs, and industrial debris. Agricultural features such as drains, watering troughs, spring boxes, abandoned sheds, or hay stacks may also be used. Incised stream channels with portions narrower and depths greater than 18 inches also may provide important summer sheltering habitat. Accessibility to sheltering habitat is essential for the survival of California red-legged frogs within a watershed, and can be a factor limiting frog population numbers and survival.

California red-legged frogs do not have a distinct breeding migration (Fellers 2005). Adults are often associated with permanent bodies of water. Some individuals remain at breeding sites year-round, while others disperse to neighboring water features. Dispersal distances are typically less than 0.5-mile, with a few individuals moving up to 1-2 miles (Fellers 2005). Movements are typically along riparian corridors, but some individuals, especially on rainy nights, move directly from one site to another through normally inhospitable habitats, such as heavily grazed pastures or oak-grassland savannas (Fellers 2005).

In a study of California red-legged frog terrestrial activity in a mesic area of the Santa Cruz Mountains, Bulger *et al.* (2003) categorized terrestrial use as migratory and non-migratory. The latter occurred from one to several days and was associated with precipitation events. Migratory movements were characterized as the movement between aquatic sites and were most often associated with breeding activities. Bulger *et al.* (2003) reported that non-migrating frogs typically stayed within 200 feet of aquatic habitat 90 percent of the time and were most often associated with dense vegetative cover, i.e., California blackberry, poison oak and coyote brush. Dispersing frogs in northern Santa Cruz County traveled distances from 0.25-mile to more than 2 miles without apparent regard to topography, vegetation type, or riparian corridors (Bulger *et al.* 2003).

In a study of California red-legged frog terrestrial activity in a xeric environment in eastern Contra Costa County, Tatarian (2008) noted that a 57 percent majority of frogs fitted with radio transmitters in the Round Valley study area stayed at their breeding pools, whereas 43 percent moved into adjacent upland habitat or to other aquatic sites. Her study reported a peak seasonal terrestrial movement occurring in the fall months associated with the first 0.2-inch of precipitation and tapering off into spring. Upland movement activities ranged from 3 to 233 feet, averaging 80 feet, and were associated with a variety of refugia including grass thatch, crevices, cow hoof prints, ground squirrel burrows at the base of trees or rocks, logs, and under man-made structures; others were associated with upland sites lacking refugia (Tatarian 2008). The majority of terrestrial movements lasted from 1 to 4 days; however, one adult female was reported to remain in upland habitat for 50 days (Tatarian 2008). Upland refugia closer to aquatic sites were

used more often and were more commonly associated with areas exhibiting higher object cover, e.g., woody debris, rocks, and vegetative cover. Subterranean cover was not significantly different between occupied upland habitat and non-occupied upland habitat.

California red-legged frogs are often prolific breeders, laying their eggs during or shortly after large rainfall events in late winter and early spring (Hayes and Miyamoto 1984). Egg masses containing 2,000 to 5,000 eggs are attached to vegetation below the surface and hatch after 6 to 14 days (Storer 1925, Jennings and Hayes 1994). In coastal lagoons, the most significant mortality factor in the pre-hatching stage is water salinity (Jennings *et al.* 1992). Eggs exposed to salinity levels greater than 4.5 parts per thousand resulted in 100 percent mortality (Jennings and Hayes 1990). Increased siltation during the breeding season can cause asphyxiation of eggs and small larvae. Larvae undergo metamorphosis 3½ to 7 months following hatching and reach sexual maturity 2 to 3 years of age (Storer 1925; Wright and Wright 1949; Jennings and Hayes 1985, 1990, 1994). Of the various life stages, larvae probably experience the highest mortality rates, with less than 1 percent of eggs laid reaching metamorphosis (Jennings *et al.* 1992). California red-legged frogs may live 8 to 10 years (Jennings *et al.* 1992). Populations can fluctuate from year to year; favorable conditions allow the species to have extremely high rates of reproduction and thus produce large numbers of dispersing young and a concomitant increase in the number of occupied sites. In contrast, the animal may temporarily disappear from an area when conditions are stressful (e.g., during periods of drought, disease, etc.).

The diet of California red-legged frogs is highly variable and changes with the life history stage. The diet of the larvae is not well studied, but is likely similar to that of other ranid frogs, feeding on algae, diatoms, and detritus by grazing on the surface of rocks and vegetation (Fellers 2005; Kupferberg 1996a, 1996b, 1997). Hayes and Tennant (1985) analyzed the diets of California red-legged frogs from Cañada de la Gaviota in Santa Barbara County during the winter of 1981 and found invertebrates (comprising 42 taxa) to be the most common prey item consumed; however, they speculated that this was opportunistic and varied based on prey availability. They ascertained that larger frogs consumed larger prey and were recorded to have preyed on Pacific chorus frogs, three-spined stickleback and, to a limited extent, California mice, which were abundant at the study site (Hayes and Tennant 1985, Fellers 2005). Although larger vertebrate prey was consumed less frequently, it represented over half of the prey mass eaten by larger frogs suggesting that such prey may play an energetically important role in their diets (Hayes and Tennant 1985). Juvenile and subadult/adult frogs varied in their feeding activity periods; juveniles fed for longer periods throughout the day and night, while subadult/adults fed nocturnally (Hayes and Tennant 1985). Juveniles were significantly less successful at capturing prey and all life history stages exhibited poor prey discrimination, feeding on several inanimate objects that moved through their field of view (Hayes and Tennant 1985).

Metapopulation and Patch Dynamics: The direction and type of habitat used by dispersing animals is especially important in fragmented environments (Forys and Humphrey 1996). Models of habitat patch geometry predict that individual animals will exit patches at more "permeable" areas (Buechner 1987; Stamps *et al.* 1987). A landscape corridor may increase the patch-edge permeability by extending patch habitat (La Polla and Barrett 1993), and allow individuals to move from one patch to another. The geometric and habitat features that constitute a "corridor" must be determined from the perspective of the animal (Forys and Humphrey 1996).

Because their habitats have been fragmented, many endangered and threatened species exist as metapopulations (Verboom and Apeldom 1990; Verboom *et al.* 1991). A metapopulation is a collection of spatially discrete subpopulations that are connected by the dispersal movements of

the individuals (Levins 1970; Hanski 1991). For metapopulations of listed species, a prerequisite to recovery is determining if unoccupied habitat patches are vacant due to the attributes of the habitat patch (food, cover, and patch area) or due to patch context (distance of the patch to other patches and distance of the patch to other features). Subpopulations on patches with higher quality food and cover are more likely to persist because they can support more individuals. Large populations have less of a chance of extinction due to stochastic events (Gilpin and Soule 1986). Similarly, small patches will support fewer individuals, increasing the rate of extinction. Patches that are near occupied patches are more likely to be recolonized when local extinction occurs and may benefit from emigration of individuals via the "rescue" effect (Hanski 1982; Gotelli 1991; Holt 1993; Fahrig and Merriam 1985). For the metapopulation to persist, the rate of patches being colonized must exceed the rate of patches going extinct (Levins 1970). If some subpopulations go extinct regardless of patch context, recovery actions should be placed on patch attributes. Patches could be managed to increase the availability of food and/or cover.

Movements and dispersal corridors likely are critical to California red-legged frog population dynamics, particularly because the animals likely currently persist as metapopulations with disjunct population centers. Movement and dispersal corridors are important for alleviating over-crowding and intraspecific competition, and also they are important for facilitating the recolonization of areas where the animal has been extirpated. Movement between population centers maintains gene flow and reduced genetic isolation. Genetically isolated populations are at greater risk of deleterious genetic effects such as inbreeding, genetic drift, and founder effects. The survival of wildlife species in fragmented habitats may ultimately depend on their ability to move among patches to access necessary resources, retain genetic diversity, and maintain reproductive capacity within populations (Hilty and Merenlender 2004; Petit *et al.* 1995; Buza *et al.* 2000).

Most metapopulation or meta-population-like models of patchy populations do not directly include the effects of dispersal mortality on population dynamics (Hanski 1994; With and Crist 1995; Lindenmayer and Possingham 1996). Based on these models, it has become a widely held notion that more vagile species have a higher tolerance to habitat loss and fragmentation than less vagile species. But models that include dispersal mortality predict exactly the opposite: more vagile species should be more vulnerable to habitat loss and fragmentation because they are more susceptible to dispersal mortality (Fahrig 1998; Casagrandi and Gatto 1999). This prediction is supported by Gibbs (1998), who examined the presence-absence of five amphibian species across a gradient of habitat loss. He found that species with low dispersal rates are better able than more vagile species to persist in landscapes with low habitat cover. Gibbs (1998) postulated that the land between habitats serves as a demographic "drain" for many amphibians. Furthermore, Bonnet *et al.* (1999) found that snake species that frequently make long-distance movements have higher mortality rates than do sedentary species.

Threats: Habitat loss, non-native species introduction, and urban encroachment are the primary factors that have adversely affected the California red-legged frog throughout its range. Several researchers in central California have noted the decline and eventual local disappearance of California and northern red-legged frogs in systems supporting bullfrogs (Jennings and Hayes 1990; Twedt 1993), red swamp crayfish, signal crayfish, and several species of warm water fish including sunfish, goldfish, common carp, and mosquitofish (Moyle 1976; Barry 1992; Hunt 1993; Fisher and Schaffer 1996). This has been attributed to predation, competition, and reproduction interference. Twedt (1993) documented bullfrog predation of juvenile northern red-legged frogs (*Rana aurora*), and suggested that bullfrogs could prey on subadult California red-

legged frogs as well. Bullfrogs may also have a competitive advantage over California red-legged frogs. For instance, bullfrogs are larger and possess more generalized food habits (Bury and Whelan 1984). In addition, bullfrogs have an extended breeding season (Storer 1933) during which an individual female can produce as many as 20,000 eggs (Emlen 1977). Furthermore, bullfrog larvae are unpalatable to predatory fish (Kruse and Francis 1977). Bullfrogs also interfere with California red-legged frog reproduction by eating adult male California red-legged frogs. Both California and northern red-legged frogs have been observed in amplexus (mounted on) with both male and female bullfrogs (Jennings and Hayes 1990; Twedt 1993; Jennings 1993). Thus bullfrogs are able to prey upon and out-compete California red-legged frogs, especially in sub-optimal habitat.

The urbanization of land within and adjacent to California red-legged frog habitat has also affected the threatened amphibian. These declines are attributed to channelization of riparian areas, enclosure of the channels by urban development that blocks dispersal, and the introduction of predatory fishes and bullfrogs. Diseases may also pose a significant threat, although the specific effects of disease on the California red-legged frog are not known. Pathogens are suspected of causing global amphibian declines (Davidson *et al.* 2003). Chytridiomycosis and ranaviruses are a potential threat because these diseases have been found to adversely affect other amphibians, including the listed species (Davidson *et al.* 2003; Lips *et al.* 2006). Mao *et al.* (1999 cited in Fellers 2005) reported northern red-legged frogs infected with an iridovirus, which was also presented in sympatric threespine sticklebacks in northwestern California. Non-native species, such as bullfrogs and non-native tiger salamanders that live within the range of the California red-legged frog have been identified as potential carriers of these diseases (Garner *et al.* 2006). Human activities can facilitate the spread of disease by encouraging the further introduction of non-native carriers and by acting as carriers themselves (i.e., contaminated boots, waders or fishing equipment). Human activities can also introduce stress by other means, such as habitat fragmentation, that results in the listed species being more susceptible to the effects of disease.

Negative effects to wildlife populations from roads and pavement may extend some distance from the actual road. The phenomenon can result from vehicle-related mortality, habitat degradation, noise and light pollution, and invasive exotic species. Forman and Deblinger (1998) described the area affected as the "road effect" zone. One study along a 4-lane road in Massachusetts determined that this zone extended for an average of 980 feet to either side of the road for an average total zone width of approximately 1,970 feet. However, in places they detected an effect greater than 0.6-mile from the road. The road effect zone can also be subtle. Van der Zandt *et al.* (1980) reported that lapwings and black-tailed godwits feeding at 1,575 to 6,560 feet from roads were disturbed by passing vehicles. The heart rate, metabolic rate and energy expenditure of female bighorn sheep increases near roads (MacArthur *et al.* 1979). Trombulak and Frissell (2000) described another type of "road-zone" effect due to contaminants. Heavy metal concentrations from vehicle exhaust were greatest within 66 feet of roads and elevated levels of metals in soil and plants were detected at 660 feet of roads. The "road-zone" varies with habitat type and traffic volume. Based on responses by birds, Forman (2000) estimated the road-zone along primary roads of 1,000 feet in woodlands, 1,197 feet in grasslands, and 2,657 feet in natural lands near urban areas. Along secondary roads with lower traffic volumes, the effect zone was 656 feet. The road-zone with regard to California red-legged frogs has not been adequately investigated.

The necessity of moving between multiple habitats and breeding ponds means that many amphibian species, such as the California red-legged frog are especially vulnerable to roads and well-used large paved areas in the landscape. Van Gelder (1973) and Cooke (1995) have examined the effect of roads on amphibians and found that because of their activity patterns, population structure, and preferred habitats, aquatic breeding amphibians are more vulnerable to traffic mortality than some other species. High-volume highways pose a nearly impenetrable barrier to amphibians and result in mortality to individual animals as well as significantly fragmenting habitat. Hels and Buchwald (2001) found that mortality rates for anurans on high traffic roads are higher than on low traffic roads. Vos and Chardon (1998) found a significant negative effect of road density on the occupation probability of ponds by the moor frog in the Netherlands. In addition, incidences of very large numbers of road-killed frogs are well documented (Asley and Robinson 1996), and studies have shown strong population level effects of traffic density (Carr and Fahrig 2001) and high traffic roads on these amphibians (Van Gelder 1973; Vos and Chardon 1998). Most studies regularly count road mortalities from slow moving vehicles (Hansen 1982; Rosen and Lowe 1994; Drews 1995; Mallick *et al.* 1998) or by foot (Munguira and Thomas 1992). These studies assume that every victim is observed, which may be true for large conspicuous mammals, but may be an incorrect assumption for small animals, such as the California red-legged frog. Amphibians appear especially vulnerable to traffic mortality because they readily attempt to cross roads, are small and slow-moving, and thus are not easily avoided by drivers (Carr and Fahrig 2001).

Status of the Species: The recovery plan for the California red-legged frog identifies eight recovery units (Service 2002). The establishment of these recovery units is based on the determination that various regional areas of the species' range are essential to its survival and recovery. The status of the California red-legged frog was considered within the small scale recovery units as opposed to their overall range. These recovery units are delineated by major watershed boundaries as defined by U.S. Geological Survey (USGS) hydrologic units and the limits of its range. The goal of the recovery plan is to protect the long-term viability of all extant populations within each recovery unit. Within each recovery unit, core areas have been delineated and represent contiguous areas of moderate to high California red-legged frog densities that are relatively free of exotic species such as bullfrogs. The goal of designating core areas is to protect metapopulations. Thus when combined with suitable dispersal habitat, will allow for the long term viability within existing populations. This management strategy will allow for the recolonization of habitats within and adjacent to core areas that are naturally subjected to periodic localized extinctions, thus assuring the long-term survival and recovery of California red-legged frogs.

Environmental Baseline

The action area is not located within designated critical habitat, but it is located in the South San Francisco Bay Core Area (Unit 18) and Central Coast Recovery Unit (Service 2002). The conservation needs for the South San Francisco Bay Core Area are to: (1) protect existing populations; (2) control non-native predators; (3) increase connectivity between populations; (4) reduce erosion; (5) implement guidelines for recreation activities to reduce impacts; (6) implement forest practice guidelines; and (7) reduce impacts of urbanization. According to the biological assessment (Caltrans 2010a), the project is located within the known range of the California red-legged frog, but no occurrences have been documented within the action area. However, focused California red-legged frog surveys were not conducted in support of this proposed action (Caltrans 2010a). URS Corporation biologists conducted two site visits on March 31, 2009 and April 1, 2009, to evaluate habitat suitability within the action area. An

additional follow-up site visit was conducted on January 29, 2010, to further evaluate the action area for California red-legged frogs. No California red-legged frogs were observed during these site visits.

Hydrologic features within the action area include estuarine wetlands, Easton and Sanchez creeks, roadside ditches, and an unnamed drainage channel northeast of the Bayshore Highway and Airport Boulevard intersection that extends eastward where it empties into the San Francisco Bay. Several of these aquatic features are tidally influenced as far inland as the Caltrain railroad tracks (City of Burlingame 2004, Caltrans 2010a). Two areas were identified by Caltrans (2010a) as marginally suitable non-breeding aquatic habitat comprising 0.2-acre: (1) a seasonal emergent wetland containing cattails and sedges along the southbound lane of US 101 between the highway and the backs of industrial buildings on Marsten Road; and (2) a seasonal wetland along the western boundary of the southbound US 101/Broadway off-ramp. Both features are hydrologically connected to Easton Creek and are tidally influenced. At the seasonal emergent wetland, Caltrans reported salinity levels ranged between 3.0 and 4.0 ppt, i.e. within the maximum reported tolerance ranges for eggs (4.5 ppt) and well within the tolerance range of adults (9.0 ppt) (Jennings and Hayes 1990). Caltrans (2010a) also identified 3.19 acres of marginal upland foraging and refugia, and dispersal habitat along the road verge of northbound and southbound US 101north of the US 101/Broadway interchange.

The nearest reported breeding sites are located within a freshwater drainage along PG&E transmission line corridor between Rollins Road and Adrian Road approximately 0.25-mile northwest of the project footprint. Two adult California red-legged frogs were observed immediately adjacent to this site in 2001 and 2004 (P. Kobernus pers. comm. 2010). Follow-up surveys were conducted at this location during the August 2009, but no California red-legged frogs were observed (P. Kobernus pers. comm. 2010). A portion of the undeveloped upland ruderal habitat adjacent to the wetland has been converted into a paved parking lot; however, the wetland itself has been fenced off (P. Kobernus pers. comm. 2010). This area remains a suitable breeding site for California red-legged frogs; although, ingress and egress to the site is limited to the PG&E utility corridor which connects the site to another known breeding site to the northwest near the intersection of US 101/Millbrae Avenue. Caltrans (2010a) and the City of Burlingame (2004) identified the seasonal wetlands at the US 101/Millbrae Avenue Interchange and roadside drainage along the US 101 on-ramp off of East Millbrae Avenue as suitable California red-legged frog breeding habitat. During work conducted for the City of Burlingame, Dr. Samuel McGinnis observed several adult California red-legged frogs at this location and documented an active breeding colony in 2002 (S. McGinnis pers. comm. 2010). No follow-up surveys have been conducted and the colony is considered extant. Both locations of California red-legged frog sightings are considered spatially distinct subpopulations of the Lamita Canal and Cupids Row Canal population north of East Millbrae Avenue and west of US 101 across from the San Francisco International Airport. As consistent with metapopulation dynamics, the narrow linear patches of habitat along US 101 (roadside drainages) and the PG&E utility corridor provide a viable dispersal linkage between the population to the north and identified habitat within the action area.

The action area is largely developed and is situated within a heavily urbanized setting. The majority of the action area, i.e. 47.09 acres, does not provide suitable habitat for California red-legged frogs due to the urbanized setting. The remaining 3.39 acres of suitable California red-legged frog habitat is low quality, consisting primarily of roadside drainages along US 101 that are tidally influenced. However, these areas are hydrologically connected to the areas of known

California red-legged frog occurrences previously mentioned. Undeveloped habitat within the action area is comprised of a patchy matrix of California annual grassland, landscaped iceplant, eucalyptus forest, mixed non-native forest, mixed non-native shrubland, pickleweed wetland, alkali heath wetland, brackish cattail wetland and saltgrass wetland vegetation communities. Many of the aquatic features within the action area are tidally influenced, suggesting that it is more suitable for adult California red-legged frogs that have a higher salinity threshold than smaller eggs, larvae or juveniles which have a higher surface area to volume ratio.

Based on reported occurrences less than 0.25-mile from the project footprint, connectivity to occupied habitats north of East Millbrae Avenue, and the presence of non-breeding aquatic, upland and dispersal habitat within the action area, the Service has determined there is a reasonable potential for California red-legged frogs to inhabit or disperse through the action area

Effects of the Action

The proposed project will likely adversely affect the threatened California red-legged frog by harming or harassing juveniles, subadults and adults inhabiting or transiting areas of suitable non-breeding aquatic and upland foraging and refugia, and dispersal habitat; disrupting normal behaviors; and/or altering and removing areas of suitable habitat. The project as proposed in the biological assessment (Caltrans 2010a) and in the project description of this biological opinion encompasses an area of 50.48 acres, i.e. 3.39 acres of suitable California red-legged frog habitat, and would result in the permanent removal of 0.07-acre of aquatic habitat and 1.53 acres of upland foraging and refugia, and dispersal habitat; and temporary disturbance to 0.06-acre of aquatic habitat and 0.38-acre of upland foraging and refugia, and dispersal habitat.

The Service defines temporary and permanent effects as areas denuded, manipulated, or otherwise modified from their pre-project conditions, thereby removing one or more essential components of a listed species' habitat as a result of project activities that include, but are not limited to, construction, staging, storage, lay down, vehicle access, parking, etc. Temporary effects are limited to no more than two consecutive seasons and at a minimum, are fully restored to baseline habitat values or better within one year following initial disturbance. Permanent effects are not temporally limited and include all effects not fulfilling the criteria for temporary effects. Areas subject to ongoing operations and maintenance also are considered permanent.

Project effects will be minimized by Caltrans by reducing the project footprint to the minimum area necessary to complete project. Aspects of the proposed action most likely to affect the California red-legged frog are largely confined to the construction phase. Spatial and temporal loss of habitat will result from the removal and/or disturbance of vegetation within the project footprint comprising frog non-breeding aquatic, upland and dispersal habitat within the US 101 roadside drainages that are hydrologically connected to Easton and Mills creeks. Construction noise, vibration, and increased human activity during the construction phase of the project may interfere with normal behaviors – feeding, sheltering, daily/seasonal movement/dispersal, and other frog essential behaviors – resulting in avoidance of areas that have suitable habitat but intolerable levels of disturbance. Caltrans proposes to minimize these effects by locating construction staging, storage and parking areas outside of sensitive habitat; clearly marking construction work boundaries with high-visibility ESA fencing; performing worker environmental training for all on-site construction personnel; conducting preconstruction surveys and environmental monitoring during revegetation removal and construction activities within or adjacent to suitable California red-legged frog habitat; minimizing the spread of invasive species;

and revegetating all unpaved areas disturbed by project activities with native vegetation characteristic of the habitats within the action area.

There is a risk of California red-legged frogs becoming injured or killed by construction activities due to vegetation removal, operation of construction equipment, trampling, and general construction activities. Preconstruction surveys and biological monitoring will minimize the risk of injury or mortality; however, capturing and handling frogs may result in inadvertent injury during handling, containment, and transport if relocation is determined to be necessary during project construction. Caltrans proposes to minimize these effects by using qualified Service-approved biologists, limiting the duration of handling, and relocating frogs to suitable nearby habitat in accordance with Service guidance.

If unrestricted, biologists and construction workers traveling to the action area from other project sites may transmit diseases by introducing contaminated equipment. The chance of a disease being introduced into a new area is greater today than in the past due to the increasing occurrences of disease throughout amphibian populations in California and the United States. It is possible that chytridiomycosis, caused by chytrid fungus (*Batrachochytrium dendrobatidis*), may exacerbate the effects of other diseases on amphibians or increase the sensitivity of the amphibian to environmental changes (e.g., water pH) that reduce normal immune response capabilities (Bosch *et al.* 2001, Weldon *et al.* 2004). Caltrans proposes to eliminate these risks by implementing proper decontamination procedures prior to and following aquatic surveys and handling California red-legged frogs. These will minimize the risk of transferring diseases through contaminated equipment or clothing. Relocation of California red-legged frogs that would otherwise result in mortality or injury if capture and relocation was not implemented increases the likelihood of survival of those individuals when they are handled properly and released nearby.

The amount of take resulting from construction activities and the removal of habitat will be partially minimized by installing wildlife exclusion fencing to deter California red-legged frogs from wandering onto the construction site; educating workers about their presence, their habitat, identification, regulatory laws, and avoidance and minimization measures; and requiring a Service-approved biologist to be present to monitor project activities during construction.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The Service is not aware of any projects currently planned for the area surrounding the proposed action. However, numerous activities within this urbanized setting that could negatively affect California red-legged frogs in and near the action area as a result of private or public sector actions that may occur without consultation with or authorization by the Service.

The global average temperature has risen by approximately 0.6 degrees Celsius during the 20th Century (International Panel on Climate Change 2001, 2007; Adger et al 2007). There is an international scientific consensus that most of the warming observed has been caused by human activities (International Panel on Climate Change 2001, 2007; Adger *et al.* 2007), and that it is

"very likely" that it is largely due to manmade emissions of carbon dioxide and other greenhouse gases (Adger *et al.* 2007). Ongoing climate change (Anonymous 2007; Inkley *et al.* 2004; Adger *et al.* 2007; Kanter 2007) likely imperils several listed species including the California red-legged frog, San Francisco garter snake and the resources necessary for their survival. Since climate change threatens to disrupt annual weather patterns, it may result in a loss of their habitats and/or prey, and/or increased numbers of their predators, parasites, and diseases. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat.

Conclusion

After reviewing the current status of the California red-legged frog; the environmental baseline for the action area; the effects of the proposed US 101/Broadway Interchange Reconstruction Project and the cumulative effects; it is the Service's biological opinion that the project, as proposed, is not likely to jeopardize the continued existence of this species.

INCIDENTAL TAKE STATEMENT

Section 9(a)(1) of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened fish and wildlife species without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by impairing behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by Caltrans so that they become binding conditions of any grant or permit issued to Caltrans, as appropriate, in order for the exemption in section 7(o)(2) to apply. Caltrans has a continuing duty to regulate the activity covered by this incidental take statement. If Caltrans (1) fails to require its contractors to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, and/or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse.

Amount or Extent of Take

The Service anticipates that incidental take of California red-legged frogs will be difficult to detect due to their cryptic nature and wariness of humans. Losses of these species may also be difficult to quantify due to a lack of baseline survey data and seasonal/annual fluctuations in their numbers due to environmental or human-caused disturbances. There is a risk of harm, harassment, injury and mortality as a result of the proposed construction activities, permanent and temporary loss/degradation of suitable habitat, and capture and relocation efforts; therefore, the Service is authorizing take incidental to the proposed action as (1) the injury and mortality of

no more than two adult, subadult or juvenile California red-legged frogs; and (2) the capture, harm and harassment of all California red-legged frogs within the 50.48 acre action area. Incidental take of eggs or larval California red-legged frogs is not anticipated, since the project will not affect breeding habitat for this species. The Service anticipates that the proposed action may result in take of juvenile, subadult and adult life history stages as a result of habitat loss/degradation, construction-related disturbance, or the capture and relocation of California red-legged frogs. Upon implementation of the following Reasonable and Prudent Measure incidental take associated with the US 101/Broadway Interchange Reconstruction Project will become exempt from the prohibitions described under section 9 of the Act. No other forms of take are exempted under this opinion.

Effect of the Take

The Service has determined that this level of anticipated take is not likely to result in jeopardy to the California red-legged frog, and is not likely to jeopardize the continued existence of this species.

Reasonable and Prudent Measure

The following reasonable and prudent measure is necessary and appropriate to minimize the effect of the proposed action on the California red-legged frog:

1. Harm, harassment, injury, capture, handling and mortality to the California red-legged frog shall be minimized by fully implementing the Conservation Measures in this biological opinion and adhering to the minimization measures described below in the Terms and Conditions.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, Caltrans shall ensure compliance with the following terms and conditions, which implement the reasonable and prudent measures described above.

1. The following Terms and Conditions implement Reasonable and Prudent Measure one (1):

    a. Caltrans shall require all contractors to comply with the Act in the performance of the action and shall perform the action as outlined in the Project Description of this biological opinion as provided by Caltrans in the biological assessment dated September 1, 2010, letter from Caltrans to the Service dated September 9, 2010, and email correspondence from Caltrans on December 8, 2010, and all other supporting documentation submitted to the Service in support of the action. Caltrans shall include language in their contracts that expressly requires contractors and subcontractors to work within the boundaries of the project footprint identified in this biological opinion, including vehicle parking, vehicle parking, staging, batch plants, storage yards and access roads. Changes to the Project Description or performance of work outside the scope of the Project Description are subject to the requirements of reinitiation of formal consultation as described herein.

b. Caltrans shall ensure the Resident Engineer or their designee shall have full authority to implement and enforce all Conservation Measures and Terms and Conditions of this biological opinion. The Resident Engineer or their designee shall maintain a copy of this biological opinion onsite whenever construction is in progress. Their name(s) and telephone number(s) shall be provided to the Service at least thirty (30) calendar days prior to ground-breaking at the project.

c. The qualifications of the Service-approved biologist(s) shall be presented to the Service for review and written approval at least thirty (30) calendar days prior to ground-breaking at the project site. The Service-approved biologist(s) shall keep a copy of this biological opinion in their possession when onsite. Through the Resident Engineer or their designee, the Service-approved biologist(s) shall be given the authority to communicate verbally, telephone, email or hardcopy with Caltrans personnel, contractors or any other person(s) at the project site or otherwise associated with the project. Through the Resident Engineer or their designee, the Service-approved biologist(s) shall have the authority to stop project activities if he/she determines any of the Conservation Measures or Terms and Conditions of this biological opinion is not being fulfilled. If the Service-approved biologist(s) exercises this authority, the Service shall be notified by telephone and email within 24 hours. The Service contact is Coast-Bay Branch Chief Endangered Species Program, Sacramento Fish and Wildlife Office at telephone (916) 414-6600.

d. The Service-approved biologist(s) shall maintain monitoring records that include: (1) the beginning and ending time of each day's monitoring effort; (2) a statement identifying the listed species encountered, including the time and location of the observation; (3) the time the specimen was identified and by whom and its condition; and (4) a description of any actions taken. The Service-approved biologist shall maintain complete records in their possession while conducting monitoring activities and shall immediately surrender records to the Service, California Department of Fish and Game (CDFG), and/or their designated agents upon request. All monitoring records shall be provided to the Service upon completion of the monitoring work.

e. If verbally requested through the Resident Engineer or their designee, before, during, or upon completion of ground breaking and construction activities, Caltrans shall ensure the Service and/or their designated agents can immediately and without delay, access and inspect the project site for compliance with the Project Description, Conservation Measures, and Terms and Conditions of this biological opinion.

f. Prior to the start of construction, WEF shall be installed along the project footprint in all areas where California red-legged frogs could enter the project site. The location of the fencing shall be determined by the Resident Engineer and Service-approved biologist in cooperation with the Service prior to the start of staging or surface disturbing activities. The location, type of fencing materials, installation specifications, and monitoring and repair criteria shall be approved by the Service prior to start of construction. Caltrans shall include the WEF specifications on the final project plans. Caltrans shall include the WEF specifications including installation and maintenance criteria in the bid solicitation

package special provisions. The WEF shall remain in place throughout the duration of the project and shall be regularly inspected and fully maintained. Repairs to the WEF shall be made within 24 hours of discovery. Upon project completion the WEF shall be completely removed, the area cleaned of debris and trash, and area returned to original condition or better.

g. Vegetation shall only be cleared and grubbed within the project footprint and shall only be cleared where necessary. In temporarily disturbed areas, vegetation shall be cut above the soil level to minimize erosion and allow plants that reproduce vegetatively to resprout after construction. A Service-approved biologist shall be present onsite during all vegetation clearing and grubbing activities to monitor for California red-legged frogs. Prior to vegetation removal, the Service-approved biologist shall thoroughly survey the area for California red-legged frogs. Under the supervision of the Service-approved biologist, clearing and grubbing of densely vegetated areas shall be conducted using hand tools or light construction equipment to facilitate a thorough survey of the area for California red-legged frogs. Once the Service-approved biologist has thoroughly surveyed the area for California red-legged frogs, clearing and grubbing may continue without further restrictions on equipment; however, the Service-approved biologist shall remain onsite to monitor for California red-legged frogs until all clearing and grubbing activities are complete. All cleared vegetation shall be properly disposed of off-site to prevent attracting animals to the project site. After project completion, all temporarily affected areas shall be returned to grade, protected with proper erosion control materials, and revegetated with native species appropriate for the region and habitat communities on site.

h. All slopes or unpaved areas temporarily affected by the proposed action will be revegetated with native species appropriate for the region and habitat communities on site. A revegetation plan shall be prepared and submitted to the Service for review and approval at least 6 months prior to the completion of the proposed action. The revegetation plan shall be implemented within 30 days following completion of the proposed action.

California Red-Legged Frog Protective Measures

i. To prevent California red-legged frogs from becoming entangled, trapped, injured or killed, erosion control materials that use plastic or synthetic mono-filament netting shall not be used within the action area. This includes products that use photodegradable or biodegradable synthetic netting, which can take several months to decompose. Acceptable materials include natural fibers such as jute, coconut, twine or other similar fibers.

j. Preconstruction surveys shall be conducted by a Service-approved biologist immediately prior to the initiation of any ground disturbing activities that may result in take of California red-legged frogs. All suitable aquatic and upland habitat including refugia habitat such as dense vegetation, small woody debris, refuse, burrows, etc., shall be thoroughly inspected. If a California red-legged frog is observed, the Service-approved biologist shall implement the species observation and handling protocol outlined below.

k. A Service-approved biologist shall be onsite during all activities that may result in take of California red-legged frogs. Through communication with the Resident Engineer or their designee, the Service-approved biologist shall have the authority to stop work to avoid take of listed species and shall advise the Resident Engineer or designee on how to proceed accordingly. The Service-approved biologist shall conduct clearance surveys at the beginning of each day and regularly throughout the workday when construction activities are occurring that may result in take of California red-legged frogs.

l. If a California red-legged frog(s) is encountered in the action area, work activities within 50 feet of the California red-legged frog(s) shall cease immediately and the Resident Engineer and Service-approved biologist shall be notified. Based on the professional judgment of the Service-approved biologist, if project activities can be conducted without harming or injuring the California red-legged frog(s), it may be left at the location of discovery and monitored by the Service-approved biologist. All project personnel will be notified of the finding and at no time shall work occur within 50 feet of the California red-legged frog(s) without a biological monitor present. If it is determined by the Service-approved biologist that relocating the California red-legged frog(s) is necessary, the following steps shall be followed:

   i. Prior to handling and relocation the Service-approved biologist shall take precautions to prevent introduction of amphibian diseases in accordance with the *Revised Guidance on Site Assessments and Field Surveys for the California Red-legged Frog* (Service 2005). Disinfecting equipment and clothing is especially important when biologists are coming to the action area to handle amphibians after working in other aquatic habitats.

   ii. California red-legged frogs shall be captured by hand, dipnet or other Service-approved methodology; transported by hand, dipnet or temporary holding container; and released as soon as practicable the same day of capture. Handling of California red-legged frogs shall be minimized to the maximum extent practicable. Holding/transporting containers and dipnets shall be thoroughly cleaned, disinfected and rinsed with freshwater prior to use within the action area.

   iii. California red-legged frogs shall be relocated to nearby suitable habitat outside of the work area and released in a safe area on the same side of US 101 where they were discovered. The individual(s) shall be released within the Caltrans right-of-way only if suitable habitat exists and would not pose a risk to the animal's survival or well-being. Otherwise, California red-legged frogs shall be released at a location subject to the approval of the property owner. If suitable habitat cannot be identified, the Service shall be contacted to determine an acceptable alternative. If California red-legged frogs are relocated, the Service shall be notified within 48 hours of relocation.

Reporting Requirements

Proof of environmental training shall be provided to the Endangered Species Program, Sacramento Fish and Wildlife Office, 2800 Cottage Way, Room W-2605, Sacramento, California 95825-1846. Observations of California red-legged frogs or any listed or rare species should be reported to the California Natural Diversity Database (CNDDB) within thirty (30) calendar days of the observation.

Injured California red-legged frogs must be cared for by a licensed veterinarian or other qualified person, such as the Service-approved biologist. Dead animals shall be placed in a zip-lock® plastic storage bag with a piece of paper indicating the date, time, location and name of the person who found it. The bag shall be placed in a freezer located in a secure location until instructions are received from the Service regarding the disposition of the specimen or until the Service takes custody of the specimen. The Service must be notified within 24 hours of the discovery of death or injury resulting from project-related activities or is observed at the project site. Notification shall include the date, time, and location of the incident or finding of a dead or injured animal clearly indicated on a USGS 7.5-minute quadrangle and other maps at a finer scale, as requested by the Service, and any other pertinent information. The Service contacts are Branch Chief, Endangered Species Program, Sacramento Fish and Wildlife Office at (916) 414-6600, and Resident Agent-in-Charge of the Service's Law Enforcement Division at (916) 414-6660.

Caltrans shall submit a post-construction compliance report prepared by the on-site biologist to the Sacramento Fish and Wildlife Office within sixty (60) calendar days of the date of the completion of construction activity. This report shall detail: (1) dates that construction occurred; (2) pertinent information concerning the success of the project in meeting compensation and other conservation measures; (3) an explanation of failure to meet such measures, if any; (4) known project effects on the California red-legged frog, if any; (5) incidental take of this species, if any; (6) documentation of employee/contractor environmental education; and (7) other pertinent information.

Caltrans shall report to the Service any information about take or suspected take of listed wildlife species not authorized by this biological opinion. Caltrans must notify the Service via electronic mail and telephone within twenty-four (24) hours of receiving such information. Notification must include the date, time, location of the incident or of the finding of a dead or injured animal, and photographs of the specific animal. The individual animal shall be preserved, as stated above, and held in a secure location until instructions are received from the Service regarding the disposition of the specimen or the Service takes custody of the specimen.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of listed species and critical habitat. Conservation recommendations are discretionary measures to further minimize the effects to listed species and critical habitat. They also serve as suggestions of how action agencies can assist species conservation in furtherance of their responsibilities under section 7(a)(1) of the Act, or recommend studies improving an understanding of a species' biology or ecology. Wherever possible, conservation recommendations should be tied to tasks identified in recovery plans. The Service is providing the following conservation recommendations:

1. Caltrans should assist the Service in implementing recovery actions identified in the Recovery Plan for the California Red-legged Frog (Service 2002).

2. Caltrans should consider participating in the planning for a regional habitat conservation plan for the California red-legged frog, and other listed and sensitive species.

3. Caltrans should consider establishing functioning preservation and creation conservation banking systems to further the conservation of the California red-legged frog, and other appropriate species. Such banking systems also could possibly be utilized for other required compensation (i.e., seasonal wetlands, riparian habitats, etc.) where appropriate.

4. Sightings of any listed or sensitive animal species should be reported to the California Natural Diversity Database of the California Department of Fish and Game. A copy of the reporting form and a topographic map clearly marked with the location the animals were observed also should be provided to the Service.

5. Caltrans should incorporate culverts, tunnels, or bridges on highways and other roadways that allow safe passage by California red-legged frog, other listed animals, and wildlife.

6. Caltrans should include photographs, plans, and other information in their biological assessments if they incorporate "wildlife friendly" crossings into their projects.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed and/or proposed species or their habitats, the Service requests notification of the implementation of these recommendations.

REINITIATION--CLOSING STATEMENT

This concludes formal consultation on the proposed US 101/Broadway Interchange Reconstruction Project in the City of Burlingame, San Mateo County, California. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been maintained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, including work outside of the project footprint analyzed in this opinion and including vehicle parking, staging, lay down areas, and access roads; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion including use of vehicle parking, staging, lay down areas, and access roads; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where take exceeds what was anticipated in this biological opinion, Caltrans will no longer be exempt from the prohibitions of section 9 until such time that Caltrans reinitiates formal consultation and consultation is completed.

If you have questions concerning this opinion on proposed US 101/Broadway Interchange Reconstruction Project, City of Burlingame, San Mateo County, California, please contact Jerry Roe or Ryan Olah at the letterhead address or at (916) 414-6600.

Sincerely,

Susan K. Moore
Field Supervisor

cc:
Margaret Gabil, California Department of Transportation, Oakland, California
Melissa Escaron, California Department of Fish and Game, Yountville, California
Richard Fitzgerald, California Department of Fish and Game, Yountville, California

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US101/BROADWAY INTERCHANGE RECONSTRUCTION PROJECT

PS&E Phase

Broadway Overcrossing (Bridge No. 35-0351) Foundation Report

April 2, 2013

THE CITY OF BURLINGAME

SAN MATEO COUNTY Transportation Authority

Caltrans

URS

April 2, 2013
Project 28645286

File No. 04-SM-101-PM 16.3/17.1
EA 04-235844

Mr. Jim McKim
Project Manager
San Mateo County Transportation Authority
1250 San Carlos Avenue
San Carlos, CA 94070-1306

Subject: **Foundation Report**
Broadway (Replace)
Caltrans Bridge No. 35-0351
US101/Broadway Interchange Project
Burlingame, California

Dear Mr. McKim:

URS has completed a geotechnical investigation for the Broadway Overcrossing (Replace) as part of the US101/Broadway Interchange project in Burlingame, California. The report was prepared in accordance with Caltrans Guidelines for Foundation Investigation Reports, Version 2.0, dated December 2009.

The report presents our engineering opinions and recommendations regarding the geotechnical factors influencing the design and construction of the proposed bridge replacement. The opinions and recommendations have been based upon the results of our field investigation, laboratory testing, engineering judgment and local experience. Mr. Madhu Thummuluru, Senior Staff Engineer, Mr. Allen Moore, Project Geotechnical Engineer, and Ms. Anne-Marie Moore, Geotechnical Engineer, assisted with the preparation of this report. Mr. Mark Schmoll, Certified Engineering Geologist, prepared the site geology and geologic hazards portion of this report. Mr. Michael Larson, Senior Geotechnical Project Manager, provided peer review.

If any questions should arise, or if we can be of further service, please contact the undersigned at (408) 297-9585.

Sincerely,

REGISTERED PROFESSIONAL ENGINEER
S. STEPHEN HUANG
No. GE 002150
3/31/2014
GEOTECHNICAL
STATE OF CALIFORNIA

Stephen Huang, G.E. 2150
Geotechnical Task Leader

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1.1 GENERAL

The proposed project will replace the existing Broadway Overcrossing (Bridge No. 35-0096) with a wider structure, and reconfigure all northbound and southbound ramp connections to US101. The total length of the project is 0.75 mile. The purpose of the project is to reduce congestion, enhance safety, and improve performance of the interchange. It is also intended to relieve the weaving problems at the interchange by eliminating the collector-distributor roads and thus improving the traffic safety and operations. In addition to the new overcrossing bridge, a new pile supported bridge will be constructed along a portion of the on-ramp to southbound US101 adjacent to the existing PG&E transmission towers to reduce the potential for settlement of the towers due to new fill loads.

A total of eight retaining walls are planned to minimize the right-of-way impacts to existing business properties and to support the ramp approaches and roadway embankments. The existing 6 x 6 feet double barrel box culvert at Easton Creek on the east side of northbound US 101 will be extended by approximately 50 feet to accommodate the construction of the new northbound US 101 on-ramps. The pedestrian overcrossing located approximately 50 feet south of the existing Broadway Overcrossing will remain. The new interchange will be constructed in several stages in order to keep traffic flowing.

Excessive settlement of the underlying mapped Bay Mud was identified as a major geotechnical and construction concern during the preliminary planning stages of the project, and the decision was made to use Cement Deep Soil Mixing (CDSM) ground improvement to reduce the magnitude of long-term settlement to tolerable levels. CDSM is currently proposed to a minimum depth of about 50 feet at the bridge abutments.

The subject of this foundation report (FR) is removal and construction of the Broadway Overcrossing (Replace) as part of the US101/Broadway Interchange Project in the City of Burlingame, California. The approximate location of the project site is shown on the Project Vicinity Map, Figure 1. The project alignment, including the location of the proposed Broadway Overcrossing, is shown on the layout sheets included in Appendix A. Recommendations for other structures including the proposed bridge adjacent to the PG&E transmission towers, retaining walls, box culvert extension, and several overhead sign structures are presented in accompanying reports.

1.2 SCOPE OF INVESTIGATION

The geotechnical services provided for the Broadway Overcrossing (Replace) were as follows:

- Review existing subsurface information and as-built plans
- Geotechnical field investigation including three exploratory borings (R-11-011, R-11-013 and R-11-014) and two cone penetration tests (CPT-11-012 and CPT-11-016). The locations of these explorations are shown on the Site and Exploration Location Plan, Figure 2.
- Laboratory testing to estimate pertinent engineering properties
- Design recommendations and opinions were developed for the following topics:
  - ♦ Pile foundation design recommendations
    - – Vertical capacity

  - Tip elevations
  - ♦ Resistance to lateral loads
  - ♦ Pile foundation and approach fill settlement
  - ♦ Abutment grading and approach fill construction
- Earthquake information consistent with Caltrans Seismic Design Criteria
- Assessment of the potential for earthquake induced liquefaction, settlement, and lateral spreading
- Corrosion testing and analysis
- Address construction issues, including:
  - ♦ Earthwork for abutments and new bridge approaches
  - ♦ Installation of pile foundations, as applicable

This Foundation Report includes our observations of the site conditions, a summary of the subsurface conditions at the field exploration locations, and geotechnical laboratory test results. As part of the project, a soil corrosion evaluation was made by our subconsultant, V&A Consulting Engineers.

1.3 CALTRANS REVIEW COMMENTS

We reviewed comments prepared by Caltrans for the Broadway Overcrossing (Replace) Foundation Report dated November 16, 2012. Our responses to these comments are incorporated into this report. Copies of the review comments and our responses are presented in Appendix L.

The proposed improvements will include the construction of a new Broadway Overcrossing approximately 100 feet to the north of the existing four-lane structure. The overcrossing structure will be approximately 208 feet long and about 115 feet wide. It will have seven lanes of traffic, a sidewalk for pedestrians, 5-foot-wide bike lanes on each side, and a 3-foot-wide median. The proposed structure type will be either a two-span precast prestressed bulb-tee girder or a two-span cast-in-place prestressed box girder. Bottom of pile cap is expected to be at Elevation 5.5, 5.0 and 4.5 feet at Abutment 1, center Bent 2 and Abutment 3, respectively. Bottom of footing at the abutment return walls (RW) supporting the approach fills at Abutment 3 will be at Elevation 4.5 feet. The ground surface at the base of the wingwalls will slope at 2:1 (horizontal:vertical) down to existing grade. The approach fills at Abutment 1 will be supported by MSE retaining walls. Precast prestressed (PCPS) piles are planned for the abutments whereas cast-in-steel shell (CISS) piles are planned for the foundation support of Bent 2. Approach fills up to 22 feet high are planned.

The pedestrian overcrossing located approximately 50 feet south of the existing Broadway Overcrossing will remain. Most of the existing on-ramps and off-ramps will be realigned. In general, proposed ramps will have standard 12-foot-wide lanes and standard shoulders as required.

General Plans, No. 1 and No. 2, and the Foundation Plan for the Broadway Overcrossing (Replace) are included in Appendix A.

All project elevations reference NAVD88; exploration stationing is based on NAD83.

The US101/Broadway Interchange is located on the western margin of the San Francisco Bay block within the central portion of the Coast Ranges geomorphic province of California. Northwest-southeast-trending valleys and ridges characterize the regional morphology of the Coast Ranges province. These topographic features are controlled by folds and faults that resulted from the collision of the Farallon and North American plates and subsequent predominantly strike-slip faulting along the San Andreas fault system between the Pacific and North American plates. The San Francisco Bay block is a relatively stable, seismic block bounded by the San Andreas and Hayward faults to the west and east, respectively.

The project site is located just east and northeast of the historic San Francisco bay margin. The historic tidal flats have been covered with artificial fill to create the present day topography. The artificial fill covers the majority of the project area and is mapped from about Rollins Road extending north to the edge of the bay (Witter, et al, 2006; Brabb, et al, 1998). A portion of the geology map covering the project area prepared by Brabb is included as Figure 3. Witter (2006) shows the artificial fill as being underlain by estuarine deposits (Bay Mud). South and southwest of Rollins Road, Quaternary deposits exposed at the surface are mapped by Witter (2006) as Holocene (less than 10,000 years old) alluvial fan deposits consisting of sand, silt and clayey silt, underlain by older Pleistocene alluvial fan and fluvial deposits consisting of gravel, sand and silt. Mapping by Brabb, (1998) classifies the deposits south of Rollins Road as the Pleistocene age Colma Formation consisting of fine to medium-grained sand with silt and clay. Bedrock consisting of Franciscan Complex sandstone outcrops are approximately 1 mile south of the site. The depth to bedrock at the site is unknown; however bedrock is at a depth of 270 feet at the west end of the San Mateo Bridge (Goldman, 1969) and is estimated to be in the range of 150 to 200 feet deep at the project site.

4.1 GENERAL

Prior to the start of drilling, boring and cone penetration test (CPT) locations were checked for conflict with underground utilities by contacting Underground Service Alert (USA) Network and a private utility locator. URS obtained drilling permits from the San Mateo County Department of Environmental Health. All explorations were backfilled with cement grout as required.

The locations of the borings and CPTs advanced during this study are shown on Figure 2.

4.2 EXPLORATORY BORINGS

Truck-mounted rotary wash drilling equipment was used to advance the borings to depths of 100 and 101.5 feet between October 6 and 26, 2011. Samples of the soil encountered in the exploratory borings were collected with either a modified California sampler (1.96-inch inside diameter)), a standard split spoon sampler (1.38-inch inside diameter) or thin walled Shelby tube (2.97-inch inside diameter). The split spoon and modified California samplers were driven 18 inches into the soil with a 140 pound hammer free falling 30 inches, with blow counts being recorded for the last 12 inches of driving. When very dense or hard materials were encountered and the blow count exceeded 50 blows per 6 inches, refusal criteria were met. The amount of penetration was recorded along with the blow count. Shelby tubes were hydraulically pushed into the soil; the pressure required to push the sampler 30 inches was recorded on the boring log.

After the sampler was advanced to the desired depth, it was withdrawn from the borehole. The exposed soil was examined, classified, and the brass liners containing the samples were sealed to preserve the natural moisture. The samples were taken to our geotechnical laboratory for further examination and testing.

A representative of URS observed the drilling operations and soil sampling. Visual classifications of the soils encountered were made from cuttings and soil samples. The soil samples collected from the borings were sealed and labeled immediately to preserve their natural moisture content.

The Unified Soil Classification System, as well as guidelines summarizing soil consistency and relative density, is presented on the LOTB legend. The logging method is consistent with guidelines presented in Caltrans Soil & Rock Logging, Classification, and Presentation Manual, dated 2010. The LOTBs presented in Appendix B also illustrate the notation used for the size of samplers and the methods of advancing them.

4.3 LABORATORY TESTING

Soil classifications made in the field were verified in the laboratory after further examination and testing. Laboratory tests were performed on selected soil samples. These tests include grain size distribution and unconfined compressive strength. The results of these tests are presented at the corresponding sample locations on the LOTBs included in Appendix B.

Plasticity index (PI), water content, and dry unit weight were determined for selected samples from the borings; the results of these tests are presented in Appendix C. One dimensional consolidation and unconsolidated undrained triaxal compression tests were performed on

relatively undisturbed samples retrieved from our borings. The results of these tests are presented graphically in Appendix C.

4.4 CONE PENETRATION TESTS (CPTS)

CPT exploration consists of pushing a cone-tipped probe into the soil while simultaneously recording the cone tip resistance and side friction resistance to penetration. Two CPTs completed for this report were conducted on September 28 and October 17, 2011, in general accordance with ASTM specifications (ASTM D3441-98) using an electric cone penetrometer. CPTs extended to depths of 94 and 100 feet.

The CPT equipment consists of a cone assembly mounted at the end of a series of hollow rods. A set of hydraulic rams is used to push the cone and rods into the soil while a continuous record of cone and friction resistance versus depth is obtained in both analog and digital form at the ground surface. A specially designed all-wheel drive truck is used to transport and house the test equipment and to provide a 20-ton reaction to the thrust of the hydraulic rams.

The cone penetrometer assembly consists of a conical tip and a cylindrical friction sleeve. The conical tip has a 60-degree apex angle and a projected cross-sectional area of 2.3 in^2. The cylindrical friction sleeve has a surface area of 35 in^2. Both the conical tip and cylindrical friction sleeve have outer diameters of 1.75 inches. The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurement of cone tip and friction sleeve resistance during penetration. Continuous electric signals from the strain gauges are transmitted by a cable in the rods to analog and digital data recorders in the CPT truck.

Data obtained during a CPT consists of continuous stratigraphic information with close vertical resolution. Stratigraphic interpretation is based on relationships between cone tip resistance and friction resistance. The calculated friction ratio (CPT friction sleeve resistance divided by cone tip resistance) is used as an indicator of soil type. Granular soils typically have low friction ratios and high cone resistance, while cohesive or organic soils have high friction ratios and low cone resistance. These stratigraphic material categories form the basis for all subsequent calculations that utilize the CPT data. Soil interpretation presented on the CPT logs from this investigation was based on correlations developed by Robertson, 1990. CPT logs are presented on the LOTBs in Appendix B.

4.5 PORE PRESSURE DISSIPATION AND SHEAR WAVE VELOCITY TEST RESULTS FROM CPTS

Pore pressure dissipation tests were performed at each CPT location to provide an estimate of the groundwater depth. Shear wave velocity tests were performed at selected depths at two CPT locations. The results of the pore pressure dissipation tests are presented on the LOTBs included in Appendix B and summarized on figures included in Appendix D. The results of shear wave velocity tests are shown graphically at the corresponding average test depths in Appendix D.

5.1 SITE TOPOGRAPHY AND SURFACE CONDITIONS

The project site is located in the City of Burlingame adjacent to and southwest of San Francisco Bay. The northeast side of the project where the new overpass will connect to Airport Boulevard lies next to the edge of the bay, and the southwest side of the project near the intersection of Broadway and Carolan Avenue is up to 1,200 feet south of the edge of the bay. The majority of the project lies northeast (offshore) of the historic limits of the shoreline of San Francisco Bay. Except for the elevated bridge embankments for the existing Broadway Overcrossing of US101, the ground surface is relatively flat, ranging in elevation from about 8 to 14 feet. The elevated bridge embankments range up to about Elevation 22 feet. Development at the project site includes the freeway, the Broadway Overcrossing, a pedestrian overcrossing, on-ramps, off-ramps, and channelization of Easton and Sanchez Creeks. Bayside Park, hotels and a gas station are located northeast of the freeway, and a PG&E substation, a gas station, businesses and an apartment complex lie southwest of the freeway. Vegetation within the on-ramp/off-ramp loops includes grasses, shrubs and a few mature trees.

There are three existing PG&E towers located just north of the existing Broadway Overcrossing western approach. Tower 1 is the northernmost tower and located closest to proposed southbound US101 on-ramp. The towers consist of metal cross braces connected to four tapered metal legs with base widths of 22 feet. Based on available plans, we understand that each tapered tower leg is supported on a concrete spread footing extending to a depth of about 15 feet below ground surface (bgs).

5.2 SUBSURFACE CONDITIONS

5.2.1 Field Exploration

Log of Test Borings for construction of the existing Broadway Overcrossing, circa 1949, were not available.

URS drilled three rotary wash borings (R-11-011, R-11-013 and R-11-014), and advanced two CPTs (CPT-11-012 and CPT-11-016) to characterize conditions at the proposed bridge abutments and center bent. The borings were advanced to depths of 100 to 101.5 feet, and the CPTs were advanced to depths of 94 and 100 feet. The field exploration was performed between September 28 and October 26, 2011.

The locations of the borings and CPTs are shown on Figure 2. The Log of Test Borings (LOTBs) presented in Appendix B provide detailed descriptions of the soils encountered.

5.2.2 Fills

Boring R-11-013 was drilled in the median of US101 and encountered 12 inches of asphalt concrete (AC) overlying 12 inches of aggregate base (AB). The pavement section was underlain by hard sandy lean clay with gravel and dense silty, clayey sand with gravel fill to a depth of about 9 feet bgs (Elevation 3.5 feet), underlain by soft sandy lean clay with gravel fill to a depth of about 11 feet bgs (Elevation 1.5 feet).

Borings R-11-011 and R-11-014 were drilled off of the freeway and did not encounter a pavement section. Fills consisting of sandy silt with gravel, sandy lean clay with gravel and lean clay with sand were encountered from the surface to depths of about 6 and 9 feet bgs (Elevation 3.5 and 2.5 feet).

The consistency and make up of the fill were not evaluated at CPT-11-012 or CPT-11-016 since the upper 5 to 8 feet of the explorations were hand augered to minimize the potential of damaging existing utilities.

5.2.3 Native Soils

Below the fill material, soft to medium organic fat clay, locally known as Bay Mud, was encountered in each of the borings and CPTs. The Bay Mud is generally 6 to 9 feet thick in the vicinity of the proposed bridge and extends to depths of approximately 12 to19 feet bgs (Elevation -2.5 to -5.5 feet).

An approximately 2-foot-thick layer of loose silty sand was encountered directly below the Bay Mud in Boring R-11-014. Medium dense clayey sand was encountered directly below the Bay Mud in Boring R-11-013 to a depth of approximately 30½ feet bgs.

Medium to very stiff lean clay was encountered below the granular layers described above in Borings R-11-013 and R-11-014, and below the Bay Mud in Boring R-11-011. This lean clay layer extended to depths of 40 to 54½ feet bgs in the three borings.

Below the lean clays, alternating layers of stiff to hard lean and sandy lean clay as well as medium dense to dense silty sand to clayey sand were encountered to between 100 and 101½ feet bgs, the terminal depths of the borings. However, Boring R-11-011 encountered medium dense poorly graded sand between depths of 40 to 45½ feet bgs, Boring R-11-013 encountered stiff fat clay between depths of 69 to 75 feet bgs, and Boring R-11-014 encountered very dense silty gravel between depths of 56½ to 61 feet and 75 to 90½ feet bgs.

CPT-11-012 was advanced on the shoulder of northbound US101 and CPT-11-016 was advanced on the shoulder of southbound US101. These CPT records suggest similar subsurface conditions as those described above for the borings with the following exceptions. Two 2-foot-thick layers of silty sand were encountered below the Bay Mud in CPT-011-016. In addition, CPT-011-016, which is adjacent to Boring R-11-014, encountered very dense granular material between depths of about 75 to 81 feet below the ground surface (Boring R-11-014 encountered this layer between depths of about 75 to 90½ feet bgs).

5.2.4 Groundwater

Free groundwater was encountered at depths of about 5 to 8 feet bgs in each of the borings, corresponding to about Elevation 4½ to 5 feet. A final or stabilized groundwater level reading was not taken in any of these borings.

Porewater pressure dissipation tests performed in the CPTs suggest free groundwater at depths of about 0.5 and 3.4 feet bgs, corresponding to about Elevation 10.5 and 6.6 feet, respectively.

Free groundwater was reportedly encountered in the generally vicinity of the Broadway Overcrossing at a depth of about 4 feet (Elevation 8.1 feet, datum not specified) in 1970 borings by Caltrans and at depths of about 8 to 11½ feet (Elevation 2 and 0 feet, NAVD88) in borings drilled by others in 2002.

In cohesive soils, as generally encountered at the site, a fairly long time would be required for the groundwater to seep into the borehole and attain an equilibrium position with the long-term hydrostatic groundwater table. Thus, the immediate readings obtained may or may not be representative of the actual groundwater table level.

Groundwater levels at the site are likely influenced by tidal fluctuations in the nearby San Francisco Bay, and to a lesser extent by water levels in nearby Sanchez Creek and Easton Creek. In addition, seasonal fluctuations in the groundwater level should be anticipated throughout the year with variations in precipitation, evaporation, and surface runoff.

6.1 REGIONAL TECTONIC SETTING AND SEISMICITY

The project alignment lies between known active and potentially active geologic faults. In general, earthquakes occur as a result of movement along active faults. For the purpose of activity classification, faults are generally grouped into the following categories by the California Division of Mines and Geology (renamed the California Geological Survey, CGS) (Jennings, 1994):

- Holocene: displacement has occurred within the last 10,000 to 11,000 years.
- Late Quaternary: displacement has occurred within the last 700,000 years, but evidence of Holocene activity is lacking.
- Quaternary: evidence of displacement within the last 1.6 million years, but evidence of Holocene activity is lacking.
- Pre-quaternary: no recognized evidence of displacement in the last 1.6 million years.

Generally, faults with Holocene movement are considered to be "active" while faults with late Quaternary to Quaternary movement are considered to be "potentially active".

The closest active faults to the project site are the San Andreas, San Gregorio-Palo Colorado, Hayward and Monte Vista faults (Mualchin, 1996). The California Geological Survey (2000) has produced maps showing Alquist-Priolo Earthquake Fault Zones along faults with known Holocene activity that pose a potential surface faulting hazard. The Hayward, San Andreas and onshore section of the San Gregorio-Palo Colorado fault are included as Alquist-Priolo (A-P) zoned faults. The San Andreas fault is the closest fault, located about 2.5 miles west of the project site. The San Gregorio-Palo Colorado fault is located about 9.5 miles southwest of the site and the Hayward fault is located about 16 miles northeast of the site. The Monte Vista fault (west branch) is located about 14 miles southeast of the site. More distant active faults include the Calaveras fault and Greenville faults located 24.5 miles and 34 miles northeast of the site, respectively. Figure 4 shows active faults within the site region relative to the project. The project alignment does not cross any mapped A-P zoned faults.

The following are brief descriptions of the nearby active faults.

6.1.1 San Andreas Fault Zone

The dominant active fault structure in this region is the San Andreas fault. The fault extends from the Gulf of California, Mexico, to Point Delgada on the Mendocino Coast in northern California, a total distance of 746 miles. The San Andreas fault accommodates the majority of the motion between the Pacific and North American plates. This fault is the largest active fault in California and is responsible for the largest known earthquake in Northern California, the 1906 **M** 7.9 San Francisco earthquake (Wallace, 1990). Movement on the San Andreas fault is right-lateral strike-slip, with a total offset of some 348 miles (Irwin, 1990). In northern California, the San Andreas fault is clearly delineated, striking northwest, approximately parallel to the vector of plate motion between the Pacific and North American plates. Over most of its length, the San Andreas fault is a relatively simple, linear fault trace. Immediately south of the Bay, however, the fault splits into a number of branch faults or splays, including the Calaveras

and Hayward faults. In the Bay Area, the main trace of the San Andreas fault forms a linear depression along the Peninsula, occupied by the Crystal Springs and San Andreas Lake reservoirs. The 1906 earthquake resulted from rupture of the fault from San Juan Bautista north to Point Delgada, a distance of approximately 295 miles. The average amount of slip on the fault during this earthquake was 16.7 feet in the area to the north of the Golden Gate and 8.2 feet in the Santa Cruz Mountains (WGNCEP, 1996). The California Seismic Hazards Map (Mualchin, 1996) assigns a maximum credible earthquake magnitude of 8.0 for the San Andreas fault (North Coast segment).

6.1.2 San Gregorio-Palo Colorado Fault Zone

This northwest-striking fault is the principal active fault west of the San Andreas fault in the coastal region of central California. The fault extends from just offshore of Point Sur, northward to Bolinas Lagoon, where it merges with the North Coast segment of the San Andreas fault. The majority of the fault is located offshore, with only two short sections, at Seal Cove and Moss Beach, occurring on land. Because of the limited onshore extent of the fault, the fault is relatively poorly understood. Jennings (1994) shows the fault as two distinct segments, separated by a prominent step in Monterey Bay. Simpson *et al.* (1997) carried out one of the few paleoseismic investigations along the fault. They demonstrated late Holocene right-lateral movement on the Seal Cove section of the fault. The most recent surface faulting event on the fault occurred sometime after A.D. 1270 to A.D. 1400, but prior to 1775. Mualchin (1996) assigns a maximum credible earthquake magnitude of 7.5 for the San Gregorio-Palo Colorado fault.

6.1.3 Hayward Fault

The Hayward fault extends for 62 miles from the area of Mount Misery, east of San Jose, to Point Pinole on San Pablo Bay. At Point Pinole, the Hayward fault runs into San Pablo Bay. The northern continuation of this fault system is the Rodgers Creek fault. The two faults are separated by a 3 miles wide right step beneath San Pablo Bay. Systematic right-lateral geomorphic offsets and creep offset of cultural features have been well documented along the entire length of the fault (Lienkaemper, 1992). The last major earthquake on the Hayward fault, in October 1868, occurred along the southern segment of the fault. This M6.8 event caused toppling of buildings in Hayward and other localities within about 3 miles of the fault. The surface rupture associated with this earthquake is thought to have extended for approximately 19 miles, from Warm Springs to San Leandro, with a maximum reported displacement of 3.3 feet. The Hayward fault is considered the most likely source of the next major earthquake in the Bay Area (WGCEP, 1999). As well as undergoing displacement earthquake ruptures, the Hayward fault also moves by aseismic creep. Measurements along the fault over the last two decades show that the creep rate is 0.2 to 0.35 inch/year (Lienkaemper and Galehouse, 1997). Mualchin (1996) assigns a maximum credible earthquake magnitude of 7.5 for the Hayward fault.

6.1.4 Monte Vista Fault

The 34 mile long Monte Vista fault is one of the primary range-front faults and probably the most extensively studied fault in the Foothills thrust belt. The exposed fault strikes northwest and places Jurassic Franciscan Complex rocks, Miocene Santa Clara Formation, and Pleistocene alluvium over Pleistocene and older strata. To the south, the fault merges with the Shannon fault, while at its northern end it intersects the San Andreas, via the Hermit fault, between Woodside and Redwood City. Limited exploratory trenching indicates that the Monte Vista fault has had late Quaternary and possibly Holocene displacement. Recent geomorphic mapping by Hitchcock et al. (1994) shows that late Pleistocene fluvial terraces flanking Stevens Creek are deformed. The style of late Quaternary deformation affecting these terrace surfaces is consistent with reverse faulting on the Monte Vista fault. Hitchcock and Kelson (1999) estimated an average late Pleistocene slip rate of 0.007 ± 0.004 inch/year for the Monte Vista fault. Mualchin (1996) assigns a maximum credible earthquake magnitude of 6.5 for the Monte Vista fault (west branch).

6.2 GEOLOGIC HAZARDS

6.2.1 Fault-Related Ground Rupture

Surface fault rupture tends to recur along existing fault traces. The highest potential for surface faulting is along existing fault traces that have had Holocene fault displacement. The California Geological Survey (formerly Division of Mines and Geology) has produced maps showing Alquist-Priolo Earthquake Fault Zones along faults with known Holocene activity that pose a potential surface faulting hazard. There are no Alquist-Priolo zones mapped in the vicinity of the project site. The closest active fault to the site is the San Andreas fault, approximately 2.5 miles to the west; therefore, the potential for surface fault rupture at the site is considered remote.

6.2.2 Liquefaction Potential

Soil liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. In extreme cases, the soil particles can be suspended in groundwater, resulting in the deposit becoming mobile and fluid-like. Three conditions are generally required for liquefaction to occur: 1) a cohesionless soil of loose to medium dense relative density; 2) a saturated condition; and 3) rapid, large strain cyclic loading normally induced by earthquake ground shaking. Liquefaction can result in loss of foundation bearing capacity, differential settlements, and lateral spreading. Traditionally, a depth of 50 feet has been used as the depth of analysis for the evaluation of liquefaction.

In a regional study of the nine-county San Francisco Bay region for the U.S. Geological Survey, Witter et al. (2006) mapped the liquefaction susceptibility of the site soils in the project vicinity. The artificial fill overlying the Bay Mud found at the site is mapped as having “very high” liquefaction susceptibility. The Association of Bay Area Governments (ABAG, 2004) has also published a liquefaction susceptibility map based on mapping in the USGS Open File Report 00-

444 by Knudsen et al (2000). The map also shows the project site as having "very high" liquefaction susceptibility. A copy of this map is included as Figure 5.

Potentially liquefiable deposits were encountered in many of the recent borings, ranging in thickness from about 1 to 4.5 feet. We estimated post-liquefaction ground surface settlement for a peak ground acceleration (PGA) of 0.68g and design earthquake moment magnitude, M_{Max}, of 7.9; a discussion of PGA and design earthquake magnitude is presented in more detail in Section 8 of this report. The measured driving resistance (blow counts) in the field were corrected for hammer type, sampler size, overburden pressure, rod length, and fines content. We assumed groundwater depths of 3½ to 7 feet below top of boring (corresponding to about Elevation 6 feet). Copies of these calculations are included in Appendix E. Results are summarized in the following table.

Table 6-1 Estimated Post Liquefaction Ground Surface Settlement at Borings

Boring Number	Material Type (USCS)	Depth to Top of Layer (feet)	Layer Thickness (feet)	Estimated Ground Surface Settlement (inches)
R-11-011	SC-SM	40	1.5	¼
R-11-013	SC-SM	5	4.5	1½
R-11-014	SM	14.5	1.5	½

We estimated post-liquefaction settlement at two CPT locations using the computer program LIQUEFY PRO for the same PGA and design earthquake, and for groundwater depths of 4 and 5 feet below top of CPT (corresponding to about Elevation 6 feet). The CPTs generally encountered thin, interbedded potentially liquefiable silt and sand layers throughout the soil profile; therefore, settlement estimates for distinct soil layers are not summarized for the CPTs. Copies of these calculations are included in Appendix E. Results are summarized in the following table.

Table 6-2 Estimated Post Liquefaction Ground Surface Settlement at CPTs

CPT Number	Estimated Ground Surface Settlement (inches)
CPT-11-012	½
CPT-11-016	¾

Based on our analysis, we estimate that post liquefaction ground surface settlement could be on the order of about ½- to ¾-inch at the abutments and up to about 1½ inches at the center bent.

6.2.3 Consolidation Settlement

Settlement occurs when soil is loaded by a structure or embankment fill placed on top of the soil. This settlement can occur quickly in unsaturated and free-draining soils, and it can occur gradually when pore pressures in saturated soils, increased by vertical loading, gradually dissipate over time.

The Bay Mud and fat clays that underlie the site are very soft to medium stiff, have moderate to high compressibilities, and are normally to slightly overconsolidated. On this basis, we expect that settlement of these clays under the weight of the proposed embankment fills, ranging to 22 feet high, will be excessive, up to 17 inches beneath the tallest approach fills and up to about 7 inches at the proposed Broadway Overcrossing abutments. Appendix F presents a summary of the consolidation settlement analysis. Our analyses indicate that approach fill surcharge pressures will not induce additional overburden stresses on the compressible clays at the center bent, and therefore, consolidation settlement at Bent 2 is not anticipated.

Since the native clays have low to very low permeability, the total estimated settlements will not be realized during a reasonable construction period (8 to 12 months) without implementation of a surcharge program with wick drains. Based on results of laboratory consolidation testing, we estimate that the settlement period to reach 90 to 95% consolidation of the Bay Mud and underlying fat clays would be about 3 to 4 years.

We anticipate that this settlement period could be shortened to 8 to 12 months with surcharging and wickdrains, however consideration would need to be given to the potential adverse effects of surcharge loads and resulting settlement on existing nearby structures and underground utilities which are to remain.

Alternatively, the strength and compressibility characteristics of these underlying clays can be improved with the use of cement deep soil mixing (CDSM) or equivalent, or the magnitudes of the predicted settlements could be reduced to tolerable amounts by using a very lightweight embankment fill alternative such as expanded polystyrene (EPS) blocks.

6.2.4 Subsidence and Seismic Compaction

Subsidence typically occurs as a result of subsurface fluid extraction (e.g. groundwater, petroleum) or compression of soft, geologically young sediments. Groundwater extraction for high volume municipal and agricultural use has the potential to cause future ground subsidence in the region. However, we are not aware of subsidence in the area. No active petroleum wells are present within many miles of the site (California Division of Oil, Gas and Geothermal Resources, 2001).

Compaction settlement, or seismic densification, occurs when loose granular soils above the water table increase in density as a result of earthquake shaking. The soil densification can result in differential settlement because of variations in soil composition, thickness, and initial density. Occasional layers of granular soil were encountered within the unsaturated fills. These granular deposits may be subject to cyclic densification during strong ground shaking, resulting in compaction settlement. Since CDSM treatment is planned at both abutments, settlement due to seismic compaction of the granular fills is not anticipated. CDSM treatment is not planned at the center bent and, therefore, these piles would need to be designed to resist downdrag forces associated with post-liquefaction and seismic compaction settlement as discussed in Section 10 of this report.

6.2.5 Landslide and Lateral Spreading

US101 is located on relatively flat ground along the project alignment and is not subject to landsliding; therefore, landsliding is not a potential hazard.

Liquefaction induced lateral spreading occurs on gentle slopes underlain by loose sands and shallow groundwater. When liquefaction occurs, the unsaturated overburden can slide as intact blocks over the lower liquefied deposit. Surface displacements proceed downslope or toward a steep free face, such as a stream bank, with the formation of fissures and scarps. The geologic conditions conducive to lateral spreading are frequently found along streams and other waterfronts in recent alluvial or deltaic deposits as well as loosely placed, saturated sandy fills (Youd and Hoose, 1976).

As discussed in the liquefaction section of this report, pockets of potentially liquefiable fill were encountered at several of the exploration locations; in addition, potentially liquefiable native sands were identified below the Bay Mud at several exploration locations. Therefore, in our opinion, liquefaction induced lateral spreading is a potential hazard at the site.

The U.S. Geological Survey published a map with digitized locations of historic post-earthquake ground effects (Youd and Hoose, 1978, and Tinsley and others, 1998); this data is plotted on the geologic map in USGS Open File Report 00-444 by Knudsen et al (2000). Based on review of these digitized locations, no historic failures have been documented at the project site, but sand boils were noted at a location about one mile east of the site following the Loma Prieta earthquake in 1989. In addition, settlement and ground cracking were noted about one mile northwest of the site following the 1906 earthquake.

Use of CDSM or equivalent extending through the potentially liquefiable soils across the project area would, in our opinion, reduce the potential for lateral spreading to affect new structures, pavements and underground utilities at the site.

6.2.6 Scour

Because the proposed overcrossing structure is to be located outside waterways, scour is not an issue for foundation design.

6.2.7 Flooding

The project site is located within the FEMA 100-year flood zone (Zone A) as shown on the ABAG flood hazard map (2007). A copy of the ABAG flood hazard map is included as Figure 6.

Floodplain information on the project area is discussed in more detail in the Project Location Hydraulic Study Report (WRECO, 2011). The study identifies three areas of flooding potential as discussed below.

The most problematic flooding is in the vicinity of the northeastern landing of the Broadway Overcrossing. The source of this flooding is the relatively high tailwater elevation in the unlined channel northeast of the corner of Airport Boulevard and Bayshore Highway. The outfall from the storm drain system draining the flooded area is buried under the channel bottom. The

combination of the high tailwater elevation in the channel relative to the storm drain system and the buried outfall prevents adequate conveyance, which results in water frequently ponding in the vicinity of the intersection of Bayshore Highway and Airport Boulevard.

Another area believed to experience flooding due to high tides is between the Crowne Plaza Hotel parking lot and the northbound US101 off-ramp to Airport Boulevard.

A third area subject to flooding is where overbank flow from Easton Creek has historically flooded an area between Bayshore Highway and the on-ramp from Bayshore Highway to northbound US101. The Project has no impacts on the existing floodplains.

6.3 GEOLOGICAL PROFILES AND ENGINEERING PARAMETERS

The LOTBs presented in Appendix B include borings from previous investigations, and current field information and laboratory testing from our recent exploration at the proposed foundation support locations. Geotechnical engineering soil parameters used in our analyses were selected based on laboratory test results as well as engineering judgment and experience.

The undrained shear strength, internal friction angle (for granular soil), relative density, dry unit weight and moisture content are the geotechnical soil parameters used in our foundation design and analysis. Atterberg limits and particle size analysis tests were performed for classification of soils and to assess liquefaction potential. In general, unconfined compression tests were performed on cohesive soil samples to estimate the undrained shear strength. Some disturbance may occur while sampling cohesive soils; therefore unconfined compressive strengths in localized areas can be lower than the insitu field conditions. Consequently, engineering judgment and experience were applied in our interpretation of the laboratory test results. The relative density of cohesionless soils was estimated from vertical effective stress and Standard Penetration Resistance, N (blows per foot) based on correlations developed by Gibbs and Holtz (DM7.1 – 87, 1986). Where non-standard sampler sizes were used, such as the modified California sampler (2½ inch outside diameter), a correction factor was applied to the observed blows per foot to estimate the Standard Penetration resistance.

A generalized soil profile is presented in Figure 7 illustrating the layering of the various soil strata and summarizing the corresponding geotechnical parameters. It should be noted that this profile was developed based on extrapolation of available data from the borings drilled for this investigation and previous explorations by others and, therefore, may differ from actual conditions.

7.1 CORROSION EVALUATION

An assessment of the potential for corrosion of various buried foundation and pipe structures was performed by V&A Consulting Engineers (V&A). The results of their investigation are presented in Appendix G, and summarized below.

7.2 SUMMARY

V&A was retained by URS Corporation to perform a soil corrosivity investigation for the proposed US101/Broadway Interchange Replacement Project in the City of Burlingame, San Mateo County. The objective of this investigation was to provide recommendations for corrosion control of structural foundation materials under consideration for the Broadway overcrossing bridge. The structures being considered as part of this investigation are buried steel and reinforced concrete structures, and cast-in-drilled-hole (CIDH) concrete piles.

The investigation was conducted in accordance with California Department of Transportation's Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch *Corrosion Guidelines*, Version 1.0, dated September 2003. These Guidelines consider representative soil or water samples to be corrosive to metallic or reinforced concrete structural elements if one or more of the following conditions exist:

1. The chloride concentration is 500 parts per million (ppm) or greater and/or
2. The sulfate concentration is 2,000 ppm or greater and/or
3. The pH is 5.5 or less.

Evaluation of the soil environment was made in terms of potential corrosion damage to buried metal and reinforced concrete structures. Soil resistivity measurements were conducted by V&A in the field during the initial stages of the work. Resistivity measurements were taken in increments to a depth of 100 feet below grade at the proposed Broadway overcrossing bridge abutment sites. In addition, four soil samples taken during the geotechnical investigation by URS were sent to Cooper Testing Laboratory in Palo Alto, California, for chemical analysis. The soil samples were analyzed for as received and minimum (saturated) resistivity, pH, and water-soluble chloride and sulfate ion concentrations. All of these chemical properties affect the corrosion rate of buried metal and reinforced concrete structures.

The results are summarized in the following table.

Table 7-1 Soil Corrosion Test Results Summary

Sample ID	Depth (feet)	Minimum Resistivity[1] (ohm-cm)	pH[2]	Chloride Content[3] (mg/kg)	Sulfate Content[4] (mg/kg)
R-11-011	0-6	1,252	8.0	246	9
R-11-011-13-3	55-60	719	7.7	341	9
R-11-014-1	5-6.5	1,328	7.6	181	8
R-11-014-13-4	57-58	2,829	8.0	43	<5

The following information is provided as reference for the preceding Table 7-1:
1. Minimum resistivity by Caltrans Method 643
2. pH by Caltrans Method 643
3. Chloride by Caltrans Method 422-modified
4. Sulfate by Caltrans Method 417-modified

As shown in the preceding table, the four soil samples taken from URS boreholes R-11-011 and R-11-014 and analyzed at Cooper Testing Laboratory had minimum (saturated) resistivities that range from 719 to 2,829 ohm-cm. The soil pH values varied from 7.6 to 8.0. Water-soluble chlorides range from 43 to341 mg/kg (ppm), and the water-soluble sulfate concentrations were less than 5 to 9 mg/kg (ppm). Based on the pH values and the water-soluble chloride and sulfate concentrations, the soil samples from the proposed overcrossing bridge abutment sites are non-corrosive to buried steel and reinforced concrete structures as defined by the Caltrans *Corrosion Guidelines*.

7.3 CONCLUSIONS

- Four soil samples taken from URS soil boreholes R-11-011 and R-11-014 had soluble chloride concentrations less than 500 mg/kg (ppm) and soluble sulfate concentrations less than 2,000 mg/kg (ppm). According to the Caltrans *Corrosion Guidelines*, these soils are *non-corrosive* to buried steel and reinforced concrete structures.
- Boring logs indicate that groundwater was encountered at a depth of 5 feet near the proposed east overcrossing bridge abutment and at 12½ to 16 feet near the proposed west overcrossing bridge abutment. Bare steel and reinforced concrete are more vulnerable to corrosion in aerated soils above the water table.
- Although the analyzed soil boring samples at the proposed Broadway overcrossing bridge abutment locations (boreholes R-11-011 and R-11-014) are considered to be non-corrosive, soil samples from boreholes approximately 300 feet from the east and west proposed overcrossing bridge abutment sites (A-11-030-2-4, R-11-010-1-3, and R-11-018-2-2) have water-soluble chloride contents greater than 500 mg/kg (ppm) and water-soluble sulfate contents greater than 2,000 mg/kg (ppm).
- Based on the corrosive soil samples from nearby boreholes (A-11-030-2-4, R-11-010-1-3, and R-11-018-2-2), the potential exists for corrosive soil to be present at the bridge abutment sites.
- The project site is located within 1,000 feet of salt water or brackish water.

7.4 RECOMMENDATIONS

7.4.1 General

Corrosion protection against a marine atmosphere is required by the *Corrosion Guidelines* for above-ground steel and reinforced concrete structures at the proposed overcrossing bridge abutment locations. Design of structures installed in these locations should include corrosion mitigation measures as detailed below.

7.4.2 Buried Reinforced Concrete Structures and PCPS Piles

Buried concrete structures should be constructed of durable concrete as described in ACI Standards 201.2R and 222R and Chapter 850.3, "Corrosion," of the Caltrans *Highway Design Manual* (last updated September 28, 2011). Criteria for protecting reinforced concrete structures under corrosive conditions discussed in Caltrans Standard Special Provision (SSP) S8-C04, "Corrosion Control for Portland Cement Concrete" (a modification of Bridge Design Specifications, Section 8, "Reinforced Concrete"), should be followed. These recommendations include, but are not limited to, the following for reinforced concrete in corrosive soil:

- Based on a worst-case corrosive soil with water-soluble sulfate content greater than 2,000 mg/kg (ppm) or water-soluble chloride content greater than 5,000 mg/kg (ppm), the following concrete compositional requirements are recommended per the Caltrans Standard Specifications updated July 28, 2011, Section 90-1.02H, "Concrete in Corrosive Environments":
  - The cementitious material used in the concrete must be a combination of Type II or Type V Portland cement and SCM (supplementary cementitious materials).
  - The concrete must contain at least 675 pounds of cementitious material per cubic yard.
  - The reduction of cementitious material content specified in Section 90-1.02E (2) is not allowed.
  - The specifications for SCM content in Section 90-1.02B (3) do not apply.
  - The cementitious material must be composed of one of the following by weight:
    - 25% natural pozzolan or fly ash with a CaO content of up to 10%, and 75% Portland cement,
    - 20% natural pozzolan or fly ash with a CaO content of up to 10%, 5% silica fume, and 75% Portland cement,
    - 12% silica fume, metakaolin, or UFFA (ultra-fine fly ash) and 88% Portland cement,
    - 50% GGBFS (ground granular blast furnace slag) and 50% Portland cement.
  - A maximum water-to-cementitious material ratio of 0.40 shall be used in the concrete.

- Concrete sealant (silane) shall not be allowed as an option for concrete in a corrosive environment.
- A minimum concrete cover of 3 inches for a 50-year design life, and 4 inches for a 75-year design life, shall be applied over all steel reinforcement. This is based on a soil water-soluble chloride concentration of 5,000 to 10,000 mg/kg (ppm) for buried reinforced concrete above the groundwater table.
- This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete Cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.

- Sand and water used in concrete mixtures should contain a maximum of 100 mg/kg (ppm) of water-soluble chloride ions and water-soluble sulfate ions. Sand and water pH shall be between 6.5 and 8.0. Potable water should be used in all concrete mixtures.

7.4.3 Reinforced Concrete Exposed to Marine Atmosphere

Above-ground reinforced concrete structures within 1,000 feet of brackish or salt water are exposed to a corrosive marine atmosphere. The following minimum concrete cover over unprotected reinforcing steel is recommended for the concrete structures listed below:

- 3 inches concrete cover for the following:
  - ◊ Footings and pile caps
  - ◊ Walls, columns, and cast-in-place piles
  - ◊ Cast-in-place "I" and "T" girders, box-girder webs, bent caps, diaphragms, and hinged joints
- 2.5 inches of concrete cover for the top surface of deck slabs
- 2 inches of concrete cover for the precast piles and pile extensions
- 1.5 inches concrete cover for the following:
  - Bottom surface of deck slab
  - Box-girder bottom slabs

This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.

7.4.4 Steel Piles

For steel pilings driven into undisturbed soil, the region of greatest corrosion concern is from the bottom of the pile cap or footing down to 3 feet below the water table. Here the soil is oxygenated and can sustain corrosion reactions.

Under corrosive soil conditions, as defined in the Summary, the Caltrans LRFD Memo to Designers 3-1, July 2008, recommends the following:

- A corrosion allowance (sacrificial metal thickness) for pilings driven into undisturbed soil (soil-embedded zone) of 1 mil (0.001 inch) per year for the desired service life.
- For steel H-piling, the corrosion allowance should be doubled because two sides of the flanges and web are exposed to corrosive soil or water.
- For pipe piles, shells, and casings, the corrosion allowance applies only to the exterior pile surfaces. The interior pipe surface (soil plug side) will not be exposed to sufficient oxygen to support significant corrosion.

This information is also discussed in Section 10.1, "Corrosion Mitigation Measures for Steel Piles," in the Caltrans *Corrosion Guidelines*.

7.4.5 Cast-in-Drilled-Hole (CIDH) Piles

- Cast-in-drilled-hole (CIDH) concrete piling shall conform to the provisions in Section 49-3, "Cast-In-Place concrete Piles," of the Caltrans Standard Specifications.
- The concrete used in CIDH piles should be dense and homogeneous throughout the length and cross-section of the pile per California Test 233.
- Concrete for portions of CIDH concrete piling to be formed shall contain not less than 675 pounds of cementitious material per cubic yard and shall contain 6.0±1.5 percent air entrainment in the freshly mixed concrete.
- Concrete shall conform to the requirements in "Corrosion Control for Portland Cement Concrete" of Standard Special Provision S8-04C, August 5, 2011.

8.1 RESOURCES

The seismic design methodology adopted for this project is based on Caltrans Seismic Design Criteria (SDC), v 1.6, November 2010.

8.2 PEAK BEDROCK ACCELERATION

The closest active fault to this section of US101 is the San Andreas fault (SAN). This fault is designated with a Maximum Magnitude (M_{Max}) of 7.9 in the Caltrans 2007 fault database. The location of this fault is based on Caltrans ARS Online (2009). The horizontal distance from the site to the San Andreas fault is about 2.5 miles.

Table 8-1 Seismic Source Parameters

Fault	Type	M_{Max}	Distance* (miles)	Near Field Effects?
San Andreas (north coast segment)	strike-slip	7.9	2.5	Yes
San Gregario-Palo Colorado	strike-slip	7.2	9.5	No
Hayward (northern section)	strike-slip	7.3	16.0	No
Monte Vista-Shannon	reverse	6.7	14.0	No

*The distances are based on Caltrans ARS Online (2009).

Figure 4 shows the locations of these faults relative to the project site.

For design, a site PGA of 0.68 g was estimated using Caltrans ARS Online tool; this value of PGA corresponds to a site specific average shear wave velocity of 820 feet per second (fps).

8.3 FAULT TYPE, NEAR-FIELD, AND SPECTRAL ACCELERATION INCREASES

The 2007 fault database that accompanies the 2007 Caltrans Deterministic PGA Map indicates that the nearby active faults have strike-slip displacement. Therefore, in accordance with Caltrans design procedures referenced above, no increase in design spectral accelerations is required for fault type. However, since the project site is located less than 9.3 miles from the nearest active fault, the design spectral accelerations should be modified to account for near-field effects as shown in the following table:

Table 8-2 Near Field Effects

Period (sec)	Increase in Spectral Acceleration (%)
< 0.5	0
0.5 – 1.0	0 – 20 (determined by linear interpolation)
≥1	20

Since the fundamental period of the proposed structure is not known at this time, the spectral acceleration has not been adjusted for the effect of fundamental period. If the fundamental period of the structure is determined to be greater than 1.5 seconds, then an adjustment should be made in accordance with Caltrans design procedures.

8.4 DESIGN ACCELERATON RESPONSE SPECTRA

The design response spectrum for the site is estimated with spectral acceleration values generated using Caltrans ARS Online (2009). This method was developed by Caltrans Geo Research Group in partnership with United States Geological Survey (USGS), Pacific Earthquake Engineering Research (PEER) and California Department of Conservation. This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in Appendix B of Caltrans SDC.

The deterministic spectrum is determined as the average of median response spectra calculated using the Campbell-Bozorgnia (2008) and Chiou-Youngs (2008) ground motion prediction equations developed under the "Next Generation Attenuation" project coordinated through the PEER-Lifelines program. These equations are applied to all faults considered to be active in the last 750,000 years (late-Quaternary age) that are capable of producing a moment magnitude earthquake of 6.0 or greater. The probabilistic spectrum is obtained from the USGS (2008) National Hazard Map for 5% probability of exceedance in 50 years. Caltrans design spectrum is based on the larger of the deterministic and probabilistic spectral values. Both the deterministic and probabilistic spectra account for soil effects through incorporation of the parameter V_{S30}, the average shear wave velocity in the upper 30 meters (100 feet) of the soil profile. As discussed in Section 4, shear wave velocity tests were conducted in CPT-11-012 and CPT-11-016. Based on these tests, V_{S30} was estimated to be 820 feet per second. Appendix E presents a summary of the seismic response spectra analysis results.

The input values we selected for Caltrans ARS Online included:

- V_{S30} of 820 feet per second
- Maximum Magnitude (M_{Max}) 7.9 (San Andreas fault)
- No ARS increase for fault-type or long period structure
- ARS increase for near-field effects

The calculated spectra using the Caltrans ARS Online tool for both deterministic and probabilistic methods are presented as the blue curve on Figure 8A. Since the average shear wave velocity at the site is less than 1,000 feet per second, Caltrans requires that the calculated spectra be determined using the USGS deaggregation tool; this curve is plotted in red on Figure 8A. In cases where the calculated spectra for the two curves (Caltrans and USGS) differ by 10 percent or more for periods of less than 0.5 second, Caltrans requires that the USGS calculated spectra be used for design.

As shown on Figure 8A, the calculated spectral value for the 0.5 second period is about 1.3g based on Caltrans ARS and just over 1.4g based on the USGS deaggregation. Therefore, in accordance with Caltrans requirements, the USGS calculated spectra should be used for design (Figure 8B). Appendix H of this report presents the ground motion evaluation for this site

including output pages of the ARS Online tool, the estimates of V_{s30} based on in-situ measurements and the results of the USGS deaggregation tool.

The existing Broadway Overcrossing consists of four lanes and spans across US101. The bridge has a 4-foot-wide walkway on each side with metal railing and was constructed around 1949. Based on as-built plans provided by Caltrans dated September 1949, the existing bridge is a 12-span structure supported on two abutments and 11 bents. The overall length of the structure is approximately 760 feet. The superstructure was constructed with a concrete slab supported on steel I-beams. According to the as-built drawings, the abutments are supported on driven steel H-piles (12BP53), vertical and batter, and bents are supported on three rows of vertical untreated timber piles. Steel piles at the abutments are estimated to be approximately 50 to 55 feet long with a specified capacity of 24 tons, and the timber piles at bents are estimated to be approximately 40 feet long with a specified capacity of 20 tons. Based on our review of the available as-built and soil boring information, it appears that the existing pile foundations at the Broadway Overcrossing derive support through a combination of skin friction in the upper 40 to 50 feet of the alluvial soil profile, and potentially through end-bearing resistance in the dense sands and gravels encountered below approximately Elevation -40 feet. Bottom of pile cap at the abutments of the original structure ranges from Elevation 9.5 to 11.5 feet at Abutment 1 and from Elevation 13.7 to 14.5 feet at Abutment 13; the bottom of pile cap at all bents is Elevation 1 foot.

The interchange was modified in 1970 with the addition of an on-ramp from Broadway to southbound US101. The on-ramp is a four span cast-in-place slab bridge on pile extensions consisting of corrosion resistant Class XI concrete piles (45-ton capacity). The specified tip elevation for these concrete piles was Elevation -40 feet.

The General Plan, Sheet 1 of 10, for the 1970 improvements lists the datum as USC & GC. We were not provided with the General Plan, Sheet 1 of 18, for the 1949 original construction and therefore, do not have information regarding that project datum.

Copies of these as-built structure plans are presented in Appendix I.

10.1 DISCUSSION

The proposed bridge and approach areas are blanketed by about 6 to 12 feet of fill, underlain by up to 9 feet of very soft to medium stiff and highly compressible Bay Mud and occasional discontinuous layers of moderately compressible lean to fat clays. In addition, potentially liquefiable sands were encountered near the surface at the proposed abutment and bent locations.

The principal geotechnical issues at the site are:

- Excessive total and differential settlements due to consolidation of foundation soils under the weight of new approach fills,
- Risk of embankment slope instability if fill placement occurs rapidly due to weak underlying Bay Mud,
- Post-liquefaction settlement of potentially liquefiable soils and the potential for liquefaction induced lateral spreading at and near the bridge,
- Selection of the type and depth of foundation that will be compatible with the underlying soils, and
- Construction issues associated with the proximity of proposed new fills to existing structures.

We understand that 16-inch square precast, prestressed (PCPS) concrete piles, vertical and batter, are planned at the abutments, and that 24-inch diameter cast-in-steel shell (CISS) piles, vertical only, are planned at the center bent. Piles at the abutments will be Class 140 and piles at the bent will be Class 200.

As discussed in the "Consolidation Settlement" section of this report, we estimate that elastic and long-term consolidation settlement of the Bay Mud and other clays under the weight of the proposed fills could be as much as 17 inches beneath the thickest approach fills, and on the order of about 7 to 8 inches at the abutments. Settlement of this magnitude will induce downdrag loads on the piles and potentially cause distress of approach fills and the overlying structural pavement sections. Due to the very low permeability of the Bay Mud and other native clays, we estimate that the settlement period to reach 90 to 95% consolidation would be approximately 3 to 4 years.

We considered three alternatives for approach fill construction to mitigate consolidation settlement and soil shear strength concerns at the site, including:

- Surcharge proposed structure backfill and embankment fill areas using wick drains to facilitate drainage and to accelerate settlement and strength gain of the underlying Bay Mud and other native clays.
- Use of very lightweight expanded polystyrene (EPS) blocks as an alternative to Caltrans standard embankment fill and structure backfill so that new loads imposed on the underlying highly compressible clays are reduced significantly, resulting in tolerable post-construction total and differential settlements at foundations.
- Cement Deep Soil Mixing (CDSM) ground treatment of the underlying Bay Mud, potentially liquefiable granular deposits and fat clays at the abutment locations to reduce post liquefaction and long-term consolidation settlements to tolerable levels.

CDSM is currently proposed to a depth of about 50 feet at the abutments to mitigate consolidation and post-liquefaction settlement. CDSM ground improvement typically consists of a regular grid of in-place columns that are placed in rows (treatment zones) aligned parallel to the longitudinal axis of an embankment. The horizontal extent and pattern of the CDSM columns near the bridge abutments are shown on the CDSM Plans, Figures 9A to 9D. A more detailed discussion of CDSM is presented in Section 11.

Provided that one or more of the above options is implemented, we believe downdrag loads on the abutment piles can be mitigated. Since new fills are not planned in close proximity to the center bent, consolidation settlement is not expected to affect the CISS piles. However, because pockets of potentially liquefiable soils were encountered in Boring R-11-013 advanced near the center bent, we have included the estimated average downdrag force in the design pile tip elevations, consistent with Caltrans requirements.

We also considered alternatives to reduce the potential for lateral spreading to affect areas of new construction. As discussed in Special Publication 117: Guidelines for Evaluating and Mitigating Seismic Hazards in California (Division of Mines and Geology), the hazards associated with lateral spreading can be mitigated by 1) removal of potentially liquefiable material, 2) in-situ ground densification, 3) deep soil mixing or other equivalent form of in-situ ground improvement, and/or 4) use of deep foundations designed to accommodate liquefaction effects. The magnitude and extent of potential lateral spreading that could occur at the site are difficult to quantify. In our opinion, use of CDSM in areas of new construction and extending ground improvement to the bottom of the potentially liquefiable soils (generally 30 feet bgs) should mitigate the risk of lateral spreading at the site.

10.2 PILE DESIGN CAPACITY AND TIP ELEVATION

10.2.1 Axial Pile Capacity Analysis

Based on our review of the subsurface conditions encountered in the current explorations, we recommend the proposed replacement structure be supported on Class 140 (mod) Alt ”X” 16-inch square PCPS piles at the abutments, and 24-inch diameter CISS piles (0.5-inch thick shell) at the center bent (Bent 2).

For Bent 2, closed-end CISS piles have the advantage that steel reinforcement and concrete can be placed in relatively neat and dry conditions. However, Caltrans Office of Structure Construction reportedly has experienced ground heaving in driving relatively large diameter displacement piles in soft ground. To reduce the potential risk of ground heave, we recommend open-end CISS piles be used in lieu of the closed-end alternative. For open-end CISS piles, the design pile tip elevations are based on a combination of end-bearing and frictional pile resistance developed in the subgrade soils. We expect the medium to very stiff lean clay and medium dense to dense silty sand interbeds below a depth of 30 feet bgs (approximate Elevation -20 feet) will develop a soil plug within the open end of the pile that will, in turn, provide end-bearing resistance of the piles. We recommend that a minimum soil plug of 8 times the pile diameter

remain within the bottom section of the pile and that the upper pile section be cleaned and filled with concrete.

Current Caltrans practice is to design abutments in accordance with Working Stress Design (WSD) methodology and bents in accordance with LRFD. The following table presents a summary of the foundation design data provided by the Structural Engineer.

Table 10-1 Foundation Design Data for Broadway Overcrossing (Replace)

Location	Design Method	Pile Type	Finished Grade Elevation (ft)	Cut-off Elevation (ft)	Pile Cap Size (ft) W x L	Permissible Settlement Under Service Load	No. of Piles per Support
Abut 1	WSD	Class 140	11.0	5.75	15.0 x 116.3	1-inch	75
Bent 2	LRFD	24-inch CISS	12.5	5.25	22.0 x 22.0	1-inch	16
Abut 3	WSD	Class 140	10.0	4.75	15.0 x 123.25	1-inch	75
Abut 3 Lt RW	LRFD	Class 140	Varies 10.0 to 32.0	4.75	15.0 x 50.0	1-inch	48
Abut 3 Rt RW	LRFD	Class 140	Varies 10.0 to 32.0	4.75	15.0 x 50.0	1-inch	48

Lt: Left, Rt: Right

The design loading conditions and nominal resistance are developed in accordance with the LRFD approach. Loads from LRFD Service-1 Limit State are used as design loads for WSD of abutments. The table below presents the design loads.

Table 10-2 Foundation Design Loads for Broadway Overcrossing (Replace)

Location	Service Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Maximum per Pile	Per Support	Per Support	Maximum per Pile	Per Support	Maximum per Pile	Per Support	Maximum per Pile	Per Support	Maximum per Pile
Abut 1	6,702	120	5,388	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bent 2	2,774	210	1,507	2,969	230	n/a	n/a	1,880	423	n/a	193

Table 10-2 Foundation Design Loads for Broadway Overcrossing (Replace) (continued)

Location	Service Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Limit State (Controlling Group, kips)			
	Total Load		Permanent Loads	Compression		Tension		Compression		Tension	
	Per Support	Maximum per Pile	Per Support	Per Support	Maximum per Pile	Per Support	Maximum per Pile	Per Support	Maximum per Pile	Per Support	Maximum per Pile
Abut 3	7,836	137	6,267	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Abut 3 Lt RW	2,639	122	2,543	3,547	174	n/a	3	2,591	253	n/a	123
Abut 3 Rt RW	2,639	122	2,543	3,547	174	n/a	3	2,591	253	n/a	123

Tables 10-3 and 10-4 present the foundation design recommendations for the abutments, bent and return walls, respectively.

Table 10-3 Foundation Recommendations for Abutments

Location	Pile Type	Cut-off Elevation (ft)	LRFD Service-I Limit State Load (kips) per Support		LRFD Service-I Limit State Total Load (kips) per pile (Compression)	Nominal Resistance (kips)	Design Tip Elevation (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance (kips)
			Total	Permanent					
Abut 1	Class 140 Alt "X",T=16 in	5.75	6,702	5,388	120	240	-45 (a) -20 (c) -16 (d)	-45	240
Abut 3	Class 140 Alt "X", T=16 in	4.75	7,836	6,267	137	280	-53 (a) -28 (c) -16 (d)	-53	280

Design tip elevation is controlled by the following demands: (a) Compression, (c) Settlement, (d) Lateral

Table 10-4 Foundation Recommendations for Bent 2 and Return Walls

Location	Pile Type	Cut-off Elevation (ft)	Service-I Limit State Load (kips) per support	Total Permissible Support Settlement (inches)	Required Factored Nominal Resistance (kips)				Design Tip Elevation (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance (kips)*
					Strength Limit		Extreme Event				
					Comp. (ø=0.7)	Tension (ø=0.7)	Comp. (ø=1)	Tension (ø=1)			
Bent 2	CISS NPS 24 x 0.5 in	5.25	2,774	1	230	n/a	423	193	-38 (a-I) n/a (b-I) -47 (a-II) -28 (b-II) -25 (c) -25 (d)	-47	440
Abut 3 Lt RW	Class 140 Alt "X", T=16 in	4.75	2,639	1	174	3	253	123	-53 (a-I) -0 (b-I) -53 (a-II) -23 (b-II) -28(c) -16 (d)	-53	260
Abut 3 Rt RW	Class 140 Alt "X", T=16 in	4.75	2,639	1	174	3	253	123	-53 (a-I) -0 (b-I) -53 (a-II) -23 (b-II) -28(c) -16 (d)	-53	260

* Nominal driving resistance is the sum of nominal resistance and downdrag
Design tip elevation is controlled by the following demands: (a-I) Compression (Strength Limit, (b-I) Tension (Strength Limits, (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement, (d) Lateral Load

The specified tip elevations presented below in Table 10-5 are based on skin friction in the native clays and sands. The estimated pile embedment at Bent 2 includes additional penetration depth to resist a potential downdrag load of 5 kips we estimate could act on the piles due to post-construction liquefaction induced settlement of the shallow fills, not mitigated by CDSM.

Table 10-5 Pile Data Table for Broadway Overcrossing (Replace)

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance (kips)*
		Compression	Tension			
Abut 1	Class 140 Alt "X",T=16 in	240	0	-45 (a) -20 (c) -16 (d)	-45	240
Bent 2	CISS NPS 24 x 0.5 in	430	200	-47 (a) -28 (b) -25 (c) -25 (d)	-47	440

Table 10-5 Pile Data Table for Broadway Overcrossing (Replace) (continued)

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance (kips)*
		Compression	Tension			
Abut 3	Class 140 Alt "X", T=16 in	280	0	-53 (a) -28 (c) -16 (d)	-53	280
Abut 3 Lt RW	Class 140 Alt "X", T=16 in	260	140	-53 (a) -23 (b) -28 (c) -16 (d)	-53	260
Abut 3 Rt RW	Class 140 Alt "X", T=16 in	260	140	-53 (a) -23 (b) -28 (c) -16 (d)	-53	260

* Nominal driving resistance is the sum of nominal resistance and downdrag
Design tip elevation is controlled by the following demands: (a) Compression, (b) Tension, (c) Settlement, (d) Lateral

The results of our axial pile capacity analysis, which form the basis of our selection of the design tip elevations, are presented in Appendix J.

No group reduction factor needs to be applied to the single pile compression load capacities presented above provided a center-to-center spacing of at least three pile diameters is used.

10.2.2 Lateral Load Capacity

Pile foundations are capable of resisting lateral loads through bending of the pile and by pile-soil interaction. The magnitude of the lateral load resistance that can develop depends upon factors such as the pile size, the physical properties of the surrounding soils, and the structural design of the pile. We used LPILE 5.0 (Reese et al., July 2004) and GROUP 7.0 (Reese et al., July 2006) to assist in estimating the lateral load resistance of PCPS and CISS piles and the corresponding lateral pile group effects. Both programs model the soil response in the form of load-deflection (p-y) curves. Charts presenting load versus deflection based on LPILE output for free and fixed head conditions at top of pile (both abutments and bent) are included in Appendix K.

California Amendment to AASHTO LRFD Bridge Design Specifications recommends that a P-multplier (P_m) be applied to the lateral capacity of individual piles to account for pile group efficiency. Table 10-6 presents the Caltrans recommended P_m for the corresponding rows of piles within a group based on Caltrans Amendments of AASHTO LRFD, Section 10.7.2.4. Row 1 refers to the leading row of piles in the direction of loading.

Table 10-6 Pile P-Multiplier, Pm for Multiple Row Shading

Pile Center-to-Center Spacing (in the direction of loading)	Group Efficiency Factor (P-Multiplier, P_m)		
	Row 1	Row 2	Row 3 and higher
2 x Pile Width/Diameter (B)	0.60	0.35	0.25
3 B	0.75	0.55	0.4
5 B	1.0	0.85	0.7
7 B	1.0	1.0	0.9

If additional lateral capacity is needed beyond the lateral load capacity of the PCPS piles at abutments, passive resistance against the abutment walls or pile cap can be utilized, provided that abutment backfill meets the requirements for Caltrans structure backfill. For abutments, Caltrans limits the soil resistance at the back wall to a 5.5 foot wall height and a maximum uniform soil pressure of 5,000 pounds per square foot (psf). For wall heights less than 5.5 feet, the average unit pressure should be reduced linearly in proportion to the height. The uniform soil pressure of 5,000 psf is an ultimate value, and should be used with an appropriate load resistance factor for the service limit-state consistent with the LRFD approach.

10.2.3 Axial Pile Load-Deflection

Axial pile load-deflection curves are used by the Structural Engineer to develop vertical foundation stress-strain coefficients for use in the superstructure analyses. The computer program TZPILE 2.0 (Ensoft, Inc. 2005) was used to model the axial pile load behavior. Axial load deflection curves were developed for 16-inch square PCPS piles and 24-inch diameter CISS piles. The results of TZPILE analyses are presented in Appendix J.

10.3 PILE INSTALLATION

All piles should be installed under the direct observation of the Geotechnical Engineer and in accordance with Section 49 of the Caltrans Standard Specifications, “Piling.” Specific additions and modifications to these requirements are discussed below.

The Contractor should submit evidence of compatibility of the proposed pile hammer with the pile type [16-inch square Class 140, Alt “X” PCPS and 24-inch diameter Class 200 CISS] and soil conditions at the site. The Contractor’s hammer submittal should include, as a minimum, a dynamic analysis of the pile driving system that is based on wave equation analysis using computer programs such as WEAP. Acceptance criteria for driven piles should follow Caltrans Standard Specifications Section 49-1.08, Pile Driving Acceptance Criteria as well as Special Provisions 49-228, Redriving. As discussed in Special Provisions 29-228, piles which do not meet the required bearing value when the pile tip has reached the specified pile tip elevation should be allowed to stand for a “set period” without driving. The “set period” should be at least 24 to 48 hours unless the bearing has been obtained sooner. After the required “set period” has elapsed piles that do not meet criteria should be redriven. Driven piles reaching refusal within 10 feet of the specified tip elevation and meeting the acceptance criteria may be cut-off above the tip elevation required by the compression loads. This assumes that the design lateral load and tension load tip elevations have been reached (see Pile Data Table 10-5). Preliminarily, we

recommend that the refusal criteria be two times the minimum required blowcount. However, refusal criteria should be defined during construction based on the pile driving system proposed by the Contractor.

As discussed in Section 10.2.1, CISS piles will be driven "open end." At the Contractor's option cutting shoes made with a tough material such as cast alloy steel could be used to protect the end of the steel pipe; addition of a cutting shoe minimizes curling of the pipe end during hard driving in the dense sand and facilitates installation to the specified tip elevation. During driving CISS piles "open end," the interior soil of the steel shells should be reamed out with an auger (defined as "central relief") concurrently as the pile is driven. At no time should the auger advance ahead of the pile tip. Furthermore, "central relief" should be stopped at an elevation 8 times the pile diameter above the specified pile tip elevation.

We anticipate that "hard driving" conditions could be encountered within dense sand and gravel found at approximately Elevation -43 feet in explorations near Abutment 1, approximately Elevation -30 feet near Bent 2, and Elevation -50 feet near Abutment 3. When required, and as approved by the Geotechnical Engineer, predrilling should be used to assist in the installation of the Class 140 Alt "X" PCPS piles to the required tip elevations. Predrilled holes should be no larger than the least dimension of the new pile, in conformance with the provisions of Section 49-1.05 of the Standard Specifications, Driving Equipment. The use of water in the predrilling process or jetting should not be allowed, unless approved in advance by the Geotechnical Engineer.

10.4 APPROACH EMBANKMENT SETTLEMENT

Approach fills as high as 22 feet are currently planned. As discussed in the "Subsurface Conditions" section of this report, the native soils below the fill consist of as much as 9 feet of soft to very soft and highly compressible Bay Mud which is underlain in some areas by moderately compressible fat clay. We estimated the settlement of the approach embankment due to placement of new fill in a single stage to the grades shown on the 'BWY' Line profile. Based on these assumptions, we estimate that total settlement on the order of 17 inches could occur along the approach centerline and up to 7 inches at the abutments.

Because of the very low permeability of the Bay Mud and other native clays, the settlement period to reach 90 to 95% of the total estimated consolidation settlement under the weight of new fills is expected to be 3 to 4 years, which is not practical from a construction standpoint. To reduce the potential for downdrag loads to act on the driven pile foundations, we evaluated the following construction options to limit post-construction settlements at the bridge abutments to less than about ½-inch:

1. Accelerate settlement under normal weight fill using surcharging and wick drains. With this alternative, consideration must be given to the potential adverse effects of fill loads on existing underground utilities and adjacent structures to remain. Construction of the embankment fill will have to be in multiple stages in order to avoid risk of slope instability due to weak underlying Bay Mud.
2. Decrease settlement to tolerable amounts using very light weight EPS blocks in the approach fills.

3. Improve the strength and compressibility characteristics of the native clays using CDSM ground improvement to a depth of approximately 50 feet at the abutments.

At present, the CDSM ground improvement option has been identified as the most cost-effective option for mitigating potential settlements. A discussion of methodology and construction of CDSM ground improvement is presented in the "Construction Considerations" section of this report.

10.5 SLOPE STABILITY

Consistent with Caltrans standards, the proposed inclination of new embankments slopes at the Abutment 3 approach to the Broadway Overcrossing is shown as 2 to 1 (horizontal to vertical) or flatter on the General Plan. The approach embankment slopes in this area would consist of new embankment fill underlain by existing fill and native Bay Mud. We analyzed the stability of the proposed embankment slopes at Abutment 3 for typical structure and embankment fill and CDSM treatment of existing fill and underlying Bay Mud, and calculated a minimum (critical) factor of safety of more than 2, which exceeds the minimum required value of 1.3 for the end of construction condition and 1.5 for the long-term drained condition.

Provided that the embankments are constructed in accordance with the recommendations of this report (including CDSM treatment or equivalent of the native soils) and Caltrans Standard Specifications, the planned fill slopes of 2:1 (horizontal:vertical) or flatter, could be constructed as planned.

10.6 APPROACH FILL EARTHWORK

All earthwork should be completed in accordance with the applicable sections of the Caltrans Standard Specifications and as described in the companion Geotechnical Design and Materials Report for the US101/Broadway Interchange Project, prepared by URS.

10.7 APPROACH FILLS AND ABUTMENT EXCAVATION

All earthwork should be completed in accordance with applicable section of the Caltrans Standard Specifications and as described in URS' companion Geotechnical Design and Materials Report for US101/Broadway Interchange project. The requirements of structural backfill and pervious backfill are set forth under Section 19-3.06 and 19-3.065, respectively, in the Standard Specifications (Caltrans 2006).

Expansive soil materials including Bay Mud and other native fat clays, should not be placed as part of the proposed embankment within the limits of the abutment for the full width of the embankment. Expansive soil materials for this requirement are defined as having either an Expansion Index (EI) greater than 50 (EI to be determined in accordance with ASTM D 4829), or a Sand Equivalent (SE) less than 20 (SE to be determined in accordance with California Test 217). This requirement is exclusive of the structure backfill and pervious backfill requirements as shown on the plans and set forth under Sections 19-3.06 and 19-3.065, respectively, in the Standard Specifications (Caltrans, 1999).

The fills that blanket the site can be used as general fill for the project provided that they meet Caltrans material requirements. The native fat clays and Bay Mud should not be used as engineered fill due to their high moisture and organic contents, and expansive nature, i.e. potential to shrink and swell with moisture changes. We therefore, recommend that the native clays be hauled offsite and not be used in constructing the approach fill and bent and abutment backfill.

Footing/pile cap areas should be excavated as required to bring those areas to their finish subgrade elevations. All loose soil should be removed from the exposed subgrade prior to pile cap construction. Because shallow groundwater could be encountered, we recommend the type of excavation at the abutments and bents be classified as "Structure Excavation Type D" in accordance with Section 11 of Bridge Design Aids, March 2005.

11.1 CEMENT DEEP SOIL MIXING

Cement deep soil mixing (CDSM) is a process whereby soil is improved by injecting cement grout through one or more augers that simultaneously mix the soil, forming in-place soil-cement columns. CDSM is performed in a regular grid of in-place columns to effectively improve the target soils with the layout typically consisting of blocks of CDSM columns that are placed in rows (treatment zones) aligned parallel to the longitudinal axis of an embankment. The blocks consist of exterior and interior walls formed by adjacent CDSM columns. Analysis of settlement and stability of CDSM improved soil ignores the strength of the soils within and between the blocks.

The CDSM mix is designed by a specialty contractor with the improved properties of the stabilized soil governed by a number of factors including soil type, slurry properties, mixing procedures and curing conditions. High strengths can be attained in the final soil-cement product, typically greater than 100 pounds per square inch (psi).

The challenges associated with CDSM construction include limitations on space for construction staging and rig operations, coordination during excavation and embankment reconstruction, assessing the effectiveness of the soil improvement, and evaluating the depth of penetration. Close coordination between the design team and the specialty CDSM contractor is important to avoid cost overruns and/or schedule impacts to the project. Locations of CDSM columns should be carefully reviewed and coordinated between the Design Team and Specialty Contractor in order to avoid conflict with the pile layouts; this may require more than one iteration during design.

To assess the effectiveness of the CDSM improvements, a detailed monitoring and testing program should be established. The program should include test sections utilizing several different mix designs with varied cement contents and water-cement ratios, monitoring of various parameters during CDSM construction, full depth coring of the completed CDSM columns, unconfined compressive strength testing on selected CDSM core samples, test borings prior to CDSM construction or adjacent to completed CDSM columns, and test redrilling of cured CDSM.

Special provisions for CDSM construction will be included as part of the final Geotechnical Design and Materials report for the US101/Broadway Interchange project.

11.2 TEMPORARY CONSTRUCTION EXCAVATIONS

We anticipate that pile cap excavations to about Elevation 4.5 feet will require cuts on the order of 6 to 7 feet in height. Based on the recent explorations, it appears likely that these excavations will be through the existing roadway embankment fills and are not likely to encounter Bay Mud.

Safety standards set by OSHA limit the height of the unshored vertical excavations to 5 feet if construction personnel will be working in the excavations. The set of guidelines published by OSHA (Department of Labor, Occupational Safety and Health Administration, 1999), classifies soils in detail as Type A, B, or C. In general, Type A soils are stronger, Type B soils are intermediate, and Type C soils are weaker. Based on the soil type, depth, and duration the excavation is open, and sequence of soils exposed in the excavation, OSHA recommends

maximum allowable slopes. Based on the strengths of the soils encountered in our recent borings, the existing roadway embankment fills are generally considered to be OSHA Type B and Type C. On this basis, we recommend that temporary slopes in these soils be cut no steeper than 1½:1 (horizontal:vertical).

We expect that OSHA guidelines for Type A soils would be applicable for excavations in soil stabilized with CDSM ground improvement. However, if excavations are made into untreated Bay Mud (i.e., no CDSM), then the Contractor's Engineer should determine the maximum slope inclination for cuts in Bay Mud overlain by existing fill. The Contractor's Engineer should submit his calculations to Caltrans for review prior to excavation.

We recommend that the Geotechnical Engineer be retained to review the conditions in temporary cut slopes as they are exposed during construction. Additional recommendations could be provided at that time regarding the advisability of different temporary slope inclinations in particular areas.

For locations where excavation with sloping sides is not viable because of space limitations or in areas where temporary slopes steeper than 1:1 are planned, shoring will be required. The Contractor should retain an experienced Registered Civil Engineer to design the shoring system.

11.3 CONSTRUCTION DEWATERING

Free groundwater was encountered in each of the borings drilled in the vicinity of the Broadway Overcrossing at depths ranging from about 5 to 8 feet bgs (Elevation 4.5 to 5 feet); these are the depths where free groundwater was first encountered during drilling and therefore do not necessarily represent a stabilized groundwater level at the boring locations.

Pore pressure dissipation tests at two CPT locations suggest groundwater depths ranging from 0.5 and 3.4 feet bgs, corresponding to Elevation 10.5 and 6.6 feet, respectively.

With bottom of pile cap at ranging from Elevation 4.5 to 5.5 feet for the abutments, center bent and return walls, it is likely that groundwater will be encountered in the pile cap excavations. Therefore, we recommend that the Contractor be prepared to dewater the excavations as necessary during construction.

It should be noted that the recent explorations were completed during the dry 2011 summer and fall seasons and higher groundwater levels might occur during the winter months. As discussed previously, groundwater encountered in the explorations does not represent a stabilized groundwater elevation and/or could represent perched conditions. In addition, fluctuations in the groundwater level could occur due to tidal action in the nearby San Francisco Bay, water level fluctuations in nearby Easton Creek or Sanchez Creek, and variations in rainfall or other factors not in evidence at the time of the investigation.

11.4 PILE CUTOFF

When driven piles develop the required compressive capacities before reaching the specified tip elevation, the Contractor may be given the option, with the Geotechnical Engineer's approval, to stop driving and cut off the piles. Pile cut-off should be approved only if the piles also have satisfied the tension and lateral demand requirements, and the structural capacity has not been

compromised. For maximum pile cut-off length, refer to the Standard Plans Sheet B2-5 of (Caltrans, 2010).

11.5 EFFECTS OF CONSTRUCTION WORK ON ADJACENT STRUCTURES

Efforts should be made to minimize effects of construction work on adjacent structures. A monitoring program should be required for pile driving at, or adjacent to, existing structures that are susceptible to damage or sensitive to noise and/or vibration.

In addition, a settlement monitoring program, including video taping, should be implemented for adjacent existing structures and underground utilities, particularly before and during CDSM soil mixing and embankment fill placement.

The opinions, conclusions and recommendations presented in this Foundation Report are based on information obtained from new and previous explorations made at widely separated locations, site reconnaissance, review of available topographic information and historic data, and upon experience and engineering judgment.

The recommendations presented in this report are based on the assumption that the soil and geologic conditions do not deviate substantially from those encountered in the exploratory borings and CPTs. If any variations are encountered during construction, URS should be contacted so that supplementary recommendations can be made.

If the planned construction is changed from that presently conceived, URS should be retained to review the changes and make modifications to the original recommendations presented in this report in order to meet the project needs.

The Geotechnical Engineer should review the final specifications and drawings to verify that these documents are consistent with the intent of the geotechnical recommendations. Geotechnical issues may arise during construction which are not apparent at this time. URS should be retained during construction to review the soil conditions encountered and the construction procedures. All earthwork and testing, as well as pile installation, should be done under the direct observation of a representative of our firm.

The elevations shown on the new LOTBs are based on interpolation from spot and contour elevations shown on available topographic maps.

As-built drawings pertinent only to the geotechnical investigation are included.

Specific review and investigation for environmental issues and subsurface environmental contamination were beyond the scope of our services.

The opinions and recommendations presented in this Foundation Report were developed with the standard of care commonly used as state of the practice in the profession. No other warranties are included, either express or implied, as to the professional advice provided in this report.

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INDEX OF PLANS

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

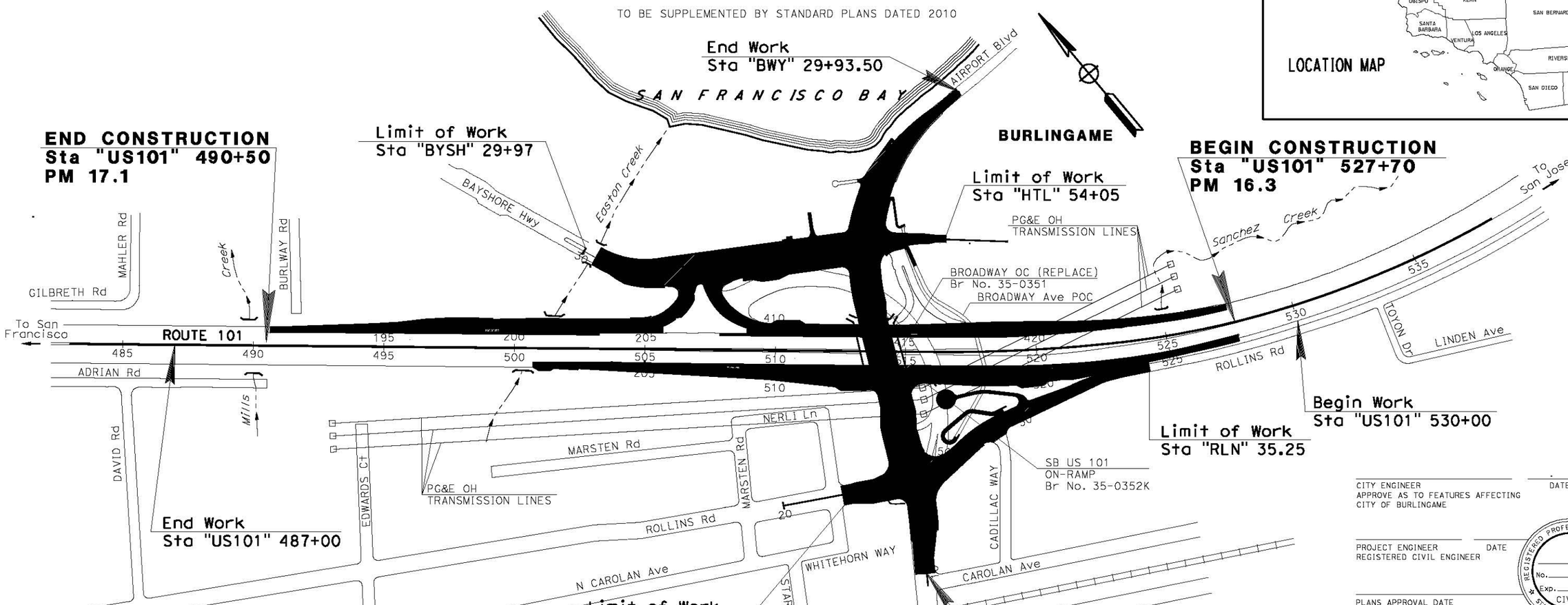
PROJECT PLANS FOR CONSTRUCTION ON AND ADJACENT TO
STATE HIGHWAY

IN SAN MATEO COUNTY
IN BURLINGAME
FROM 0.3 MILE NORTH OF ANZA BOULEVARD TO 0.9 MILE SOUTH OF MILLBRAE AVENUE

TO BE SUPPLEMENTED BY STANDARD PLANS DATED 2010

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

LOCATION MAP



PROJECT VICNITY MAP
FIGURE 1

NO SCALE

65% PS&E SUBMITTAL
JUNE 28, 2012

THE CONTRACTOR SHALL POSSESS THE CLASS (OR CLASSES) OF LICENSE AS SPECIFIED IN THE "NOTICE TO BIDDERS."

CITY ENGINEER — DATE
APPROVE AS TO FEATURES AFFECTING CITY OF BURLINGAME

PROJECT ENGINEER — DATE
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER — No. — Exp. — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

URS CORPORATION
100 W. SAN FERNANDO St, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

CONTRACT No.	04-235844
PROJECT ID	0400000684

LAST REVISION 12-23-11
DATE PLOTTED => 6/19/2012
TIME PLOTTED => 3:25:10 PM

APPROVED AS TO IMPACT ON STATE FACILITIES AND CONFORMANCE WITH APPLICABLE STATE STANDARDS AND PRACTICES AND THAT TECHNICAL OVERSIGHT WAS PERFORMED.

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SCOTT KELSEY	X	.	.	.

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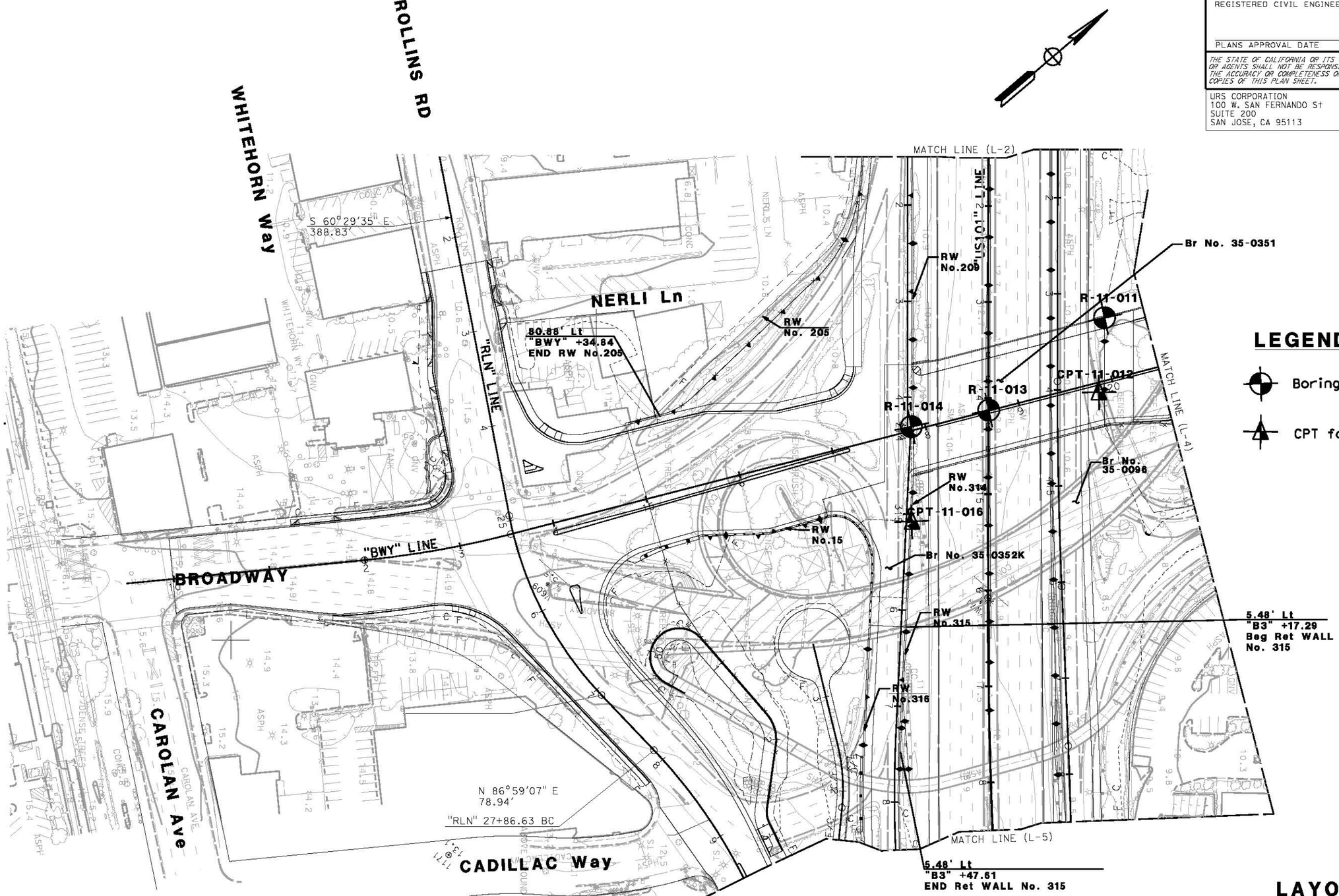

LEGEND

Boring for this study

CPT for this study

SITE and BORING LOCATION PLAN
FIGURE 2

LAYOUT
SCALE 1" = 50'

L-3

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.	.

CALCULATED-DESIGNED BY . CHECKED BY .

CONSULTANT FUNCTIONAL SUPERVISOR

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Caltrans

LAST REVISION 12-23-11

DATE PLOTTED => 6/19/2012
TIME PLOTTED => 3:53:41 PM

BORDER LAST REVISED 7/2/2010

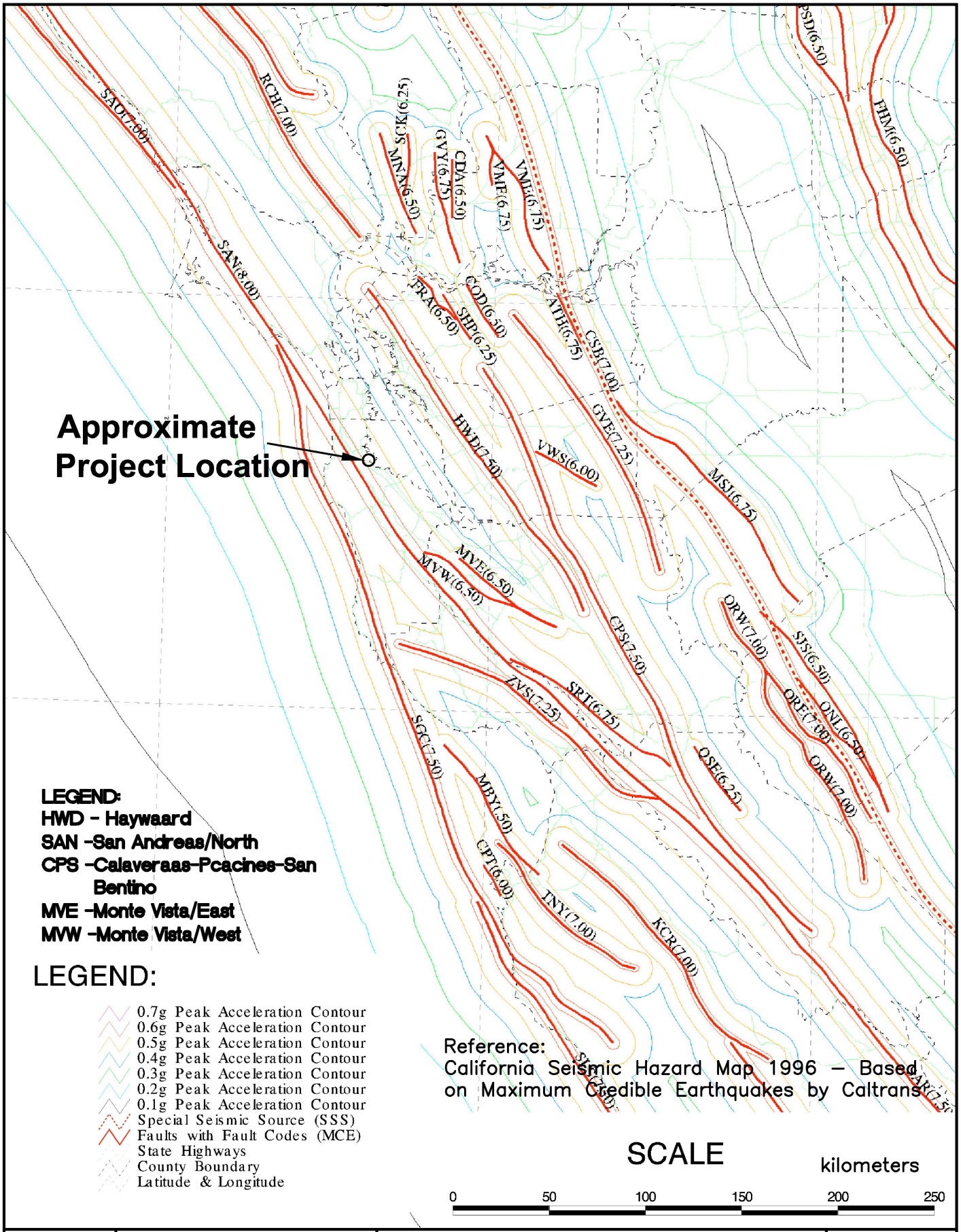
USERNAME => madhu_thummaluru
DGN FILE => Bridge FR_Figure 2a.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

URS	US 101/Broadway Interchange Reconstruction Project	GEOLOGY MAP	Not to Scale Figure 3 April 2009



URS	US 101/Broadway Interchange Reconstruction Project	REGIONAL FAULT MAP SAN MATEO COUNTY	Not to Scale Figure 4 April 2009

Susceptibility Level

- Very High
- High
- Moderate
- Low
- Very Low

Major Roads

Local Roads

N

Scale: 1 inch equals 0.33 miles

This map is intended for planning use only and is not intended to be site-specific. Rather, it depicts the general risk within neighborhoods and the relative risk from community to community. More detailed maps are needed for site development decisions.

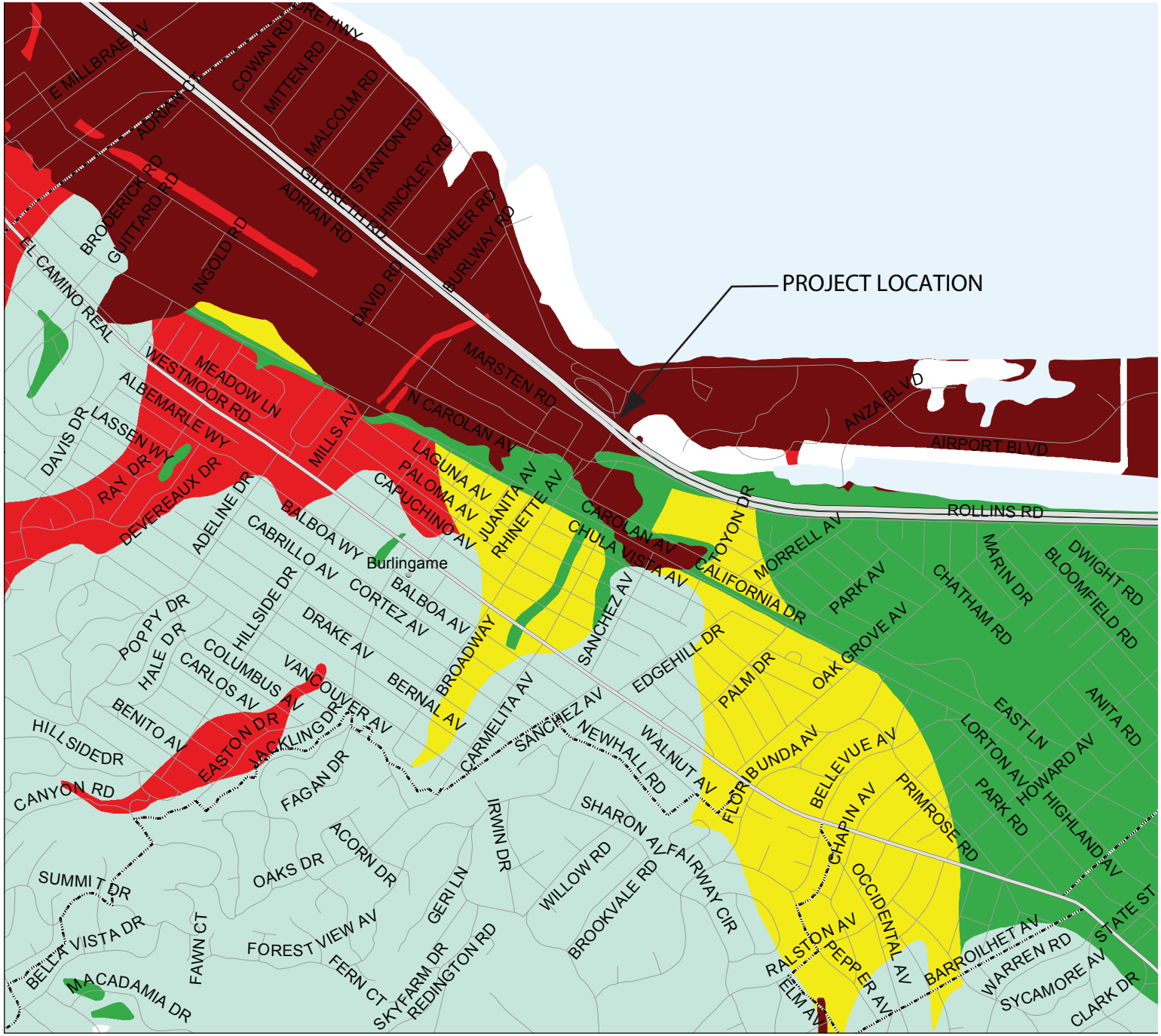
This map is available at http://quake.abag.ca.gov

Source:
This map is based on work by William Lettis & Associates, Inc. and USGS. USGS Open-File Report 00-444, Knudsen & others, 2000

For more information visit: http://geopubs.wr.usgs.gov/open-file/of00-444/

Map Prepared by the ABAG Earthquake Program. April 2004.

ABAG Geographic Information Systems



Project No. 28645286	Broadway Interchange Reconstruction U. S. 101 Burlingame, California	LIQUEFACTION SUSCEPTIBILITY MAP	Figure 5
URS			February 2012

W:\101BdwyPSE_28645286\450_Geotech\Report\FR\RetainingWalls\PDF\Figure\lig_fig.pdf

Flood Hazard Areas

- Zone V- (100 yr. Flood Zone)
- Zone A- (100 yr. Flood Zone)
- Zone X500- (500 yr. Flood Zone or other concerns)
- Urbanized Area

Shaded to show topographical relief

Detailed FEMA Explanation

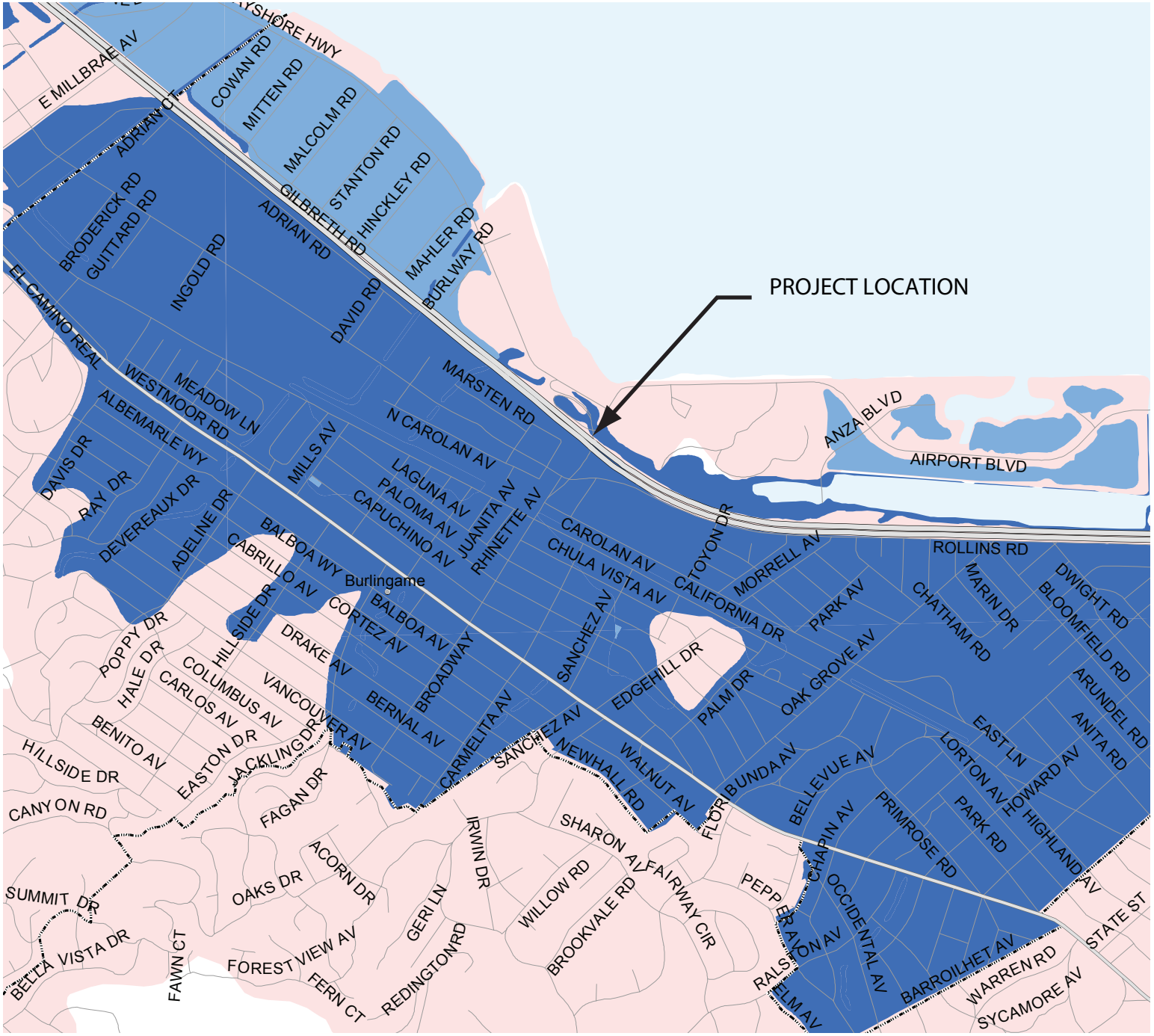
Flood Zone	Description
Zone V	This code identifies an area inundated by 1% annual chance flooding with velocity hazard (wave action).
Zone A	This code identifies an area inundated by 1% annual chance flooding.
Zone X500	This code identifies an area inundated by 0.2% annual chance flooding; an area inundated by 1% annual chance flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from 1% annual chance flooding.

N

Scale: 1 inch equals 0.32 miles

Source: FEMA Q3 Flood Data and ABAG.
The Q3 Flood Data do not replace the existing hardcopy FIRM, or, if one exists, Digital FIRM product.
The product has been designed to support planning activities.
A more detailed version of this map is available at http://quake.abag.ca.gov

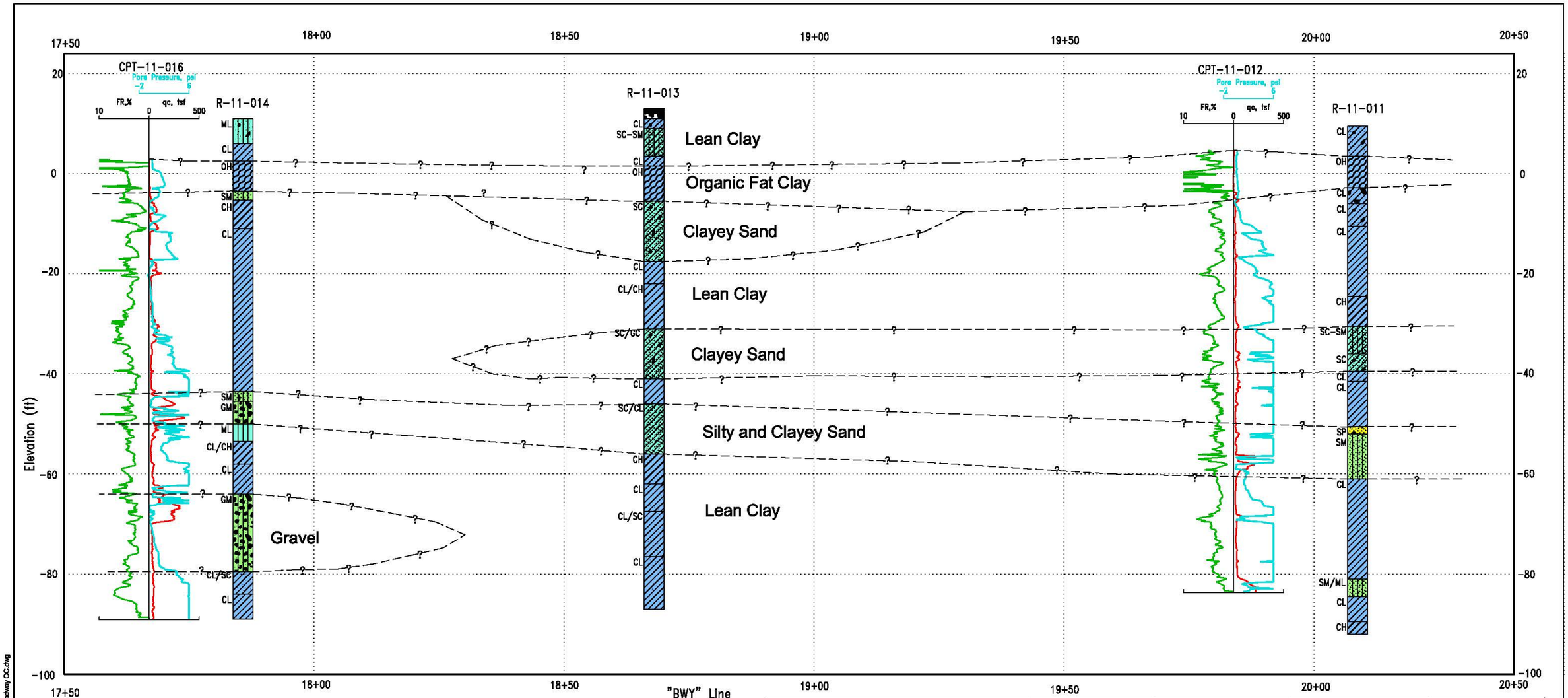
ABAG Geographic Information Systems



Project No. 28645286	Broadway Interchange Reconstruction U. S. 101 Burlingame, California	FEMA FLOOD HAZARD AREAS MAP	Figure 6 February 2012

URS

W:\101BdwyPSE_28645286\450_Geotech\Report\FR\RetainingWalls\PDF\Figure\Flood_fig.pdf



NOTES:

1. The generalized soil profile was developed based on extrapolation of the borings drilled for this investigation and, therefore, may differ from actual conditions. The dashed lines connecting the various layers at each exploration location are done for schematic illustration purposes only. They are not in any way to be construed as the actual conditions in the field.
2. Engineering soil parameters presented on the profile were selected from laboratory test restsuls as well as engineering judgement and local experience.
3. For detailed descriptions of materials encountered, refer to Log of Test Borings 1 and 2 (Appendix B).

Soil Layer	Dry Unit Weight (pcf)	Moisture Content (%)	Undrained Shear Strength (psf))	Internal Friction Angle (Degrees)
Lean Clay	120	13	2,000	NA
Organic Fat Clay	47–62	64–94	320–985	NA
Clayey Sand	122	15	NA	32–36
Lean Clay	75–109	21–46	1730–7280	NA
Clayey Sand	115–117	16	NA	36–38
Silty and Clayey Sand	104–133	9–24	NA	36–40
Lean Clay	80–125	14–41	3,560–9,750	NA

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LITHOLOGY GRAPHICS

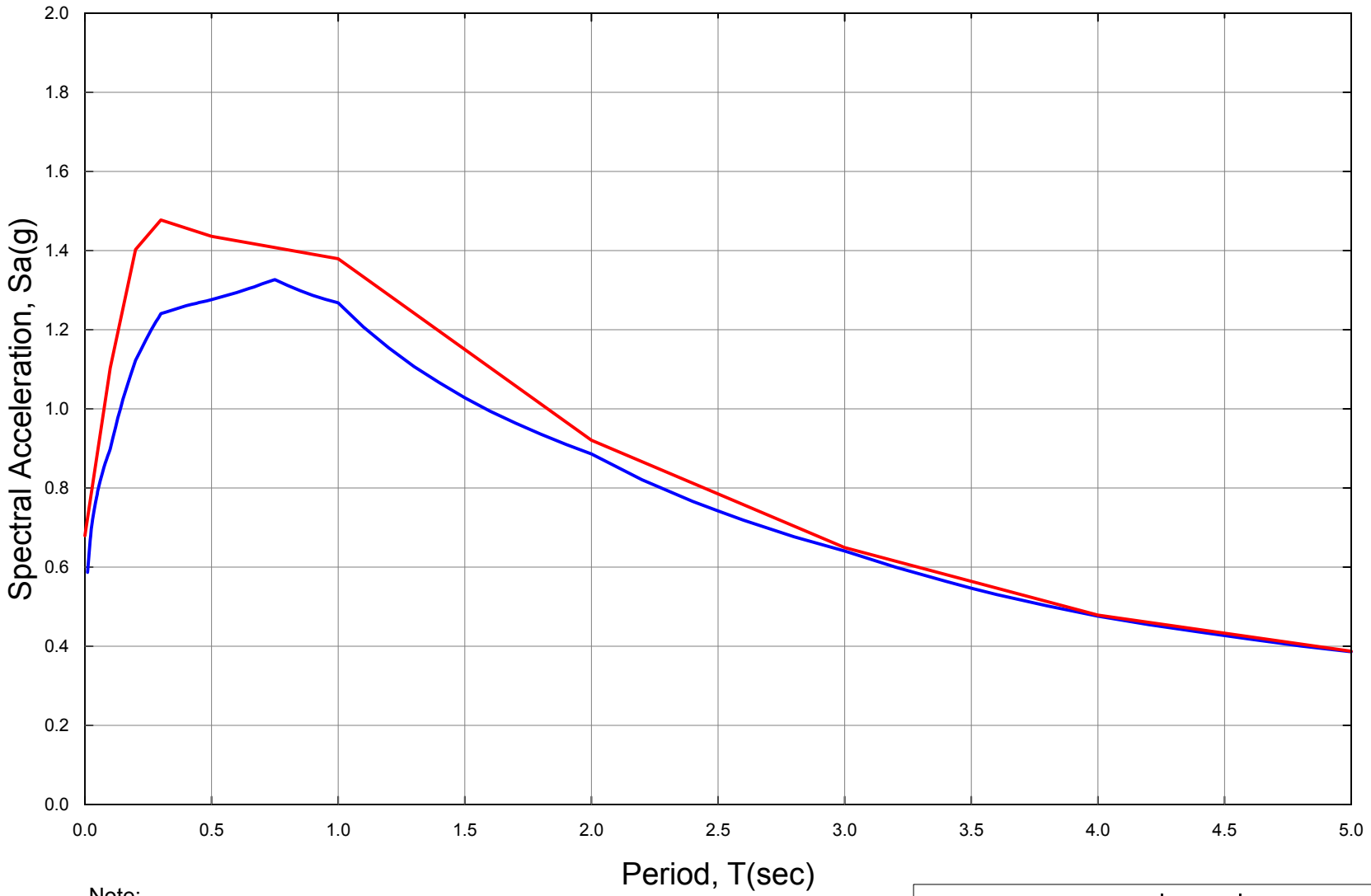
- USCS Silty Gravel (poorly graded)
- USCS Poorly Graded Gravel
- USCS Lean Clay
- USCS Clayey Gravel
- USCS Clayey Sand
- USCS Sandy Lean Clay with gravel
- USCS Clayey Sand with gravel
- USCS Sandy Lean Clay
- USCS Silty Sand
- USCS Poorly Graded Sand
- USCS Poorly Graded Sand with silt
- USCS Silty, Clayey Sand
- USCS Organic Fat Clay
- USCS Fat Clay with sand
- USCS Fat Clay

GENERALIZED SOIL PROFILE
Broadway Overcrossing (Replace)

BURLINGAME, CALIFORNIA

FIGURE 7

W:\101BowyPSE_28645280\450_Geotech\Analysis\Site Characterization\generalized soil profile_Broadway OC.dwg

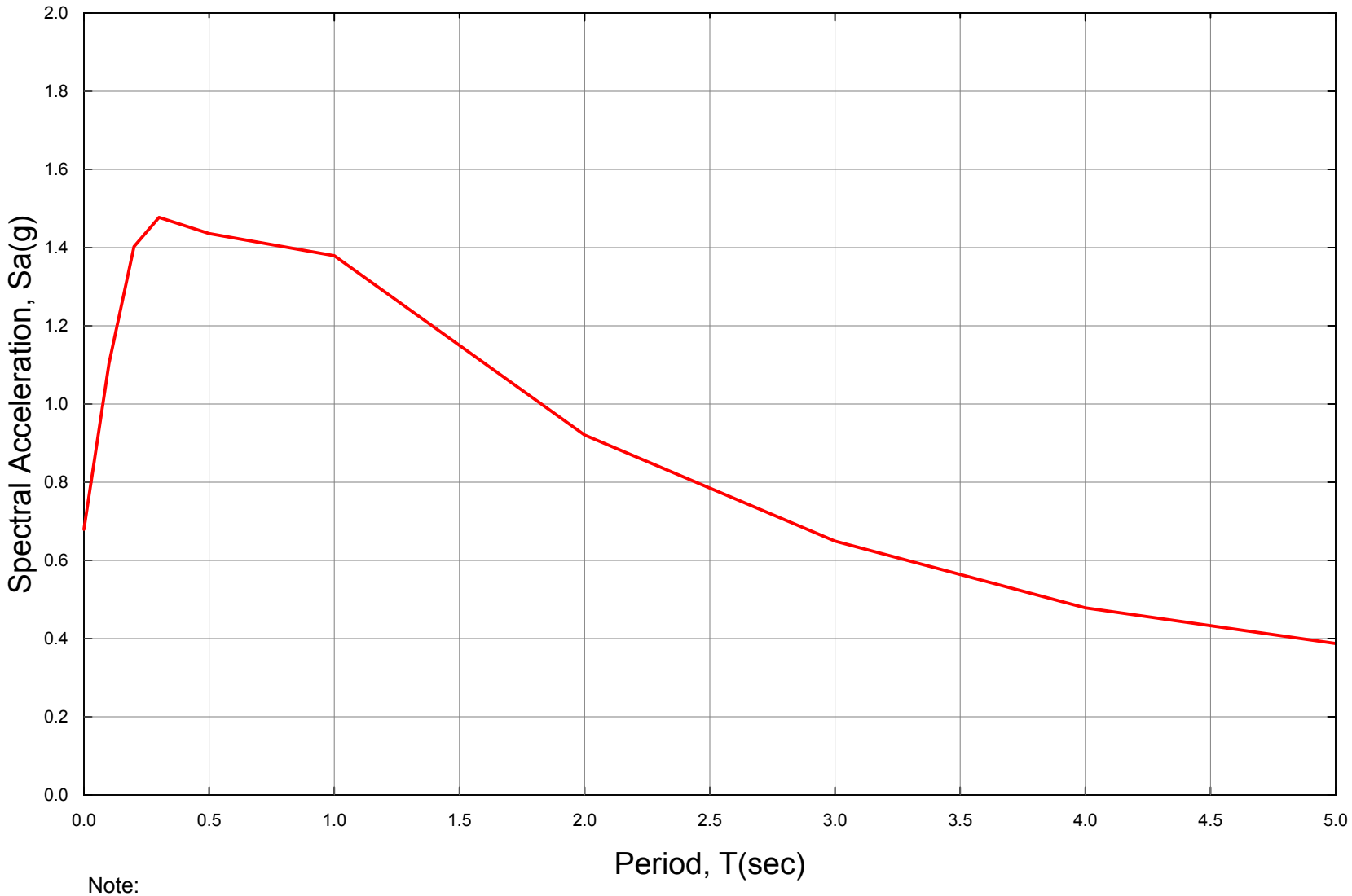


Note:
1. Site Location: LAT = 37.590061 LONG = -122.361241
2. V_{s30} = 820 feet per second

Legend
Caltrans ARS Online
USGS Deaggregation/Design Curve

Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	Acceleration Response Spectra Comparisons	Figure 8A
URS			

W:\101BdwyPSE_28645286\450_Geotech\Analysis\ARS Online\Broadway OC (Replace)_ARS Curve.grf



Note:
1. Site Location: LAT = 37.590061 LONG = -122.361241
2. V_{s30} = 820 feet per second

Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**Recommended Acceleration Response Spectra**	Figure 8B
URS			

W:\101BdwyPSE_28645286\450_Geotech\Analysis\ARS Online\Broadway OC (Replace)_ARS Design.grf

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NOTES:

1. FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.
2. SEE C-47 FOR CEMENT DEEP SOIL MIXING DETAILS AND SECTION VIEWS.
3. SEE C-48 TO C-50 FOR LIGHTWEIGHT EMBANKMENT MATERIAL (CELLULAR CONCRETE) DETAILS AND PROFILES.

LEGEND:

- SOIL-CEMENT - 33% PATTERN & 25' COLUMN LENGTH
- SOIL-CEMENT - 21% PATTERN & 15' COLUMN LENGTH
- SOIL-CEMENT - 21% PATTERN & 25' COLUMN LENGTH
- SOIL-CEMENT - 33% PATTERN & 50' COLUMN LENGTH
- LIGHTWEIGHT EMBANKMENT MATERIAL (CELLULAR CONCRETE)

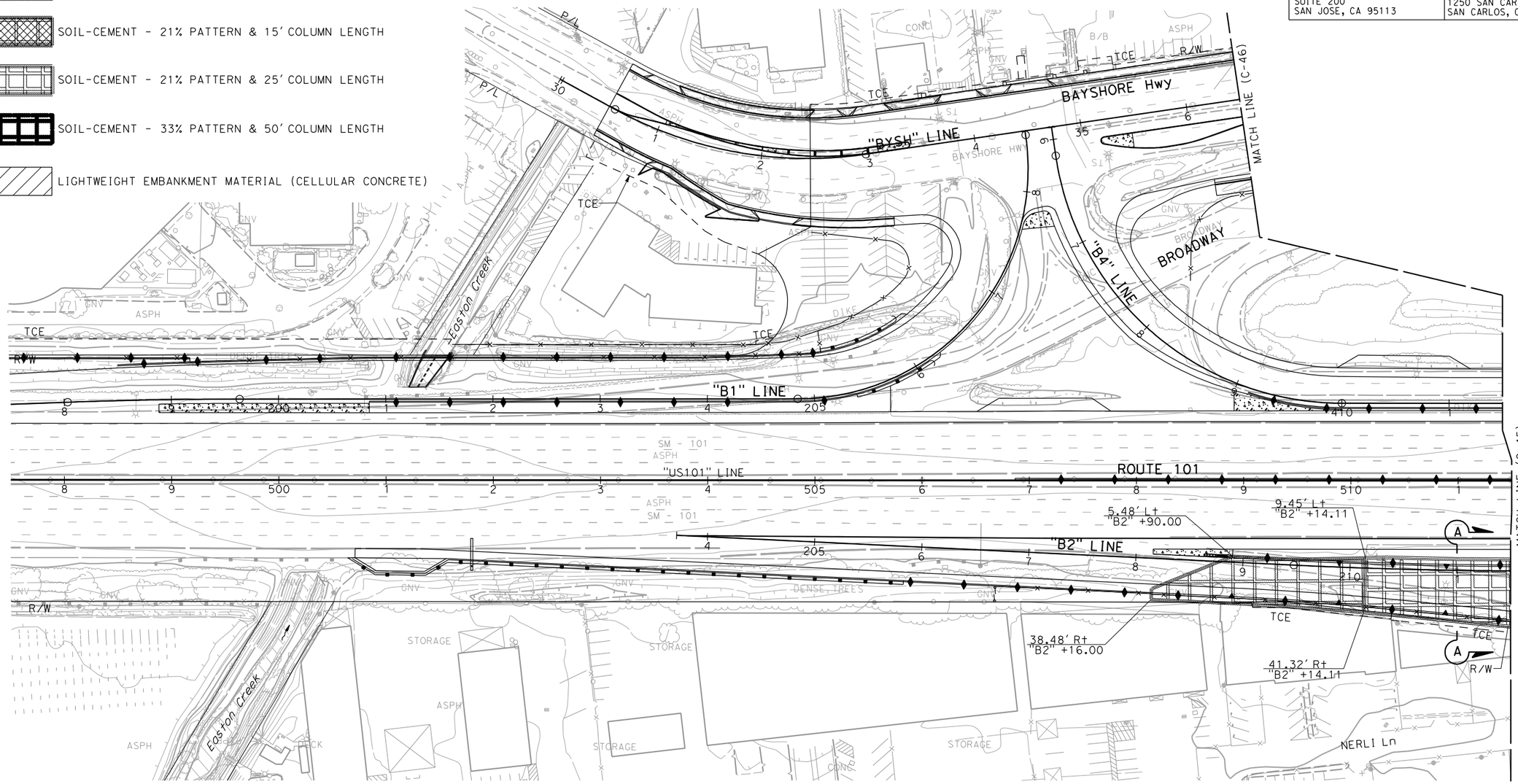

FIGURE 9A - CDSM GROUND IMPROVEMENT PLAN

CONSTRUCTION DETAILS
(SOIL TREATMENT)

SCALE 1" = 50'

C-44

		AB	01/15/13
		REVISED BY	DATE REVISED
ABHIJEET BHOI	ELIE ABI-JAOUDE		
CALCULATED-DESIGNED BY	CHECKED BY		
CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN		

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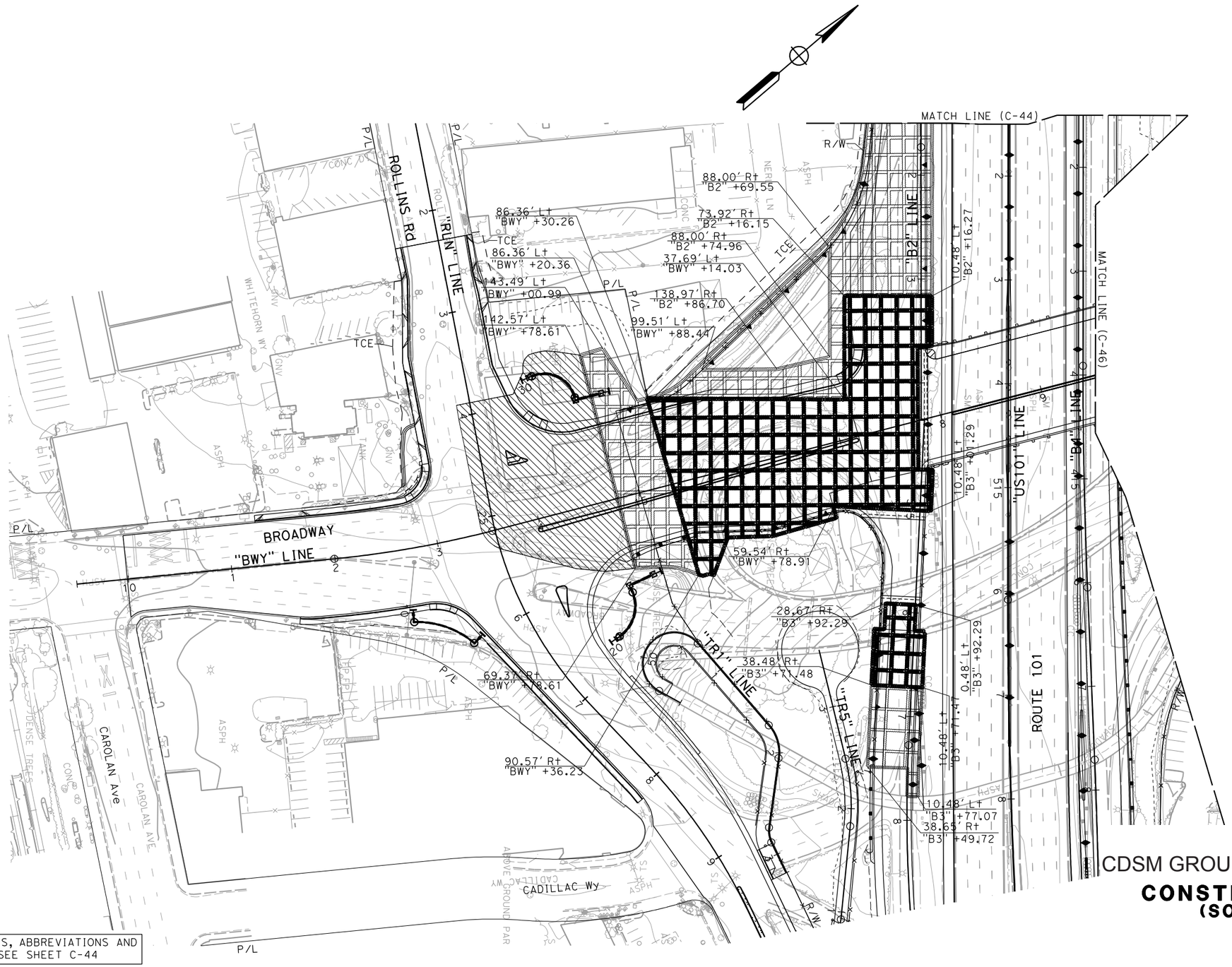

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET C-44

FIGURE 9B -
CDSM GROUND IMPROVEMENT PLAN

CONSTRUCTION DETAILS
(SOIL TREATMENT)
SCALE 1" = 50'

C-45

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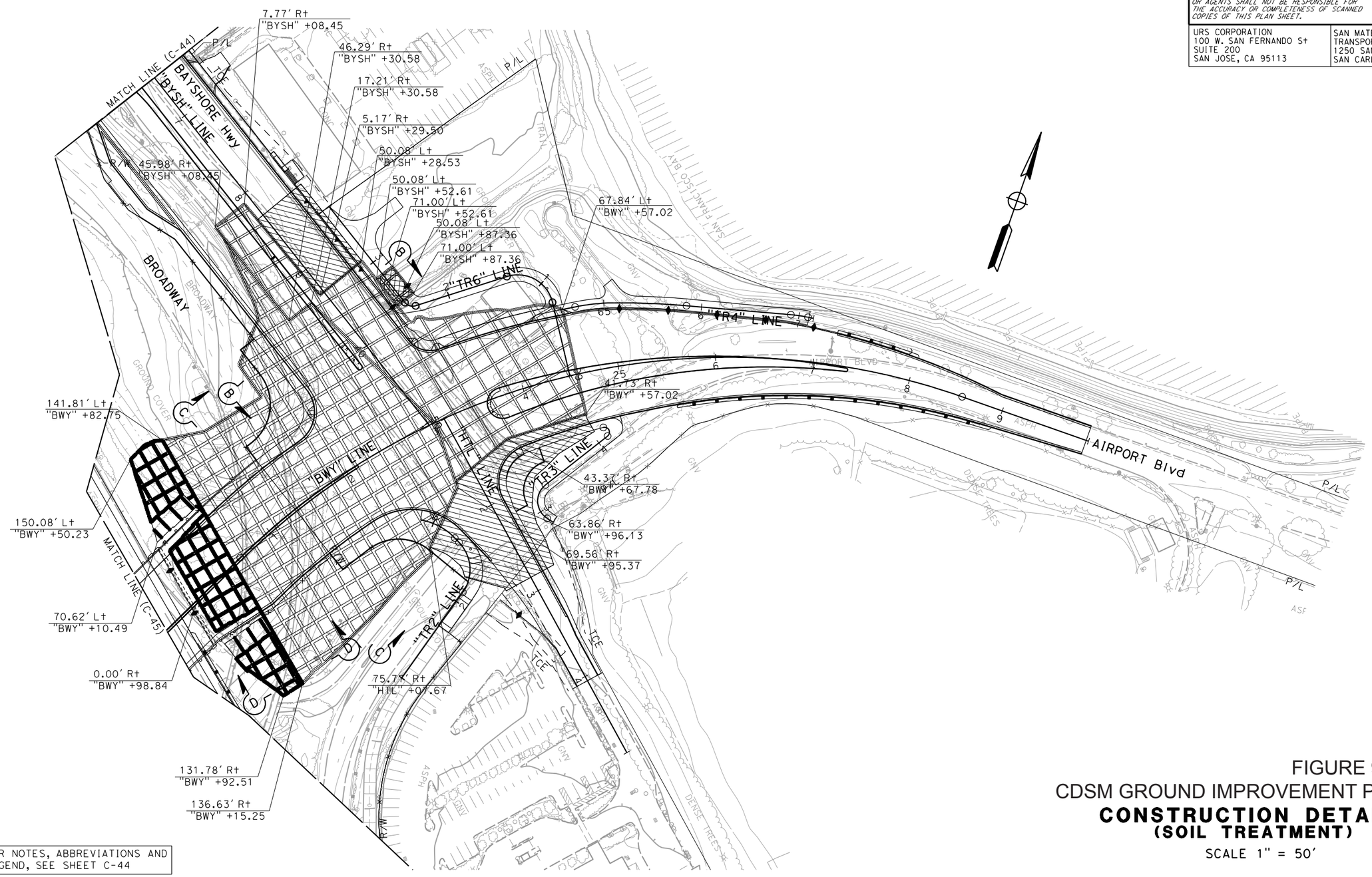

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET C-44

FIGURE 9C - CDSM GROUND IMPROVEMENT PLAN

CONSTRUCTION DETAILS (SOIL TREATMENT)

SCALE 1" = 50'

C-46

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION — Caltrans

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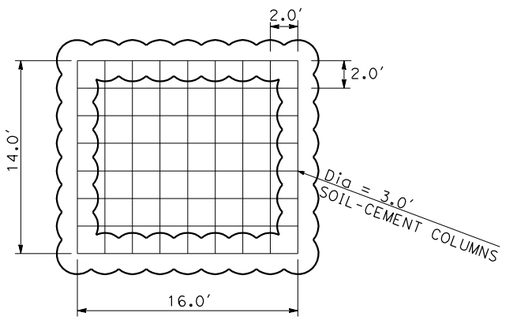
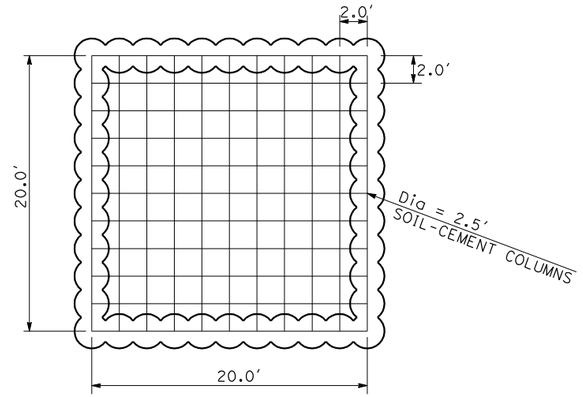


SOIL-CEMENT TREATMENT 33% PATTERN LAYOUT

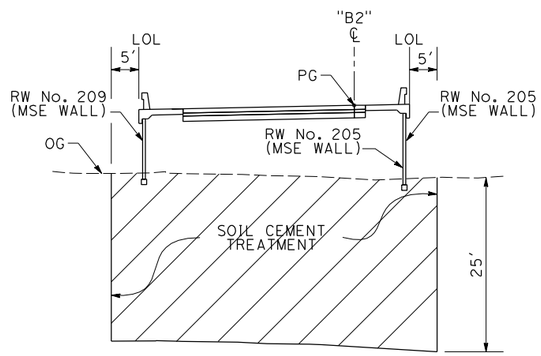


SOIL-CEMENT TREATMENT 21% PATTERN LAYOUT

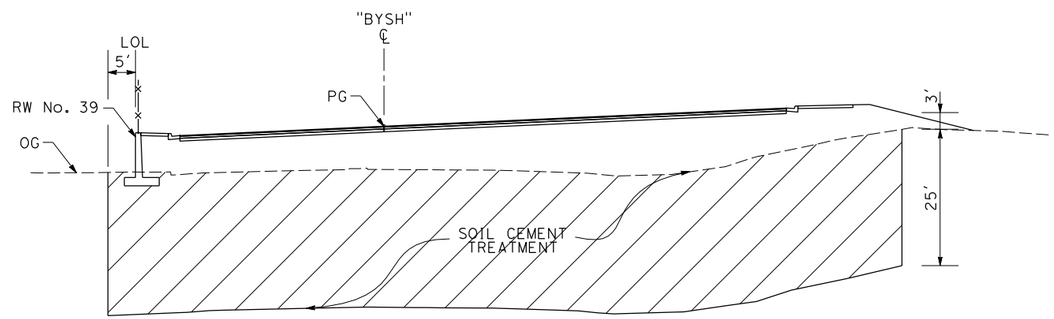
TABLE A

STATION LIMITS	PATTERN	SOIL CEMENT-COLUMN LENGTH
"B2" 208+16.00 TO "B2" 210+14.11	0.21	25
"B2" 210+14.11 TO "B2" 213+16.25	0.33	25
"B2" 213+16.25 TO "BWY" 15+33.17	0.33	50
"BWY" 14+78.61 TO "BWY" 15+33.17	0.33	25
"B3" 315+92.29 TO "B3" 316+71.47	0.33	50
"B3" 316+71.47 TO "B3" 317+77.07	0.21	25
"BWY" 19+98.84 TO "BWY" 20+50.65	0.33	50
"BWY" 20+50.65 TO "BWY" 23+03.53	0.33	25
"BWY" 23+03.53 TO "BWY" 24+57.02	0.21	25
"BYSH" 39+52.61 TO "BYSH" 39+87.36	0.21	15

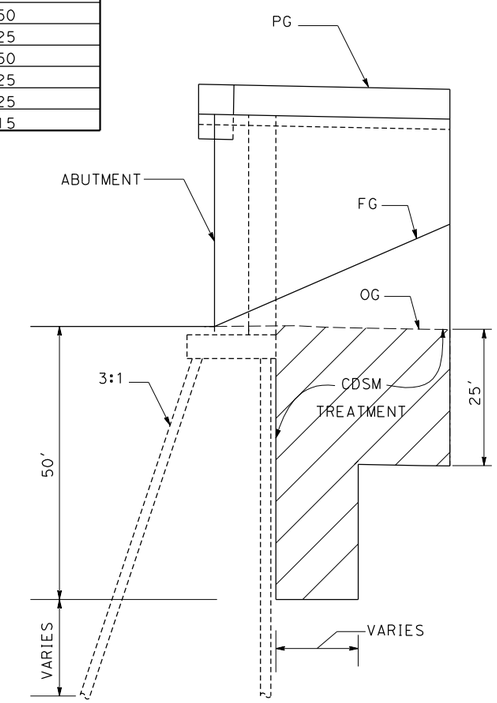
* COLUMN LENGTH INCREASES TO 50.0' NEAR BRIDGE ABUTMENTS AND PG&E TOWER LOCATIONS, SEE TABLE A.



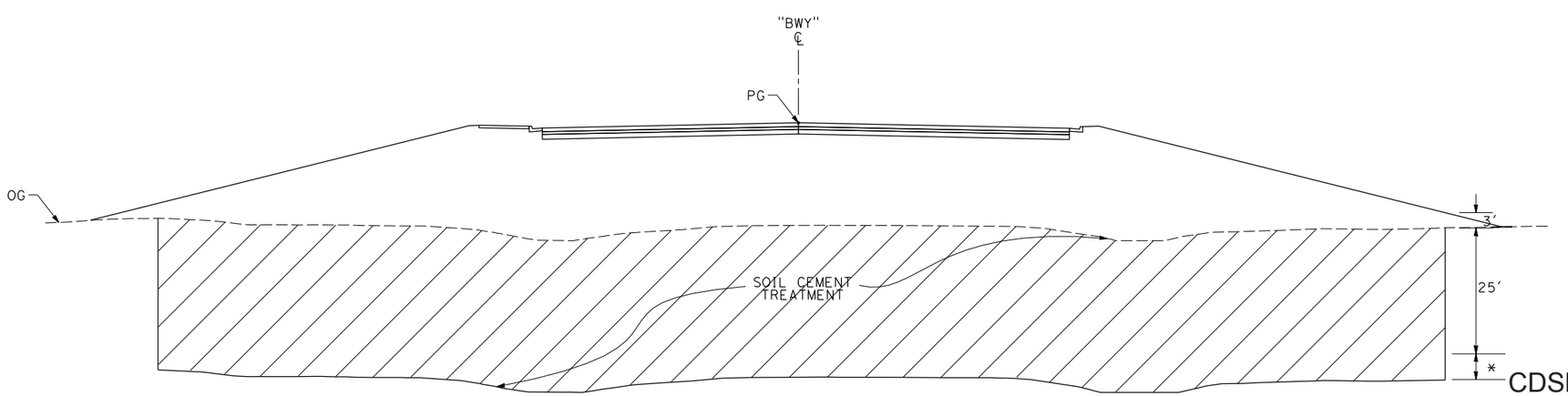
TYPICAL SECTION A-A



TYPICAL SECTION B-B



TYPICAL SECTION D-D



TYPICAL SECTION C-C

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET C-44

FIGURE 9D -
CDSM GROUND IMPROVEMENT PLAN

CONSTRUCTION DETAILS
(SOIL TREATMENT)

NO SCALE

C-47

REVISED BY	DATE REVISED
AB	01/15/13

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CHECKED BY: ELIE ABI-JAOUDE
CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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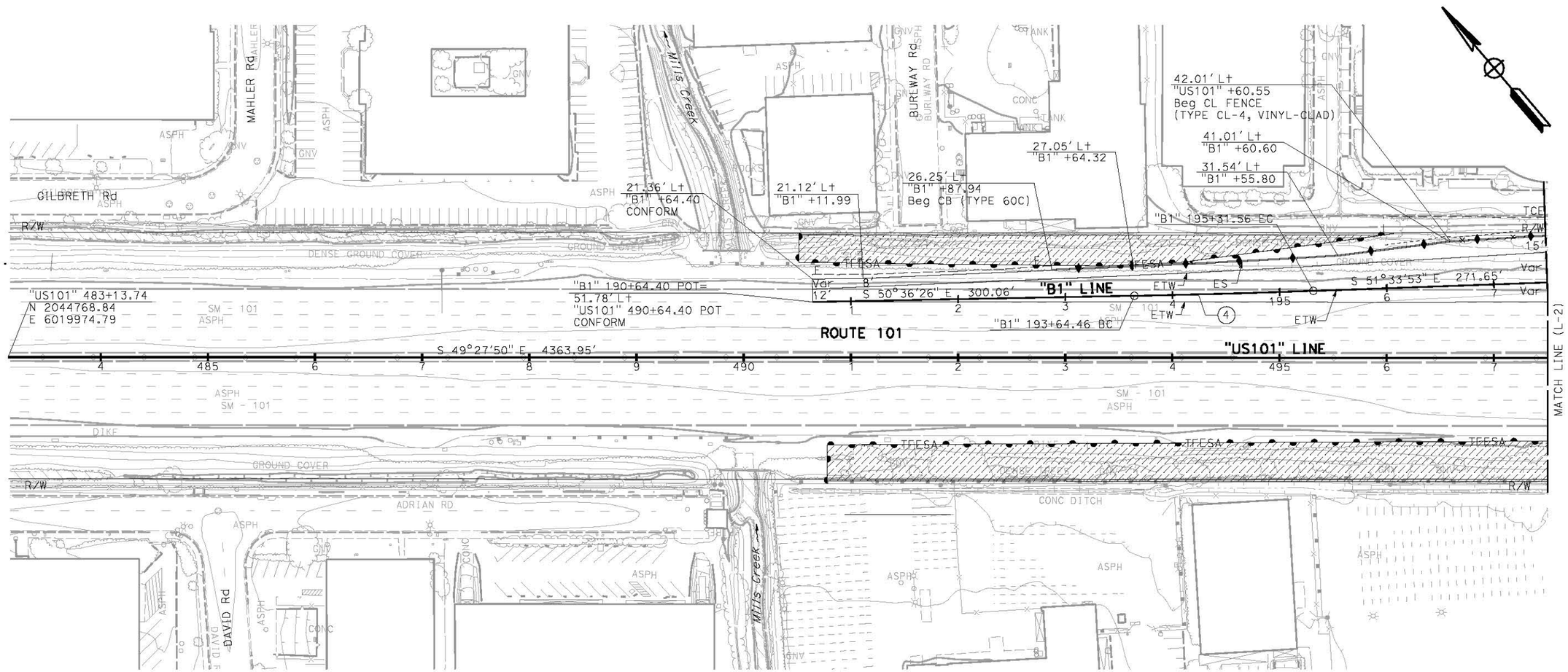
2. COORDINATES, DISTANCES AND BEARINGS SHOWN ARE BASED ON CALIFORNIA COORDINATE SYSTEM ZONE 3. THE HORIZONTAL DATUM IS NAD 1983. THE VERTICAL DATUM IS NAVD 1988.
3. FOR LOCATIONS AND TYPES OF HMA DIKES, MBGR, FENCES, BARRIERS, AND REMOVAL ITEMS, REFER TO LAYOUT AND QUANTITY SHEETS.
4. TEMPORARY FENCE SHALL BE PLACED ALONG TEMPORARY CONSTRUCTION EASEMENTS. SEE QUANTITY SHEETS FOR LOCATIONS.
5. FOR ADDITIONAL GEOMETRICAL DESIGN INFORMATION ON LOCAL ROADS, SEE CONSTRUCTION DETAIL SHEETS.

ABBREVIATIONS:

ASA	ARCHEOLOGICALLY SENSITIVE AREA
ESA	ENVIRONMENTALLY SENSITIVE AREA
TFESA	TEMPORARY FENCE (TYPE ESA)
Veg Ctrl	VEGETATION CONTROL (MINOR CONCRETE)

LEGEND:

- ARCHEOLOGICALLY SENSITIVE AREA
- —TFESA— TEMPORARY REINFORCED SILT FENCE (TYPE 1)
- ENVIRONMENTALLY SENSITIVE AREA
- (No.) CURVE ALIGNMENT DATA
- MINOR CONCRETE (TEXTURED PAVING)



CURVE DATA

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LAYOUT
SCALE 1" = 50'

L-1

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CONSULTANT FUNCTIONAL SUPERVISOR | CALCULATED-DESIGNED BY | CHECKED BY | REVISED BY | DATE REVISED

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BORDER LAST REVISED 7/2/2010 | USERNAME => virgil_jimenez | DGN FILE => 0400000684ea001.dgn | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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CURVE DATA

No.	R	△	T	L	N-COORDINATE	E-COORDINATE
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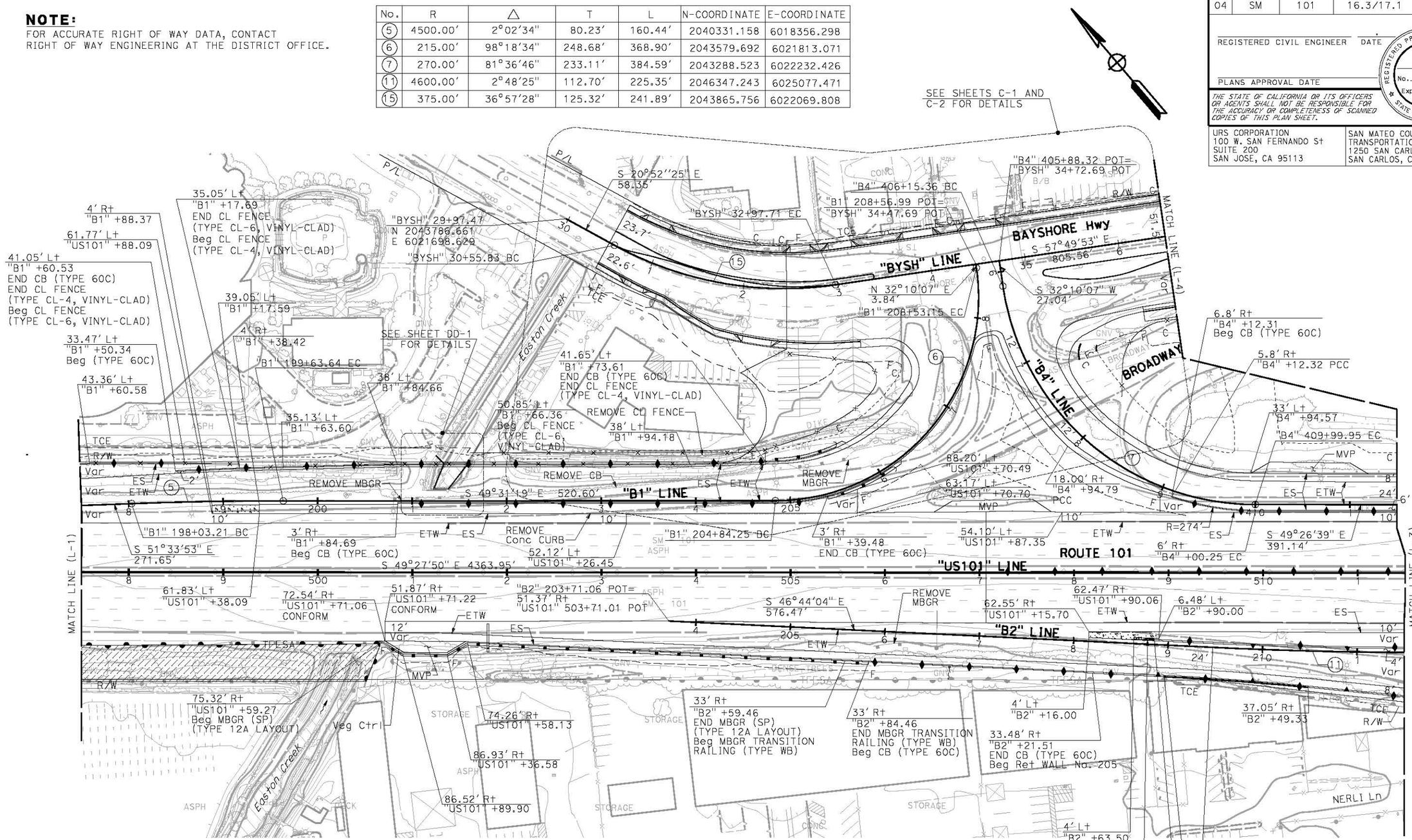
6	215.00′	98°18′34"	248.68′	368.90′	2043579.692	6021813.071
7	270.00′	81°36′46"	233.11′	384.59′	2043288.523	6022232.426
11	4600.00′	2°48′25"	112.70′	225.35′	2046347.243	6025077.471
15	375.00′	36°57′28"	125.32′	241.89′	2043865.756	6022069.808

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET L-1

LAYOUT
SCALE 1" = 50′

L-2

APPROVED FOR LAYOUT WORK ONLY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR | CALCULATED-DESIGNED BY | CHECKED BY | REVISED BY | DATE REVISED

LAST REVISION 12-23-11 | DATE PLOTTED => 6/15/2012 | TIME PLOTTED => 11:57:27 PM

BORDER LAST REVISED 7/2/2010 | USERNAME => virgil_jimenez | DGN FILE => 0400000684ea002.dgn | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. EXP. CIVIL STATE OF CALIFORNIA

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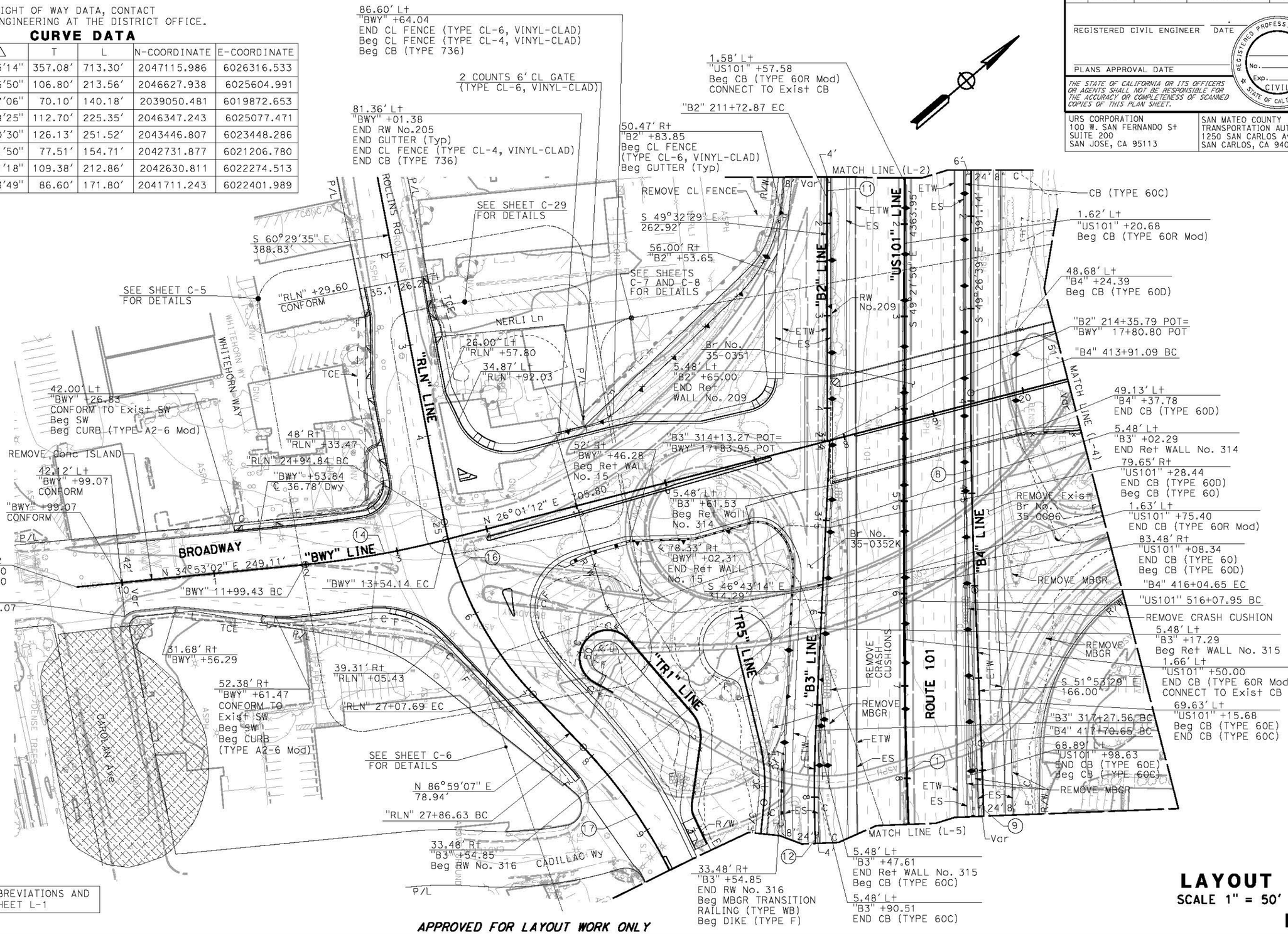
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

CURVE DATA

No.	R	△	T	L	N-COORDINATE	E-COORDINATE
1	5905.50'	6°55'14"	357.08'	713.30'	2047115.986	6026316.533
8	5000.00'	2°26'50"	106.80'	213.56'	2046627.938	6025604.991
9	4500.00'	1°47'06"	70.10'	140.18'	2039050.481	6019872.653
11	4600.00'	2°48'25"	112.70'	225.35'	2046347.243	6025077.471
12	1350.00'	10°40'30"	126.13'	251.52'	2043446.807	6023448.286
14	1000.00'	8°51'50"	77.51'	154.71'	2042731.877	6021206.780
16	375.00'	32°31'18"	109.38'	212.86'	2042630.811	6022274.513
17	550.00'	17°53'49"	86.60'	171.80'	2041711.243	6022401.989



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET L-1

APPROVED FOR LAYOUT WORK ONLY

LAYOUT
SCALE 1" = 50'

L-3

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
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DATE PLOTTED => 6/15/2012
TIME PLOTTED => 1:58:47 PM

BORDER LAST REVISED 7/2/2010

USERNAME => virgil_jimenez
DGN FILE => 0400000684ea003.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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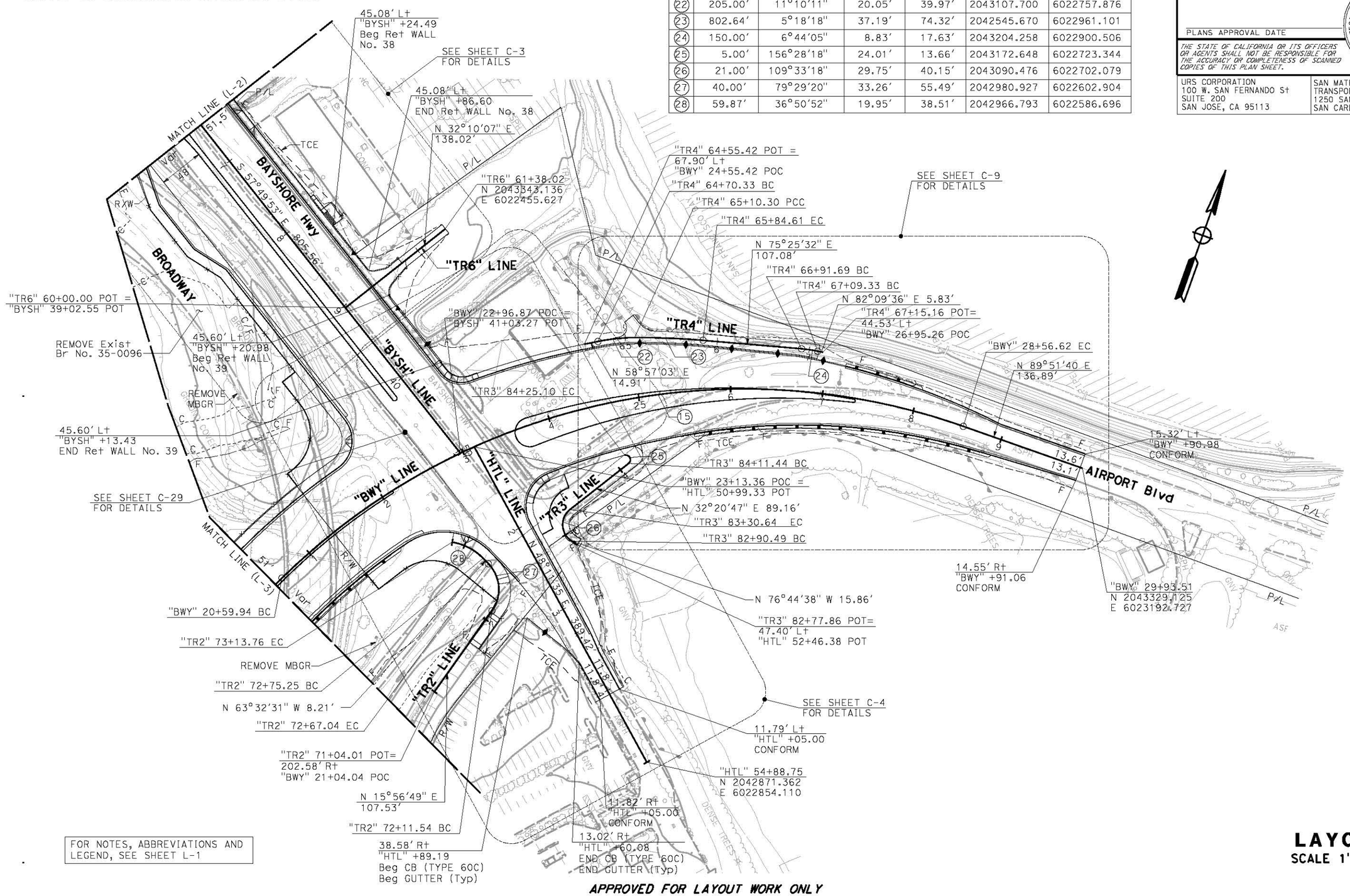
SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

CURVE DATA

No.	R	Δ	T	L	N-COORDINATE	E-COORDINATE
15	715.00′	63°50′′28"	445.41′	796.68′	2042613.796	6023057.573
22	205.00′	11°10′11"	20.05′	39.97′	2043107.700	6022757.876
23	802.64′	5°18′18"	37.19′	74.32′	2042545.670	6022961.101
24	150.00′	6°44′05"	8.83′	17.63′	2043204.258	6022900.506
25	5.00′	156°28′18"	24.01′	13.66′	2043172.648	6022723.344
26	21.00′	109°33′18"	29.75′	40.15′	2043090.476	6022702.079
27	40.00′	79°29′20"	33.26′	55.49′	2042980.927	6022602.904
28	59.87′	36°50′52"	19.95′	38.51′	2042966.793	6022586.696



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET L-1

APPROVED FOR LAYOUT WORK ONLY

LAYOUT
SCALE 1" = 50′

L-4

REVISED BY	DATE REVISED
.	.

CALCULATED-DESIGNED BY . CHECKED BY .

CONSULTANT FUNCTIONAL SUPERVISOR

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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LAST REVISION 12-23-11

DATE PLOTTED => 6/15/2012
TIME PLOTTED => 2:00:48 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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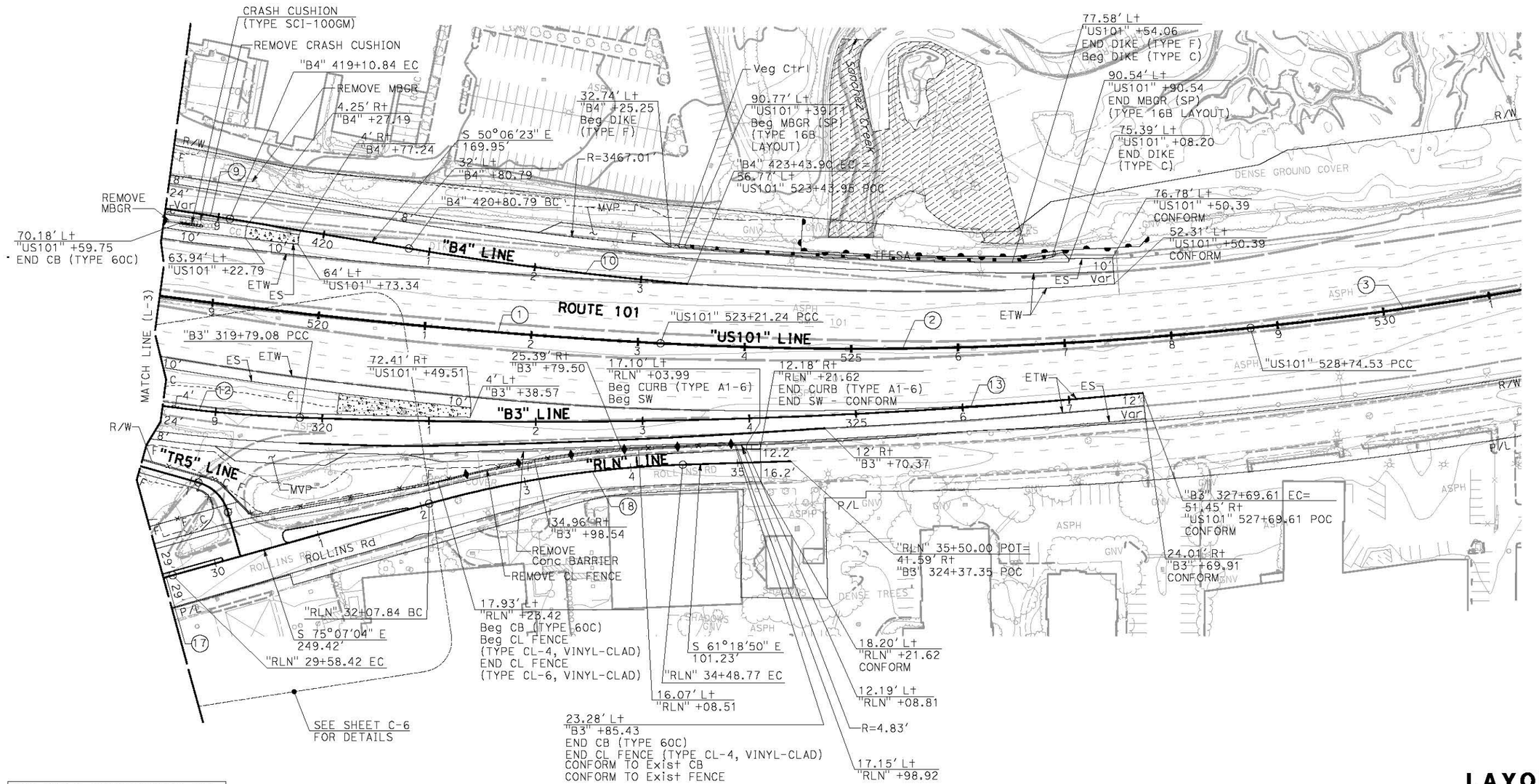
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

CURVE DATA

No.	R	△	T	L	N-COORDINATE	E-COORDINATE
1	5905.50′	6°55′14″	357.08′	713.30′	2047115.986	6026316.533
2	3444.88′	9°12′09″	277.24′	553.29′	2045066.854	6024954.280
3	3872.29′	21°26′24″	733.07′	1449.00′	2045456.052	6025130.938
9	4500.00′	1°47′06″	70.10′	140.18′	2039050.481	6019872.653
10	3499.98′	4°18′25″	131.61′	263.10′	2045079.373	6025133.928
12	1350.00′	10°40′30″	126.13′	251.52′	2043446.807	6023448.286
13	6000.00′	7°32′56″	395.84′	798.53′	2047364.018	6025953.871
17	550.00′	17°53′49″	86.60′	171.80′	2041711.243	6022401.989
18	1000.00′	13°48′14″	121.05′	240.93′	2041212.279	6022527.467



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET L-1

LAYOUT
SCALE 1" = 50′

L-5

APPROVED FOR LAYOUT WORK ONLY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
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LAST REVISION 12-23-11 | DATE PLOTTED => 6/15/2012 | TIME PLOTTED => 2:02:10 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER NO. EXP. CIVIL STATE OF CALIFORNIA

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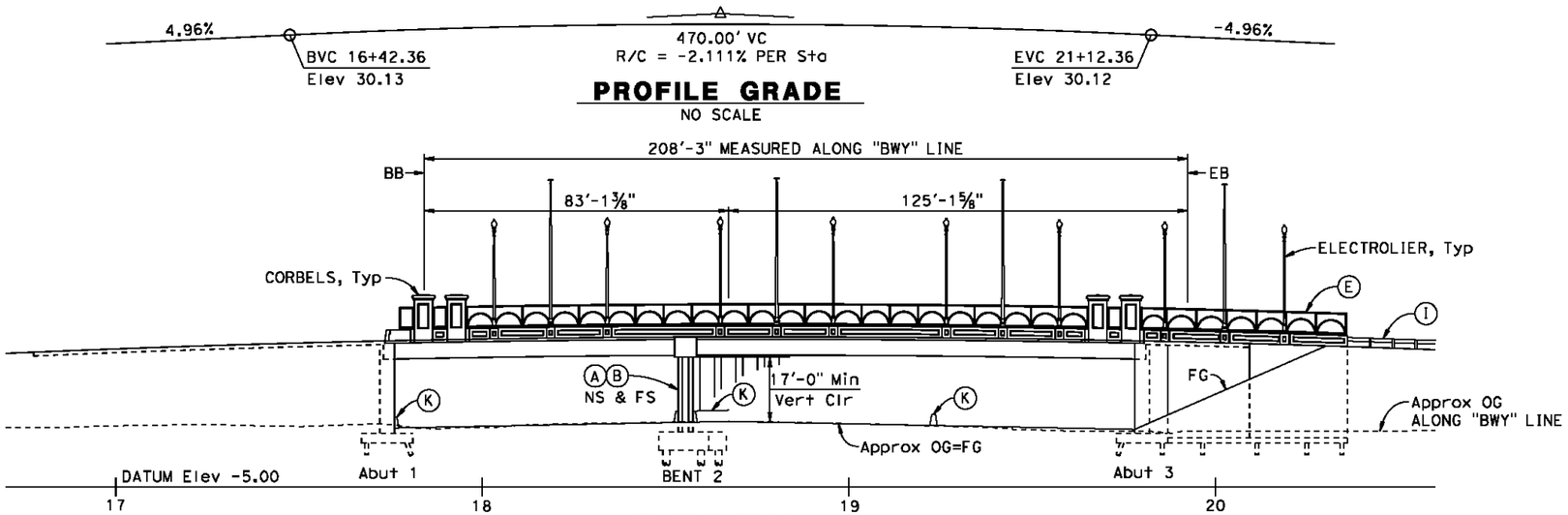
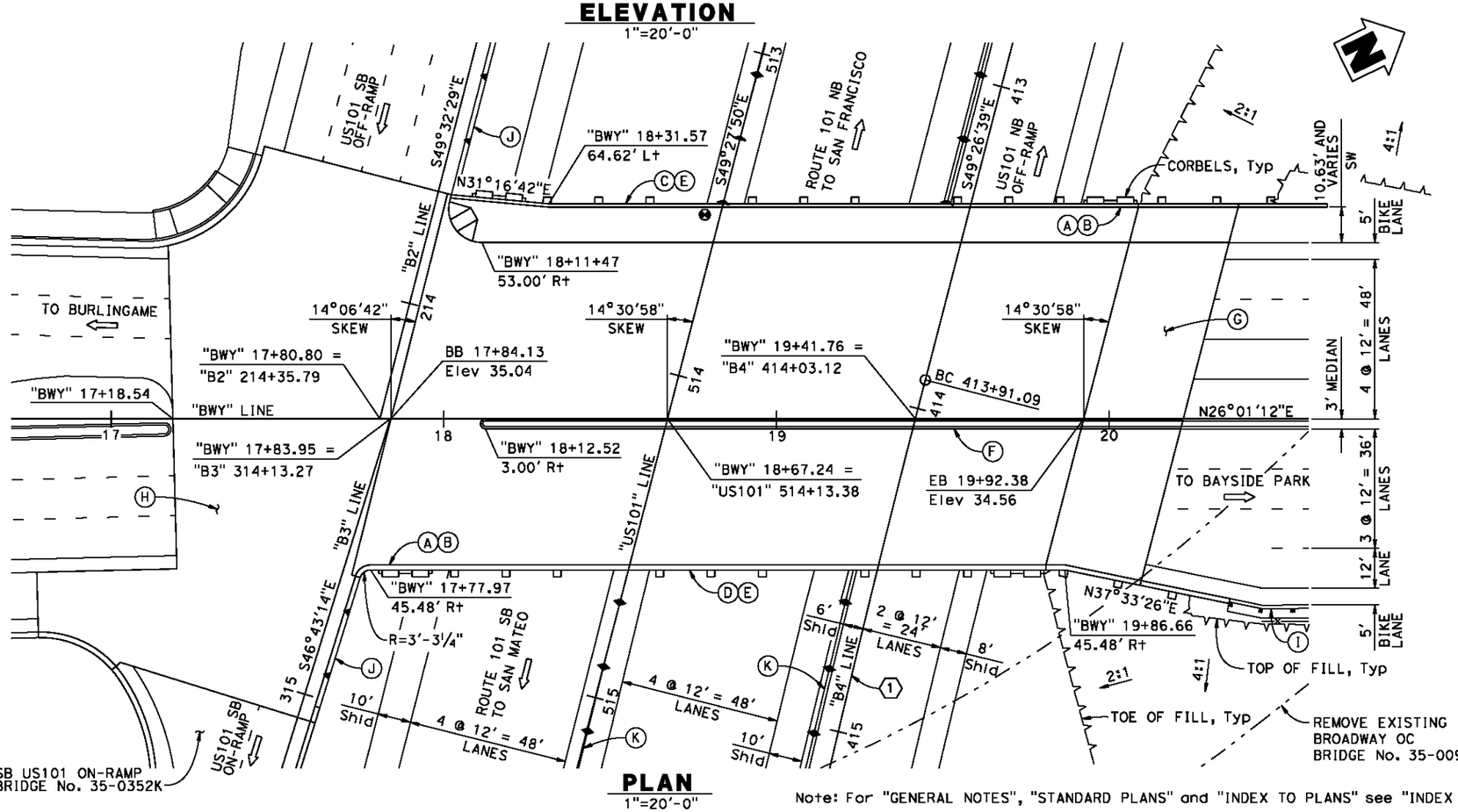
SAN CARLOS, CA 94070-1306

URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997





Note: For "GENERAL NOTES", "STANDARD PLANS" and "INDEX TO PLANS" see "INDEX TO PLANS" sheet.

NOTES:

- (A) Paint "Bridge No. 35-0351" and Year Constructed
- (B) Paint "Bridge Name"
- (C) Concrete Barrier (Type 26 Modified)
- (D) Concrete Barrier (Type 736 Modified)
- (E) Ornamental Railing
- (F) Raised Median
- (G) Structure Approach Type N(30S)
- (H) Structure Approach Type N(30S) Modified
- (I) MBGR, see "ROAD PLANS"
- (J) MSE Wall, see "RETAINING WALL" sheets
- (K) Concrete Barrier, see "ROAD PLANS"

LEGEND:

- - - — Indicates existing structure
- ⇨ Indicates direction of traffic
- ❽ Point of minimum vertical clearance

CURVE DATA

CURVE	R	Δ	T	L
(1)	5000.00'	2°26'50"	106.80'	213.56'

DESIGN OVERSIGHT	DESIGN	BY A. Prince	CHECKED J. Hueser	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 W/"LOW-BOY"; PERMIT DESIGN VEHICLE
	DETAILS	BY R. Lim	CHECKED J. Hueser	LAYOUT	BY A. Prince / CHECKED J. Hueser
SIGN OFF DATE	QUANTITIES	BY A. Prince	CHECKED S. Landis	SPECIFICATIONS	BY D. Harnagel / PLANS AND SPECS COMPARED

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Tony Dubovik
PROJECT ENGINEER

BRIDGE NO. 35-0351
POST MILES

BROADWAY OC (REPLACE)
GENERAL PLAN No. 1

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 12-16-11 2-24-12 3-8-12 11-15-12

SHEET 1 OF 38

FILE => 35-0351-a-gp01.dgn

USERNAME => raymond_l DATE PLOTTED => 11/14/2012 TIME PLOTTED => 9:57:13 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER NO. EXP. CIVIL STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

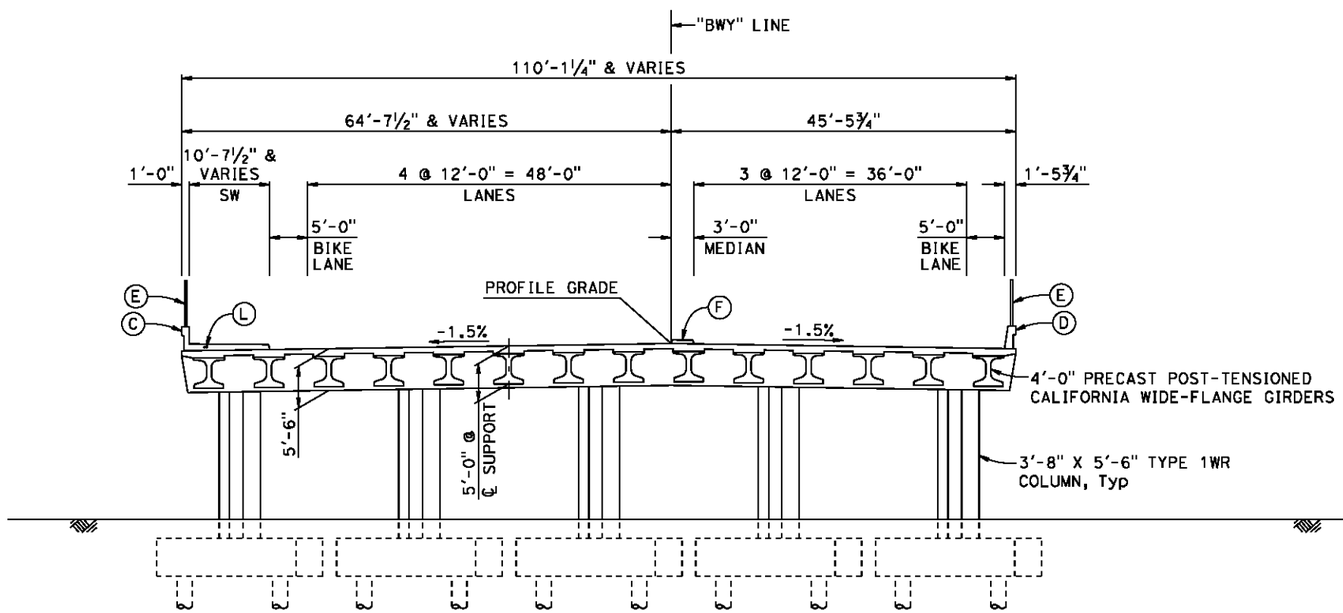
URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997

NOTES:

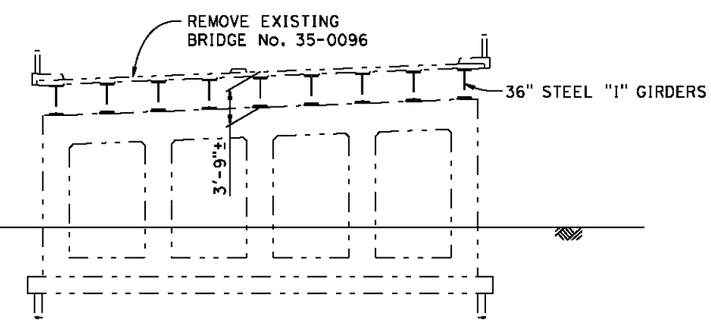
(C) Concrete Barrier (Type 26 Modified)
(D) Concrete Barrier (Type 736 Modified)
(E) Chain Link Railing Type 7
(F) Raised Median
(L) 2" Galv steel pipe (supply line) and sprinkler control conduit

LEGEND:

- - — Indicates existing structure



TYPICAL SECTION
1" = 10'-0"



DESIGN OVERSIGHT	DESIGN	BY A. Prince	CHECKED	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 W/"LOW-BOY"; PERMIT DESIGN VEHICLE
	DETAILS	BY R. Lim	CHECKED	LAYOUT	BY / CHECKED
SIGN OFF DATE	QUANTITIES	BY	CHECKED	SPECIFICATIONS	BY / PLANS AND SPECS COMPARED

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Tony Dubovik
PROJECT ENGINEER

BRIDGE NO. 35-0351
POST MILES

BROADWAY OC (REPLACE)
GENERAL PLAN No. 2

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 11-11-11 12-16-11 2-24-12

SHEET 2 OF

FILE => 35-0351-a-gp02.dgn

USERNAME => raymond_l DATE PLOTTED => 6/15/2012 TIME PLOTTED => 9:26:18 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER NO. EXP. CIVIL STATE OF CALIFORNIA

SMCTA
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997

PILE DATA TABLE

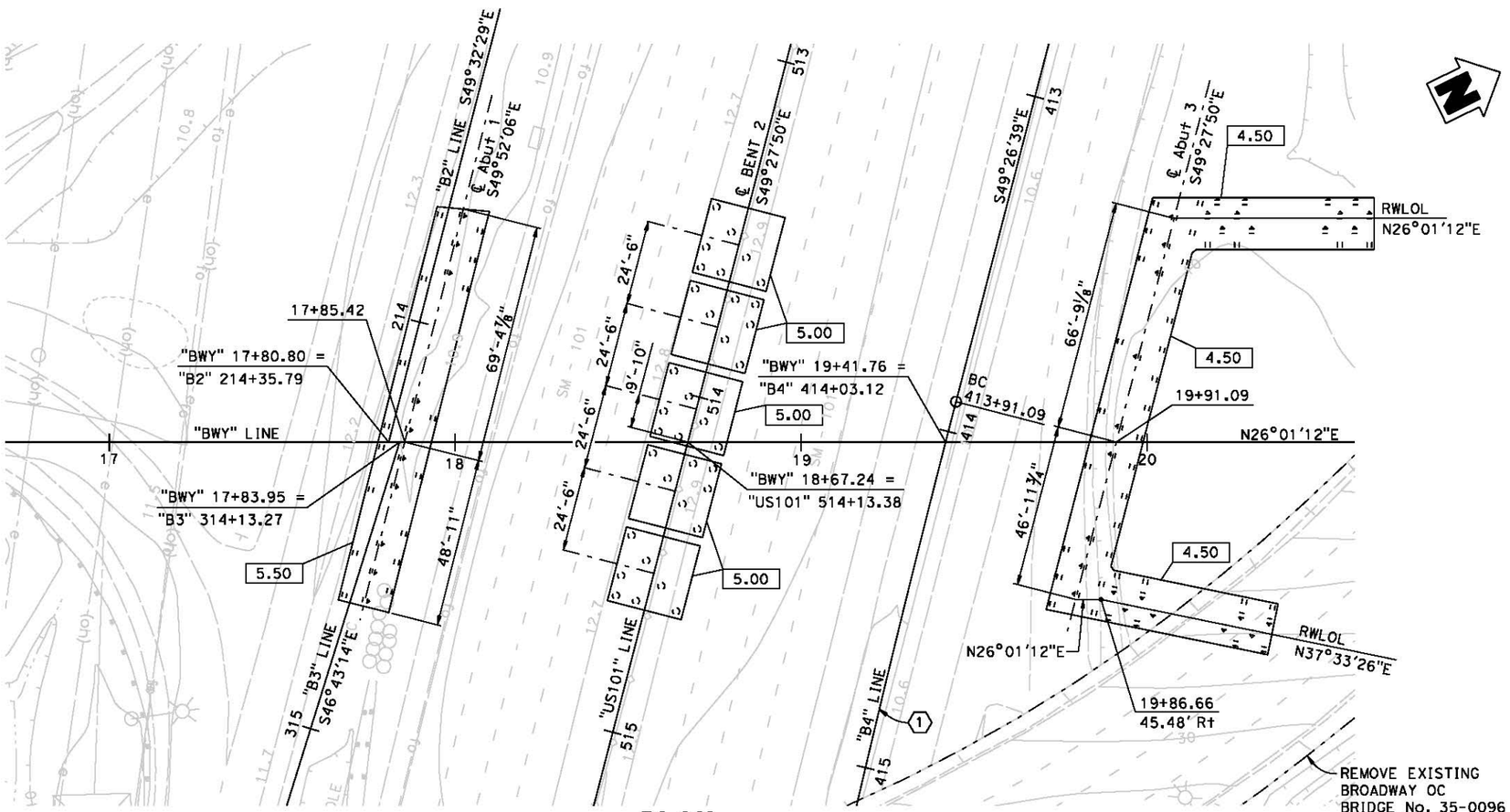
LOCATION	PILE TYPE	NOMINAL RESISTANCE (kips)		DESIGN TIP ELEVATION (ft)	SPECIFIED TIP ELEVATION (ft)	NOMINAL DRIVING RESISTANCE (kips)*
		COMPRESSION	TENSION			
Abut 1	CLASS 140 Alt "X", T=16"	280	0	-45(A), -20(C), -16(D)	-45	280
BENT 2	24" CISS NPS 24 x 0.5"	430	200	-47(A), -28(B), -25(C), -25(D)	-47	440
Abut 3	CLASS 140 Alt "X", T=16"	280	0	-53(A), -28(C), -16(D)	-53	280
Abut 3 Lt RW	CLASS 140 Alt "X", T=16"	280	140	-53(A), -23(B), -28(C), -16(D)	-53	280
Abut 3 Rt RW	CLASS 140 Alt "X", T=16"	280	140	-53(A), -23(B), -28(C), -16(D)	-53	280

DESIGN TIP ELEVATION IS CONTROLLED BY THE FOLLOWING DEMANDS:
(A) COMPRESSION, (B) TENSION, (C) SETTLEMENT, (D) LATERAL.
* NOMINAL DRIVING RESISTANCE IS THE SUM OF NOMINAL RESISTANCE AND DOWNDRAG.

BENCH MARK

BENCH MARK	N	E	ELEV	DESCRIPTION
1003	2043769.910	6021712.494	10.93	STANDARD CITY WELL MONUMENT AT THE CENTERLINE OF BAYSHORE HWY IN A CURB MEDIAN OVER A BOX CULVERT AT EASTON CREEK
510	2042355.119	6022633.562	12.66	SURVEY SPIKE & URS WASHER ON THE BROADWAY ON-RAMP TO SB US 101, IN THE AC SHOULDER, ± 3.2' SOUTHWEST OF ETW & ± 3' NORTHWEST OF EP

SURVEY CONTROL
HORIZONTAL CONTROL FOR THIS SURVEY IS BASED ON THE CALIFORNIA COORDINATE SYSTEM, ZONE 3, US SURVEY FEET, NORTH AMERICAN DATUM OF 1983 (NAD83 2007),
VERTICAL CONTROL IS THE NORTH AMERICAN VERTICAL DATUM (NAVD88 RCFCD).



PLAN

NOTE:

1. For location of utilities, see "UTILITY PLANS".

LEGEND:

- Indicates CISS piles (not all piles shown)
- Indicates Class 140 battered piles
- Indicates Class 140 vertical piles
- Indicates bottom of footing elevation

CURVE DATA

CURVE	R	Δ	T	L
1	5000.00'	2°26'50"	106.80'	213.56'

GEOTECHNICAL PROFESSIONAL APPROVAL DATE

DESIGN OVERSIGHT

SIGN OFF DATE

SCALE: 1"=20'-0"	VERT.DATUM	HORZ.DATUM	
PHOTOGRAMMETRY AS OF:		ALIGNMENT TIES	
SURVEYED	BY	DRAFTED	BY
FIELD CHECKED	BY	CHECKED	BY

	BY	CHECKED
DESIGN	A. Prince	J. Hueser
DETAILS	R. Lim	J. Hueser
QUANTITIES	A. Prince	S. Landis

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Syed Kazmi
PROJECT ENGINEER

BRIDGE NO. 35-0351
POST MILES

BROADWAY OC (REPLACE)
FOUNDATION PLAN

FOUNDATION PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 12-16-11 2-24-12 8-8-12 11-16-12

SHEET 6 OF 38

FILE => 35-0351-e-fdpl.dgn

USERNAME => raymond_l DATE PLOTTED => 11/14/2012 TIME PLOTTED => 9:57:14 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997

INDEX TO PLANS

SHEET NO.	TITLE
1	GENERAL PLAN No. 1
2	GENERAL PLAN No. 2
3	INDEX TO PLANS
4	BRIDGE CONSTRUCTION SEQUENCE
5	DECK CONTOURS
6	FOUNDATION PLAN
7	TYPICAL SECTION
8	GIRDER LAYOUT
9	GIRDER POST-TENSIONING
10	GIRDER DETAILS No. 1
11	GIRDER DETAILS No. 2
12	GIRDER DETAILS No. 3
13	GIRDER DETAILS No. 4
14	STRUCTURE APPROACH TYPE N(30S)
15	STRUCTURE APPROACH DRAINAGE DETAILS
16	LOG OF TEST BORINGS 1 OF 5
17	LOG OF TEST BORINGS 2 OF 5
18	LOG OF TEST BORINGS 3 OF 5
19	LOG OF TEST BORINGS 4 OF 5
20	LOG OF TEST BORINGS 5 OF 5
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	

GENERAL NOTES
LOAD AND RESISTANCE FACTOR DESIGN

DESIGN: AASHTO LRFD Bridge Design Specifications, 4th edition and the Caltrans Amendments, preface dated September 2010; except that concrete barriers and bridge details taken from Standard Plans 2006 are designed using Bridge Design Specifications ('96 AASHTO with Revisions by Caltrans)

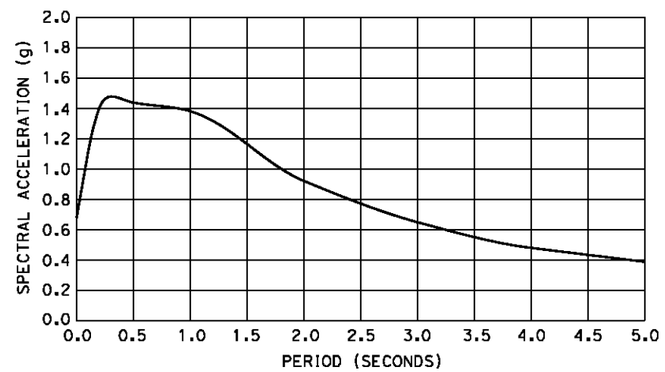
SEISMIC DESIGN: Caltrans Seismic Design Criteria (SDC), Version 1.6 Dated November 2010

DEAD LOAD: Includes 35 psf for future wearing surface.

LIVE LOAD: HL93 and permit design load

SEISMIC LOAD: Soil profile: Type D
Shear wave velocity, Vs30 = 1312 ft/sec for the top 100 ft of soil
Moment Magnitude: 7.3g
Peak Ground Acceleration = 0.828g

CONCRETE: fy = 60 ksi
f'c = 3.6 ksi
n = 8
See prestressing notes on "GIRDER LAYOUT No. 1" sheet.



ARS CURVE

STANDARD PLANS DATED 2010

A10A	ABBREVIATIONS (SHEET 1 OF 2)
A10B	ABBREVIATIONS (SHEET 2 OF 2)
A10C	LINES AND SYMBOLS (SHEET 1 OF 3)
A10D	LINES AND SYMBOLS (SHEET 2 OF 3)
A10E	LINES AND SYMBOLS (SHEET 3 OF 3)
A10F	LEGEND - SOIL (SHEET 1 OF 2)
A10G	LEGEND - SOIL (SHEET 2 OF 2)
A62C	LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL BRIDGE
B0-1	BRIDGE DETAILS
B0-3	BRIDGE DETAILS
B0-5	BRIDGE DETAILS
B0-13	BRIDGE DETAILS
B11-52	CHAIN LINK RAILING TYPE 7
B11-54	CONCRETE BARRIER TYPE 26
B11-56	CONCRETE BARRIER TYPE 736

STANDARD PLAN SHEET No.

DETAIL No.

CONCRETE STRENGTH AND TYPE LIMITS

NO SCALE

DESIGN OVERSIGHT

SIGN OFF DATE

	BY	CHECKED
DESIGN	A. Prince	
DETAILS	R. Lim	
QUANTITIES		

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Tony Dubovik
PROJECT ENGINEER

BRIDGE NO. 35-0351
POST MILES

BROADWAY OC (REPLACE)
INDEX TO PLANS

DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 3 OF

FILE => 35-0351-a-itp.dgn

USERNAME => raymond_l DATE PLOTTED => 6/15/2012 TIME PLOTTED => 9:26:19 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/14 CIVIL STATE OF CALIFORNIA

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100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

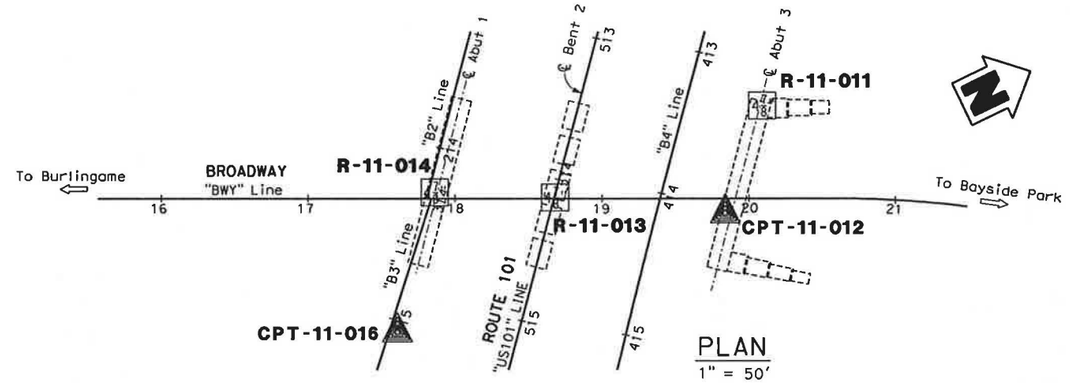
BENCH MARK

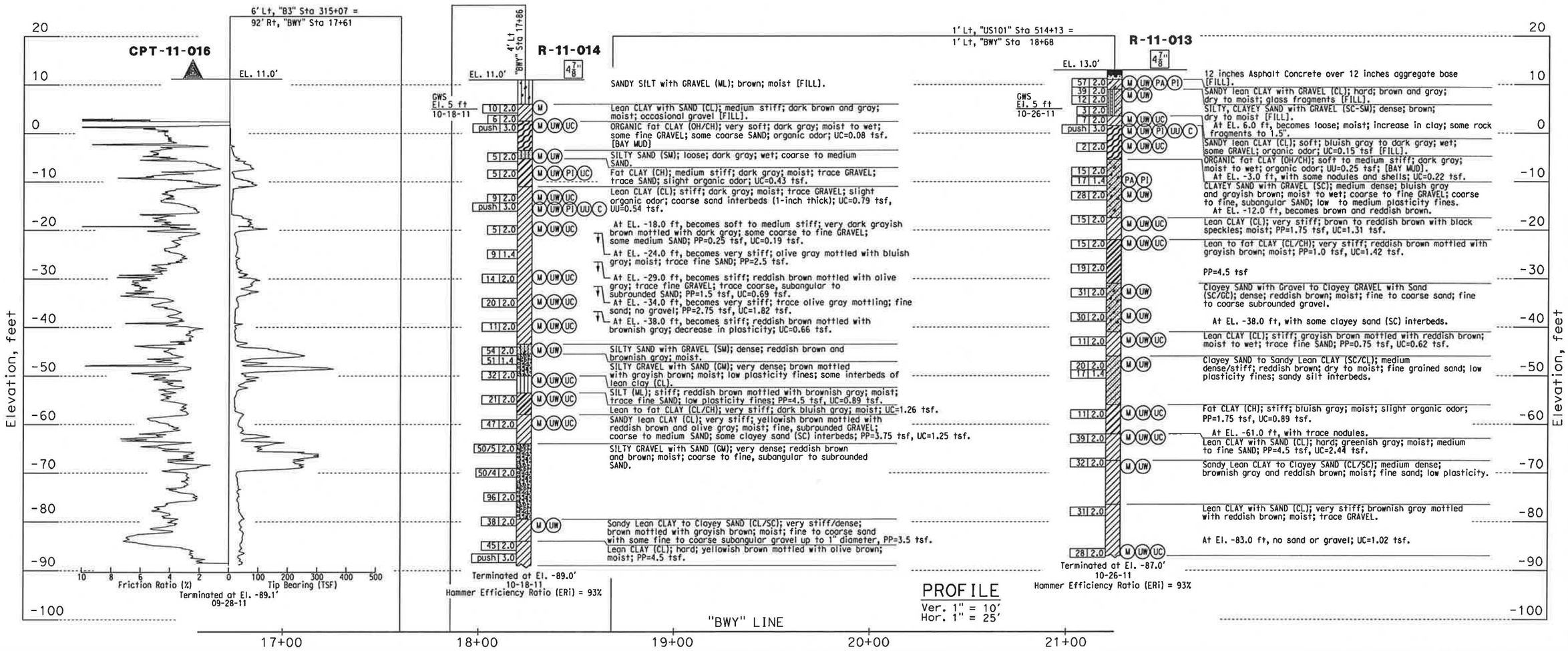
All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83.

BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

1. This LOTB Sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).
2. Standard Penetration test sampler I.D. = 1.44 inch (1.4)
   Modified California sampler I.D. = 1.96 inch (2.0)
   Thin-walled Shelby tube sampler I.D. = 2.97 inch (3.0)
3. UC and UU values reported are undrained shear strengths in tsf.





DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. HUANG
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:		PROJECT ENGINEER

BRIDGE NO. 35-0351
POST MILES X-XX

BROADWAY OC (REPLACE)
LOG OF TEST BORINGS (1 OF 3)

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 06-14-12 11-14-12 SHEET OF

FILE => 35-0351-z-ltb01.dgn

USERNAME => mooma, thubaisu PLOTTED => 11/14/2012 TIME PLOTTED => 11:30:12 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/14 CIVIL STATE OF CALIFORNIA

URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83.

BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

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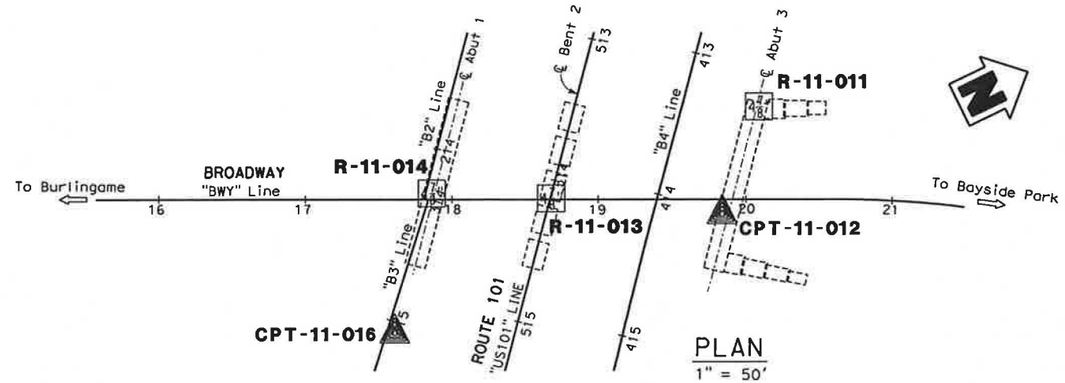
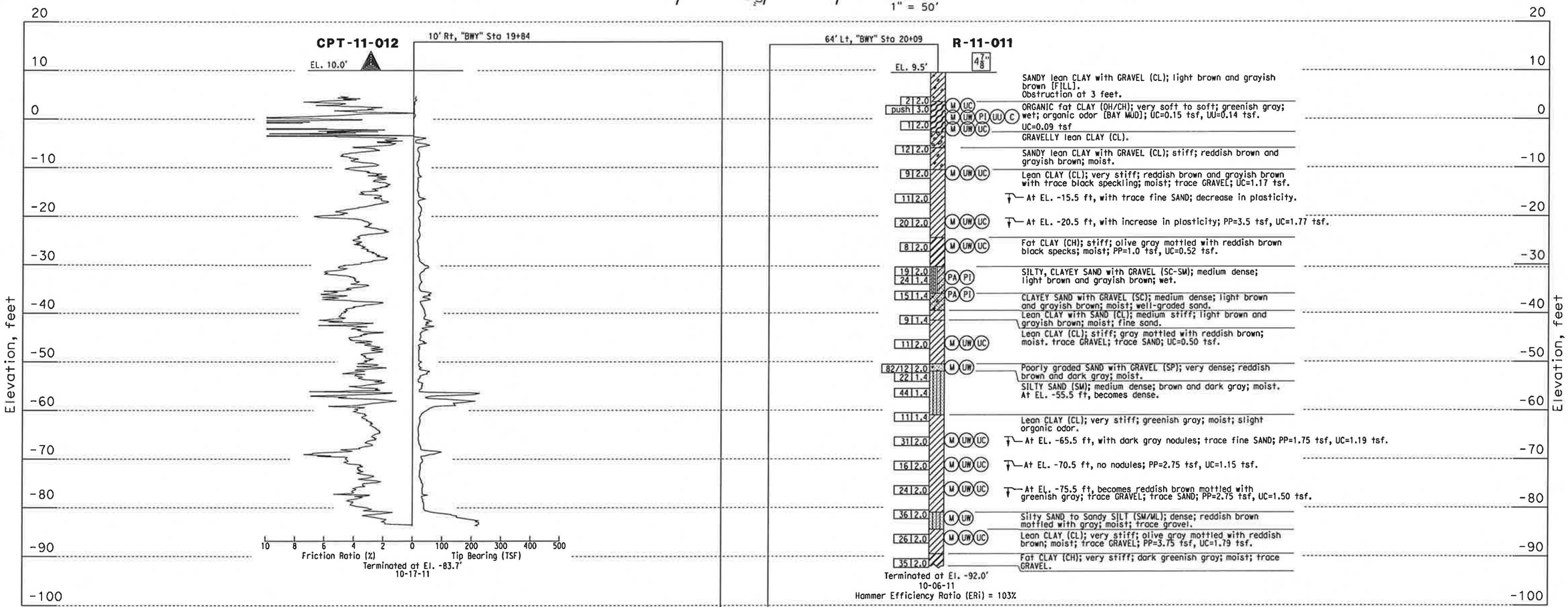


PLAN
1" = 50'



PROFILE
Ver. 1" = 10'
Hor. 1" = 25'

"BWY" LINE
17+00 18+00 19+00 20+00 21+00 22+00

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. HUANG
PROJECT ENGINEER

BRIDGE NO. 35-0351
POST MILES X-XX

BROADWAY OC (REPLACE)
LOG OF TEST BORINGS (2 OF 3)

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES 06-14-12 11-14-12

REVISION DATES SHEET OF

FILE => 35-0351-z-ltb02.dgn

USERNAME => mooamu_thu; DATE/PLOTTED => 11/14/2012 TIME PLOTTED => 11:00:33 AM

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	MILE POST-TOTAL PROJECT	Sheet No.	Total Sheets
04	SM	101	16.3/17.1		

REGISTERED GEOTECHNICAL ENGINEER — DATE

DATE PLOTTED => 11/9/2012

BROADWAY OC (REPLACE)

LOG OF TEST BORINGS (3 OF 3)

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE ANDINVESTIGATIONS, SACRAMENTO, CALIFORNIA

CU: 04
EA: 235844

BRIDGE No. 35-0351

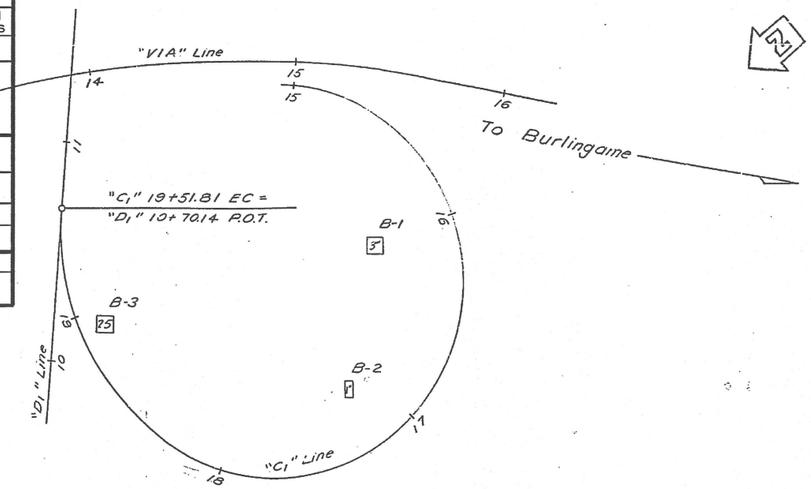
Sheet ___ of ___

Boring	Station	Offset from "BWY" Line
B-1	15+94	68.9 Rt
B-2	16+15	10.9 Rt
B-3	16+92	81.5 Rt

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.6	62	62

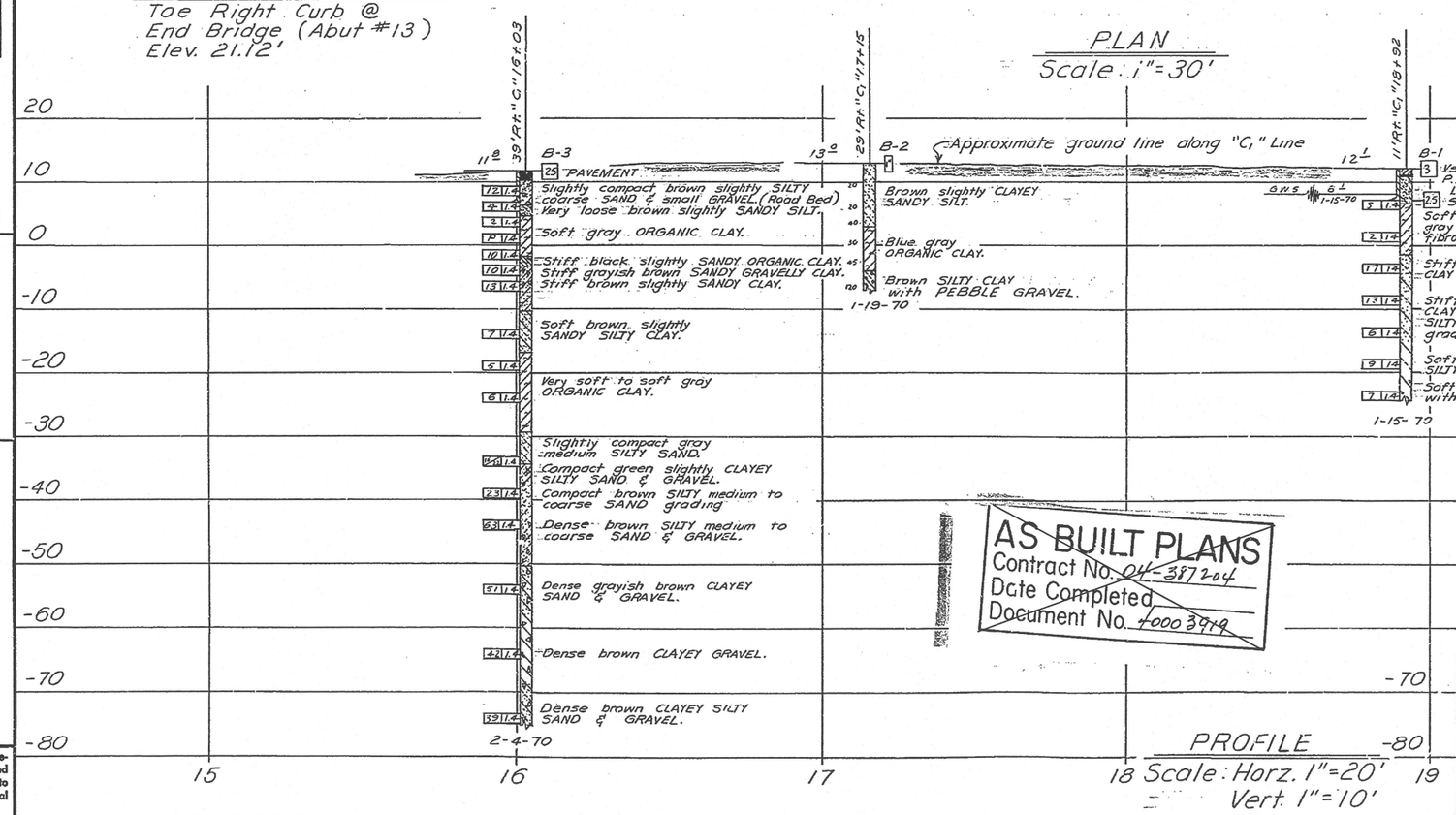
BRIDGE ENGINEER — REGISTERED CIVIL ENGINEER NO. 9946
DATE APPROVED September 14, 1976

REGISTERED PROFESSIONAL ENGINEER
Stephen Huang
No. C 42289
Exp. 03/31/12
GEOTECHNICAL
STATE OF CALIFORNIA



PLAN
Scale: 1" = 30'

B.M.
Toe Right Curb @ End Bridge (Abut #13) Elev. 21.12'



PROFILE
Scale: Horz. 1" = 20'
Vert. 1" = 10'

AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 4000 3419

LEGEND OF BORING OPERATIONS

LEGEND OF EARTH MATERIALS

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

FIELD STUDY By G. Miller 2-70
DRAWN By S. Kongsgard 2-8-70
CHECKED By G. Miller 2-8-70
Approval Recommended by J. L. Sommers 11/75

BRIDGE DEPARTMENT
ENGINEERING GEOLOGY SECTION

62

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING

LOG OF TEST BORINGS

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
35-96	16.6		10	10

WO 387201
CU 04205

Disregard prints bearing earlier revision dates

REVISION DATES (PRELIMINARY STAGE ONLY) 2/8/70

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF PUBLIC WORKS.

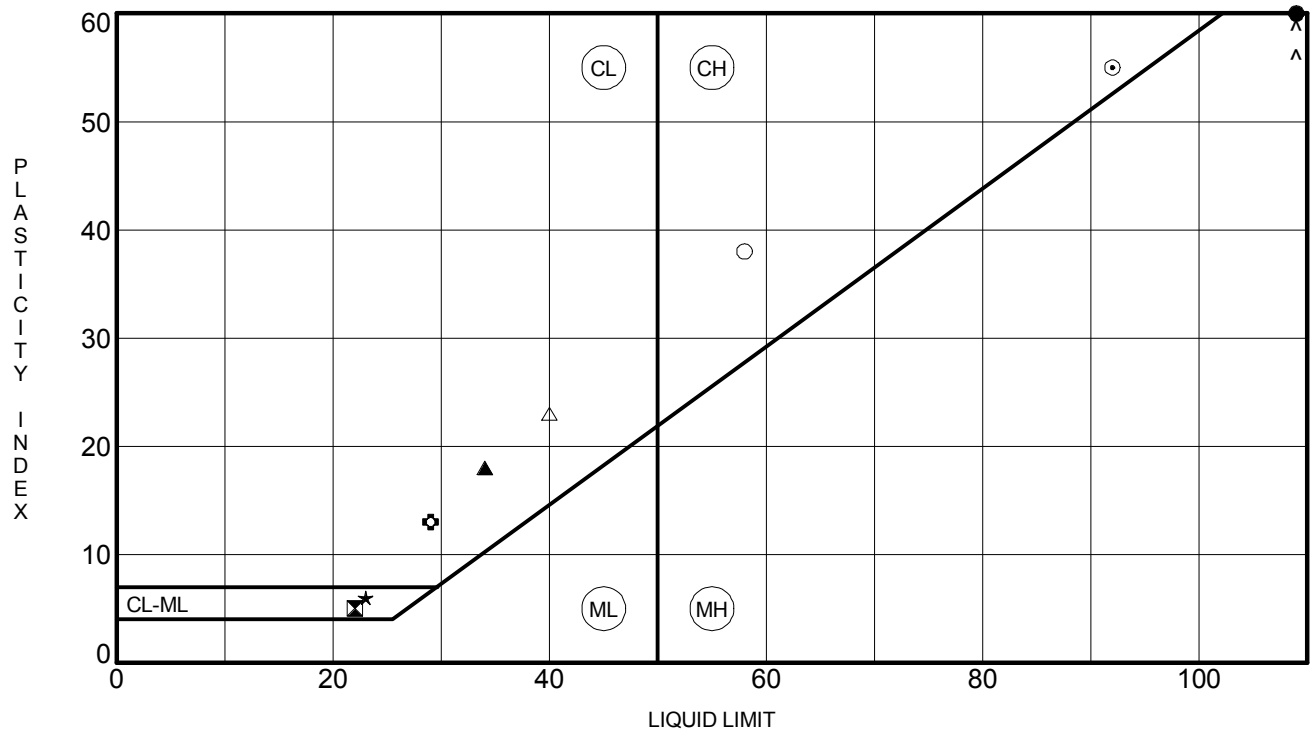
DATE 6-13-77 SIGNATURE ___ TITLE CD DIV.

TABLE C-1
SUMMARY OF LABORATORY TEST RESULTS

						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	6.1																	580	69.3	
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	6.3																			
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	8														109	42	67	555	86.7	48
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	10																	350	94.2	47
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	20																	4670	22.9	105
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	30																	7090	21.1	97
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	35																	2080	46.2	75
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	41.5	100	100	100	95	92	79	71	63	55	44	32	23		22	17	5			
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	45	100	100	96	92	90	82	70	61	55	48	40	33		34	16	18			
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	55																	2010	25.7	100
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	60																		9.3	133
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	75																	4750	13.8	125
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	80																	4590	24.1	102
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	85																	6010	18.6	113
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	91																		16.8	113
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	95																	7150	18.5	112
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	2	100	100	90	86	84	61	52	46	41	36	29	20		23	17	6		13.3	120
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	4.5																		6.6	127
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	9.5																	600	23	103
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	11														92	37	55	985	77.3	51
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	15																	880	80.1	53
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	22	100	100	100	97	96	81	68	57	47	37	29	22		29	16	13			
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	25																		15.3	122
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	31																	5250	21.7	106
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	35																	5690	27.8	96
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	45																		16.1	115
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	50																		16	117
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	55																	2480	30.5	92
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	60																		23.6	104
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	70																	3560	41.1	80
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	75																	9750	18.4	114
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	81																		22.8	104
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	98.5																	4070	26.2	99
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	5																		21.7	

TABLE C-1
SUMMARY OF LABORATORY TEST RESULTS

						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	8.7																	320	64	62
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	15																		22.3	104
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	18.5														58	20	38	1730	35.9	86
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	23.5																	3170	26.7	97
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	25														40	17	23	2166	22.3	103
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	30																	770	20.8	109
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	40																	2760	21.5	106
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	45																	7280	23.7	103
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	50																	2640	30.6	92
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	55																		11.2	128
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	61.2																	3570	24.3	101
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	65																	5050	31.1	92
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	70																	4990	15.5	118
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	91																		18.1	113



	Sample Identification/Depth (ft)		LL	PL	PI	Fines	Classification
●	**R-11-011**	**8.0**	**109**	**42**	**67**		**ORGANIC fat CLAY (CH)**
⧗	**R-11-011**	**41.5**	**22**	**17**	**5**	**23**	**SILTY, CLAYEY SAND with GRAVEL (SC-SM) ()**
▲	**R-11-011**	**45.0**	**34**	**16**	**18**	**33**	**CLAYEY SAND with GRAVEL (SC) ()**
★	**R-11-013**	**2.0**	**23**	**17**	**6**	**20**	**SILTY, CLAYEY SAND with GRAVEL (SC-SM) ()**
⊙	**R-11-013**	**11.0**	**92**	**37**	**55**		**ORGANIC fat CLAY (CH)**
✿	**R-11-013**	**22.0**	**29**	**16**	**13**	**22**	**CLAYEY SAND with GRAVEL (SC) ()**
○	**R-11-014**	**18.5**	**58**	**20**	**38**		**Fat CLAY (CH)**
△	**R-11-014**	**25.0**	**40**	**17**	**23**		**Lean CLAY (CL)**

URS

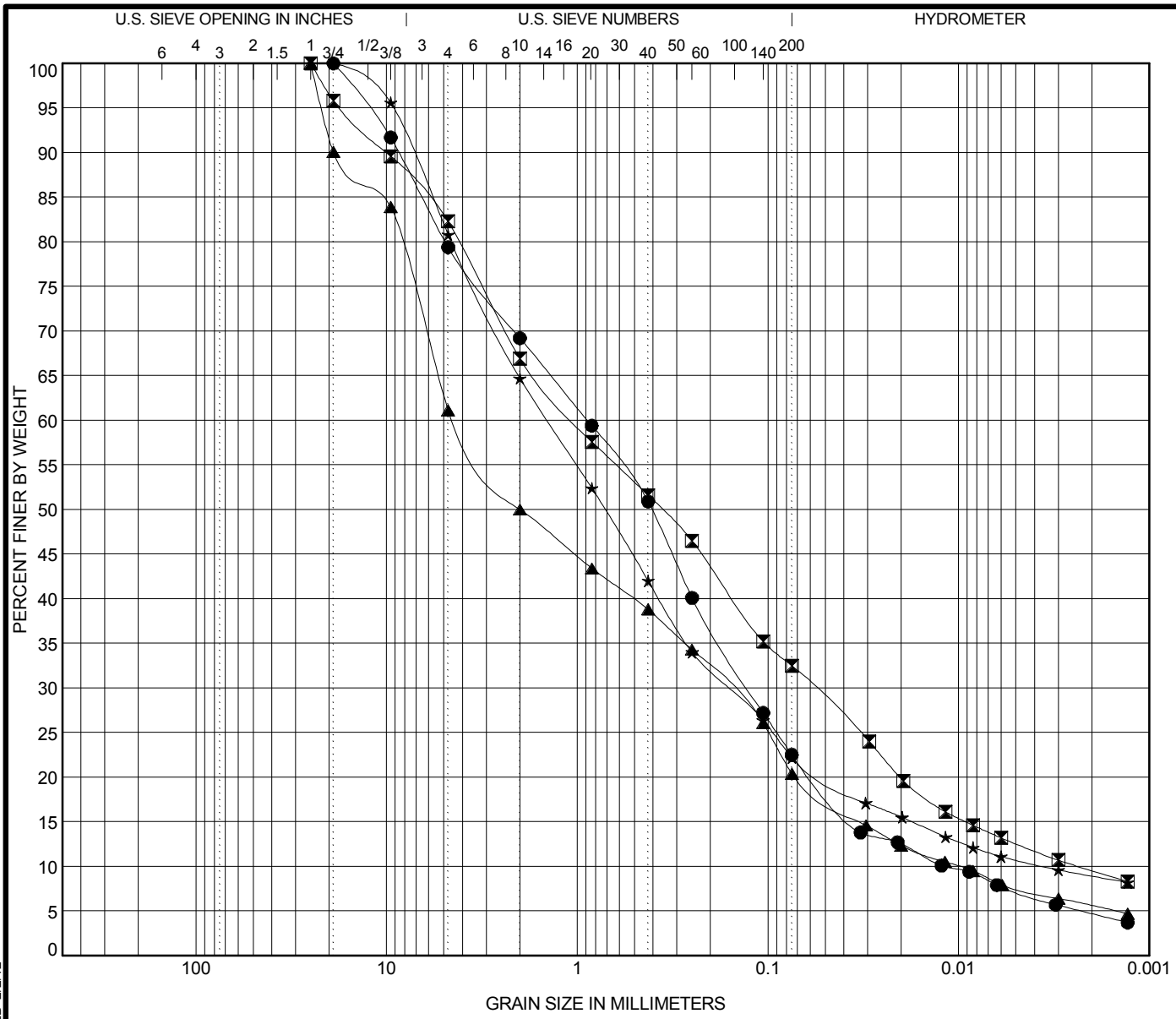
San Jose office

100 W. San Fernando St, Suite 200
San Jose, CA 95113

ATTERBERG LIMITS RESULTS

Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS ATTERBERG LIMITS 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/2/12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Identification/Depth (ft)		Classification	LL	PL	PI	Cc	Cu
●	R-11-011	41.5	SILTY, CLAYEY SAND with GRAVEL (SC-SM)	22	17	5	1.57	75.55
⊠	R-11-011	45.0	CLAYEY SAND with GRAVEL (SC)	34	16	18	1.31	447.00
▲	R-11-013	2.0	SILTY, CLAYEY SAND with GRAVEL (SC-SM)	23	17	6	0.59	437.91
★	R-11-013	22.0	CLAYEY SAND with GRAVEL (SC)	29	16	13	4.89	397.81

	Sample Identification/Depth (ft)		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-11-011	41.5	19	0.886	0.128	0.012	20.6	56.9	15.3	7.2
⊠	R-11-011	45.0	25	1.051	0.057	0.002	17.7	49.8	20.0	12.5
▲	R-11-013	2.0	25	4.36	0.159	0.01	38.9	40.7	12.9	7.5
★	R-11-013	22.0	19	1.436	0.159	0.004	19.2	58.6	11.5	10.7

URS

San Jose Office

100 W. San Fernando, Ste 200
San Jose, CA 95113

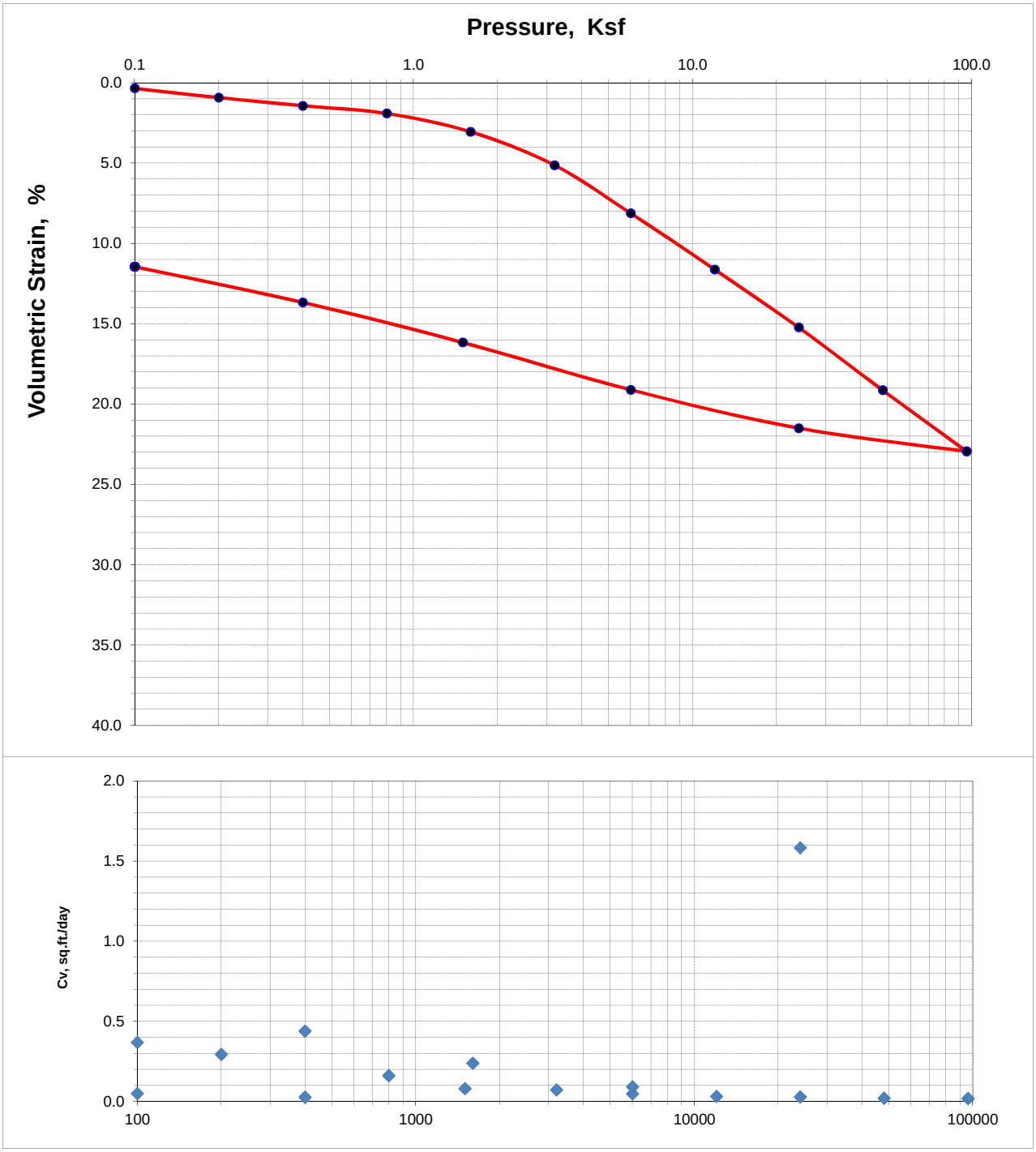
GRAIN SIZE DISTRIBUTION

Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS GRAIN SIZE 28645286-BROADWAY INTERCHANGE RECONSTRUCTION SM.GPJ SNJ_CT.GLB 2/2/12

CONSOLIDATION TEST

Boring Number	R-11-014	Sample Number	7	Depth (ft)	25-27.5			
Soil Description	Dark olive gray lean clay							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	26.0	123.8	0.715	98.0	1.00	2.420	(assumed) 2.70	40	23
Final	18.5	134.5	0.485	102.7	0.866				

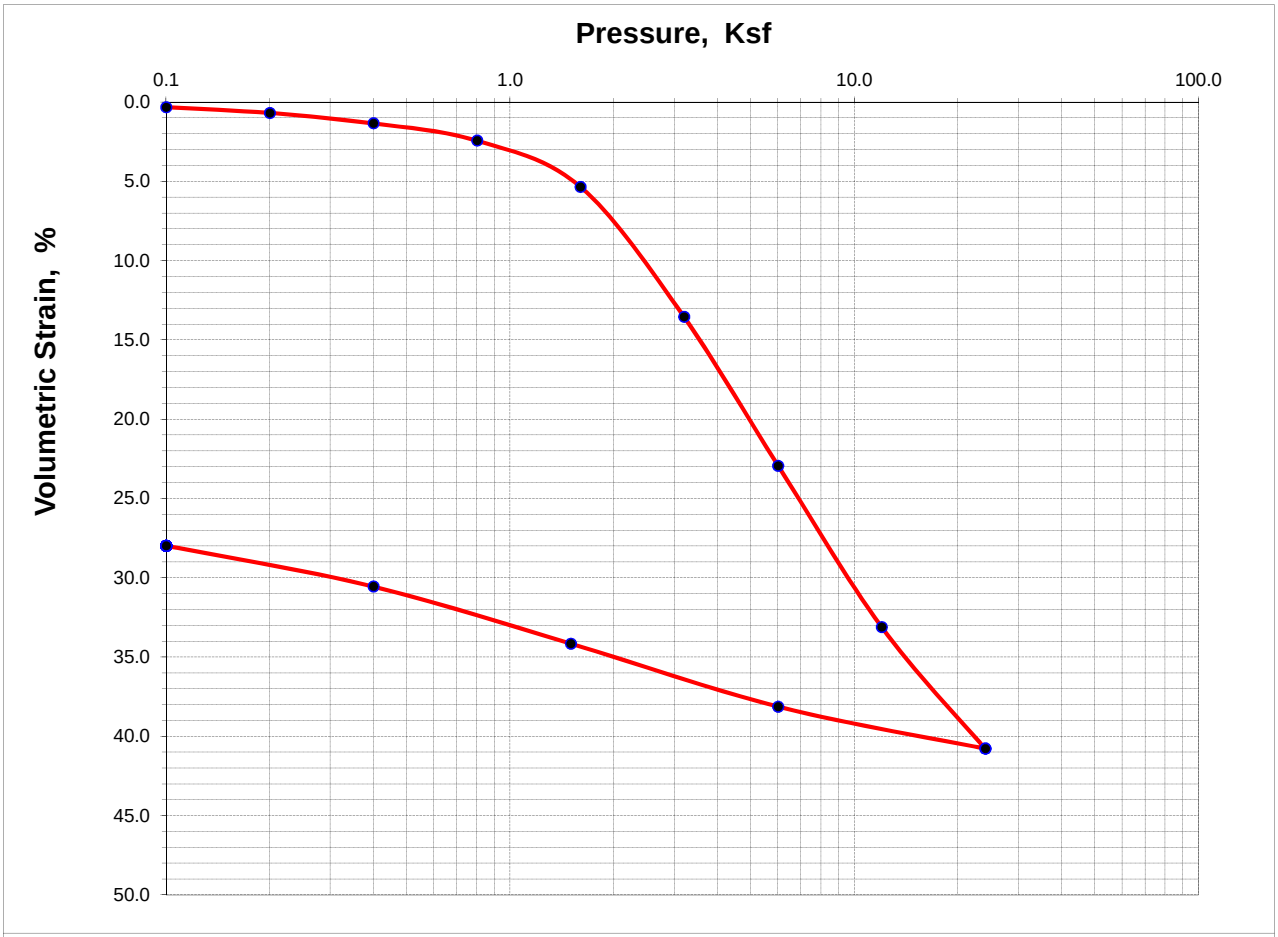


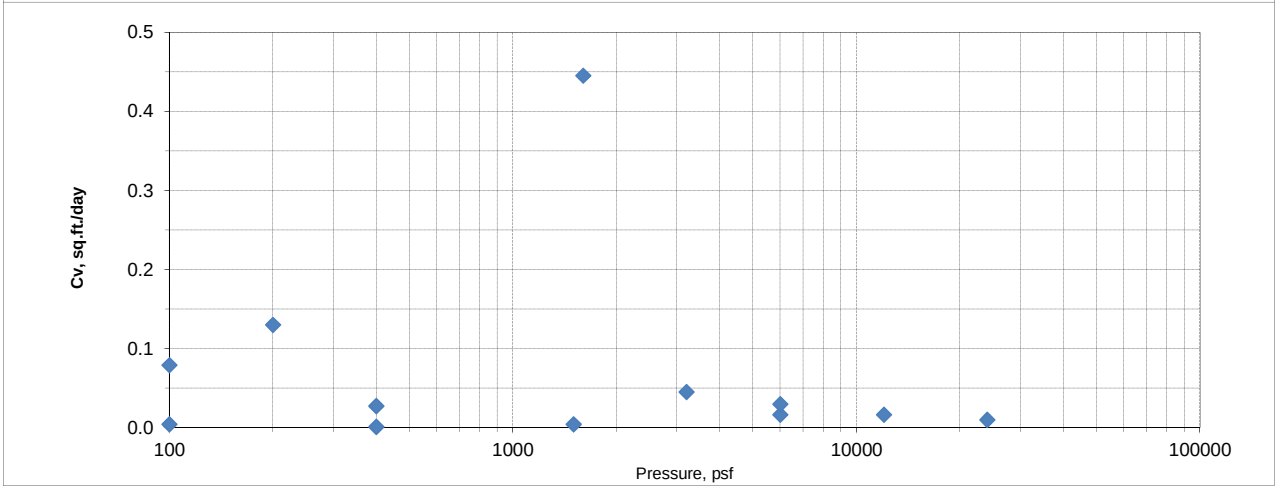
28645286.02

CONSOLIDATION TEST

Boring Number	R-11-013	Sample Number	6	Depth (ft)	11-13.5	
Soil Description	Dark olive gray fat clay with organics					

	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	102.3	87.1	2.918	94.7	1.00	2.420	(assumed) 2.70	92	55
Final	66.3	101.6	1.760	101.7	0.704				

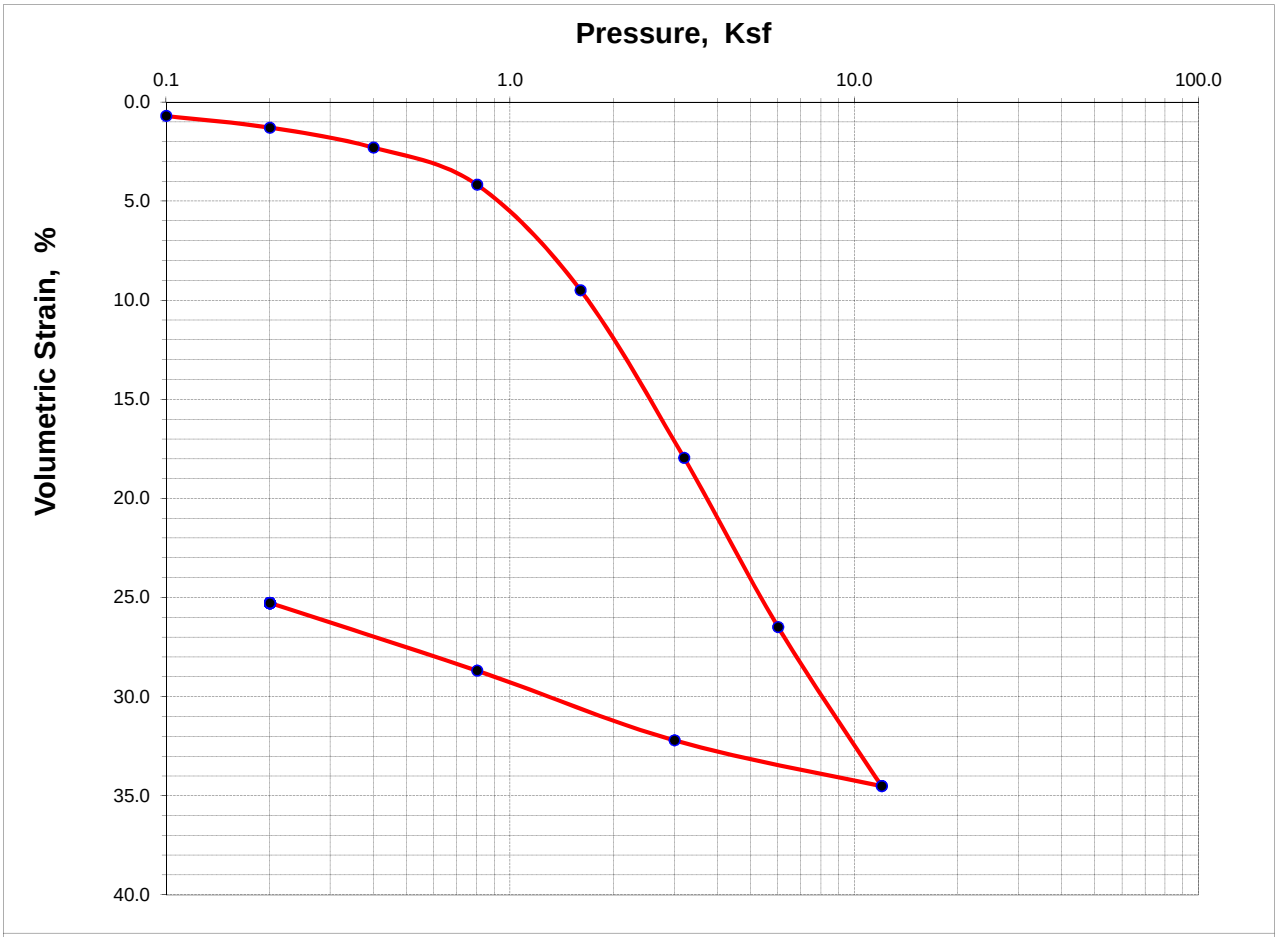


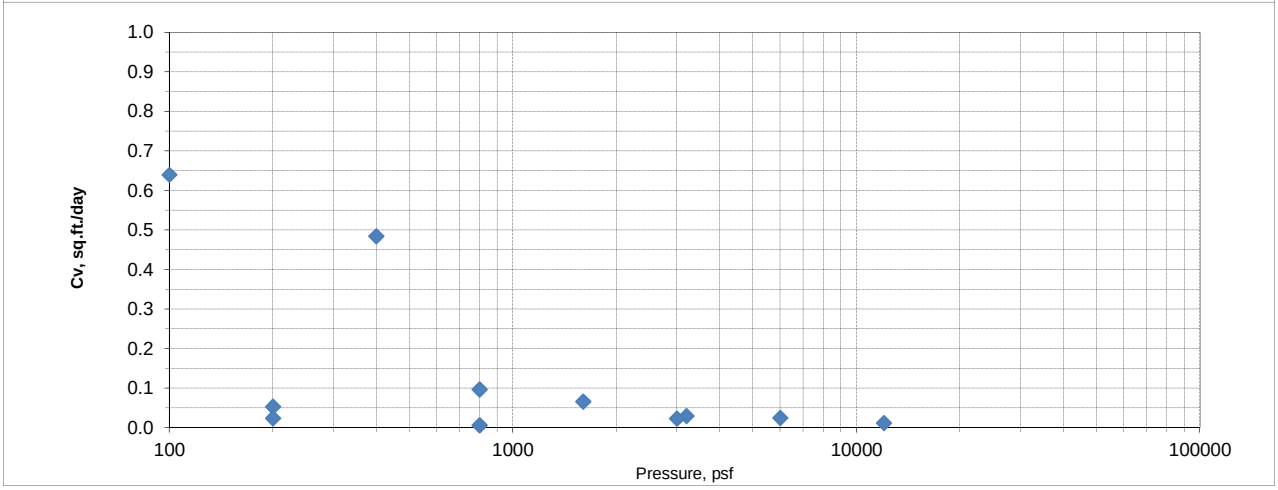


28645286.02

CONSOLIDATION TEST

Boring Number	R-11-011	Sample Number	2	Depth (ft)	6.5-9				
Soil Description	Dark olive gray fat clay with organics								
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	101.4	87.6	2.875	95.2	1.00	2.420	(assumed) 2.70	109	67
Final	67.8	101.2	1.796	102.0	0.721				





28645286.02

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-014
Sample # : 7
Depth (ft) : 25-27.5
Date tested : 11/30/11
Soil : Dark olive gray lean clay

Data Reduction:

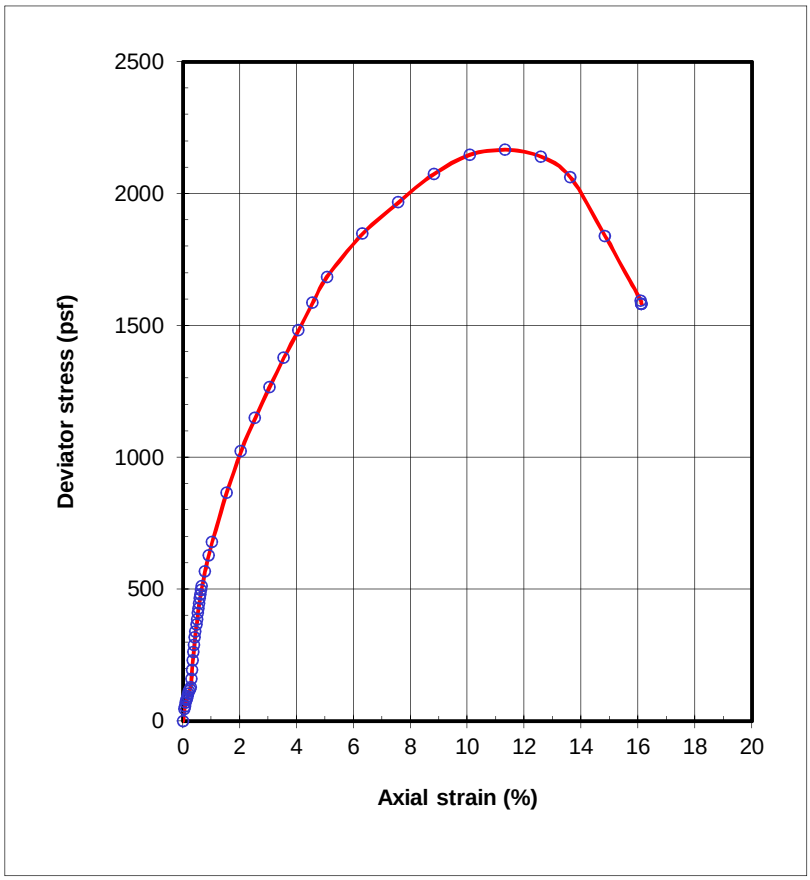
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt. =	1252.6	gms
Ht. =	5.970	in
Ave dia. =	2.840	in
Area =	6.337	sq.in
Volume =	620.0	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.634	
Ht/Dia ratio =	2.10	
Moisture =	22.3	%
Total density =	126.1	pcf
Dry density =	103.1	pcf
Saturation =	94.9	%
Chamber pressure =	1650	psf
Max. deviator stress =	2166	psf
Strain @ failure =	11.33	%

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	2.0	0.05	45.4
0.003	2.4	0.07	55.5
0.004	3.0	0.10	69.0
0.006	3.5	0.12	79.7
0.007	3.8	0.15	85.6
0.009	4.2	0.17	95.2
0.010	4.6	0.20	103.5
0.012	5.0	0.22	114.2
0.013	5.4	0.25	121.9
0.015	5.7	0.27	129.0
0.016	7.0	0.30	158.8
0.018	8.6	0.32	195.0
0.019	10.1	0.35	229.1
0.021	11.6	0.37	262.5
0.022	12.8	0.40	288.8
0.024	14.0	0.42	317.1
0.025	15.0	0.45	340.3
0.027	16.1	0.47	365.1
0.028	17.0	0.50	385.0
0.030	18.1	0.52	409.0
0.031	18.9	0.55	427.0
0.033	19.7	0.57	446.0
0.034	20.6	0.60	465.4
0.036	21.3	0.62	480.8
0.037	22.1	0.65	498.1
0.039	22.7	0.67	512.2
0.045	25.1	0.77	566.2
0.052	27.9	0.90	627.8
0.060	30.2	1.02	679.6
0.090	38.7	1.53	865.2
0.120	45.9	2.04	1022.6
0.150	51.9	2.54	1150.4
0.180	57.5	3.04	1266.3
0.210	62.9	3.55	1378.3
0.241	68.0	4.06	1481.7
0.271	73.1	4.56	1586.1
0.301	78.1	5.06	1684.3
0.376	86.8	6.32	1848.8
0.451	93.7	7.57	1967.2
0.525	100.1	8.82	2074.8
0.600	105.1	10.08	2147.1
0.675	107.5	11.33	2166.1
0.750	107.8	12.58	2140.4
0.812	105.1	13.62	2062.3
0.885	95.1	14.84	1839.5
0.960	83.6	16.10	1593.7
0.961	83.0	16.12	1582.2



UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-013
Sample # : 6
Depth (ft) : 11-13.5
Date tested : 11/30/11
Soil : Dark olive gray fat clay with organics

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

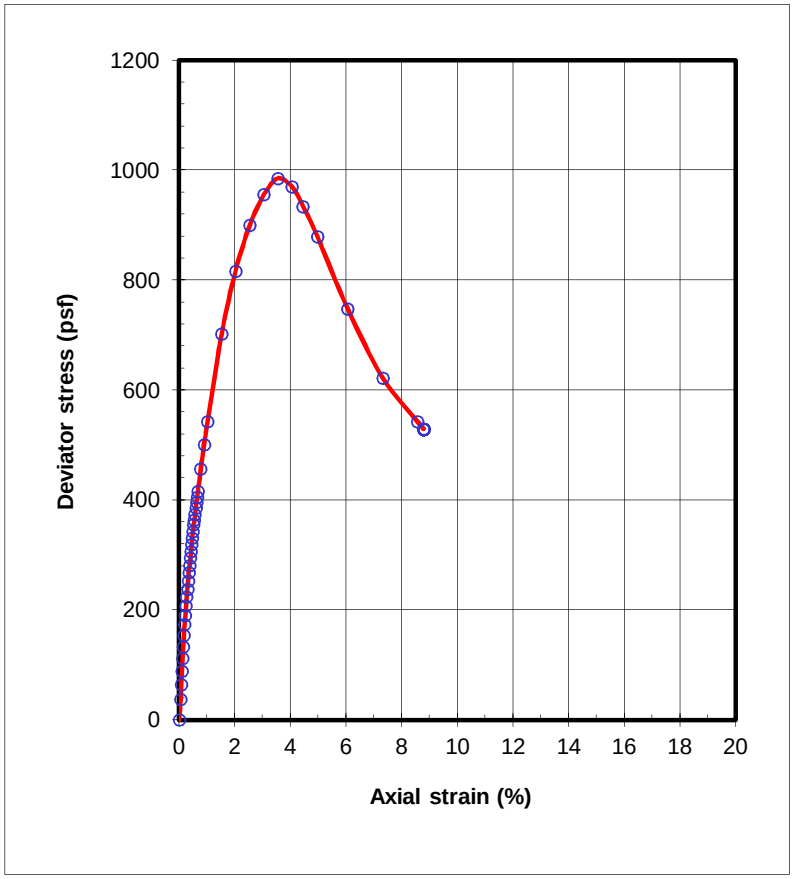
Specimen:

Total wt. =	910.7	gms
Ht. =	6.000	in
Ave dia. =	2.863	in
Area =	6.442	sq.in
Volume =	633.4	c.c.
Shearing rate =	0.05	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	2.331	
Ht/Dia ratio =	2.10	
Moisture =	77.4	%
Total density =	89.7	pcf
Dry density =	50.6	pcf
Saturation =	89.6	%
Chamber pressure =	1100	psf
Max. deviator stress =	985	psf
Strain @ failure =	3.54	%

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	1.7	0.05	37.5
0.003	2.9	0.07	64.4
0.005	4.0	0.10	88.7
0.006	5.0	0.12	111.9
0.008	5.9	0.15	132.6
0.009	6.9	0.17	153.9
0.011	7.8	0.20	173.4
0.012	8.5	0.22	189.8
0.014	9.3	0.25	207.3
0.015	10.0	0.27	223.0
0.017	10.7	0.30	238.0
0.018	11.3	0.32	252.2
0.020	12.0	0.35	267.8
0.021	12.6	0.37	281.1
0.023	13.2	0.40	294.0
0.024	13.8	0.42	306.6
0.026	14.3	0.45	318.6
0.027	14.8	0.47	330.3
0.029	15.4	0.50	341.9
0.030	16.0	0.52	355.2
0.032	16.4	0.55	363.6
0.033	16.8	0.57	374.1
0.035	17.4	0.60	385.6
0.036	17.8	0.62	395.6
0.038	18.3	0.65	405.6
0.039	18.7	0.67	415.6
0.045	20.6	0.77	456.3
0.053	22.6	0.90	501.0
0.060	24.5	1.02	543.1
0.090	31.9	1.52	701.8
0.120	37.3	2.03	816.8
0.151	41.3	2.54	900.7
0.182	44.1	3.05	955.7
0.211	45.7	3.54	985.4
0.242	45.2	4.06	970.0
0.266	43.7	4.45	934.1
0.297	41.4	4.96	879.7
0.362	35.6	6.06	747.5
0.438	30.0	7.32	622.3
0.513	26.5	8.57	542.3
0.526	26.0	8.79	529.2



UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-011
Sample # : 2
Depth (ft) : 6.5-9
Date tested : 11/30/11
Soil : Dark olive gray fat clay with organics

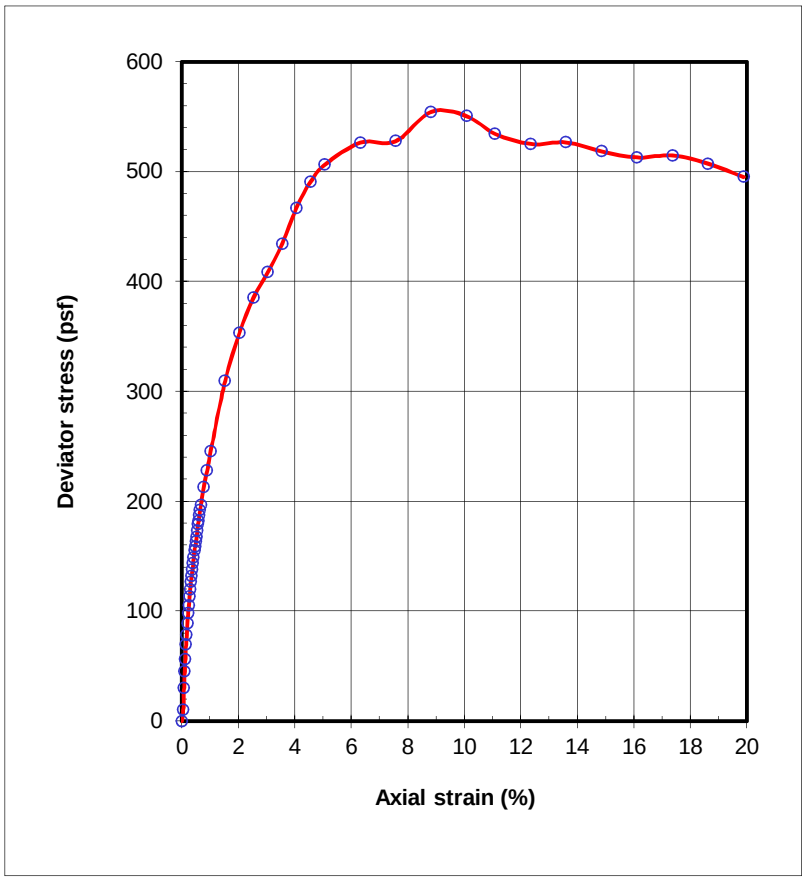
Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt. =	893.0	gms
Ht. =	5.980	in
Ave dia. =	2.833	in
Area =	6.308	sq.in
Volume =	618.1	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	2.487	
Ht/Dia ratio =	2.11	
Moisture =	86.6	%
Total density =	90.2	pcf
Dry density =	48.3	pcf
Saturation =	94.0	%
Chamber pressure =	800	psf
Max. deviator stress =	555	psf
Strain @ failure =	8.82	%



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	0.4	0.05	10.2
0.003	1.3	0.07	30.2
0.004	2.0	0.10	45.1
0.006	2.5	0.12	56.5
0.007	3.1	0.15	69.6
0.009	3.5	0.17	78.7
0.010	3.9	0.20	88.8
0.012	4.3	0.22	98.6
0.013	4.6	0.25	105.5
0.015	5.0	0.27	113.3
0.016	5.3	0.30	119.9
0.018	5.6	0.32	127.1
0.019	5.8	0.35	132.0
0.021	6.1	0.37	138.0
0.022	6.3	0.40	143.5
0.024	6.6	0.42	149.0
0.025	6.8	0.45	155.6
0.027	7.0	0.47	159.0
0.028	7.2	0.50	163.6
0.030	7.4	0.52	167.9
0.031	7.6	0.55	173.7
0.033	7.9	0.57	179.2
0.034	8.0	0.60	182.3
0.036	8.3	0.62	187.6
0.037	8.5	0.65	192.1
0.039	8.7	0.67	196.5
0.045	9.4	0.77	212.8
0.052	10.1	0.90	228.3
0.060	10.9	1.02	245.7
0.090	13.8	1.53	309.6
0.120	15.8	2.03	353.3
0.150	17.3	2.54	385.5
0.181	18.5	3.04	408.6
0.211	19.7	3.55	434.5
0.241	21.3	4.05	467.0
0.271	22.5	4.56	491.0
0.301	23.4	5.06	506.5
0.376	24.6	6.31	526.5
0.451	25.0	7.57	527.8
0.526	26.6	8.82	554.5
0.601	26.8	10.08	550.6
0.661	26.3	11.08	534.4
0.736	26.2	12.34	525.2
0.812	26.7	13.60	526.8
0.887	26.7	14.85	518.5
0.962	26.8	16.11	512.9
1.037	27.3	17.37	515.0
1.112	27.3	18.62	507.3

LANKELMA

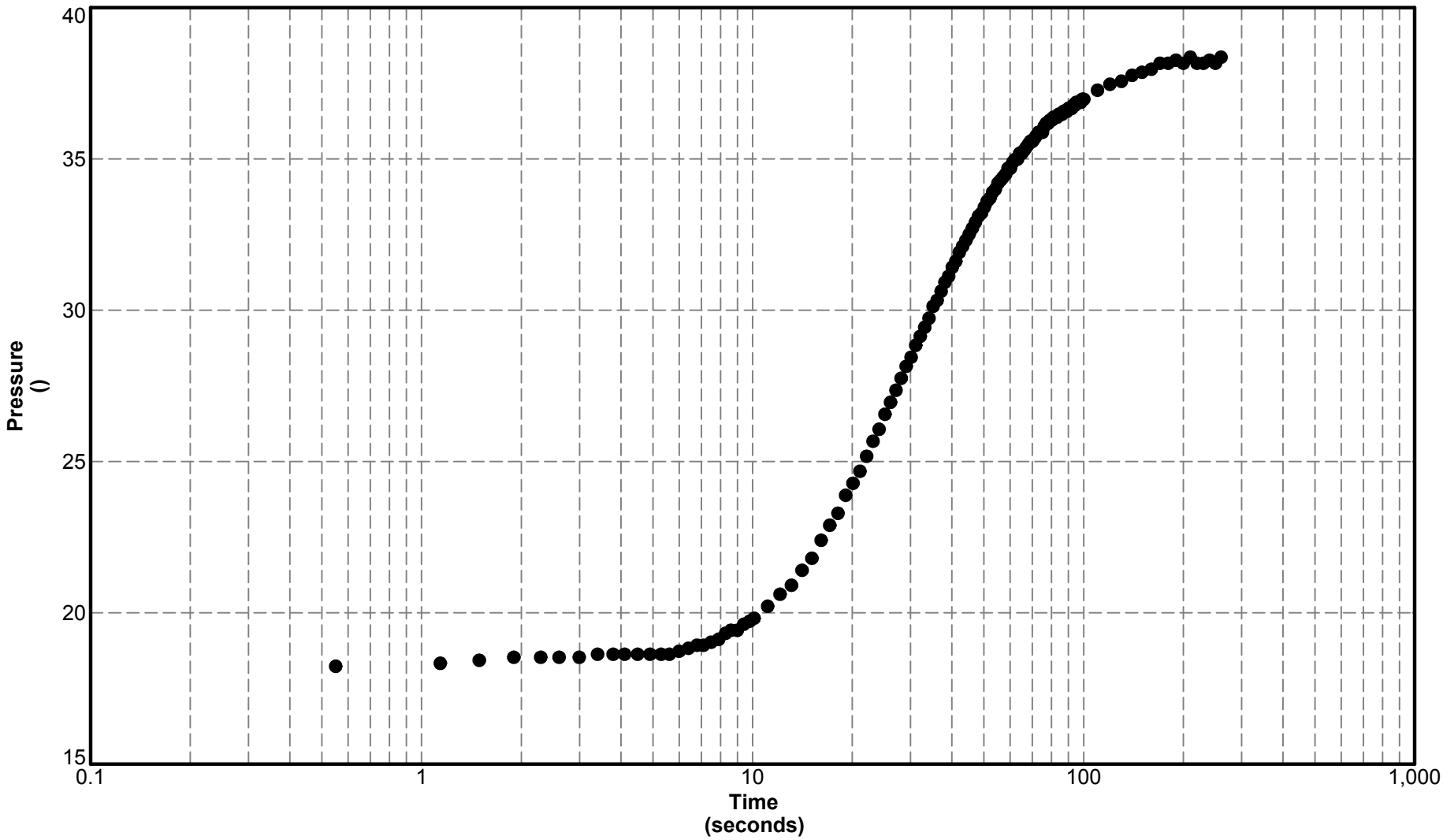
BIRP
(Burlingame,California)
Project Number :17326636

Pore Pressure Dissipation:

Date: Oct. 17, 2011
Estimated Water Depth: 3.4
Rig/Operator: JT | VB

Northing: N/A
Easting: N/A
Elevation: N/A

Total Depth: 93.7 ft
Termination Criteria:
Test Depth: 93.1 ft



CPT-11-012

LANKELMA

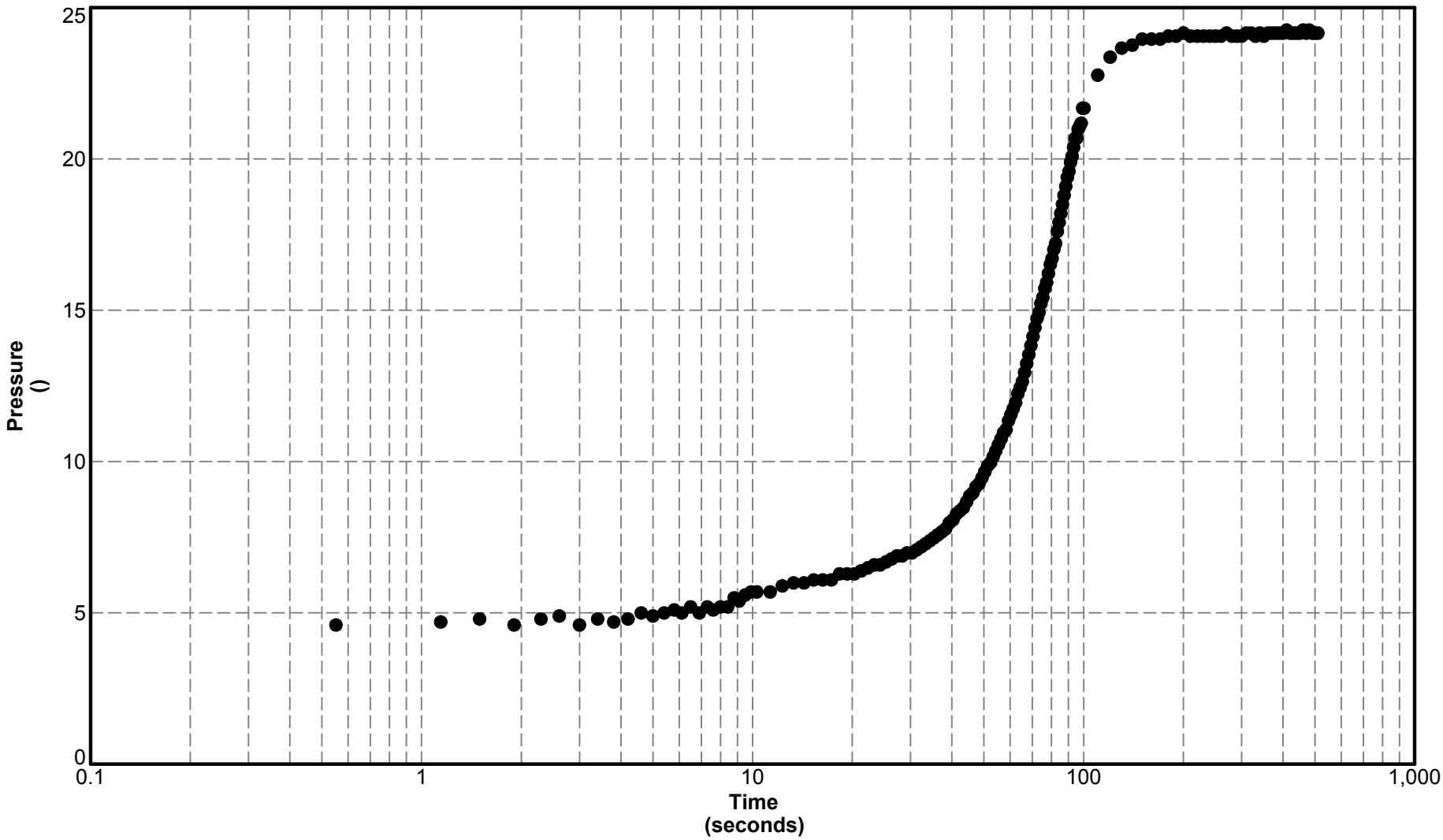
BIRP
(Burlingame,California)
Project Number :17326636

Pore Pressure Dissipation:

Date: Sep. 28, 2011
Estimated Water Depth: 0.5
Rig/Operator: JT | VB

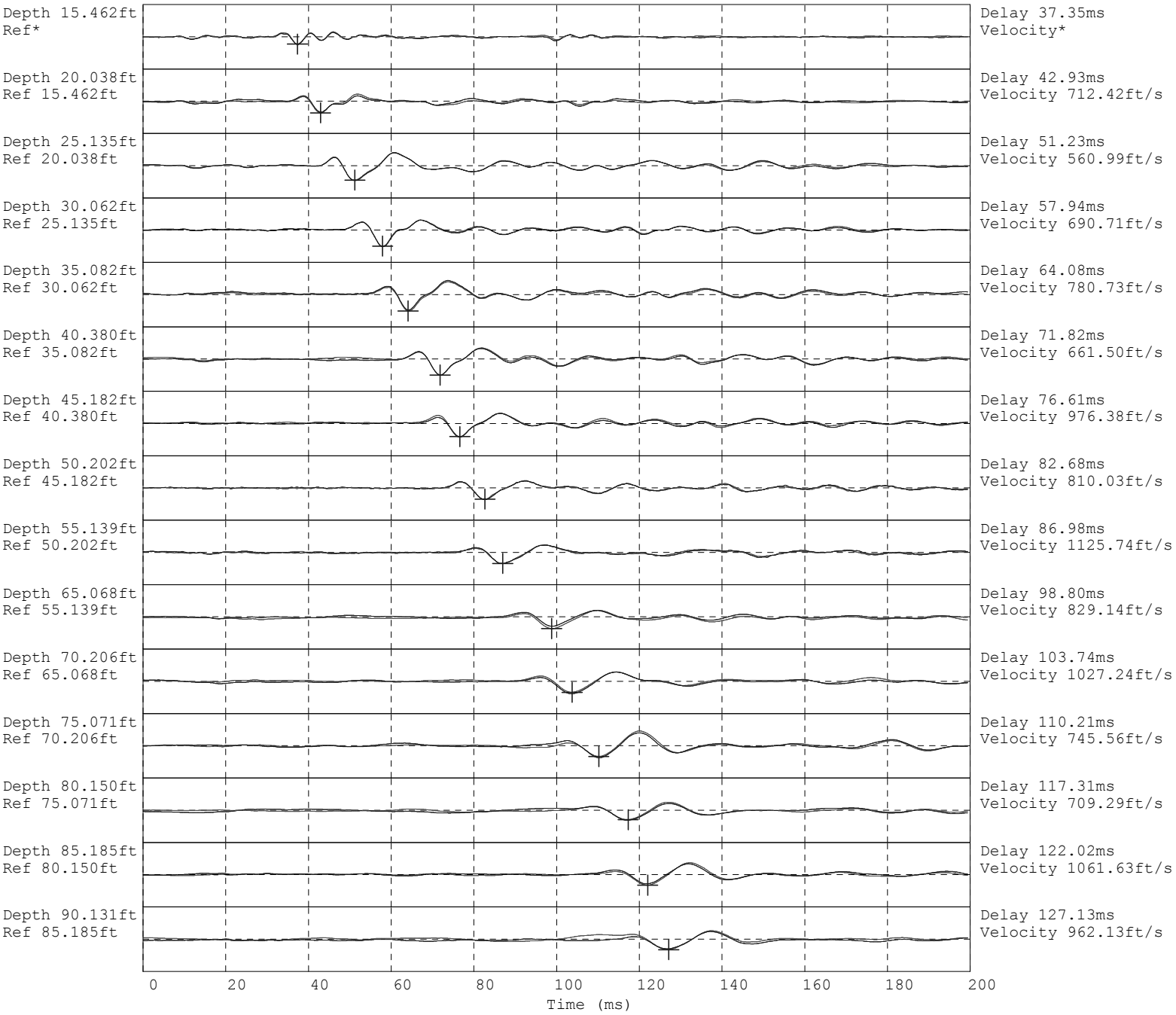
Northing: N/A
Easting: N/A
Elevation: N/A

Total Depth: 100.1 ft
Termination Criteria: Target Depth
Test Depth: 55.8 ft



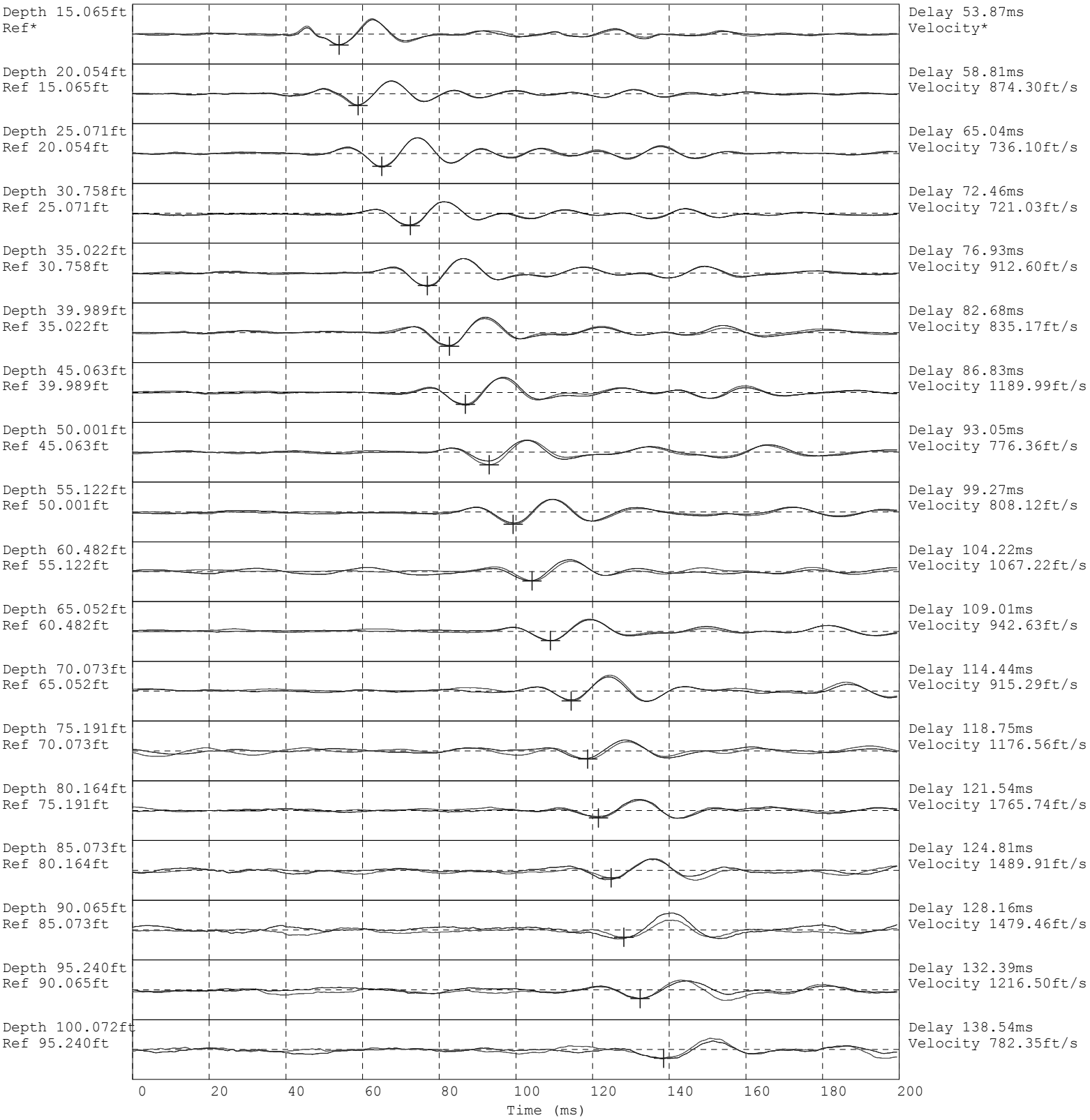
CPT-11-016

S-Wave CPT-11-012
BIRP SCPT



Hammer to Rod String Distance 3.05 (m)
* = Not Determined

S-Wave CPT-11-016
BIRP SCPT



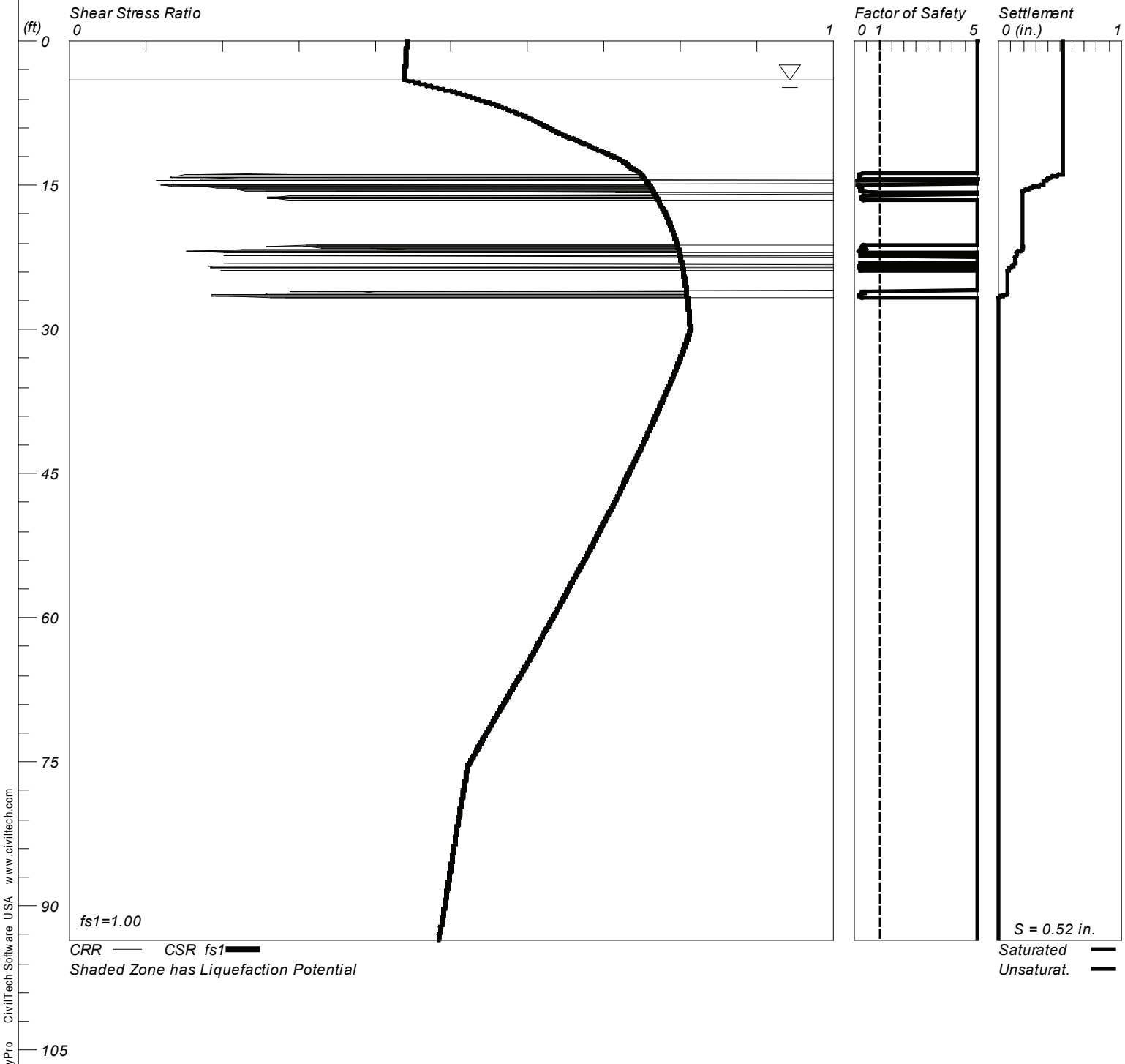
Hammer to Rod String Distance 3.05 (m)
* = Not Determined

LIQUEFACTION ANALYSIS

Broadway Interchange Reconstruction

Hole No.=CPT-11-012 Water Depth=4 ft Surface Elev.=10 ft

Magnitude=7.9
Acceleration=0.68g

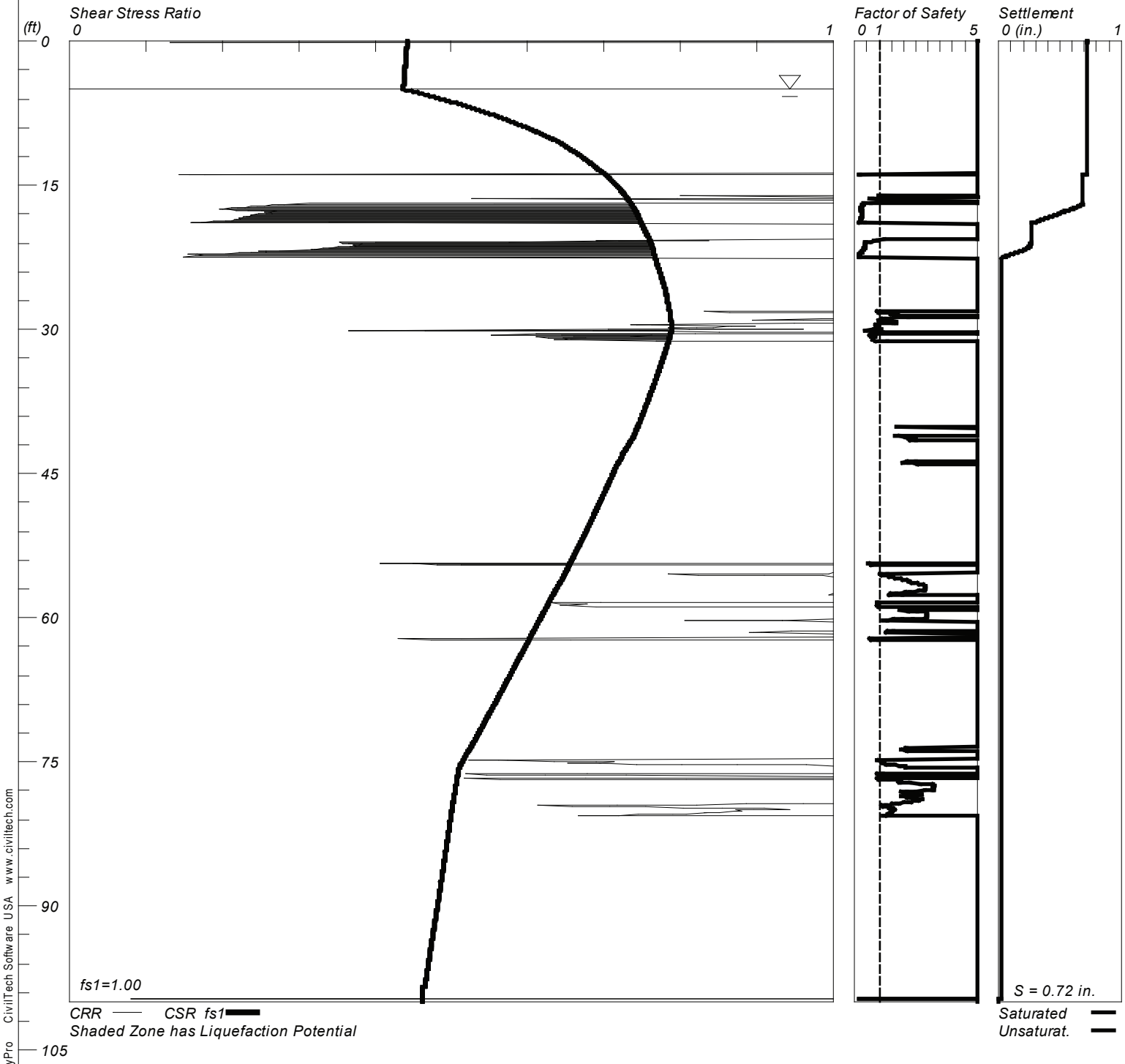


LIQUEFACTION ANALYSIS

Broadway Interchange Reconstruction

Hole No.=CPT-11-016 Water Depth=5 ft Surface Elev.=11 ft

Magnitude=7.9
Acceleration=0.68g



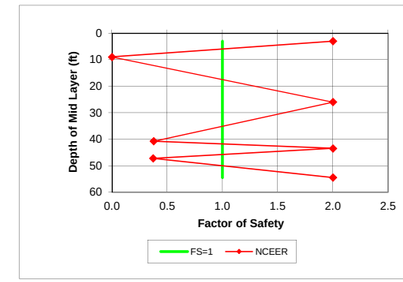
LIQUEFACTION ANALYSIS

Project	Broadway Interchange Reconstruction
Project No.	28645286
Boring No.	R-11-011

PGA =	0.68	
M_w =	7.9	
GWT during EQ	3.5	ft
Sampler:	Symbol	Corr. Factor
SPT	S	1
Mod.Cal	M	0.8
California	C	0.7
Mag. Weighting Factor($CSR_M/CSR_{M=7.5}$)		1.16

Note: Cells in Red must be input

Hammer type :	Type		C_E	Code	C_E
	Donut		0.75	1	3
	Safety		1	2	
	Auto		1.72	3	
Borehole Diameter:	(inch)	(mm)	C_B		C_B
	2.5-4.5	65-115	1	1	1
	6	150	1.05	2	
	8	200	1.15	3	
Rod Length:	(feet)	(m)	C_R		
	Default			999	
Sampling Method:	Type		Cs		
	Stand		1		
	No liners		1.2		



Note: F.S. greater than 2 is set to be equal to 2

Layer Number	Soil Type (USCS)	γ_m pcf	At Bottom of Layer Depth ft	Depth m	At Center of Layer Depth ft	Depth m	σ_o psf	EQ u psf	EQ σ'_o psf	r_d	EQ CSR	N raw	Sampler	N SPT	Fines Content %	C_{fines}	C_N EQ	C_E	C_B	C_R	C_S	$(N_1)_{60-cs}$ during EQ	$CRR^*_{7.5,1tsf}$ Critical	Magnitude Scaling Factor NCEER K_m Lower	Upper	Middle	Overburden Correction K_σ	Above GWT?	F.S. NCEER	Liquefy ? NCEER	F.S=1.0
1	CL	120	6.0	1.83	3	0.91	360	0	360	0.995	0.440													0.88	0.84	0.86	1.000	Y	2.00	N	1
2	OH/CH	90	12.0	3.66	9.0	2.74	990	343	647	0.981	0.664													0.88	0.84	0.86	1.000	N	0.00	Liquef	1
3	CL	120	40.0	12.19	26.0	7.92	2,940	1,404	1,536	0.938	0.794													0.88	0.84	0.86	1.000	N	2.00	N	1
4	SC-SM	120	41.5	12.65	40.8	12.42	4,710	2,324	2,386	0.844	0.737	19	M	15	23	1.14	0.92	1.72	1.00	1.00	1.00	27	0.330	0.88	0.84	0.86	0.981	N	0.38	Liquef	1
5	SC-SM	120	45.5	13.87	43.5	13.26	5,040	2,496	2,544	0.818	0.717	24	S	24	23	1.12	0.90	1.72	1.00	1.00	1.00	41	0.459	0.88	0.84	0.86	0.972	N	2.00	N	1
6	SC	120	49.0	14.94	47.3	14.40	5,490	2,730	2,760	0.781	0.687	15	S	15	32	1.20	0.86	1.72	1.00	1.00	1.00	27	0.312	0.88	0.84	0.86	0.959	N	0.37	Liquef	1
7	CL	140	60.0	18.29	54.5	16.61	6,470	3,182	3,288	0.708	0.616													0.88	0.84	0.86	0.930	N	2.00	N	1

Layer Number	Depth to Bot. Layer	Thickness ft	σ_o psf	u psf	σ'_o psf	r_d	$(N_1)_{60-cs}$	Liquefy ? NCEER	τ_{cyc} psf	$CSR_{M=7.5}$ τ_{cyc}/σ'_o	CSR_M τ_{cyc}/σ'_o	Volumetric Strain** %	Settl. in	
1	6.0	6.0	360	0	360	0.995	0.0	N	158.3	0.440	0.51			
2	12.0	6.0	990	343	647	0.981	0.0	Liquef	429.4	0.664	0.77			
3	40.0	28.0	2,940	1,404	1,536	0.938	0.0	N	1219.1	0.794	0.92			
4	41.5	1.5	4,710	2,324	2,386	0.844	27.5	Liquef	1757.8	0.737	0.86	1.0	0.18	
5	45.5	4.0	5,040	2,496	2,544	0.818	41.4	N	1823.2	0.717	0.83			
6	49.0	3.5	5,490	2,730	2,760	0.781	26.6	Liquef	1894.8	0.687	0.80	0.0	0.00	LL=34, PI=18, -#200=32%, Clay= 12.5%, Falls in Zone B, Nearby borings have WC ~16%, WC<0.85LL, NON LIQUEFIABLE
7	60.0	11.0	6,470	3,182	3,288	0.708	0.0	N	2024.9	0.616	0.72			

Total Settlement (inch) = 0.18

* Note: The equation used to obtain $CRR_{7.5}$ is not valid for corrected $(N_1)_{60}$ higher than 30. According to NCEER 1997, the soil layer with corrected $(N_1)_{60}$ higher than 30 blows per foot is unlikely to be susceptible to liquefaction.

** Note: These values were obtained from a chart for estimation of volumetric strain in saturated sands based on a cyclic stress ratio and standard penetration resistance (Tokimatsu and Seed, 1987).
See figure 9.53 from "Geotechnical Earthquake Engineering" by S. Kramer.

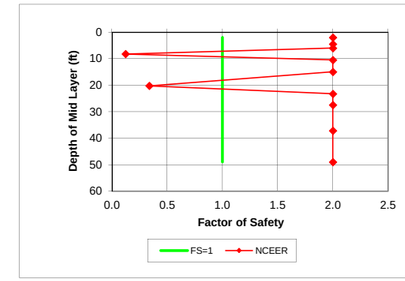
LIQUEFACTION ANALYSIS

Project	Broadway Interchange Reconstruction
Project No.	28645286
Boring No.	R-11-013

PGA =	0.68	
M_w =	7.9	
GWT during EQ	7.0	ft
Sampler:	Symbol	Corr. Factor
SPT	S	1
Mod.Cal	M	0.8
California	C	0.7
Mag. Weighting Factor($CSR_M/CSR_{M=7.5}$)		1.16

Note: Cells in Red must be input

Hammer type :	Type		C_E	Code	C_E
	Donut		0.75	1	3
	Safety		1	2	
	Auto		1.55	3	
Borehole Diameter:	(inch)	(mm)	C_B		C_B
	2.5-4.5	65-115	1	1	1
	6	150	1.05	2	
	8	200	1.15	3	
Rod Length:	(feet)	(m)	C_R		
	Default			999	
Sampling Method:	Type		Cs		
	Stand		1		
	No liners		1.2		



Note: F.S. greater than 2 is set to be equal to 2

Layer Number	Soil Type	γ_m	At Bottom of Layer Depth		At Center of Layer Depth		σ_o	EQ u	EQ σ'_o	r_d	EQ CSR	N raw	Sampler	N SPT	Fines Content	C_{fines}	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60-cs}$	$CRR^*_{7.5,1tsf}$	Magnitude Scaling Factor NCEER K_m Lower	Upper	Middle	Overburden Correction K_σ	Above GWT?	F.S.	Liquefy ?	F.S=1.0
	(USCS)	pcf	ft	m	ft	m	psf	psf	psf						%							during EQ	Critical						NCEER	NCEER	
1	CL	135	4.0	1.22	2	0.61	270	0	270	0.997	0.441													0.88	0.84	0.86	1.000	Y	2.00	N	1
2	SC-SM	135	5.0	1.52	4.5	1.37	608	0	608	0.991	0.438	39	M	31	20	1.09	1.87	1.55	1.00	0.75	1.00	74	0.459	0.88	0.84	0.86	1.000	Y	2.00	N	1
3	SC-SM	130	7.0	2.13	6.0	1.83	805	0	805	0.988	0.437	12	M	10	20	1.14	1.62	1.55	1.00	0.75	1.00	21	0.222	0.88	0.84	0.86	1.000	Y	2.00	N	1
4	SC-SM	125	9.5	2.90	8.3	2.51	1,091	78	1,013	0.983	0.468	3	M	2	20	1.34	1.40	1.55	1.00	0.75	1.00	5	0.067	0.88	0.84	0.86	1.000	N	0.12	Liquef	1
5	CL	125	11.5	3.51	10.5	3.20	1,373	218	1,154	0.978	0.514													0.88	0.84	0.86	1.000	N	2.00	N	1
6	OH/CH	90	18.5	5.64	15.0	4.57	1,813	499	1,313	0.969	0.591													0.88	0.84	0.86	1.000	N	2.00	N	1
7	SC	125	22.0	6.71	20.3	6.17	2,346	827	1,519	0.956	0.653	15	M	12	22	1.14	1.16	1.55	1.00	0.95	1.00	23	0.258	0.88	0.84	0.86	1.000	N	0.34	Liquef	1
8	SC	125	24.5	7.47	23.3	7.09	2,721	1,014	1,707	0.948	0.668	17	S	17	22	1.13	1.09	1.55	1.00	0.95	1.00	31	0.459	0.88	0.84	0.86	1.000	N	2.00	N	1
9	SC	140	30.5	9.30	27.5	8.38	3,298	1,279	2,018	0.932	0.673	28	M	22	22	1.12	1.01	1.55	1.00	0.95	1.00	37	0.459	0.88	0.84	0.86	1.000	N	2.00	N	1
10	CL	120	44.0	13.41	37.3	11.35	4,528	1,888	2,640	0.874	0.662													0.88	0.84	0.86	0.966	N	2.00	N	1
11	SC/GC	135	54.0	16.46	49.0	14.94	6,013	2,621	3,392	0.763	0.598	30	M	24	22	1.13	0.78	1.55	1.00	1.00	1.00	33	0.459	0.88	0.84	0.86	0.924	N	2.00	N	1

Layer Number	Depth to Bot. Layer	Thickness	σ_o	u	σ'_o	r_d	$(N_1)_{60-cs}$	Liquefy ?	τ_{cyc}	$CSR_{M=7.5}$	CSR_M	Volumetric Strain**			Settl.	
		ft	psf	psf	psf			NCEER	psf	τ_{cyc}/σ'_o	τ_{cyc}/σ'_o		%		in	
1	4.0	4.0	270	0	270	0.997		N	119.0	0.441	0.51					
2	5.0	1.0	608	0	608	0.991	74.1	N	266.2	0.438	0.51					LL=23, PI=6, -#200=20%, Clay=7.4%
3	7.0	2.0	805	0	805	0.988	20.5	N	351.5	0.437	0.51		1.5		0.36	
4	9.5	2.5	1,091	78	1,013	0.983	5.2	Liquef	474.1	0.468	0.54		4.0		1.20	
5	11.5	2.0	1,373	218	1,154	0.978		N	593.3	0.514	0.60					
6	18.5	7.0	1,813	499	1,313	0.969		N	775.9	0.591	0.69					
7	22.0	3.5	2,346	827	1,519	0.956	23.3	Liquef	991.7	0.653	0.76		0.0		0.00	LL=29, PI=13, -#200=22%, Clay=10.6, falls in Zone B, Non Liquefiable
8	24.5	2.5	2,721	1,014	1,707	0.948	30.9	N	1139.8	0.668	0.78					
9	30.5	6.0	3,298	1,279	2,018	0.932	37.3	N	1358.6	0.673	0.78					
10	44.0	13.5	4,528	1,888	2,640	0.874		N	1748.9	0.662	0.77					
11	54.0	10.0	6,013	2,621	3,392	0.763	32.8	N	2027.5	0.598	0.70					
												Total Settlement (inch) =			**1.56**	

* Note: The equation used to obtain $CRR_{7.5}$ is not valid for corrected $(N_1)_{60}$ higher than 30. According to NCEER 1997, the soil layer with corrected $(N_1)_{60}$ higher than 30 blows per foot is unlikely to be susceptible to liquefaction.

** Note: These values were obtained from a chart for estimation of volumetric strain in saturated sands based on a cyclic stress ratio and standard penetration resistance (Tokimatsu and Seed, 1987).
See figure 9.53 from "Geotechnical Earthquake Engineering" by S. Kramer.

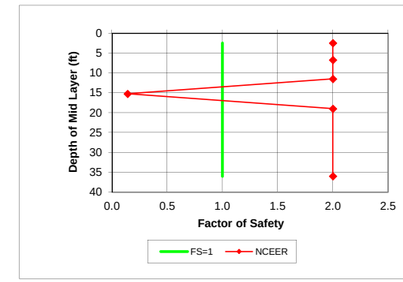
LIQUEFACTION ANALYSIS

Project	Broadway Interchange Reconstruction
Project No.	28645286
Boring No.	R-11-014

PGA =	0.68	
M_w =	7.9	
GWT during EQ	5.0	ft
Sampler:	Symbol	Corr. Factor
SPT	S	1
Mod.Cal	M	0.8
California	C	0.7
Mag. Weighting Factor($CSR_M/CSR_{M=7.5}$)		1.16

Note: Cells in Red must be input

Hammer type :	Type		C_E	Code	C_E
	Donut		0.75	1	3
	Safety		1	2	
	Auto		1.55	3	
Borehole Diameter:	(inch)	(mm)	C_B		C_B
	2.5-4.5	65-115	1	1	1
	6	150	1.05	2	
	8	200	1.15	3	
Rod Length:	(feet)	(m)	C_R		
	Default			999	
Sampling Method:	Type		Cs		
	Stand		1		
	No liners		1.2		



Note: F.S. greater than 2 is set to be equal to 2

Layer Number	Soil Type	γ_m	At Bottom of Layer: Depth		At Center of Layer: Depth		σ_o	EQ: u	EQ: σ'_o	r_d	EQ CSR
	(USCS)	pcf	ft	m	ft	m	psf	psf	psf		
1	ML	120	5.0	1.52	2.5	0.76	300	0	300	0.996	0.440
2	CL	120	8.5	2.59	6.8	2.06	810	109	701	0.986	0.504
3	OH/CH	100	14.5	4.42	11.5	3.51	1,320	406	914	0.976	0.623
4	SM	125	16.0	4.88	15.3	4.65	1,714	640	1,074	0.968	0.683
5	CH	115	22.0	6.71	19.0	5.79	2,153	874	1,279	0.959	0.714
6	CL	125	50.0	15.24	36.0	10.97	4,248	1,934	2,313	0.883	0.717

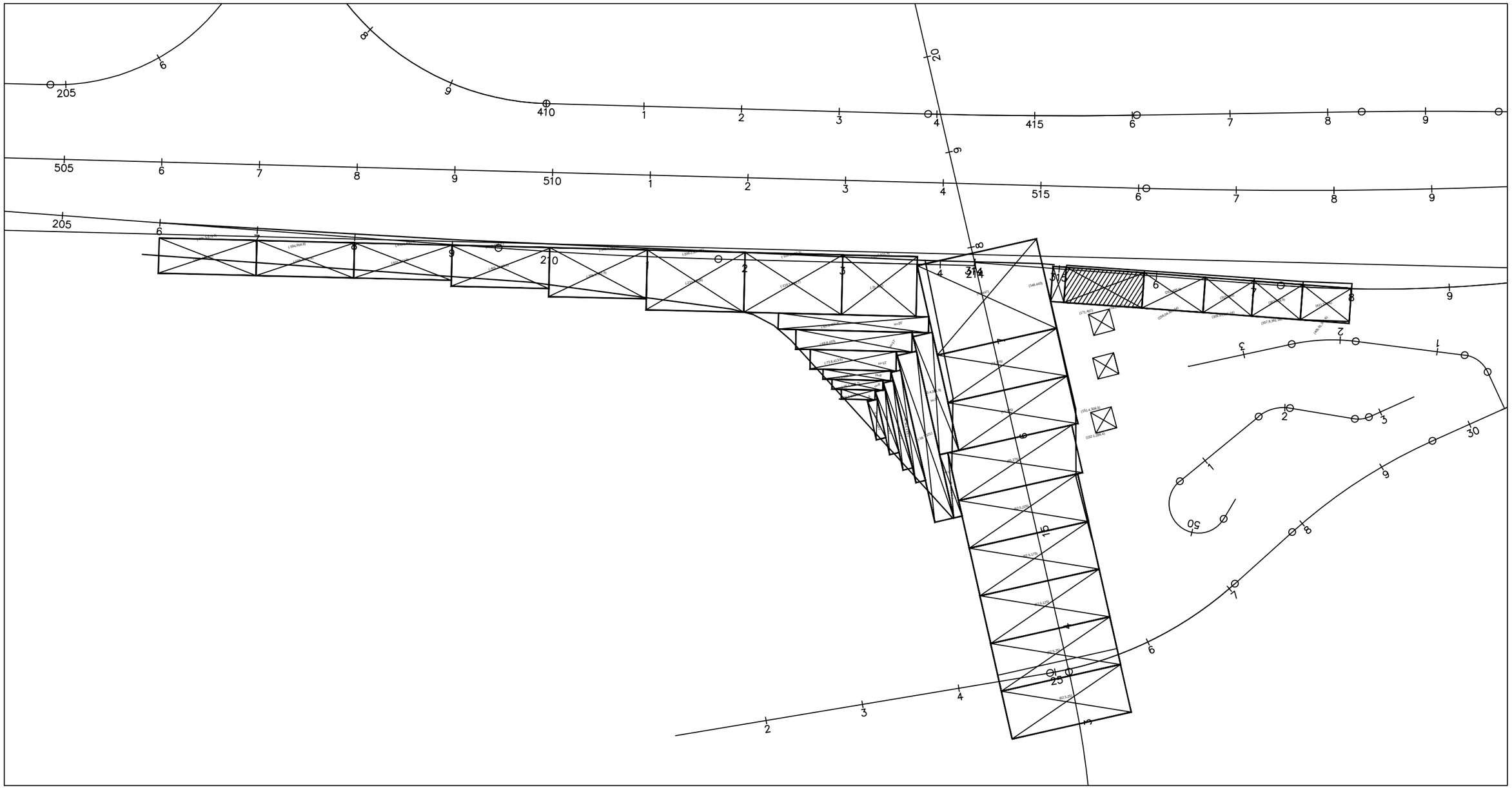
Layer Number	N raw	Sampler	N SPT	Fines Content	C_{fines}	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60-cs}$	$CRR^*_{7.5,1tsf}$	Magnitude Scaling Factor: NCEER K_m Lower	Upper	Middle	Overburden Correction K_σ	Above GWT?	F.S.	Liquefy ?	F.S=1.0
				%		EQ					during EQ	Critical						NCEER	NCEER	
1													0.88	0.84	0.86	1.000	Y	2.00	N	1
2													0.88	0.84	0.86	1.000	N	2.00	N	1
3													0.88	0.84	0.86	1.000	N	2.00	N	1
4	6	M	5	20	1.20	1.36	1.55	1.00	0.85	1.00	10	0.112	0.88	0.84	0.86	1.000	N	0.14	Liquef	1
5													0.88	0.84	0.86	1.000	N	2.00	N	1
6													0.88	0.84	0.86	0.986	N	2.00	N	1

Layer Number	Depth to Bot. Layer	Thickness	σ_o	u	σ'_o	r_d	$(N_1)_{60-cs}$	Liquefy ?	τ_{cyc}	$CSR_{M=7.5}$	CSR_M	Volumetric Strain**	Settl.
		ft	psf	psf	psf			NCEER	psf	τ_{cyc}/σ'_o	τ_{cyc}/σ'_o	%	in
1	5.0	5.0	300	0	300	0.996	0.0	N	132.1	0.440	0.51		
2	8.5	3.5	810	109	701	0.986	0.0	N	353.1	0.504	0.59		
3	14.5	6.0	1,320	406	914	0.976	0.0	N	569.4	0.623	0.73		
4	16.0	1.5	1,714	640	1,074	0.968	10.3	Liquef	733.3	0.683	0.79	2.4	0.43
5	22.0	6.0	2,153	874	1,279	0.959	0.0	N	912.8	0.714	0.83		
6	50.0	28.0	4,248	1,934	2,313	0.883	0.0	N	1658.6	0.717	0.83		

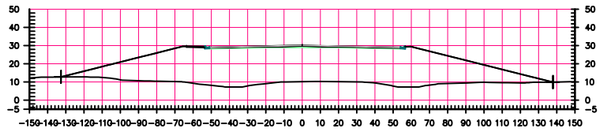
Total Settlement (inch) = 0.43

* Note: The equation used to obtain $CRR_{7.5}$ is not valid for corrected $(N_1)_{60}$ higher than 30. According to NCEER 1997, the soil layer with corrected $(N_1)_{60}$ higher than 30 blows per foot is unlikely to be susceptible to liquefaction.

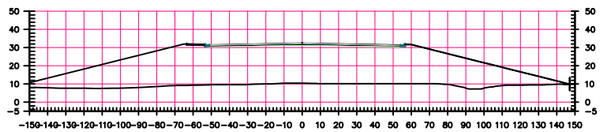
** Note: These values were obtained from a chart for estimation of volumetric strain in saturated sands based on a cyclic stress ratio and standard penetration resistance (Tokimatsu and Seed, 1987).
See figure 9.53 from "Geotechnical Earthquake Engineering" by S. Kramer.



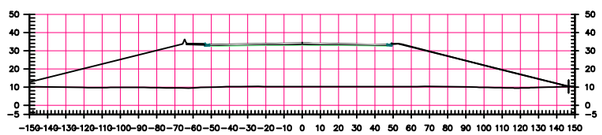
Embankment Load Estimates
West Approach Embankment &
Southbound On-/Off-Ramp
101 / Broadway (BWY and B2, B3)



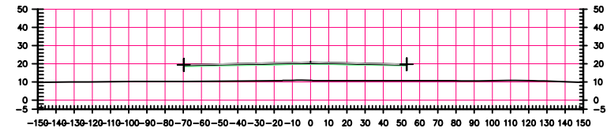
21+12
(x,y) = (-2.5, 145); H=20 ft



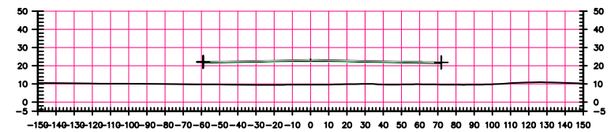
20+60
(x,y) = (-2.5, 75); H=22 ft



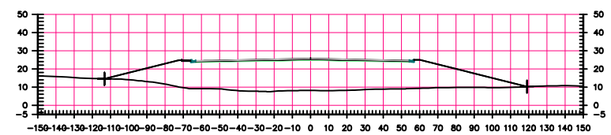
20+10
(x,y) = (-5, 25); H=24 ft



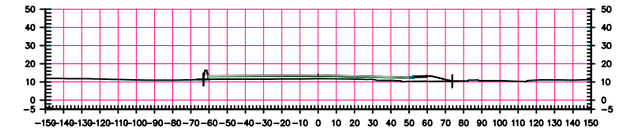
23+00
(x,y) = (-7.5, 315); H=10 ft



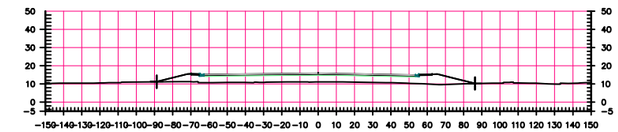
22+50
(x,y) = (5, 265); H=13.5 ft



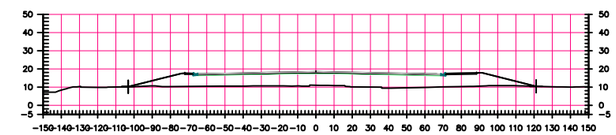
22+03
(x,y) = (-5, 215); H=17.5 ft



24+60
(x,y) = (5, 470); H=2 ft



24+00
(x,y) = (-2.5, 420); H=5 ft



23+48
(x,y) = (10, 365); H=8 ft

Legend:

(x,y) = local coordinates;
0,0 at BWY Station 20+10, 0 offset.
H = height of rectangular block of fill simulating embankment load

Embankment Load Estimates
Cross-sections
East Approach Embankment
Broadway (BWY)

URS

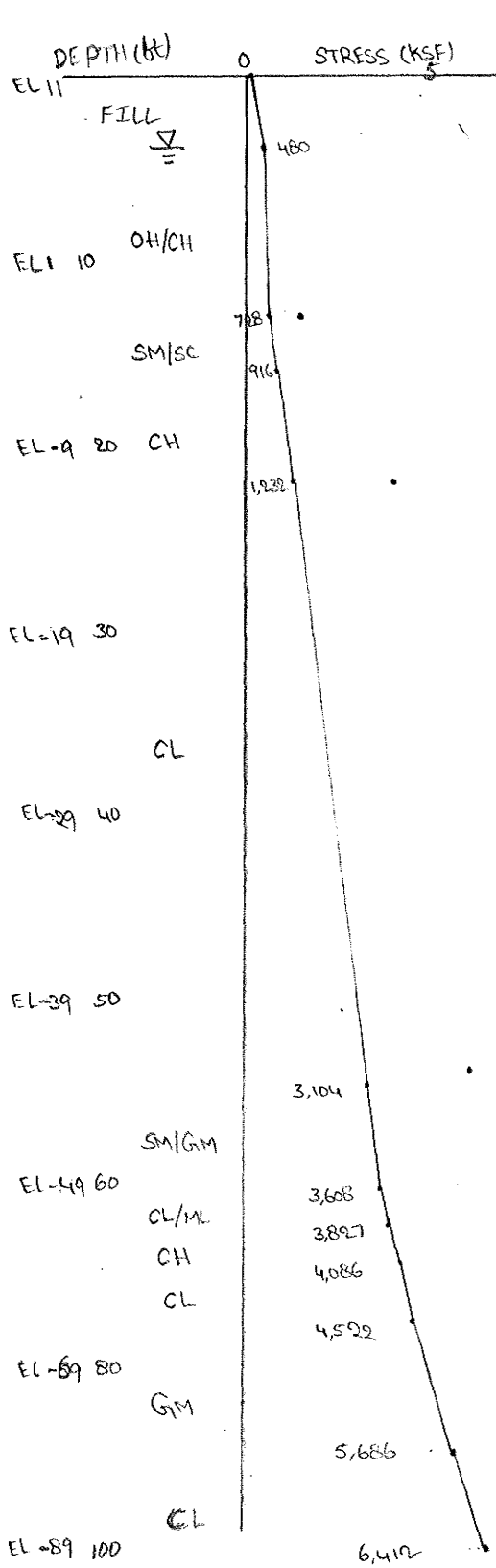
Page ____ of ____

Job BROADWAY INTERCHANGE RECONSTRUCTION Project No. 28645286 Sheet ____ of ____

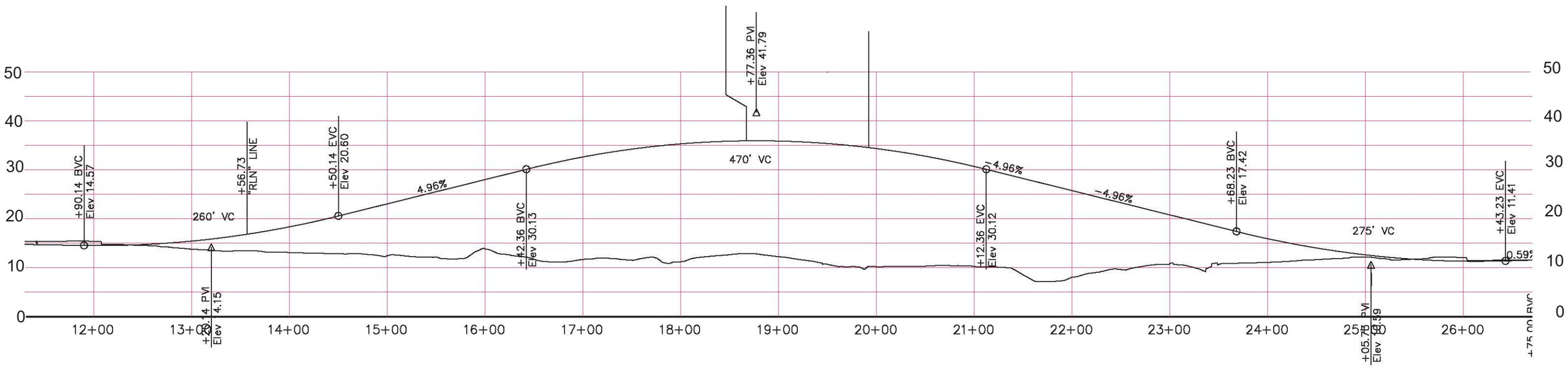
Description BROADWAY WEST APPROACH EMBANKMENT SETTLEMENT Computed by MT Date 12/8/11

Checked by SHUANG Date 1/20/12

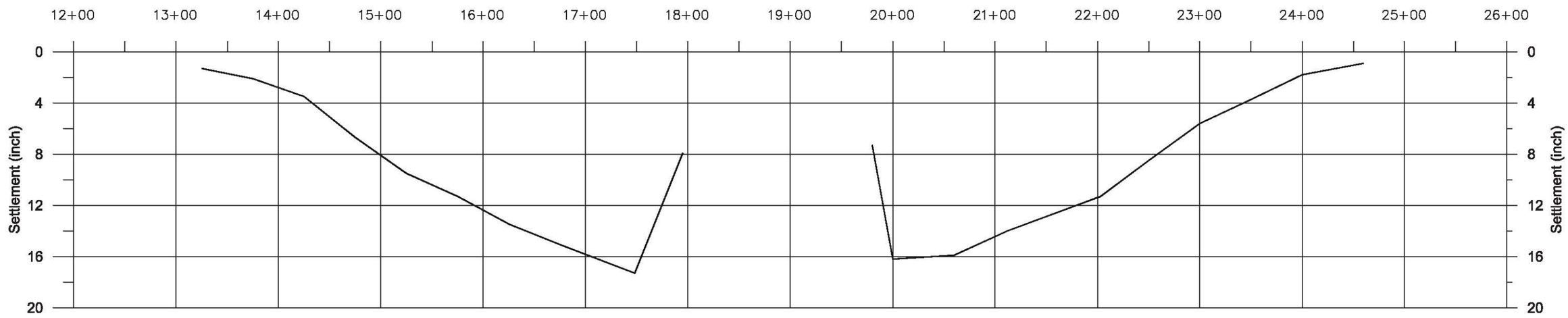
Reference



	γ' PCF	C_{CE}	$C_{\gamma E}$	P_p (KSF)	E $\times 10^6$ PSF	μ	C_α	A	t_{ZERO}	S_u/σ_{vo}
FILL	120	-	-		0.30	0.3	-	1	10	
OH/CH	27.6	0.30	0.03	1.3 / 1.8	0.03	0.5	0.015	1	10	
SM/SC	62.6	-	-	-	0.23	0.3	-	1	10	
CH	52.6	0.19	0.02	3.5	0.26	0.5	-	1	10	
CL	57.6	0.12	0.015	4.5 / 5.5	0.78	0.5	-	1	10	
SM/GM	77.6	-	-		0.80	0.4	-	1	10	
CL/ML	62.6	0.12	0.015	7.0	0.70	0.5	-	1	10	
CH	57.6	0.19	0.02		1.00	0.5	-	1	10	
CL	72.6	0.05	0.005		1.00	0.5	-	1	10	
GM	77.6	-	-		1.65	0.4	-	1	10	
CL	72.6	0.05	0.005		1.00	0.5	-	1	10	


+77.36 PVI
Elev 41.79
+90.14 BVC
Elev 14.57
+56.73
"RLN" LINE
+50.14 EVC
Elev 20.60
470' VC
4.96%
-4.96%
+68.23 BVC
Elev 17.42
+43.23 EVC
Elev 11.41
260' VC
275' VC
+42.36 BVC
Elev 30.13
+12.36 EVC
Elev 30.12
+29.14 PVI
Elev 4.15
+05.75 PVI
Elev 19.59
0.59%
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00
0
10
20
30
40
50

"BWY" LINE


12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00
Settlement (inch)
0
4
8
12
16
20

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1
FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

bwy_2.dat
NUMBER OF SOIL LAYERS: 13

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	11.0	7.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	7.0	3.0	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
3	3.0	-2.0	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
4	-2.0	-5.0	62.6	.000	.000	3000.0	.230	.30	.00000	1.000	5.00
5	-5.0	-11.0	52.6	.190	.020	3500.0	.260	.50	.00000	1.000	5.00
6	-11.0	-27.0	57.6	.120	.015	4500.0	.780	.50	.00000	1.000	5.00
7	-27.0	-43.5	57.6	.120	.015	5500.0	.780	.50	.00000	1.000	5.00
8	-43.5	-50.0	77.6	.000	.000	6500.0	.800	.40	.00000	1.000	5.00
9	-50.0	-53.5	62.6	.120	.015	7000.0	.700	.50	.00000	1.000	5.00
10	-53.5	-58.0	57.6	.190	.020	7500.0	1.000	.50	.00000	1.000	5.00
11	-58.0	-64.0	72.6	.050	.005	8000.0	1.000	.50	.00000	1.000	5.00
12	-64.0	-79.0	77.6	.000	.000	9000.0	1.700	.40	.00000	1.000	5.00
13	-79.0	-89.0	72.6	.050	.005	10000.0	1.000	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 36

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	62.50	25.00	.00	11.00	125.00	50.00	375.00
2	62.50	75.00	.00	11.00	125.00	50.00	625.00
3	62.50	125.00	.00	11.00	125.00	50.00	938.00
4	62.50	175.00	.00	11.00	125.00	50.00	1375.00
5	62.50	225.00	.00	11.00	125.00	50.00	1750.00
6	65.00	275.00	.00	11.00	130.00	50.00	2000.00
7	74.00	325.00	.00	11.00	125.00	50.00	2375.00
8	74.00	375.00	.00	11.00	125.00	50.00	2625.00
9	74.00	447.00	.00	11.00	125.00	93.80	3000.00
10	148.00	443.00	16.70	11.00	13.50	36.00	3000.00
11	193.00	430.00	16.70	11.00	80.00	36.00	.10
12	261.00	409.50	16.70	11.00	62.70	36.00	1625.00
13	315.00	393.00	16.70	11.00	50.00	36.00	1125.00
14	363.00	378.50	16.70	11.00	50.00	36.00	625.00
15	411.50	364.00	16.70	11.00	50.00	36.00	250.00
16	-31.00	482.00	14.10	11.00	76.40	61.10	3000.00
17	-116.50	503.70	14.10	11.00	100.00	61.10	2625.00
18	-213.50	528.00	14.10	11.00	100.00	61.10	2250.00
19	-309.10	557.60	14.10	11.00	100.00	50.00	1500.00
20	-405.10	585.50	14.10	11.00	100.00	42.00	1000.00
21	-501.50	613.00	14.10	11.00	100.00	36.00	625.00
22	-598.40	637.40	14.10	11.00	100.00	36.00	375.00
23	-695.40	661.70	14.10	11.00	100.00	36.00	250.00

24	-65.30	450.80	14.10	11.00	153.60	16.30	2500.00
25	-68.80	433.00	14.10	11.00	118.90	20.00	2125.00
26	-73.80	413.60	14.10	11.00	88.06	20.00	1500.00
27	-73.50	398.10	14.10	11.00	69.30	10.00	1000.00
28	-75.10	388.20	14.10	11.00	52.06	10.00	750.00
29	-76.60	378.20	14.10	11.00	34.43	10.00	500.00
30	-63.70	349.10	.00	11.00	10.00	40.12	500.00
31	-53.70	344.20	.00	11.00	10.00	66.10	750.00
32	-43.60	338.50	.00	11.00	10.00	91.39	1000.00
33	-33.10	335.20	.00	11.00	10.00	115.70	1500.00
34	-18.70	321.00	.00	11.00	19.98	174.87	2125.00
35	-4.40	266.90	.00	11.00	8.62	66.38	2125.00
36	.40	361.90	.00	11.00	20.00	123.84	2500.00

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TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5
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SETTLEMENT POINT : 74.0, 493.8

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1595.3	1507.8	1472.5	1.000	.002	.000	.112	.114
2	535.2	1531.5	1396.8	1417.5	1.000	3.454	.578	.199	4.231
3	659.4	1516.7	1302.5	1356.2	1.000	2.268	.722	.375	3.365
4	822.3	1509.3	1224.8	1302.5	1.000	.000	.000	.118	.118
5	1074.0	1501.8	1142.4	1243.2	1.000	.547	.000	.086	.633
6	1692.6	1477.7	963.0	1105.2	1.000	.785	.000	.109	.894
7	2628.6	1422.6	755.0	923.3	1.000	.558	.000	.148	.706
8	3356.0	1373.0	642.6	811.8	1.000	.000	.000	.077	.077
9	3717.7	1349.8	601.0	767.7	1.000	.085	.000	.040	.125
10	3956.9	1330.8	570.3	734.3	1.000	.136	.000	.037	.173
11	4304.3	1305.6	533.3	692.7	1.000	.041	.000	.050	.091
12	5104.1	1254.4	468.7	617.1	1.000	.000	.000	.087	.087
13	6049.1	1193.9	405.0	538.9	1.000	.047	.000	.087	.134
						7.924	1.300	1.523	10.748

SETTLEMENT POINT : 74.0, 447.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2999.9	2898.5	2881.3	1.000	.003	.000	.203	.206
2	535.2	2998.0	2697.0	2646.6	1.000	6.808	.578	.522	7.908
3	659.4	2989.7	2476.2	2392.6	1.000	6.309	.722	1.111	8.142
4	822.3	2974.0	2288.1	2180.4	1.000	.000	.000	.256	.256
5	1074.0	2945.4	2088.3	1960.8	1.000	1.561	.000	.255	1.816
6	1692.6	2826.0	1663.3	1517.7	1.000	1.264	.000	.304	1.568
7	2628.6	2565.0	1200.8	1075.9	1.000	.878	.000	.362	1.240
8	3356.0	2362.4	970.4	869.5	1.000	.000	.000	.159	.159
9	3717.7	2276.2	889.1	798.2	1.000	.131	.000	.086	.217
10	3956.9	2209.0	830.8	747.3	1.000	.208	.000	.077	.285
11	4304.3	2123.8	762.2	687.7	1.000	.063	.000	.101	.163
12	5104.1	1964.4	647.3	587.8	1.000	.000	.000	.156	.156
13	6049.1	1794.7	540.1	494.1	1.000	.068	.000	.153	.221
						17.294	1.300	3.743	22.337

SETTLEMENT POINT : 74.0, 375.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2625.0	2545.6	2565.1	1.000	.003	.000	.175	.178

2	535.2	2624.6	2387.9	2445.2	1.000	6.109	.578	.333	7.020
3	659.4	2622.6	2214.0	2310.6	1.000	5.480	.722	.721	6.924
4	822.3	2618.4	2064.4	2191.6	1.000	.000	.000	.210	.210
5	1074.0	2610.0	1903.6	2059.6	1.000	1.043	.000	.174	1.217
6	1692.6	2567.7	1552.4	1751.9	1.000	1.155	.000	.225	1.380
7	2628.6	2447.3	1151.1	1357.3	1.000	.849	.000	.303	1.152
8	3356.0	2332.1	941.5	1127.4	1.000	.000	.000	.147	.147
9	3717.7	2277.5	865.8	1039.8	1.000	.131	.000	.079	.210
10	3956.9	2232.7	811.0	974.8	1.000	.210	.000	.072	.282
11	4304.3	2172.8	745.9	895.8	1.000	.064	.000	.097	.161
12	5104.1	2052.1	635.5	757.8	1.000	.000	.000	.158	.159
13	6049.1	1910.9	531.2	623.5	1.000	.072	.000	.160	.232
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						15.116	1.300	2.855	19.271

SETTLEMENT POINT : 136.5, 375.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1312.5	1295.3	1293.0	1.000	.002	.000	.086	.087
2	535.2	1312.7	1260.8	1253.5	1.000	2.754	.578	.089	3.421
3	659.4	1313.4	1222.0	1207.9	1.000	1.501	.722	.197	2.421
4	822.3	1314.5	1187.3	1165.9	1.000	.000	.000	.095	.095
5	1074.0	1316.1	1148.3	1117.0	1.000	.500	.000	.051	.551
6	1692.6	1319.8	1053.4	992.8	1.000	.721	.000	.073	.794
7	2628.6	1315.1	917.6	812.9	1.000	.523	.000	.114	.637
8	3356.0	1300.6	827.3	698.4	1.000	.000	.000	.067	.067
9	3717.7	1291.5	789.9	652.9	1.000	.082	.000	.034	.116
10	3956.9	1282.9	760.9	618.6	1.000	.132	.000	.032	.164
11	4304.3	1270.3	724.1	576.1	1.000	.040	.000	.045	.085
12	5104.1	1240.9	654.8	499.9	1.000	.000	.000	.082	.083
13	6049.1	1200.1	580.1	422.9	1.000	.047	.000	.084	.131
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						6.303	1.300	1.049	8.653

SETTLEMENT POINT : .4, 361.9

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2499.5	2380.7	2414.5	1.000	.003	.000	.170	.173
2	535.2	2487.5	2164.2	2250.3	1.000	5.832	.578	.448	6.858
3	659.4	2455.0	1969.8	2084.3	1.000	5.071	.722	.856	6.649
4	822.3	2420.6	1827.1	1952.8	1.000	.000	.000	.201	.202
5	1074.0	2381.0	1687.6	1819.2	1.000	.731	.000	.174	.904
6	1692.6	2281.6	1411.8	1540.5	1.000	1.068	.000	.198	1.266
7	2628.6	2133.9	1112.5	1218.3	1.000	.767	.000	.246	1.012
8	3356.0	2033.6	947.8	1036.6	1.000	.000	.000	.121	.121
9	3717.7	1991.1	885.0	967.0	1.000	.117	.000	.064	.181
10	3956.9	1957.6	838.0	914.9	1.000	.189	.000	.058	.247
11	4304.3	1914.1	780.3	851.0	1.000	.058	.000	.079	.137
12	5104.1	1828.5	677.4	736.9	1.000	.000	.000	.134	.134
13	6049.1	1729.0	573.7	622.1	1.000	.066	.000	.136	.201

13.900	1.300	2.885	18.085

SETTLEMENT POINT : 74.0, 325.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2375.0	2299.0	2319.5	1.000	.003	.000	.158	.161
2	535.2	2374.1	2148.0	2209.4	1.000	5.593	.578	.313	6.483
3	659.4	2370.4	1982.3	2088.6	1.000	4.856	.722	.670	6.248
4	822.3	2363.7	1840.5	1985.0	1.000	.000	.000	.190	.190
5	1074.0	2351.7	1689.1	1873.2	1.000	.725	.000	.158	.883
6	1692.6	2302.3	1362.0	1621.4	1.000	1.074	.000	.200	1.274
7	2628.6	2185.8	994.1	1302.9	1.000	.781	.000	.263	1.044
8	3356.0	2083.3	804.9	1113.6	1.000	.000	.000	.128	.128
9	3717.7	2036.1	737.2	1039.8	1.000	.119	.000	.069	.188
10	3956.9	1997.6	688.4	984.3	1.000	.192	.000	.063	.254
11	4304.3	1946.7	630.8	916.0	1.000	.058	.000	.084	.143
12	5104.1	1844.8	534.2	793.7	1.000	.000	.000	.139	.139
13	6049.1	1726.3	444.2	670.1	1.000	.065	.000	.140	.206
						13.467	1.300	2.576	17.343

SETTLEMENT POINT : 136.5, 325.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1187.5	1170.0	1158.4	1.000	.001	.000	.078	.080
2	535.2	1186.5	1135.0	1102.1	1.000	2.312	.578	.109	2.999
3	659.4	1183.2	1096.2	1045.0	1.000	.968	.722	.225	1.915
4	822.3	1178.1	1062.2	1000.7	1.000	.000	.000	.088	.088
5	1074.0	1171.1	1024.7	957.1	1.000	.461	.000	.050	.511
6	1692.6	1153.7	936.2	867.5	1.000	.650	.000	.062	.712
7	2628.6	1133.6	814.3	751.2	1.000	.462	.000	.089	.552
8	3356.0	1120.4	734.7	674.1	1.000	.000	.000	.054	.054
9	3717.7	1114.1	701.9	641.8	1.000	.072	.000	.027	.098
10	3956.9	1108.8	676.6	616.7	1.000	.116	.000	.025	.141
11	4304.3	1101.2	644.4	584.6	1.000	.036	.000	.035	.071
12	5104.1	1083.9	583.9	523.9	1.000	.000	.000	.068	.068
13	6049.1	1059.6	518.7	457.9	1.000	.042	.000	.069	.111
						5.121	1.300	.978	7.399

SETTLEMENT POINT : 65.0, 275.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)

1	240.0	2000.0	1937.7	1964.8	1.000	.002	.000	.133	.135
2	535.2	1999.9	1813.8	1894.1	1.000	4.732	.578	.233	5.543
3	659.4	1999.2	1676.6	1813.6	1.000	3.834	.722	.508	5.064
4	822.3	1997.3	1558.1	1741.1	1.000	.000	.000	.158	.158
5	1074.0	1993.0	1430.0	1659.4	1.000	.656	.000	.124	.780
6	1692.6	1967.2	1147.5	1464.3	1.000	.965	.000	.163	1.127
7	2628.6	1886.3	821.3	1204.9	1.000	.698	.000	.222	.919
8	3356.0	1805.6	652.1	1047.6	1.000	.000	.000	.110	.110
9	3717.7	1766.9	591.9	985.9	1.000	.106	.000	.059	.165
10	3956.9	1734.9	548.7	939.3	1.000	.171	.000	.054	.224
11	4304.3	1692.1	498.2	881.7	1.000	.052	.000	.072	.124
12	5104.1	1605.4	414.6	777.8	1.000	.000	.000	.119	.120
13	6049.1	1503.8	339.0	671.3	1.000	.058	.000	.120	.178
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						11.273	1.300	2.074	14.648

SETTLEMENT POINT : 130.0, 275.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1000.0	986.0	994.5	1.000	.001	.000	.065	.066
2	535.2	1000.5	958.0	982.3	1.000	1.597	.578	.049	2.224
3	659.4	1002.4	926.4	965.1	1.000	.723	.722	.113	1.558
4	822.3	1005.1	898.1	946.3	1.000	.000	.000	.071	.071
5	1074.0	1008.7	866.2	921.6	1.000	.414	.000	.032	.446
6	1692.6	1015.9	788.8	852.9	1.000	.588	.000	.048	.636
7	2628.6	1016.3	679.9	748.3	1.000	.422	.000	.077	.498
8	3356.0	1009.3	608.9	678.1	1.000	.000	.000	.048	.048
9	3717.7	1004.6	579.9	649.0	1.000	.065	.000	.023	.089
10	3956.9	1000.3	557.5	626.3	1.000	.106	.000	.022	.128
11	4304.3	993.8	529.3	597.5	1.000	.032	.000	.031	.063
12	5104.1	978.4	476.9	542.8	1.000	.000	.000	.060	.061
13	6049.1	956.4	421.3	483.1	1.000	.038	.000	.061	.099
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						3.987	1.300	.700	5.987

SETTLEMENT POINT : 62.5, 225.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1750.0	1685.6	1711.9	1.000	.002	.000	.117	.119
2	535.2	1749.2	1558.0	1636.4	1.000	4.080	.578	.243	4.902
3	659.4	1745.8	1418.2	1554.2	1.000	3.051	.722	.519	4.292
4	822.3	1739.6	1299.2	1484.4	1.000	.000	.000	.142	.142
5	1074.0	1728.8	1173.0	1409.8	1.000	.600	.000	.121	.721
6	1692.6	1685.0	904.9	1244.2	1.000	.864	.000	.150	1.014
7	2628.6	1584.7	615.8	1037.5	1.000	.609	.000	.192	.801
8	3356.0	1499.5	475.7	914.9	1.000	.000	.000	.092	.092
9	3717.7	1461.1	427.6	866.9	1.000	.091	.000	.049	.140
10	3956.9	1430.4	393.7	830.7	1.000	.145	.000	.044	.189
11	4304.3	1390.2	354.7	785.9	1.000	.044	.000	.059	.103

12	5104.1	1311.7	291.8	704.6	1.000	.000	.000	.097	.097
13	6049.1	1223.7	236.7	620.6	1.000	.048	.000	.095	.143
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						9.533	1.300	1.921	12.754

SETTLEMENT POINT : 125.0, 225.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	875.0	859.2	870.7	1.000	.001	.000	.057	.058
2	535.2	875.4	827.8	861.1	1.000	1.066	.578	.050	1.693
3	659.4	876.7	792.8	847.2	1.000	.661	.722	.114	1.497
4	822.3	878.6	762.2	831.8	1.000	.000	.000	.063	.063
5	1074.0	880.7	728.6	811.7	1.000	.375	.000	.031	.405
6	1692.6	883.1	650.6	756.9	1.000	.525	.000	.044	.569
7	2628.6	876.8	547.0	675.3	1.000	.371	.000	.067	.439
8	3356.0	866.9	482.7	620.7	1.000	.000	.000	.041	.042
9	3717.7	861.5	457.0	598.0	1.000	.057	.000	.020	.077
10	3956.9	856.6	437.4	580.2	1.000	.092	.000	.019	.111
11	4304.3	849.8	413.1	557.4	1.000	.028	.000	.026	.054
12	5104.1	834.4	368.7	513.9	1.000	.000	.000	.051	.051
13	6049.1	813.8	322.8	465.8	1.000	.033	.000	.050	.083
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						3.209	1.300	.633	5.142

SETTLEMENT POINT : 62.5, 175.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1375.0	1320.6	1347.1	1.000	.002	.000	.092	.094
2	535.2	1374.4	1212.8	1291.8	1.000	2.960	.578	.195	3.733
3	659.4	1371.7	1095.0	1231.2	1.000	1.729	.722	.417	2.869
4	822.3	1366.8	994.9	1179.3	1.000	.000	.000	.112	.112
5	1074.0	1358.0	889.3	1123.7	1.000	.511	.000	.097	.608
6	1692.6	1320.9	667.6	999.7	1.000	.722	.000	.120	.841
7	2628.6	1234.5	436.3	845.9	1.000	.497	.000	.151	.647
8	3356.0	1161.8	328.9	755.7	1.000	.000	.000	.071	.071
9	3717.7	1129.5	293.1	720.5	1.000	.073	.000	.037	.110
10	3956.9	1103.9	268.2	694.1	1.000	.115	.000	.034	.149
11	4304.3	1070.8	240.0	661.3	1.000	.035	.000	.045	.079
12	5104.1	1007.2	195.5	601.8	1.000	.000	.000	.073	.073
13	6049.1	937.7	157.8	540.0	1.000	.038	.000	.071	.108
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						6.680	1.300	1.514	9.495

SETTLEMENT POINT : 125.0, 175.0

SOIL	INITIAL	VERTICAL STRESS	HORIZ. X STRESS	HORIZ. Y STRESS	SKEMPTON BJERRUM	CONSOL.	SECOND. COMP.	ELASTIC	TOTAL

LAYER	STRESS (PSF)	INCREASE (PSF)	INCREASE (PSF)	INCREASE (PSF)	FACTOR	COMP. (IN.)	20. YR (IN.)	COMP. (IN.)	COMP. (IN.)
1	240.0	687.5	674.6	680.4	1.000	.001	.000	.045	.046
2	535.2	687.4	648.9	666.3	1.000	.517	.578	.048	1.142
3	659.4	687.0	620.3	650.9	1.000	.558	.722	.103	1.383
4	822.3	686.3	595.3	637.7	1.000	.000	.000	.050	.050
5	1074.0	685.3	567.7	623.4	1.000	.309	.000	.025	.333
6	1692.6	681.5	503.6	589.9	1.000	.423	.000	.033	.456
7	2628.6	673.3	418.9	542.1	1.000	.294	.000	.049	.343
8	3356.0	665.3	366.9	509.0	1.000	.000	.000	.031	.031
9	3717.7	661.2	346.3	494.8	1.000	.045	.000	.014	.059
10	3956.9	657.7	330.7	483.5	1.000	.072	.000	.014	.086
11	4304.3	652.7	311.5	469.0	1.000	.022	.000	.019	.041
12	5104.1	641.7	276.7	440.5	1.000	.000	.000	.038	.038
13	6049.1	627.0	241.3	407.9	1.000	.026	.000	.036	.062
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						2.266	1.300	.503	4.070

SETTLEMENT POINT : 62.5, 125.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	938.0	902.0	927.1	1.000	.001	.000	.062	.063
2	535.2	938.0	830.6	904.8	1.000	1.337	.578	.112	2.028
3	659.4	937.8	752.0	878.2	1.000	.692	.722	.245	1.659
4	822.3	937.0	684.8	853.2	1.000	.000	.000	.074	.074
5	1074.0	934.7	613.1	823.7	1.000	.392	.000	.060	.451
6	1692.6	919.4	460.4	750.3	1.000	.543	.000	.077	.620
7	2628.6	870.7	298.6	650.9	1.000	.369	.000	.101	.470
8	3356.0	824.9	223.2	590.8	1.000	.000	.000	.049	.049
9	3717.7	803.8	198.0	567.3	1.000	.054	.000	.025	.079
10	3956.9	786.8	180.6	549.6	1.000	.085	.000	.023	.108
11	4304.3	764.7	161.0	527.6	1.000	.026	.000	.030	.056
12	5104.1	721.8	130.2	487.6	1.000	.000	.000	.050	.050
13	6049.1	674.5	104.5	446.0	1.000	.028	.000	.048	.075
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						3.525	1.300	.957	5.783

SETTLEMENT POINT : 125.0, 125.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	469.0	461.5	469.1	1.000	.000	.000	.030	.031
2	535.2	469.2	446.5	468.9	1.000	.394	.578	.018	.990
3	659.4	469.7	429.4	467.7	1.000	.420	.722	.042	1.185
4	822.3	470.6	414.1	465.5	1.000	.000	.000	.032	.032
5	1074.0	471.9	396.9	461.8	1.000	.228	.000	.012	.240
6	1692.6	475.0	355.0	448.8	1.000	.309	.000	.018	.327
7	2628.6	476.6	297.0	424.4	1.000	.215	.000	.029	.244
8	3356.0	474.7	260.4	405.6	1.000	.000	.000	.020	.020
9	3717.7	473.2	245.9	397.3	1.000	.033	.000	.009	.042

10	3956.9	471.7	234.8	390.6	1.000	.053	.000	.009	.061
11	4304.3	469.4	221.2	381.9	1.000	.016	.000	.012	.028
12	5104.1	463.7	196.5	364.4	1.000	.000	.000	.025	.025
13	6049.1	455.4	171.5	343.9	1.000	.019	.000	.024	.043
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						1.687	1.300	.282	3.270

SETTLEMENT POINT : 62.5, 75.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	625.0	600.7	618.5	1.000	.000	.000	.041	.042
2	535.2	624.9	552.5	605.4	1.000	.484	.578	.074	1.135
3	659.4	624.6	499.6	589.9	1.000	.521	.722	.160	1.403
4	822.3	623.8	454.3	575.4	1.000	.000	.000	.049	.049
5	1074.0	621.9	406.1	558.6	1.000	.286	.000	.039	.324
6	1692.6	610.6	303.9	517.5	1.000	.385	.000	.049	.434
7	2628.6	577.5	195.9	462.9	1.000	.256	.000	.063	.319
8	3356.0	547.2	145.8	430.3	1.000	.000	.000	.031	.031
9	3717.7	533.4	129.2	417.6	1.000	.037	.000	.016	.052
10	3956.9	522.4	117.7	407.9	1.000	.058	.000	.014	.072
11	4304.3	508.1	104.7	396.0	1.000	.017	.000	.019	.036
12	5104.1	480.8	84.5	374.1	1.000	.000	.000	.031	.032
13	6049.1	451.1	67.8	350.8	1.000	.019	.000	.029	.048
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						2.063	1.300	.615	3.978

SETTLEMENT POINT : 125.0, 75.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	312.5	307.4	313.6	1.000	.000	.000	.020	.020
2	535.2	312.6	297.1	315.6	1.000	.288	.578	.010	.876
3	659.4	312.9	285.5	317.3	1.000	.304	.722	.023	1.049
4	822.3	313.3	275.1	318.2	1.000	.000	.000	.021	.021
5	1074.0	314.0	263.5	318.6	1.000	.160	.000	.006	.167
6	1692.6	315.6	235.5	317.1	1.000	.214	.000	.010	.224
7	2628.6	316.5	197.2	311.0	1.000	.147	.000	.016	.163
8	3356.0	315.8	173.2	304.9	1.000	.000	.000	.012	.012
9	3717.7	315.1	163.7	301.9	1.000	.022	.000	.005	.027
10	3956.9	314.4	156.5	299.3	1.000	.036	.000	.005	.041
11	4304.3	313.3	147.5	295.8	1.000	.011	.000	.007	.018
12	5104.1	310.7	131.5	288.3	1.000	.000	.000	.015	.015
13	6049.1	306.9	115.3	278.6	1.000	.013	.000	.013	.026
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						1.194	1.300	.163	2.658

SETTLEMENT POINT : 62.5, 25.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	375.0	358.9	368.3	1.000	.000	.000	.025	.025
2	535.2	374.6	327.1	355.4	1.000	.332	.578	.053	.963
3	659.4	372.9	292.6	342.9	1.000	.350	.722	.110	1.183
4	822.3	370.1	263.8	333.8	1.000	.000	.000	.030	.030
5	1074.0	365.6	233.7	325.9	1.000	.183	.000	.024	.207
6	1692.6	350.7	172.2	313.2	1.000	.236	.000	.027	.262
7	2628.6	324.9	110.4	301.7	1.000	.150	.000	.030	.180
8	3356.0	307.0	82.5	294.6	1.000	.000	.000	.015	.015
9	3717.7	299.7	73.4	291.5	1.000	.021	.000	.007	.028
10	3956.9	294.1	67.2	288.9	1.000	.034	.000	.006	.040
11	4304.3	287.1	60.1	285.5	1.000	.010	.000	.008	.018
12	5104.1	274.4	49.2	278.5	1.000	.000	.000	.015	.015
13	6049.1	261.5	40.3	269.7	1.000	.011	.000	.013	.024
						1.328	1.300	.364	2.992

SETTLEMENT POINT : 125.0, 25.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	187.5	183.5	187.4	1.000	.000	.000	.012	.012
2	535.2	187.3	175.5	187.4	1.000	.188	.578	.009	.775
3	659.4	186.8	166.9	188.2	1.000	.195	.722	.018	.936
4	822.3	185.9	159.5	189.8	1.000	.000	.000	.013	.013
5	1074.0	184.6	151.7	192.5	1.000	.099	.000	.003	.103
6	1692.6	181.3	134.6	201.1	1.000	.127	.000	.003	.131
7	2628.6	178.5	113.3	212.8	1.000	.085	.000	.004	.089
8	3356.0	178.1	100.6	218.3	1.000	.000	.000	.005	.005
9	3717.7	178.2	95.7	219.9	1.000	.013	.000	.001	.014
10	3956.9	178.4	91.9	220.9	1.000	.021	.000	.001	.022
11	4304.3	178.7	87.3	221.8	1.000	.006	.000	.002	.008
12	5104.1	179.4	78.9	222.2	1.000	.000	.000	.006	.006
13	6049.1	180.3	70.5	220.8	1.000	.008	.000	.004	.012
						.742	1.300	.083	2.125

SETTLEMENT POINT : 148.0, 443.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2972.6	2224.6	2458.5	1.000	.003	.000	.251	.254
2	535.2	2612.1	1423.8	1639.9	1.000	6.085	.578	1.728	8.391
3	659.4	2127.0	1249.3	1149.8	1.000	4.201	.722	1.855	6.778
4	822.3	1836.1	1216.5	927.1	1.000	.000	.000	.187	.187
5	1074.0	1627.4	1184.9	788.8	1.000	.577	.000	.177	.754
6	1692.6	1371.7	1083.1	627.3	1.000	.742	.000	.127	.870
7	2628.6	1219.5	924.4	501.6	1.000	.492	.000	.129	.620

8	3356.0	1155.7	823.6	437.4	1.000	.000	.000	.064	.064
9	3717.7	1132.0	783.3	413.5	1.000	.073	.000	.032	.105
10	3956.9	1114.1	752.5	395.8	1.000	.116	.000	.029	.146
11	4304.3	1091.8	714.1	374.2	1.000	.035	.000	.039	.075
12	5104.1	1049.9	643.4	335.9	1.000	.000	.000	.070	.070
13	6049.1	1003.5	569.1	297.0	1.000	.040	.000	.068	.108
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						12.364	1.300	4.756	18.421

SETTLEMENT POINT : -31.0, 482.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2999.7	2877.6	2824.2	1.000	.003	.000	.206	.209
2	535.2	2993.5	2637.4	2482.8	1.000	6.800	.578	.693	8.071
3	659.4	2967.9	2382.4	2132.4	1.000	6.263	.722	1.421	8.406
4	822.3	2924.0	2175.5	1862.2	1.000	.000	.000	.268	.268
5	1074.0	2852.3	1968.2	1608.3	1.000	1.422	.000	.295	1.716
6	1692.6	2617.4	1568.4	1176.4	1.000	1.169	.000	.306	1.476
7	2628.6	2260.4	1175.7	832.6	1.000	.800	.000	.319	1.119
8	3356.0	2049.4	981.2	688.5	1.000	.000	.000	.135	.135
9	3717.7	1969.1	910.6	639.4	1.000	.116	.000	.072	.188
10	3956.9	1909.3	858.9	604.3	1.000	.185	.000	.064	.248
11	4304.3	1836.1	796.8	562.9	1.000	.056	.000	.083	.139
12	5104.1	1705.1	688.8	492.7	1.000	.000	.000	.130	.131
13	6049.1	1570.7	583.1	425.0	1.000	.060	.000	.128	.188
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						16.874	1.300	4.121	22.295

SETTLEMENT POINT : -23.5, 511.9

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1239.4	1325.3	1468.3	1.000	.002	.000	.064	.066
2	535.2	1411.5	1326.4	1409.9	1.000	3.080	.578	.069	3.727
3	659.4	1446.3	1253.1	1343.2	1.000	2.011	.722	.296	3.030
4	822.3	1455.1	1184.1	1284.9	1.000	.000	.000	.112	.112
5	1074.0	1455.0	1110.6	1221.0	1.000	.536	.000	.080	.616
6	1692.6	1432.9	957.8	1074.1	1.000	.767	.000	.103	.870
7	2628.6	1377.3	786.5	886.1	1.000	.543	.000	.137	.681
8	3356.0	1332.8	689.1	774.2	1.000	.000	.000	.073	.073
9	3717.7	1313.0	651.0	730.6	1.000	.083	.000	.037	.120
10	3956.9	1296.9	622.1	697.7	1.000	.133	.000	.034	.167
11	4304.3	1275.6	586.3	657.1	1.000	.041	.000	.047	.088
12	5104.1	1232.4	520.7	584.1	1.000	.000	.000	.084	.084
13	6049.1	1180.4	452.5	509.5	1.000	.046	.000	.084	.130
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						7.242	1.300	1.221	9.764

SETTLEMENT POINT : 151.4, 308.3

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1.0	166.8	68.4	1.000	.000	.000	-.011	-.011
2	535.2	23.4	455.5	195.9	1.000	.027	.578	-.484	.121
3	659.4	91.5	668.9	312.7	1.000	.102	.722	-.799	.025
4	822.3	173.5	772.6	390.3	1.000	.000	.000	-.027	-.027
5	1074.0	268.1	828.6	452.4	1.000	.139	.000	-.103	.036
6	1692.6	457.9	844.2	528.6	1.000	.299	.000	-.056	.243
7	2628.6	630.2	773.8	540.3	1.000	.277	.000	-.007	.270
8	3356.0	702.9	710.5	517.3	1.000	.000	.000	.021	.021
9	3717.7	726.1	682.7	503.4	1.000	.049	.000	.008	.057
10	3956.9	741.7	660.7	491.3	1.000	.081	.000	.009	.090
11	4304.3	758.9	632.4	474.3	1.000	.025	.000	.015	.040
12	5104.1	783.6	577.9	438.6	1.000	.000	.000	.040	.040
13	6049.1	799.8	517.7	395.2	1.000	.032	.000	.041	.074
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						1.032	1.300	-1.354	.978

SETTLEMENT POINT : 152.1, 286.4

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.4	111.2	58.0	1.000	.000	.000	-.008	-.008
2	535.2	9.7	317.5	168.2	1.000	.011	.578	-.373	.216
3	659.4	43.9	501.0	273.8	1.000	.050	.722	-.687	.086
4	822.3	94.7	613.9	347.4	1.000	.000	.000	-.030	-.030
5	1074.0	165.2	692.4	408.8	1.000	.089	.000	-.107	-.017
6	1692.6	339.7	752.4	488.5	1.000	.229	.000	-.069	.160
7	2628.6	524.1	710.0	509.7	1.000	.235	.000	-.022	.213
8	3356.0	605.9	656.1	494.1	1.000	.000	.000	.014	.014
9	3717.7	632.5	631.5	483.4	1.000	.043	.000	.005	.047
10	3956.9	650.7	611.7	473.6	1.000	.071	.000	.006	.077
11	4304.3	670.9	586.0	459.7	1.000	.023	.000	.011	.033
12	5104.1	701.0	536.2	429.5	1.000	.000	.000	.033	.033
13	6049.1	722.8	480.9	391.8	1.000	.029	.000	.034	.064
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						.781	1.300	-1.193	.888

SETTLEMENT POINT : 171.0, 407.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.2	102.3	34.5	1.000	.000	.000	-.007	-.007
2	535.2	4.5	299.0	101.2	1.000	.005	.578	-.313	.270
3	659.4	22.0	494.3	168.8	1.000	.026	.722	-.619	.129
4	822.3	51.7	635.9	219.5	1.000	.000	.000	-.032	-.032
5	1074.0	99.8	756.5	264.7	1.000	.056	.000	-.114	-.058

6	1692.6	253.1	906.7	328.0	1.000	.174	.000	-.090	.085
7	2628.6	468.8	913.6	342.2	1.000	.212	.000	-.040	.171
8	3356.0	579.5	858.0	325.8	1.000	.000	.000	.010	.010
9	3717.7	616.6	828.3	315.7	1.000	.042	.000	.003	.045
10	3956.9	641.9	803.5	307.0	1.000	.071	.000	.005	.075
11	4304.3	670.0	770.4	295.1	1.000	.023	.000	.010	.033
12	5104.1	711.0	704.7	270.6	1.000	.000	.000	.034	.034
13	6049.1	738.9	630.4	242.4	1.000	.030	.000	.036	.066
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						.638	1.300	-1.117	.821

SETTLEMENT POINT : 193.0, 407.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.1	65.0	14.8	1.000	.000	.000	-.004	-.004
2	535.2	1.6	192.1	43.7	1.000	.002	.578	-.186	.394
3	659.4	8.0	324.8	74.4	1.000	.009	.722	-.383	.349
4	822.3	19.5	429.1	99.1	1.000	.000	.000	-.022	-.022
5	1074.0	39.6	528.5	123.5	1.000	.023	.000	-.079	-.057
6	1692.6	114.8	690.4	166.9	1.000	.082	.000	-.077	.005
7	2628.6	252.4	768.5	196.2	1.000	.118	.000	-.058	.060
8	3356.0	341.9	757.5	200.3	1.000	.000	.000	-.004	-.004
9	3717.7	376.1	743.6	199.3	1.000	.026	.000	-.006	.021
10	3956.9	401.1	730.0	197.7	1.000	.045	.000	-.003	.042
11	4304.3	430.8	709.8	194.6	1.000	.015	.000	-.002	.013
12	5104.1	480.0	664.4	186.3	1.000	.000	.000	.015	.015
13	6049.1	522.7	607.4	174.1	1.000	.022	.000	.016	.037
						---	---	---	---
						.343	1.300	-.794	.849

URS

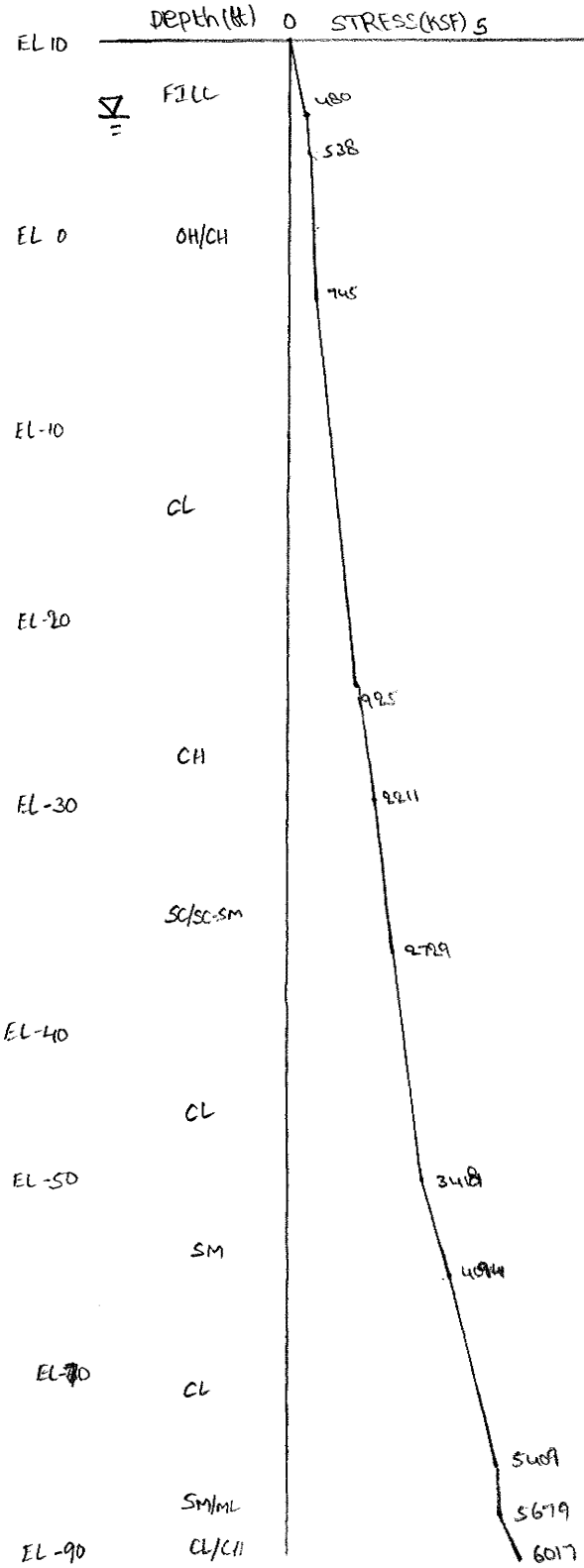
Page ____ of ____

Job BROADWAY INTERCHANGE RECONSTRUCTION Project No. 28645286 Sheet ____ of ____

Description BROADWAY EAST APPROACH EMBANKMENT SETTLEMENT Computed by MT Date 01/07/12

Checked by SHUANG Date 1/20/12

Reference



	γ' PCF	C_{CE}	$C_{\gamma E}$	P_p (KSF)	E $\times 10^6$ PSF	μ	C_α	A	t_{ZERO}	S_u/σ_{VO}
FILL	120	-	-	-	0.30	0.30	-	1	10	-
OH/CH (4 – 3.5)	27.6	0.30	0.03	1.3 / 1.5	0.03	0.5	0.015	1	10	
CL (3.5 – 24)	57.6	0.12	0.015	3.5	1.5	0.5	-	1	10	
CH (24 – 30)	47.6	0.19	0.02	4.5	0.30	0.5	-	1	10	
SC/SC-SM (30 – 39)	57.6	-	-	-	0.40	0.4	-	1	10	
CL (39 – 50)	62.6	0.12	0.015	5.5	0.40	0.5	-	1	10	
SM (50 – 60)	67.6	-	-	-	0.55	0.4	-	1	10	
CL (60 – 81)	62.6	0.12	0.015	7.0	1.0	0.5	-	1	10	
SM/ML (81 – 85)	67.6	-	-	-	0.65	0.4	-	1	10	
CL/CH (85 – 90)	67.6	0.12	0.015	8.0	1.4	0.5	-	1	10	

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1
FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

bwyeapp2.dat
NUMBER OF SOIL LAYERS: 12

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	10.0	6.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	6.0	4.0	57.6	.000	.000	1000.0	.300	.30	.00000	1.000	5.00
3	4.0	.5	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
4	.5	-3.5	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
5	-3.5	-24.0	57.6	.120	.015	3500.0	1.500	.50	.00000	1.000	5.00
6	-24.0	-30.0	47.6	.190	.020	4500.0	.300	.50	.00000	1.000	5.00
7	-30.0	-39.0	57.6	.000	.000	5000.0	.400	.40	.00000	1.000	5.00
8	-39.0	-50.0	62.6	.120	.015	55000.0	.400	.50	.00000	1.000	5.00
9	-50.0	-60.0	67.6	.000	.000	6000.0	.550	.40	.00000	1.000	5.00
10	-60.0	-81.0	62.6	.120	.015	7000.0	1.000	.50	.00000	1.000	5.00
11	-81.0	-85.0	67.6	.000	.000	7500.0	.650	.40	.00000	1.000	5.00
12	-85.0	-90.0	67.6	.120	.015	8000.0	1.400	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 50

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	-5.00	25.00	.00	10.00	120.00	50.00	3000.00
2	102.50	25.00	.00	10.00	95.00	50.00	625.00
3	87.50	25.00	.00	10.00	65.00	50.00	625.00
4	77.50	25.00	.00	10.00	45.00	50.00	625.00
5	67.50	25.00	.00	10.00	25.00	50.00	625.00
6	60.00	25.00	.00	10.00	10.00	50.00	500.00
7	-112.50	25.00	.00	10.00	95.00	50.00	625.00
8	-97.50	25.00	.00	10.00	65.00	50.00	625.00
9	-87.50	25.00	.00	10.00	45.00	50.00	625.00
10	-77.50	25.00	.00	10.00	25.00	50.00	625.00
11	-70.00	25.00	.00	10.00	10.00	50.00	500.00
12	-2.50	75.00	.00	10.00	125.00	50.00	2750.00
13	105.00	75.00	.00	10.00	90.00	50.00	625.00
14	90.00	75.00	.00	10.00	60.00	50.00	625.00
15	80.00	75.00	.00	10.00	40.00	50.00	625.00
16	70.00	75.00	.00	10.00	20.00	50.00	625.00
17	62.50	75.00	.00	10.00	5.00	50.00	250.00
18	-110.00	75.00	.00	10.00	90.00	50.00	625.00
19	-95.00	75.00	.00	10.00	60.00	50.00	625.00
20	-85.00	75.00	.00	10.00	40.00	50.00	625.00
21	-75.00	75.00	.00	10.00	20.00	50.00	625.00
22	-67.50	75.00	.00	10.00	5.00	50.00	250.00
23	-2.50	145.00	.00	10.00	125.00	90.00	2500.00
24	100.00	145.00	.00	10.00	80.00	90.00	625.00

25	85.00	145.00	.00	10.00	50.00	90.00	625.00
26	75.00	145.00	.00	10.00	30.00	90.00	625.00
27	67.50	145.00	.00	10.00	15.00	90.00	625.00
28	-97.50	145.00	.00	10.00	65.00	90.00	625.00
29	-90.00	145.00	.00	10.00	50.00	90.00	625.00
30	-82.50	145.00	.00	10.00	35.00	90.00	625.00
31	-72.50	145.00	.00	10.00	15.00	90.00	625.00
32	-5.00	215.00	.00	10.00	130.00	50.00	2188.00
33	90.00	215.00	.00	10.00	60.00	50.00	625.00
34	80.00	125.00	.00	10.00	40.00	50.00	625.00
35	67.50	215.00	.00	10.00	15.00	50.00	938.00
36	-90.00	215.00	.00	10.00	40.00	50.00	625.00
37	-80.00	215.00	.00	10.00	20.00	50.00	625.00
38	5.00	265.00	.00	10.00	130.00	50.00	1688.00
39	-7.50	315.00	.00	10.00	125.00	50.00	1250.00
40	10.00	365.00	.00	10.00	160.00	50.00	1000.00
41	105.00	365.00	.00	10.00	30.00	50.00	625.00
42	95.00	365.00	.00	10.00	10.00	50.00	375.00
43	-85.00	365.00	.00	10.00	30.00	50.00	375.00
44	-77.50	365.00	.00	10.00	15.00	50.00	625.00
45	-2.50	420.00	.00	10.00	135.00	60.00	625.00
46	75.00	420.00	.00	10.00	20.00	60.00	313.00
47	70.00	420.00	.00	10.00	10.00	60.00	313.00
48	-80.00	420.00	.00	10.00	20.00	60.00	250.00
49	-75.00	420.00	.00	10.00	10.00	60.00	250.00
50	5.00	470.00	.00	10.00	130.00	40.00	250.00

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TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5
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SETTLEMENT POINT : -5.0, .0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1500.0	1461.0	1471.1	1.000	.002	.000	.099	.101
2	537.6	1499.9	1402.6	1428.0	1.000	.001	.000	.052	.053
3	643.5	1499.5	1349.5	1388.8	1.000	3.120	.506	.182	3.808
4	747.0	1498.3	1278.0	1336.0	1.000	1.932	.578	.306	2.816
5	1392.6	1486.3	1057.0	1172.6	1.000	1.164	.000	.061	1.225
6	2125.8	1456.2	848.2	1015.9	1.000	.326	.000	.126	.452
7	2527.8	1431.7	746.0	936.8	1.000	.000	.000	.205	.205
8	3131.3	1392.4	627.5	841.3	1.000	.316	.000	.217	.533
9	3813.6	1345.0	523.1	752.2	1.000	.000	.000	.182	.182
10	4808.9	1268.3	400.9	638.9	1.000	.384	.000	.189	.573
11	5601.4	1204.0	324.8	561.2	1.000	.000	.000	.063	.063
12	5905.6	1180.8	301.4	535.8	1.000	.071	.000	.033	.104
						7.317	1.084	1.715	10.116

SETTLEMENT POINT : -5.0, 25.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2999.6	2874.7	2810.9	1.000	.003	.000	.207	.210
2	537.6	2994.6	2689.2	2536.3	1.000	.001	.000	.114	.116
3	643.5	2981.1	2524.4	2302.8	1.000	5.996	.506	.795	7.296
4	747.0	2945.2	2311.3	2022.8	1.000	5.043	.578	1.245	6.866
5	1392.6	2718.0	1731.3	1417.3	1.000	3.539	.000	.188	3.726
6	2125.8	2428.1	1283.7	1088.4	1.000	.540	.000	.298	.838
7	2527.8	2280.4	1091.2	968.1	1.000	.000	.000	.393	.394
8	3131.3	2106.0	884.5	843.2	1.000	.442	.000	.410	.852
9	3813.6	1946.4	714.4	738.6	1.000	.000	.000	.298	.298
10	4808.9	1744.4	527.6	615.0	1.000	.508	.000	.296	.804
11	5601.4	1603.6	417.1	533.8	1.000	.000	.000	.090	.090
12	5905.6	1556.9	384.1	507.8	1.000	.091	.000	.048	.139
						16.164	1.084	4.381	21.629

SETTLEMENT POINT : 55.0, 25.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2998.8	2802.1	2787.4	1.000	.003	.000	.212	.215
2	537.6	2983.9	2526.7	2481.9	1.000	.001	.000	.119	.120
3	643.5	2951.1	2307.1	2227.4	1.000	5.950	.506	.957	7.414

4	747.0	2881.9	2053.5	1929.2	1.000	4.935	.578	1.425	6.938
5	1392.6	2561.3	1468.0	1307.7	1.000	3.040	.000	.192	3.233
6	2125.8	2216.2	1081.6	984.8	1.000	.447	.000	.284	.731
7	2527.8	2052.8	927.5	870.6	1.000	.000	.000	.360	.360
8	3131.3	1869.8	767.3	754.8	1.000	.403	.000	.366	.768
9	3813.6	1711.6	637.6	659.9	1.000	.000	.000	.260	.260
10	4808.9	1523.6	494.0	549.8	1.000	.452	.000	.252	.704
11	5601.4	1399.5	406.8	478.4	1.000	.000	.000	.077	.077
12	5905.6	1359.3	380.0	455.6	1.000	.081	.000	.040	.121
						---	---	---	---
						15.313	1.084	4.545	20.941

SETTLEMENT POINT : -2.5, 75.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2750.0	2675.8	2675.3	1.000	.003	.000	.183	.186
2	537.6	2749.7	2564.9	2563.7	1.000	.001	.000	.097	.098
3	643.5	2748.8	2463.9	2462.2	1.000	5.633	.506	.400	6.539
4	747.0	2746.1	2327.8	2325.8	1.000	4.696	.578	.671	5.945
5	1392.6	2718.5	1906.1	1907.0	1.000	3.540	.000	.133	3.673
6	2125.8	2646.0	1506.4	1518.6	1.000	.817	.000	.272	1.089
7	2527.8	2585.1	1310.7	1332.4	1.000	.000	.000	.413	.413
8	3131.3	2485.7	1084.6	1120.2	1.000	.502	.000	.457	.959
9	3813.6	2365.5	886.9	937.2	1.000	.000	.000	.357	.357
10	4808.9	2173.1	659.1	727.6	1.000	.612	.000	.373	.985
11	5601.4	2015.6	520.4	599.2	1.000	.000	.000	.116	.116
12	5905.6	1959.9	478.4	560.0	1.000	.112	.000	.062	.174
						---	---	---	---
						15.919	1.084	3.533	20.535

SETTLEMENT POINT : 60.0, 75.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2747.0	2583.5	2638.5	1.000	.003	.000	.189	.192
2	537.6	2725.2	2379.6	2485.0	1.000	.001	.000	.101	.103
3	643.5	2699.6	2227.8	2358.2	1.000	5.553	.506	.569	6.628
4	747.0	2666.1	2048.6	2198.7	1.000	4.552	.578	.868	5.998
5	1392.6	2552.1	1596.7	1743.5	1.000	3.010	.000	.145	3.155
6	2125.8	2407.1	1251.0	1350.7	1.000	.512	.000	.265	.778
7	2527.8	2317.2	1097.4	1171.2	1.000	.000	.000	.381	.381
8	3131.3	2192.7	927.0	973.3	1.000	.456	.000	.410	.866
9	3813.6	2061.1	781.0	808.1	1.000	.000	.000	.311	.311
10	4808.9	1873.0	611.6	624.6	1.000	.540	.000	.316	.856
11	5601.4	1731.1	505.4	514.9	1.000	.000	.000	.098	.098
12	5905.6	1682.6	472.4	481.8	1.000	.098	.000	.052	.150
						---	---	---	---
						14.727	1.084	3.705	19.515

SETTLEMENT POINT : -2.5, 145.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2500.0	2434.9	2447.0	1.000	.003	.000	.166	.168
2	537.6	2499.8	2337.5	2367.6	1.000	.001	.000	.087	.088
3	643.5	2499.3	2248.8	2295.2	1.000	5.215	.506	.318	6.039
4	747.0	2497.7	2129.1	2197.3	1.000	4.235	.578	.535	5.348
5	1392.6	2481.2	1756.0	1889.3	1.000	2.778	.000	.108	2.886
6	2125.8	2436.2	1398.2	1585.2	1.000	.550	.000	.227	.777
7	2527.8	2396.8	1221.3	1429.4	1.000	.000	.000	.361	.361
8	3131.3	2329.8	1015.3	1241.0	1.000	.478	.000	.397	.875
9	3813.6	2244.7	834.0	1066.9	1.000	.000	.000	.324	.324
10	4808.9	2100.2	623.6	851.6	1.000	.595	.000	.343	.938
11	5601.4	1975.0	494.6	710.1	1.000	.000	.000	.110	.110
12	5905.6	1929.3	455.5	665.4	1.000	.110	.000	.059	.169
						---	---	---	---
						13.967	1.084	3.034	18.085

SETTLEMENT POINT : 60.0, 145.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2808.6	2636.1	2645.1	1.000	.003	.000	.196	.199
2	537.6	2778.7	2397.0	2449.2	1.000	.001	.000	.106	.107
3	643.5	2740.8	2209.9	2309.2	1.000	5.620	.506	.674	6.800
4	747.0	2687.2	1996.4	2144.4	1.000	4.590	.578	.987	6.155
5	1392.6	2508.2	1509.9	1713.6	1.000	2.867	.000	.147	3.014
6	2125.8	2320.5	1175.1	1371.2	1.000	.461	.000	.251	.713
7	2527.8	2220.7	1033.4	1216.9	1.000	.000	.000	.357	.357
8	3131.3	2096.1	878.9	1043.5	1.000	.441	.000	.375	.815
9	3813.6	1975.2	747.2	892.1	1.000	.000	.000	.288	.288
10	4808.9	1812.6	593.3	712.5	1.000	.525	.000	.292	.817
11	5601.4	1693.0	495.2	597.0	1.000	.000	.000	.093	.093
12	5905.6	1652.0	464.4	560.7	1.000	.096	.000	.049	.145
						---	---	---	---
						14.606	1.084	3.814	19.503

SETTLEMENT POINT : -5.0, 215.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2188.0	2117.5	2137.1	1.000	.003	.000	.146	.148
2	537.6	2187.4	2012.2	2061.5	1.000	.001	.000	.077	.078
3	643.5	2186.0	1916.9	1993.5	1.000	4.641	.506	.323	5.469
4	747.0	2181.8	1789.8	1903.8	1.000	3.594	.578	.536	4.708
5	1392.6	2147.4	1409.4	1638.7	1.000	1.623	.000	.102	1.725
6	2125.8	2077.3	1073.1	1395.5	1.000	.426	.000	.202	.629

7	2527.8	2025.7	918.1	1274.7	1.000	.000	.000	.310	.310
8	3131.3	1947.7	746.9	1130.2	1.000	.416	.000	.333	.749
9	3813.6	1858.9	604.2	996.9	1.000	.000	.000	.266	.266
10	4808.9	1723.8	446.9	829.4	1.000	.503	.000	.274	.776
11	5601.4	1616.6	354.3	715.8	1.000	.000	.000	.088	.088
12	5905.6	1579.0	326.7	679.1	1.000	.093	.000	.046	.139
						---	---	---	---
						11.299	1.084	2.703	15.086

SETTLEMENT POINT : 60.0, 215.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1875.0	1763.6	1817.7	1.000	.002	.000	.128	.130
2	537.6	1869.2	1606.9	1733.5	1.000	.001	.000	.069	.070
3	643.5	1855.4	1483.1	1660.8	1.000	3.961	.506	.397	4.863
4	747.0	1825.6	1346.9	1570.2	1.000	2.783	.578	.587	3.949
5	1392.6	1709.7	1063.1	1331.0	1.000	1.284	.000	.084	1.368
6	2125.8	1609.1	864.6	1133.4	1.000	.352	.000	.146	.499
7	2527.8	1560.6	774.0	1039.1	1.000	.000	.000	.226	.226
8	3131.3	1500.8	669.9	928.1	1.000	.337	.000	.232	.568
9	3813.6	1441.4	577.3	826.1	1.000	.000	.000	.192	.192
10	4808.9	1357.7	465.2	697.0	1.000	.408	.000	.196	.604
11	5601.4	1292.8	392.1	608.3	1.000	.000	.000	.066	.066
12	5905.6	1270.0	368.9	579.3	1.000	.076	.000	.034	.110
						---	---	---	---
						9.205	1.084	2.357	12.645

SETTLEMENT POINT : 5.0, 265.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1688.0	1628.8	1661.0	1.000	.002	.000	.112	.114
2	537.6	1687.8	1540.4	1620.5	1.000	.001	.000	.059	.060
3	643.5	1687.3	1460.4	1583.3	1.000	3.580	.506	.232	4.317
4	747.0	1685.7	1353.7	1532.3	1.000	2.434	.578	.388	3.400
5	1392.6	1667.1	1037.1	1367.1	1.000	1.261	.000	.076	1.338
6	2125.8	1617.9	766.3	1199.3	1.000	.354	.000	.152	.506
7	2527.8	1578.4	646.6	1112.0	1.000	.000	.000	.236	.236
8	3131.3	1517.7	519.0	1004.8	1.000	.340	.000	.249	.589
9	3813.6	1449.1	416.7	903.0	1.000	.000	.000	.201	.201
10	4808.9	1347.1	308.1	771.2	1.000	.405	.000	.203	.609
11	5601.4	1268.2	245.9	679.2	1.000	.000	.000	.066	.066
12	5905.6	1240.9	227.5	648.8	1.000	.075	.000	.034	.109
						---	---	---	---
						8.452	1.084	2.011	11.546

SETTLEMENT POINT : 70.0, 265.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	844.0	832.5	841.2	1.000	.001	.000	.055	.056
2	537.6	843.9	815.1	837.3	1.000	.000	.000	.028	.028
3	643.5	843.8	799.0	834.1	1.000	1.121	.506	.038	1.665
4	747.0	843.7	776.6	830.3	1.000	.473	.578	.064	1.115
5	1392.6	846.8	699.5	816.7	1.000	.761	.000	.015	.776
6	2125.8	857.5	613.1	786.4	1.000	.212	.000	.038	.250
7	2527.8	864.5	565.5	761.1	1.000	.000	.000	.090	.090
8	3131.3	872.1	505.4	720.6	1.000	.211	.000	.086	.297
9	3813.6	876.3	447.5	673.2	1.000	.000	.000	.093	.094
10	4808.9	874.0	372.3	600.1	1.000	.274	.000	.098	.372
11	5601.4	864.9	320.4	542.3	1.000	.000	.000	.038	.038
12	5905.6	860.3	303.6	522.2	1.000	.053	.000	.019	.072
						---	---	---	---
						3.108	1.084	.662	4.853

SETTLEMENT POINT : -7.5, 315.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1250.0	1206.5	1237.6	1.000	.002	.000	.083	.084
2	537.6	1250.1	1141.4	1218.5	1.000	.001	.000	.043	.044
3	643.5	1250.2	1082.4	1200.1	1.000	2.443	.506	.153	3.102
4	747.0	1250.4	1003.6	1173.3	1.000	1.201	.578	.259	2.038
5	1392.6	1244.6	767.9	1073.2	1.000	1.023	.000	.053	1.076
6	2125.8	1216.3	565.2	959.3	1.000	.283	.000	.109	.392
7	2527.8	1190.4	475.6	897.9	1.000	.000	.000	.173	.173
8	3131.3	1148.5	380.4	821.4	1.000	.269	.000	.181	.449
9	3813.6	1099.9	304.4	748.2	1.000	.000	.000	.148	.148
10	4808.9	1026.6	224.2	652.6	1.000	.318	.000	.148	.466
11	5601.4	969.6	178.6	585.1	1.000	.000	.000	.049	.049
12	5905.6	949.9	165.2	562.7	1.000	.058	.000	.025	.083
						---	---	---	---
						5.597	1.084	1.424	8.105

SETTLEMENT POINT : 55.0, 315.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	625.1	620.4	660.1	1.000	.000	.000	.039	.039
2	537.6	626.7	613.2	709.7	1.000	.000	.000	.018	.019
3	643.5	630.8	605.7	748.9	1.000	.374	.506	-.065	.815
4	747.0	641.5	593.6	789.2	1.000	.388	.578	-.080	.886
5	1392.6	700.8	539.2	823.5	1.000	.653	.000	.003	.656
6	2125.8	756.1	467.1	775.3	1.000	.190	.000	.032	.223
7	2527.8	774.3	426.3	737.6	1.000	.000	.000	.083	.083
8	3131.3	786.2	375.0	686.2	1.000	.193	.000	.084	.277
9	3813.6	787.4	326.4	634.2	1.000	.000	.000	.088	.088

10	4808.9	775.8	265.4	563.6	1.000	.246	.000	.091	.337
11	5601.4	759.2	224.8	512.0	1.000	.000	.000	.034	.034
12	5905.6	752.3	211.9	494.5	1.000	.047	.000	.017	.064
						---	---	---	---
						2.091	1.084	.346	3.520

SETTLEMENT POINT : 10.0, 365.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1000.0	966.2	979.1	1.000	.001	.000	.067	.068
2	537.6	999.7	915.9	948.2	1.000	.001	.000	.035	.036
3	643.5	998.8	870.3	920.7	1.000	1.664	.506	.145	2.314
4	747.0	996.5	809.7	885.0	1.000	.530	.578	.239	1.347
5	1392.6	978.0	629.6	784.4	1.000	.852	.000	.044	.897
6	2125.8	943.1	472.0	697.7	1.000	.230	.000	.086	.316
7	2527.8	918.7	400.0	655.7	1.000	.000	.000	.134	.134
8	3131.3	883.0	321.0	605.8	1.000	.214	.000	.138	.352
9	3813.6	843.4	255.9	559.6	1.000	.000	.000	.113	.113
10	4808.9	784.7	185.5	500.5	1.000	.248	.000	.111	.359
11	5601.4	739.4	145.2	459.1	1.000	.000	.000	.037	.037
12	5905.6	723.7	133.4	445.3	1.000	.045	.000	.019	.064
						---	---	---	---
						3.785	1.084	1.168	6.036

SETTLEMENT POINT : 90.0, 365.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	999.2	912.5	909.7	1.000	.001	.000	.072	.074
2	537.6	989.6	796.0	782.3	1.000	.001	.000	.041	.042
3	643.5	969.2	711.0	680.2	1.000	1.564	.506	.383	2.453
4	747.0	928.7	623.0	568.1	1.000	.505	.578	.533	1.616
5	1392.6	765.8	457.7	382.5	1.000	.702	.000	.057	.759
6	2125.8	622.9	371.8	335.8	1.000	.161	.000	.065	.225
7	2527.8	567.7	339.7	330.5	1.000	.000	.000	.081	.081
8	3131.3	516.9	304.9	328.8	1.000	.131	.000	.066	.197
9	3813.6	482.7	273.8	327.0	1.000	.000	.000	.053	.053
10	4808.9	453.0	234.2	320.3	1.000	.148	.000	.044	.192
11	5601.4	438.6	206.4	311.3	1.000	.000	.000	.017	.017
12	5905.6	434.6	197.2	307.4	1.000	.028	.000	.008	.036
						---	---	---	---
						3.241	1.084	1.420	5.745

SETTLEMENT POINT : -2.5, 420.0

SOIL LAYER	INITIAL STRESS	VERTICAL STRESS INCREASE	HORIZ. X STRESS INCREASE	HORIZ. Y STRESS INCREASE	SKEMPTON BJERRUM FACTOR	CONSOL. COMP.	SECOND. COMP. 20. YR	ELASTIC COMP.	TOTAL COMP.

	(PSF)	(PSF)	(PSF)	(PSF)		(IN.)	(IN.)	(IN.)	(IN.)
1	240.0	625.0	605.7	616.7	1.000	.000	.000	.041	.042
2	537.6	624.9	576.8	604.2	1.000	.000	.000	.022	.022
3	643.5	624.8	550.6	592.9	1.000	.371	.506	.074	.951
4	747.0	624.2	515.5	577.7	1.000	.380	.578	.124	1.082
5	1392.6	618.6	408.2	530.3	1.000	.589	.000	.024	.614
6	2125.8	604.2	310.5	484.9	1.000	.156	.000	.050	.206
7	2527.8	592.4	264.6	462.1	1.000	.000	.000	.081	.082
8	3131.3	573.6	213.5	434.8	1.000	.145	.000	.082	.227
9	3813.6	551.4	170.8	409.5	1.000	.000	.000	.070	.070
10	4808.9	517.2	124.3	376.9	1.000	.168	.000	.067	.235
11	5601.4	490.3	97.5	353.9	1.000	.000	.000	.023	.023
12	5905.6	481.0	89.6	346.1	1.000	.031	.000	.011	.042
						---	---	---	---
						1.840	1.084	.670	3.594

SETTLEMENT POINT : 65.0, 420.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	624.9	563.7	598.3	1.000	.000	.000	.044	.045
2	537.6	618.3	483.5	560.6	1.000	.000	.000	.024	.025
3	643.5	605.3	428.4	531.4	1.000	.363	.506	.176	1.044
4	747.0	582.1	376.3	499.4	1.000	.360	.578	.231	1.169
5	1392.6	514.9	291.1	433.4	1.000	.504	.000	.025	.529
6	2125.8	471.5	242.3	389.4	1.000	.125	.000	.037	.163
7	2527.8	454.5	220.1	370.5	1.000	.000	.000	.059	.059
8	3131.3	435.8	194.1	349.8	1.000	.112	.000	.054	.166
9	3813.6	418.8	170.2	332.3	1.000	.000	.000	.048	.048
10	4808.9	396.9	140.5	311.5	1.000	.130	.000	.043	.173
11	5601.4	381.4	120.7	297.2	1.000	.000	.000	.016	.016
12	5905.6	376.3	114.3	292.4	1.000	.024	.000	.007	.032
						---	---	---	---
						1.620	1.084	.764	3.468

SETTLEMENT POINT : 5.0, 470.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	250.0	244.4	258.7	1.000	.000	.000	.016	.016
2	537.6	250.4	236.0	271.2	1.000	.000	.000	.008	.008
3	643.5	251.2	228.0	281.3	1.000	.180	.506	-.005	.681
4	747.0	253.3	216.8	292.5	1.000	.183	.578	-.002	.759
5	1392.6	263.2	178.7	311.8	1.000	.277	.000	.003	.280
6	2125.8	270.4	140.5	316.7	1.000	.075	.000	.010	.085
7	2527.8	272.1	122.1	315.9	1.000	.000	.000	.026	.026
8	3131.3	272.3	101.3	312.5	1.000	.072	.000	.022	.093
9	3813.6	270.9	83.7	306.6	1.000	.000	.000	.025	.025
10	4808.9	267.0	64.0	295.3	1.000	.089	.000	.022	.111
11	5601.4	263.0	52.3	284.8	1.000	.000	.000	.009	.009
12	5905.6	261.4	48.7	280.9	1.000	.017	.000	.004	.021

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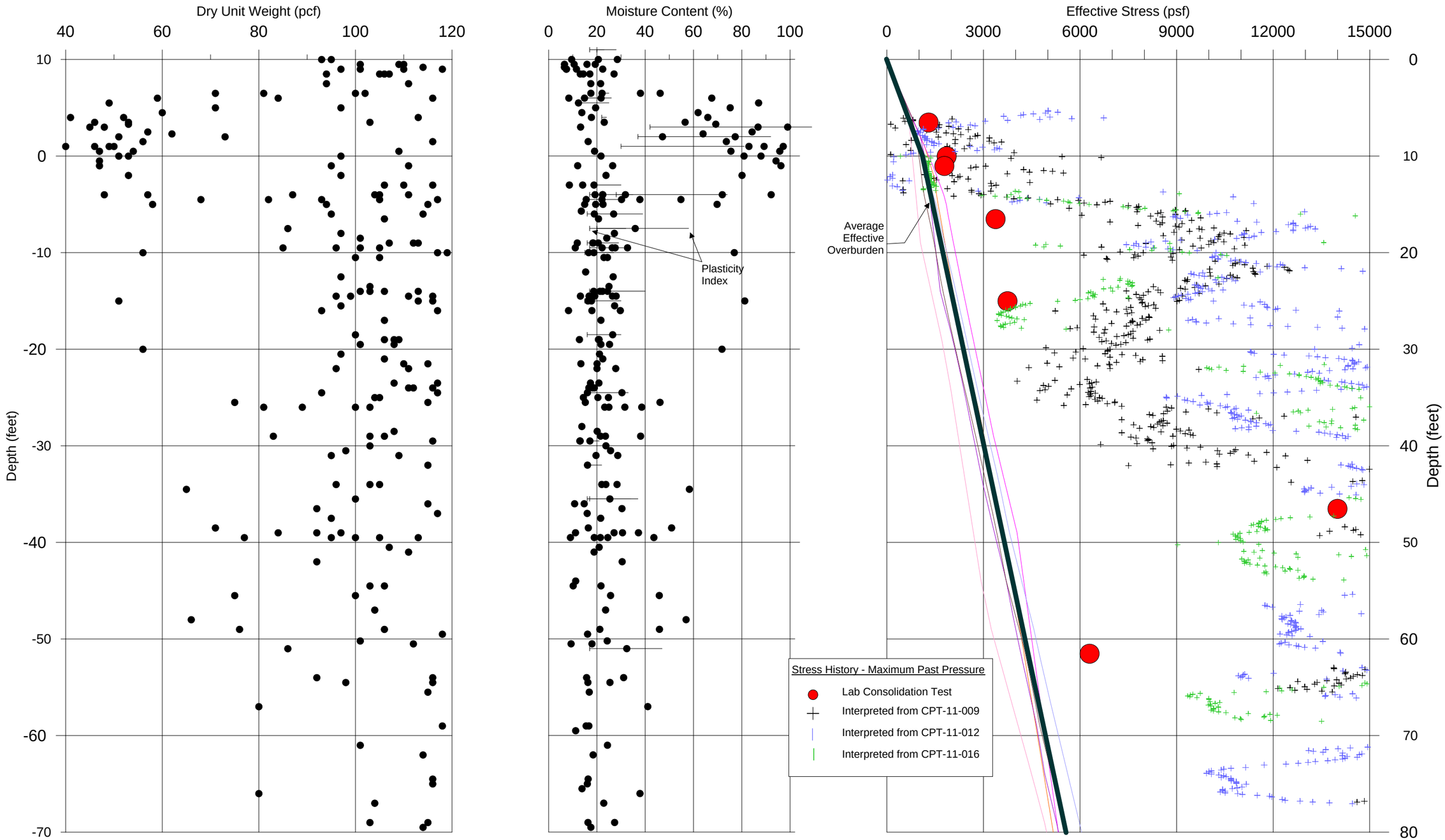
.893	1.084	.138	2.115	

SETTLEMENT POINT : 70.0, 470.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	125.0	125.5	139.4	1.000	.000	.000	.007	.007
2	537.6	125.7	126.1	159.8	1.000	.000	.000	.003	.003
3	643.5	127.2	126.3	176.1	1.000	.099	.506	-.034	.571
4	747.0	130.8	126.1	193.9	1.000	.101	.578	-.047	.632
5	1392.6	147.0	121.5	225.2	1.000	.161	.000	-.004	.156
6	2125.8	160.6	112.9	239.1	1.000	.046	.000	-.004	.042
7	2527.8	166.4	107.3	243.4	1.000	.000	.000	.007	.007
8	3131.3	173.0	99.6	246.5	1.000	.046	.000	.000	.046
9	3813.6	178.9	91.5	247.0	1.000	.000	.000	.009	.010
10	4808.9	186.0	80.2	244.2	1.000	.062	.000	.006	.068
11	5601.4	190.5	71.7	239.7	1.000	.000	.000	.005	.005
12	5905.6	191.8	68.9	237.7	1.000	.012	.000	.002	.014
						---	---	---	---
						.527	1.084	-.049	1.562



Index Properties and Stress History
U.S. 101 / Broadway Interchange Reconstruction
Burlingame, California
URS Project 28645286

Summary of Laboratory Consolidation Parameters
US 101/Broadway Interchange Reconstruction
Burlingame, California

Boring	Sample Depth (ft)	Elev (ft)	N_{60}	Water Content (%)	Dry Density (pcf)	Liquid Limit	Platicity Index	Liquidity Index	Soil Classification	C_{ce}	C_{re}	Existing Overburden Pressure (psf)	Max Past Pressure (psf)	OCR	C_v (ft^2/day)	C_v from PI (ft2/day)	e_0	Cc	Cr
B-31	14.5	-3	3	90	49	99	63	0.86	OH	0.31	0.040	1100	1100	1.0	0.22	0.01 to 0.04	na	na	na
BRO-1	9.5	0.5	1	89	51	110	72	0.71	OH	0.26	0.040	600	700	1.2	0.032	0.007 to 0.03	na	na	na
BRO-2	14.5	-3	3	82	55	98	63	0.75	OH	0.27	0.035	1200	1400	1.2	0.033	0.01 to 0.04	na	na	na
R-11-005	10	1	300 psi	83	50	81	51	1.04	OH/CH	0.30	0.020	1200	1860	1.6	0.03	0.04	2.34	1.00	0.067
											0.044					0.1			0.147
											0.053								0.177
R-11-011	6.5	3	250 psi	87	48	109	67	0.67	OH/CH	0.29	0.026	700	1,300	1.9	0.03	0.015	2.88	1.11	0.101
											-					0.025			
											0.059								0.229
R-11-013	11	2	200 psi	77	51	92	55	0.73	OH/CH	0.34	0.029	1300	1790	1.4	0.05	0.025	2.92	1.33	0.114
											-					0.05			
											0.057								0.223
R-11-015	61.5	-51	350 psi	32	86	47	30	0.50	CL/CH	0.19	0.017	4417	6300	1.4	0.05	0.18	0.86	0.34	0.032
											0.035					0.8			0.065
											0.035								0.065
R-11-014	25	-14	350 psi	22	103	40	23	0.22	CL	0.12	0.01	1813	3750	2.1	0.05	0.26	0.72	0.21	0.02
											-					1.5			
											0.04								0.07
R-11-006	16.5	-5.5	120 psi	27	95	39	23	0.48	CL	0.12	0.02	1814	3380	1.9	0.06	0.26	0.68	0.20	0.03
											0.02					1.5			0.04
											0.03								0.04
R-11-017	46.5	-35.5	250 psi	25	100	37	20	0.40	CL	0.17	0.02	3691	14000	3.8	0.4	0.3	0.73	0.29	0.03
											-					2			
											0.03								0.05

US 101/BROADWAY
INTERCHANGE RECONSTRUCTION PROJECT

PROPOSED BROADWAY OVERCROSSING

CORROSION ASSESSMENT FOR THE BRIDGE FOUNDATION REPORT

Prepared for

URS

Prepared by

V&A

January 2012

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APPENDICES

Appendix A: Soil Sample Laboratory Chemical Analysis Results

EXECUTIVE SUMMARY

V&A was retained by URS Corporation to perform a soil corrosivity investigation for the proposed US 101/Broadway Interchange Replacement Project in the City of Burlingame, San Mateo County. This project extends from Toyon Drive at the south to Mills Creek at the north, along US 101 from Post Mile 16.30 to Post Mile 17.06. The project objectives include reconstruction improvements to US 101 on-ramps and off-ramps at Rollins Road, the Bayshore Highway, Airport Boulevard, and the Crowne Plaza Hotel access road. Retaining walls, concrete barriers, a new Broadway overcrossing bridge, a single-span box girder structure over PG&E high-voltage tower foundations, and modifications to the existing US 101 pedestrian overcrossing approach structures will be constructed to accommodate the proposed US 101 mainline and Broadway interchange improvements.

This report provides recommendations for corrosion control of structural foundation materials under consideration for the Broadway overcrossing bridge. The structures being considered as part of this investigation are buried steel and reinforced concrete structures, and cast-in-drilled-hole (CIDH) concrete piles. The investigation was conducted in accordance with California Department of Transportation's Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch *Corrosion Guidelines*, Version 1.0, dated September 2003. These Guidelines consider representative soil or water samples to be corrosive to metallic or reinforced concrete structural elements if one or more of the following conditions exist:

- **The chloride concentration is 500 ppm or greater**
- **The sulfate concentration is 2,000 ppm or greater**
- **The pH is 5.5 or less**

Evaluation of the soil environment was made in terms of potential corrosion damage to buried metal and reinforced concrete structures. Soil resistivity measurements were conducted by V&A in the field during the initial stages of the work. Resistivity measurements were taken in increments to a depth of 100 feet below grade at the proposed Broadway overcrossing bridge abutment sites. In addition, four soil samples taken during a geotechnical investigation by URS were sent to Cooper Testing Laboratory in Palo Alto, California, for chemical analysis. The soil samples were analyzed for as-received and minimum (saturated) resistivity, for pH, and for water-soluble chloride and sulfate ion concentrations. All of these chemical properties affect the corrosion rate of buried metal and reinforced concrete structures. A water sample from Easton Creek was sent to XENCO Laboratories in Houston, Texas, to be analyzed for specific conductance (conductivity), pH, and chloride, sulfate, and bicarbonate ion concentration. The water sample analysis is pertinent to the proposed box culvert widening at Easton Creek. The water analysis and its impact on this structure is discussed in the "US 101/Broadway Interchange Reconstruction Project – Materials Report, Corrosion Assessment, prepared by V&A.

Four soil samples were taken from URS boreholes R-11-011 and R-11-014 (see Figure 5) and analyzed at Cooper Testing Laboratory had minimum (saturated) resistivities that ranged from 719 to

2,829 ohm-cm. The soil pH values varied from 7.6 to 8.0. Water-soluble chlorides ranged from 43 to 341 mg/kg (ppm), and the water-soluble sulfate concentrations were less than 5 to 9 mg/kg (ppm). Based on the pH values and the water-soluble chloride and sulfate concentrations, the soil samples from the proposed overcrossing bridge abutment sites are non-corrosive to buried steel and reinforced concrete structures as defined by the Caltrans *Corrosion Guidelines*.

Conclusions

- Four soil samples taken from URS soil boreholes R-11-011 and R-11-014 had soluble chloride concentrations less than 500 mg/kg (ppm) and soluble sulfate concentrations less than 2,000 mg/kg (ppm). According to the Caltrans *Corrosion Guidelines*, these soils are *non-corrosive* to buried steel and reinforced concrete structures.
- Boring logs encounter groundwater at 5.0 feet near the proposed east overcrossing bridge abutment and at 12.5 to 16.0 feet near the proposed west overcrossing bridge abutment. Bare steel and reinforced concrete are more vulnerable to corrosion in aerated soils above the water table.
- Although the analyzed soil boring samples at the proposed Broadway overcrossing bridge abutment locations (boreholes R-11-011 and R-11-014) are considered to be non-corrosive, soil samples from boreholes approximately 300 feet from the east and west proposed overcrossing bridge abutment sites (A-11-030-2-4, R-11-010-1-3, and R-11-018-2-2) have water-soluble chloride contents greater than 500 mg/kg (ppm) and water-soluble sulfate contents greater than 2,000 mg/kg (ppm).
- Based on the corrosive soil samples from nearby boreholes (A-11-030-2-4, R-11-010-1-3, and R-11-018-2-2), the potential exists for corrosive soil to be present at the bridge abutment sites.
- The project site is within 1,000 feet of salt water or brackish water.

Recommendations

General

- Corrosion protection against a marine atmosphere is required by the *Corrosion Guidelines* for above-ground steel and reinforced concrete structures at the proposed overcrossing bridge abutment locations.
- Design of structures installed in these locations should include corrosion mitigation measures as detailed below.

Buried Reinforced Concrete Structures and Prestressed Concrete Piles

Buried concrete structures should be constructed of durable concrete as described in ACI Standards 201.2R and 222R and Chapter 850.3, “Corrosion,” of the Caltrans *Highway Design Manual* (last updated September 28, 2011). Criteria for protecting reinforced concrete structures under corrosive conditions discussed in Caltrans Standard Special Provision (SSP) S8-C04, “Corrosion Control for Portland Cement Concrete” (a modification of Bridge Design Specifications, Section 8, “Reinforced

Concrete"), should be followed. These recommendations include, but are not limited to, the following for reinforced concrete in corrosive soil:

- Based on a worst-case corrosive soil with water-soluble sulfate content greater than 2,000 mg/kg (ppm) or water-soluble chloride content greater than 5,000 mg/kg (ppm), the following concrete compositional requirements are recommended per the Caltrans Standard Specifications updated July 28, 2011, Section 90-1.02H, "Concrete in Corrosive Environments":
  - The cementitious material used in the concrete must be a combination of Type II or Type V Portland cement and SCM (supplementary cementitious materials).
  - The concrete must contain at least 675 pounds of cementitious material per cubic yard.
  - The reduction of cementitious material content specified in Section 90-1.02E(2) is not allowed.
  - The specifications for SCM content in Section 90-1.02B(3) do not apply.
  - The cementitious material must be composed of one of the following by weight:
    - 25% natural pozzolan or fly ash with a CaO content of up to 10%, and 75% Portland cement.
    - 20% natural pozzolan or fly ash with a CaO content of up to 10%, 5% silica fume, and 75% Portland cement.
    - 12% silica fume, metakaolin, or UFFA (ultra-fine fly ash) and 88% Portland cement.
    - 50% GGBFS (ground granular blast furnace slag) and 50% Portland cement.
  - A maximum water-to-cementitious material ratio of 0.40 shall be used in the concrete.
- Concrete sealant (silane) shall not be allowed as an option for concrete in a corrosive environment.
- A minimum concrete cover of 3 inches for a 50-year design life, and 4 inches for a 75-year design life, shall be applied over all steel reinforcement. This is based on a soil water-soluble chloride concentration of 5,000 to 10,000 mg/kg (ppm) for buried reinforced concrete above the groundwater table.

  This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete Cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.
- Sand and water used in concrete mixtures should contain a maximum of 100 mg/kg (ppm) of water-soluble chloride ions and water-soluble sulfate ions. Sand and water pH shall be between 6.5 and 8.0. Potable water should be used in all concrete mixtures.

Reinforced Concrete Exposed to Marine Atmosphere

- Above-ground reinforced concrete structures within 1,000 feet of brackish or salt water are exposed to a corrosive marine atmosphere. The following minimum concrete cover over unprotected reinforcing steel is recommended for the concrete structures listed below:
  - 3 inches concrete cover for the following:
    - Footings and pile caps
    - Walls, columns, and cast-in-place piles

    - Cast-in-place “I” and “T” girders, box-girder webs, bent caps, diaphragms, and hinged joints
  - 2.5 inches concrete cover for the top surface of deck slabs
  - 2 inches concrete cover for precast piles and pile extensions
  - 1.5 inches concrete cover for the following:
    - Bottom surface of deck slab
    - Box-girder bottom slabs
- This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, “Minimum Concrete Cover for 75-Year Design Life”; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.

Steel Piles

For steel pilings driven into undisturbed soil, the region of greatest corrosion concern is from the bottom of the pile cap or footing down to 3 feet below the water table. Here the soil is oxygenated and can sustain corrosion reactions.

Under corrosive soil conditions, as defined in the Executive Summary, the Caltrans LRFD Memo to Designers 3-1, July 2008, recommends the following:

- A corrosion allowance (sacrificial metal thickness) for pilings driven into undisturbed soil (soil-embedded zone) of 1 mil (0.001 inch) per year for the desired service life.
- For steel H-piling, the corrosion allowance should be doubled because two sides of the flanges and web are exposed to corrosive soil or water.
- For pipe piles, shells, and casings, the corrosion allowance applies only to exterior pile surfaces. The interior pipe surface (soil plug side) will not be exposed to sufficient oxygen to support significant corrosion.

This information is also discussed in Section 10.1, “Corrosion Mitigation Measures for Steel Piles,” in the Caltrans *Corrosion Guidelines*.

Cast-in-Drilled-Hole (CIDH) Piles

- Cast-in-drilled-hole (CIDH) concrete piling shall conform to the provisions in Section 49-3, "Cast-In-Place Concrete Piles," of the Caltrans Standard Specifications.
- The concrete used in CIDH piles should be dense and homogeneous throughout the length and cross-section of the pile per California Test 233.
- Concrete for portions of CIDH concrete piling to be formed shall contain not less than 675 pounds of cementitious material per cubic yard and shall contain 6.0±1.5 percent air entrainment in the freshly mixed concrete.
- Concrete shall conform to the requirements in "Corrosion Control for Portland Cement Concrete" of Standard Special Provision S8-04C, August 5, 2011.

TESTING OVERVIEW

Figures 1 and 2 show the overall project location.

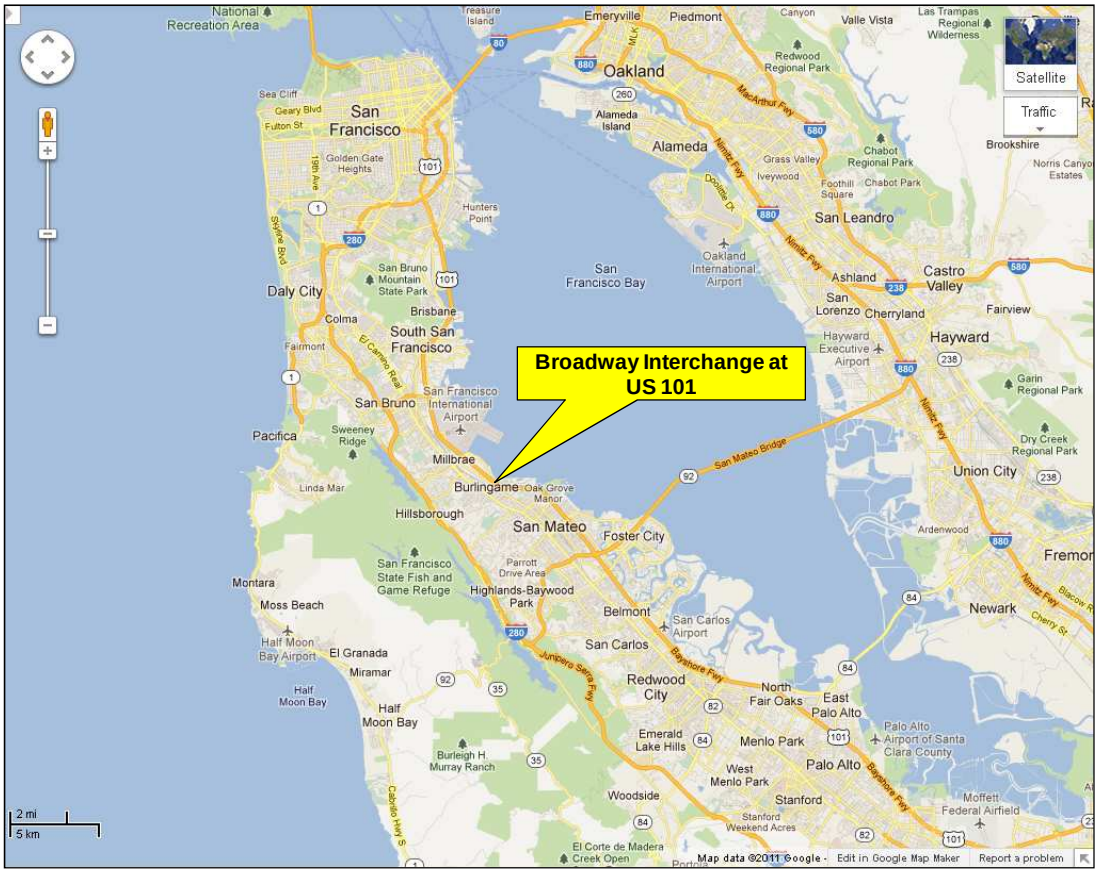

Figure 1. Vicinity and Project Site Map

Figure 2. Aerial View of Project Site (Red Box)

Proposed Broadway Overpass Bridge abutment locations are shown in Figure 3.

Figure 3. Proposed Broadway Overcrossing Bridge Abutment Locations

To predict corrosion problems associated with a particular type of structure prior to installation, it is necessary to investigate the soil conditions the structure will encounter. Since corrosion is an electrochemical process accompanied by current flow, the electrochemical characteristics of a soil are of primary importance when evaluating corrosivity. Test methods utilized during this investigation reflect the most practical methods of determining soil corrosivity. This investigation was based on field measurements of soil resistivity and laboratory analysis of soil samples from the project site. The field resistivity tests have been conducted for comparison with laboratory soil boring sample analyses.

Resistivity is a measure of the ability of a soil to conduct an electric current. Soil resistivity is primarily dependent on the chemical and moisture content of the soil. As the concentrations of soluble chemical constituents increases, the soil resistivity will decrease. Lower soil resistivity is associated with higher corrosivity to buried metal and reinforced concrete structures.

Figure 4 shows the soil resistivity test sites at the US 101/Broadway interchange project site.

Legend

1 Northbound (NB) soil resistivity test location

1 Southbound (SB) soil resistivity test location

Figure 4. Soil Resistivity Test Sites

A wide variety of water-soluble salts is typically found in soils. Two soils having the same resistivity may have significantly different corrosion characteristics, depending on the specific ions available. The major constituents that accelerate corrosion are chlorides, sulfates, and the acidity (pH) of the soil. Also, concentrations of bicarbonates tend to decrease soil resistivities. Bicarbonates are not directly aggressive to buried metallic or concrete structures, but the lower soil resistivity can promote corrosion activity.

Chloride ions break down otherwise protective surface deposits and can facilitate corrosion of buried metallic structures. Sulfates in soil can be highly aggressive to Portland cement by combining chemically with certain constituents of the concrete, principally tricalcium aluminate. This reaction is accompanied by expansion and eventual disruption of the concrete matrix. Sulfate ions reduce the soil resistivity, which also promotes corrosion activity on buried metallic structures.

Acidity, as indicated by the pH value, is another important factor of soil with respect to corrosivity. Lower pH (more acidic) will result in a greater degree of corrosivity with respect to buried metallic structures. When pH increases above 7.0 (the neutral value) the conditions become increasingly more alkaline. In alkaline environments, iron forms a protective layer on its surface. This is referred to as passivation. When the soil pH drops below about 9.0, the passive layer may break down.

Figure 5 shows the URS soil boring sites that provided soil samples for laboratory analysis.

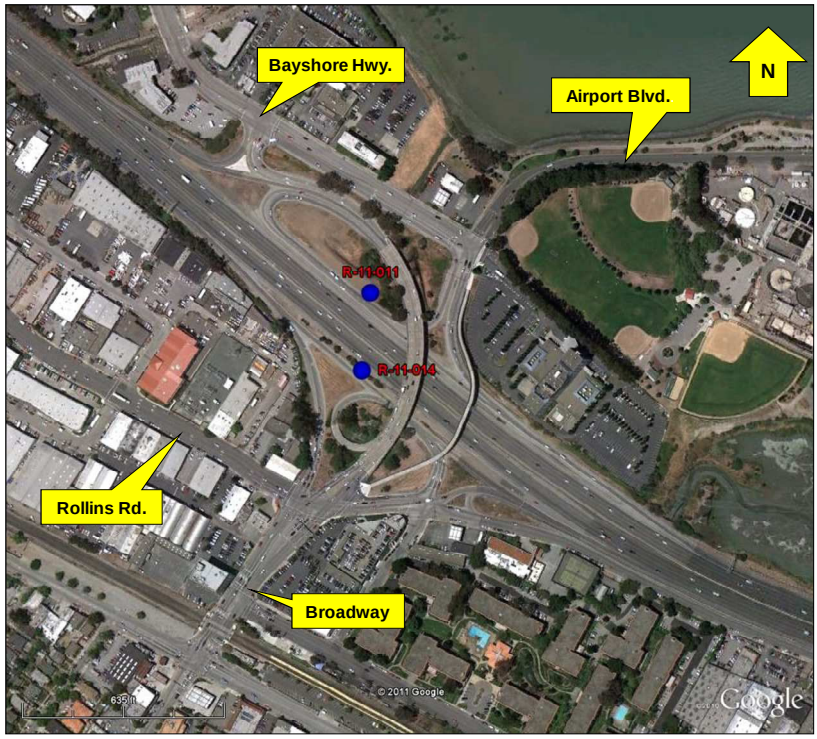

Figure 5. Proposed Bridge Abutment Soil Borehole Locations

TESTING METHODS

Field Soil Resistivity

Soil resistivities at four sites located near the abutments for the proposed Broadway Bridge Overcrossing were measured to a depth of 100 feet below the surface at test sites NB-6, NB-7, SB-6, and SB-7.

Field soil resistivity measurements were taken using the Wenner Four Electrode Method (ASTM G57), utilizing an AEMC Instruments Model 4500 soil resistance meter. The Wenner method uses four metal pins or electrodes, driven into the ground along a straight line, equidistant from each other, as shown in Figure 6. Soil resistivity measurements were conducted at electrode spacings of 2.5, 5, 7.5, 10, 15, 25, 50, 75, and 100 feet.

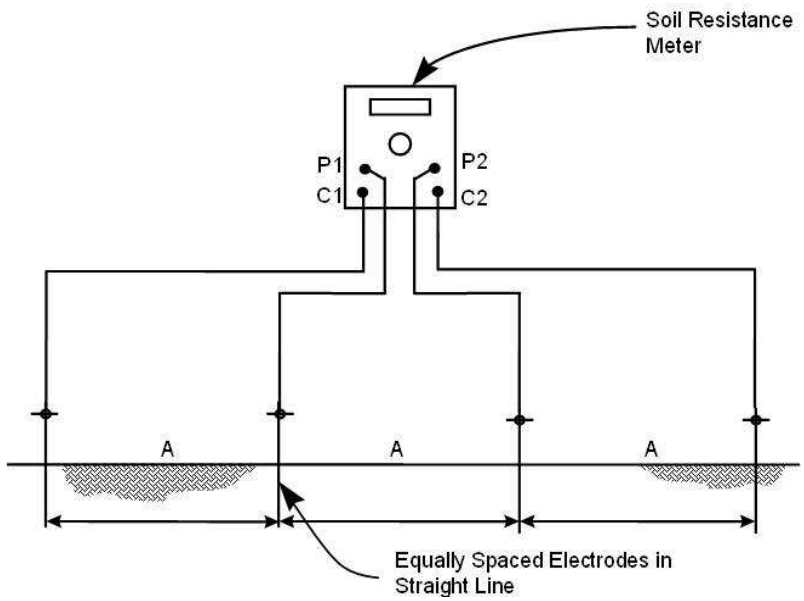

Figure 6. Soil Resistivity Measurement

An alternating current from the soil resistance meter causes a current to flow through the soil between the outer electrodes, C1 and C2. The current creates a voltage gradient in the soil, which is proportional to the average resistance of the soil mass to a depth equal to the electrode spacing. The voltage drop is then measured across pins P1 and P2. Resistivity of the soil is then computed from the instrument reading according to the formula

$$\rho = 2\pi AR$$

where ρ = soil resistivity (ohm-cm)
A = distance between electrodes (cm)
R = soil resistance, instrument reading (ohms)
π = 3.1416 (approximate).

To calculate the resistivity of a soil layer, the Barnes layer method is used based on the results of the Wenner four-pin tests. The Wenner four-pin method measures soil resistivity from the surface to various depths below grade. The Barnes layer method is used to calculate the resistivity of a soil layer between two depths below grade from the surface-to-depth resistivity measurements. The Barnes layer method assumes the soil layers are a uniform thickness and that the upper and lower boundaries are parallel to the surface.

The Barnes layer resistivity of each layer of soil was calculated using the equations

$$\rho_{b-a} = KR_{(b-a)}$$

and

$$\frac{1}{R_{b-a}} = \frac{1}{R_a} - \frac{1}{R_b}$$

where

ρ_{b-a}	=	resistivity of soil layer from depth *a* to *b* (ohm-cm)
a	=	soil depth to top of layer (cm)
b	=	soil depth to bottom of layer (cm)
R_a	=	soil resistance read at depth *a* (ohms)
R_b	=	soil resistance read at depth *b* (ohms)
R_{b-a}	=	resistance of soil layer from depth *a* to *b* (ohms)
K	=	layer constant (cm)
	=	$2\pi(b–a)$.

Laboratory Soil Analysis

For the overcrossing bridge foundation, four soil samples were obtained from two URS soil borings (Figure 5) for laboratory soil resistivity analysis. A soil box was used in accordance with California Test Method 643. The test apparatus is shown in Figure 7. It consists of a small plastic box with metal end plates for passing current through a tightly packed soil sample. Electric current flowing through the sample causes a voltage drop between pins P1 and P2. The soil resistivity is measured with a soil resistance meter. The soil box is designed so that the meter resistance reading is also the sample resistivity in ohm-cm. The soil resistivity is first measured in the "as-received" state. Distilled water is then added in increments to the soil sample. The soil resistivity is measured after each water addition. As the soil sample becomes more saturated, the resistivity decreases until the minimum soil resistivity is reached. Adding more water increases the resistivity as the soil electrolyte solution is diluted. The minimum observed resistivity is recorded.

The soil samples from URS soil bore sites were forwarded to Cooper Testing Laboratory in Palo Alto, California, for minimum resistivity measurement, pH analysis, and analysis of water-soluble chloride and sulfate ion concentrations. The analytical procedures followed California Test Methods 417, 422, 643, and 644.

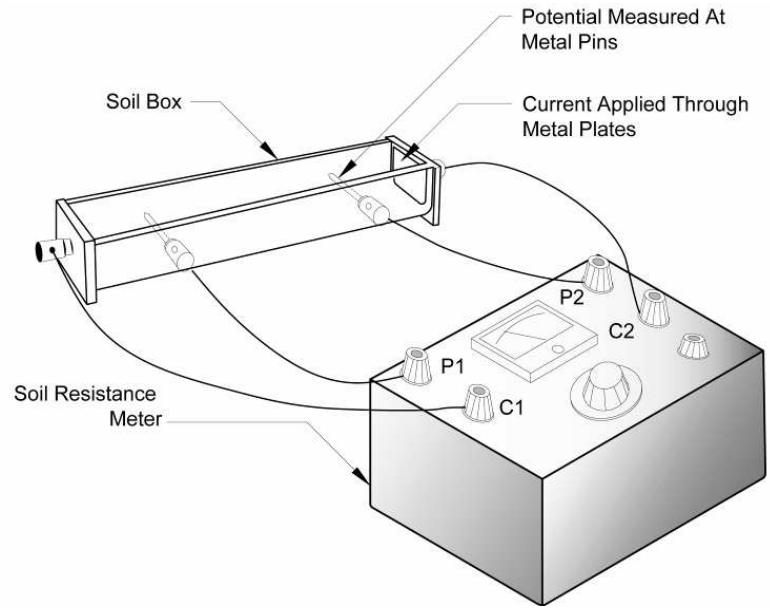

Figure 7. Soil Resistivity Measurement Using the Soil Box Method

TEST RESULTS

Field Soil Resistivity Results

Data obtained during this investigation has been tabulated for analysis and presentation. Table 1 lists the results of the Wenner Four Electrode soil resistivity measurements and Barnes Layer calculations conducted at the US 101/Broadway interchange project site. Table 1 includes all fourteen field soil resistivity sites tested by V&A using the Wenner Four Electrode Method. The tests taken to 100 feet pertain to the Broadway Bridge Overpass abutment sites.

Table 1. Field Soil Resistivity Measurements

Site	Depth (feet)	Resistivity (Ohm-cm)	Layer Depth (feet)	Layer Resistivity (ohm-cm)	Site	Depth (feet)	Resistivity (Ohm-cm)	Layer Depth (feet)	Layer Resistivity (ohm-cm)
NB-1	2.5	2,298	0 - 2.5	2,298	SB-1	2.5	2,557	0 - 2.5	2,557
	5	852	2.5 - 5	523		5	1,274	2.5 - 5	848
	7.5	417	5 - 7.5	206		7.5	603	5 - 7.5	294
	10	402	7.5 - 10	364		10	306	7.5 - 10	124
	15	259	10 - 15	151		15	259	10 - 15	197
NB-2	2.5	1,197	0 - 2.5	1,197	SB-2	2.5	2,427	0 - 2.5	2,427
	5	259	2.5 - 5	145		5	1,455	2.5 - 5	1,039
	7.5	172	5 - 7.5	103		7.5	1,508	5 - 7.5	1,626
	10	96	7.5 - 10	41		10	1,111	7.5 - 10	620
	15	29	10 - 15	12		15	1,207	10 - 15	1,458
NB-3	2.5	1,647	0 - 2.5	1,647	SB-3	2.5	5,042	0 - 2.5	5,042
	5	929	2.5 - 5	647		5	3,074	2.5 - 5	2,211
	7.5	632	5 - 7.5	386		7.5	1,566	5 - 7.5	790
	10	249	7.5 - 10	88		10	900	7.5 - 10	396
	15	172	10 - 15	107		15	373	10 - 15	172
NB-4	2.5	1,666	0 - 2.5	1,666	SB-4	2.5	1,628	0 - 2.5	1,628
	5	1,676	2.5 - 5	1,685		5	1,302	2.5 - 5	1,085
	7.5	632	5 - 7.5	281		7.5	747	5 - 7.5	403
	10	345	7.5 - 10	146		10	594	7.5 - 10	368
	15	201	10 - 15	110		15	402	10 - 15	244
NB-5	2.5	6,334	0 - 2.5	6,334	SB-5	2.5	6,195	0 - 2.5	6,195
	5	3,447	2.5 - 5	2,368		5	3,371	2.5 - 5	2,315
	7.5	4,252	5 - 7.5	7,972		7.5	1,566	5 - 7.5	756
	10	1,666	7.5 - 10	590		10	900	7.5 - 10	396
	15	431	10 - 15	174		15	718	10 - 15	511
NB-6	2.5	12,448	0 - 2.5	12,448	SB-6	2.5	3,332	0 - 2.5	3,332
	5	1,609	2.5 - 5	860		5	3,074	2.5 - 5	2,852
	7.5	862	5 - 7.5	447		7.5	1,566	5 - 7.5	790
	10	218	7.5 - 10	67		10	1,072	7.5 - 10	551
	15	204	10 - 15	180		15	172	10 - 15	64
	25	321	15 - 25	2,278		25	48	15 - 25	23
	50	278	25 - 50	245		50	**ND**	25 - 50	**ND**
	75	373	50 - 75	1,203		75	**ND**	50 - 75	**ND**
	100	315,036	75 - 100	11,031		100	**ND**	75 - 100	**ND**
NB-7	2.5	1,254	0 - 2.5	1,254	SB-7	2.5	6,464	0 - 2.5	6,464
	5	1,072	2.5 - 5	937		5	4,376	2.5 - 5	3,308
	7.5	282	5 - 7.5	114		7.5	975	5 - 7.5	382
	10	170	7.5 - 10	78		10	515	7.5 - 10	213
	15	359	10 - 15	296		15	290	10 - 15	155
	25	737	15 - 25	1,271		25	326	15 - 25	399
	50	517	25 - 50	398		50	354	25 - 50	389
	75	876	50 - 75	2,253		75	733	50 - 75	645
	100	102,267	75 - 100	1,093		100	**ND**	75 - 100	**ND**

ND: not determined. Insufficient space to set up the Wenner four-electrode test array for the indicated soil depth.

Laboratory Soil Analysis Results

Table 2 lists the minimum soil resistivity and chemical analyses of the four soil samples retrieved from URS soil borings taken at the project site and analyzed at the Cooper Testing Laboratory.

Table 2. Laboratory Soil Resistivity and Chemical Data

Boring No.	Depth (feet)	Minimum Resistivity (ohm-cm)	Chemical Data		
			pH	Chloride (mg/kg)	Sulfate (mg/kg)
R-11-011	0 - 6	1,252	8.0	246	9
R-11-011-13-3	55 - 60	719	7.7	341	9
R-11-014-1	5 - 6.5	1,328	7.6	181	8
R-11-014-13-4	57 - 58	2,829	8.0	43	<5

Minimum resistivity by Caltrans Method 643
pH by Caltrans Method 644
Chloride by Caltrans Method 422-modified
Sulfate by Caltrans Method 417-modified

The results of the soil sample chemical analyses listed in Table 2 indicate the soils are *non-corrosive* to buried steel and reinforced concrete structures. However, the bridge abutment sites are approximately 300 feet from core samples A-11-030-2-4, R-11-010-1-3, and R-11-018-2-2 which are considered *corrosive* soils based on Caltrans *Corrosion Guidelines* for minimum resistivity, water-soluble chloride content, and water soluble sulfate content. Seven of the sixteen analyzed soil boring samples at the project site are corrosive per the Caltrans *Corrosion Guidelines.* The non-corrosive nature of the sampled borings does not necessarily mean that corrosive soils will not be encountered at the Broadway Overpass Bridge abutments.

APPENDIX A: SOIL SAMPLE LABORATORY CHEMICAL ANALYSIS RESULTS

Corrosivity Test Summary

CTL #	632-011		**Date:**	12/19/2011		**Tested By:**	PJ		**Checked:**	PJ	
Client:	V&A Consulting Engineers		**Project:**	URS Hwy 101 Broadway Interchange					**Proj. No:**	11-0149	
Remarks:											

Sample Location or ID			**Resistivity @ 15.5 °C (Ohm-cm)**			**Chloride**	**Sulfate**		**pH**	**ORP**	**Moisture**	
Boring	**Sample, No.**	**Depth, ft.**	**As Rec.**	**Minimum**	**Saturated**	**mg/kg**	**mg/kg**	**%**		(Redox)	At Test	**Soil Visual Description**
						Dry Wt.	Dry Wt.	Dry Wt.		mV	%	
			ASTM G57	Cal 643	ASTM G57	Cal 422-mod.	Cal 417-mod.	Cal 417-mod.	Cal 643	SM 2580B	ASTM D2216	
A-11-002	-	2.5-5	29,118	1,236	-	92	434	0.0434	8.8	-	8.3	Olive Silty SAND (Slightly Plastic)
A-11-004	-	2.5-5	1,308	622	-	528	900	0.0900	8.3	-	16.8	Dark Olive Gray Clayey SAND w/ Gravel
A-11-020-2-3	-	5-6.5	3,566	3,566	-	<2	6	0.0006	8.3	-	20.4	Olive Brown Silty SAND
A-11-023	-	2-5	5,591	198	-	2,034	447	0.0447	8.2	-	7.8	Olive Gray Clayey SAND w/ Gravel
A-11-030-2-4	-	3-6.5	129	114	-	6,739	2,606	0.2606	7.8	-	95.7	Olive Gray CLAY w/ Organics
A-11-031-2-3	-	3-6.5	104	90	-	3,284	425	0.0425	7.7	-	77.0	Dark Greenish Gray CLAY
R-11-005	-	3.5-5	149,040	1,151	-	90	542	0.0542	7.9	-	4.8	Olive Brown Clayey SAND w/ Gravel
R-11-007-1-3	-	5-7	6,381	1,952	-	13	6	0.0006	7.9	-	12.5	Gray Clayey SAND changing to Sandy CLAY
R-11-008-1-3	-	5-7	2,904	2,517	-	<2	132	0.0132	8.0	-	7.4	Gray Clayey SAND w/ Gravel
R-11-010-1-3	-	5-7	5,515	1,768	-	24	5,391	0.5391	7.7	-	20.8	Olive Brown Clayey SAND
R-11-011	-	0-6	600,080	1,252	-	246	9	0.0009	8.0	-	3.9	Olive Brown Clayey SAND w/ Gravel
R-11-011-13-3	-	55-60	821	719	-	341	9	0.0009	7.7	-	23.6	Olive Brown Clayey SAND
R-11-014-1	-	5-6.5	1,605	1,328	-	181	8	0.0008	7.6	-	24.9	Brown Clayey SAND w/ Gravel
R-11-014-13-4	-	57-58	3,214	2,829	-	43	<5	<0.0005	8.0	-	16.1	Olive Brown Clayey SAND
R-11-017-1-2	-	5-7	561	561	-	451	272	0.0272	7.7	-	15.4	Olive Brown Sandy CLAY w/ Gravel
R-11-018-2-2	-	10-11.5	146	131	-	4965	786	0.0786	8.0	-	80.3	Gray CLAY

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- Earthquake Engineering
- Geotechnical Services

Developed By

GeoResearch Group

Caltrans Research & Innovation

In Partnership With

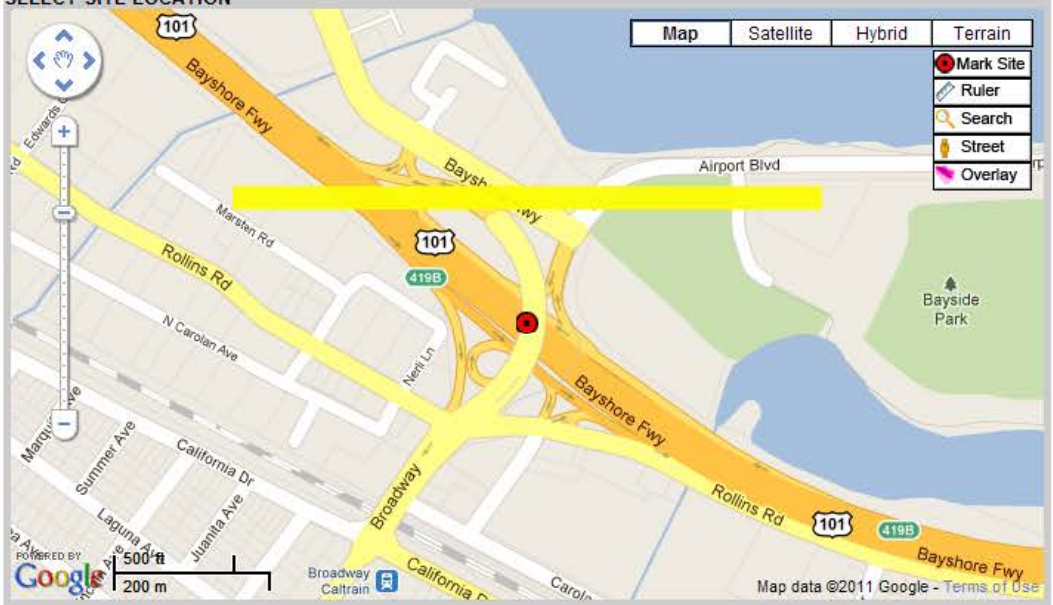
USGS science for a changing world

PACIFIC EARTHQUAKE

Caltrans ARS Online (v1.0.4)

This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in *Appendix B of Caltrans Seismic Design Criteria*. More...

SELECT SITE LOCATION



Latitude: 37.59006138 Longitude: -122.36124068 V_{S30}: 250 m/s Calculate

Done Internet 100%

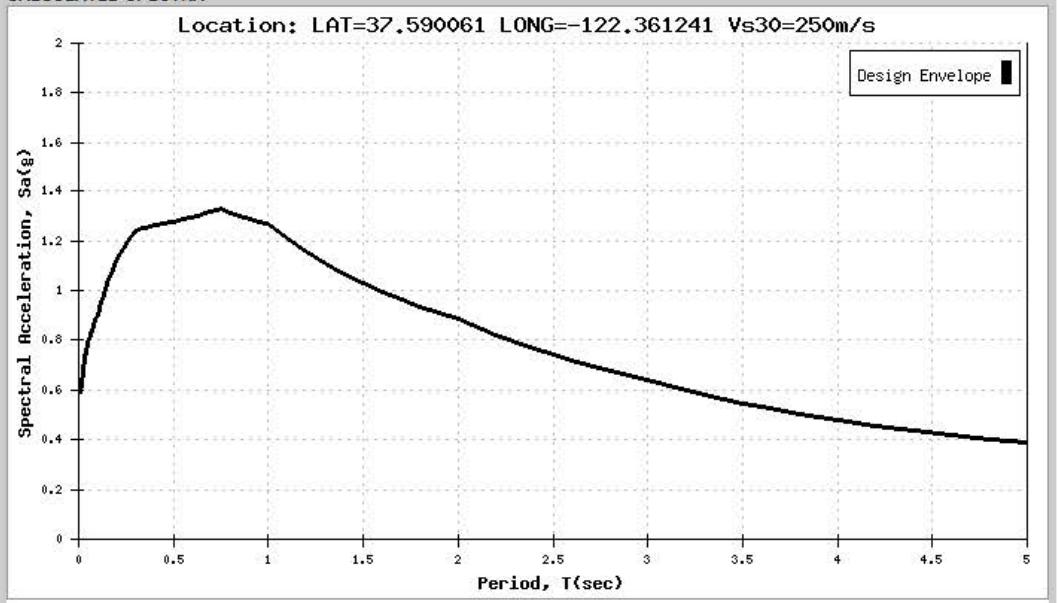
ARS Online - Windows Internet Explorer

http://dap3.dot.ca.gov/shake_stable/index.php

File Edit View Favorites Tools Help Convert Select

Gmail - Inbox (2) - madhuthu... | Welcome | ARS Online | 2008 Interactive Deaggrega...

CALCULATED SPECTRA



View Tabular Data | Remove Envelope | Hide Near Fault Adjustment | Axis Scale

Printer Friendly View | Show Basin Factor

Apply Near Fault Adjustment To:

NOTE: Caltrans SDC requires application of a Near Fault Adjustment factor for sites less than 25 km (Rrup) from the causative fault.

☑ Deterministic Spectrum Using

4.37 Km San Andreas fault zone (Peninsula section)

☑ Probabilistic Spectrum Using

3.6 Km (Recommend Performing Deaggregation To Verify)

◉ Show Spectrum with Adjustment Only

○ Show Spectrum with and without near fault Adjustment

OK

Done | Internet | 100%

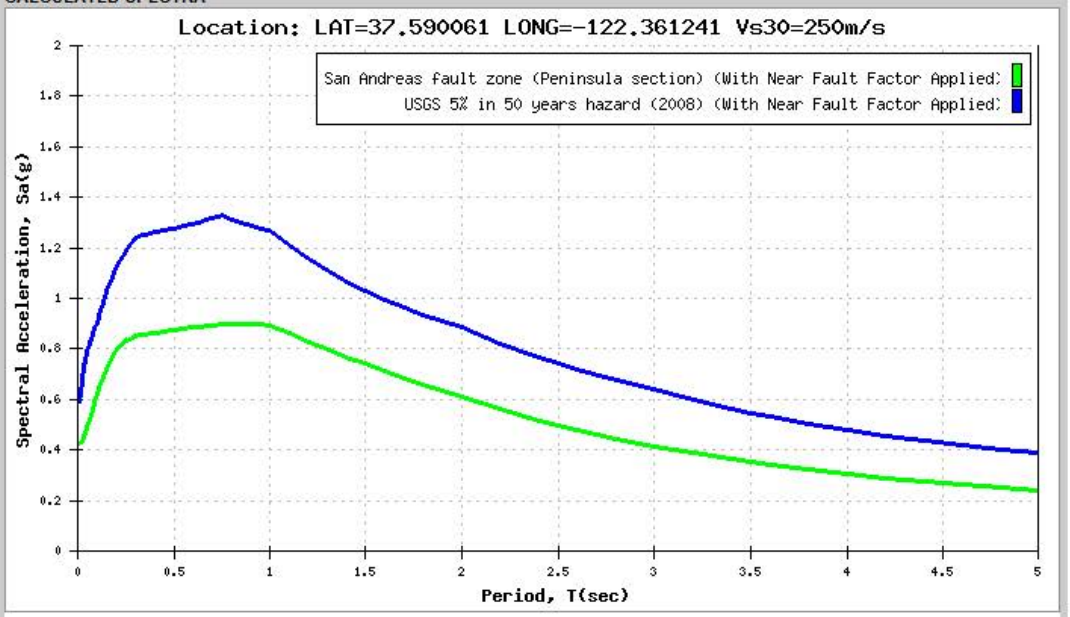
ARS Online - Windows Internet Explorer

http://dap3.dot.ca.gov/shake_stable/index.php

File Edit View Favorites Tools Help Convert Select

Gmail - Inbox (2) - madhuthu... | Welcome | ARS Online | 2008 Interactive Deaggrega...

CALCULATED SPECTRA



View Tabular Data | Show Envelope Only | Hide Near Fault Adjustment | Axis Scale

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3.6 Km (Recommenc Performing Deaggregation To Verify)

◉ Show Spectrum with Adjustment Only

○ Show Spectrum with and without near fault Adjustment

OK

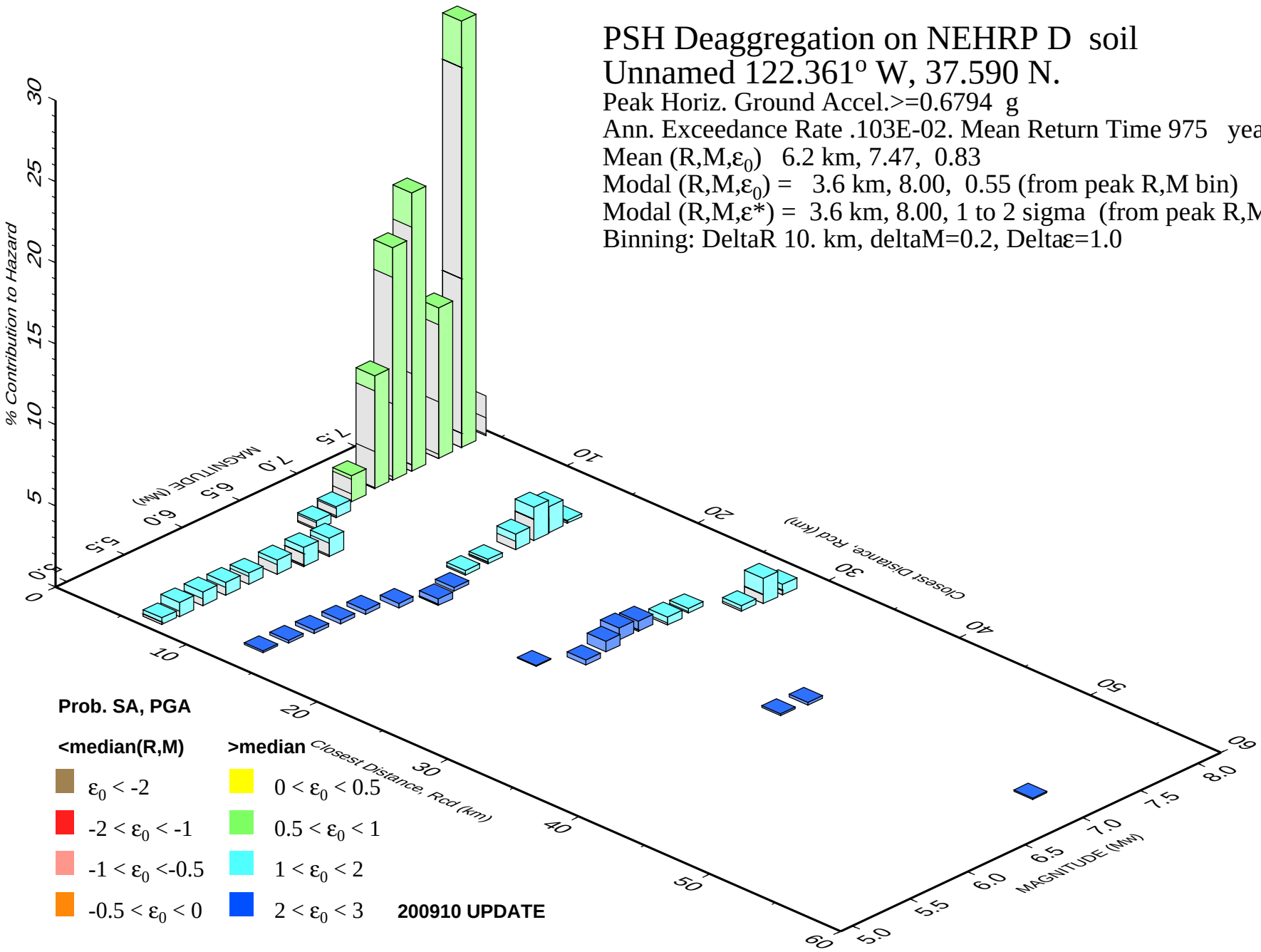
Done | Internet | 100%

Estimate of Shear Wave Velocity
Vs30
U.S. 101 Broadway Interchange Reconstruction

PointID	Depth	BottomDepth	Velocity	Layer Thickness (ft)	D/V			
CPT-11-012	5	19	712.42	14	0.019651			
CPT-11-012	19	24	560.99	5	0.008913			
CPT-11-012	24	29	690.71	5	0.007239			
CPT-11-012	29	34	780.73	5	0.006404			
CPT-11-012	34	39	661.5	5	0.007559			
CPT-11-012	39	44	976.38	5	0.005121			
CPT-11-012	44	49	810.03	5	0.006173			
CPT-11-012	49	54	1125.74	5	0.004442	Vs30=	807	ft/sec
CPT-11-012	54	64	829.14	10	0.012061		246	m/sec
CPT-11-012	64	69	1027.24	5	0.004867			
CPT-11-012	69	74	745.56	5	0.006706			
CPT-11-012	74	79	709.29	5	0.007049			
CPT-11-012	79	84	1061.63	5	0.00471			
CPT-11-012	84	99	962.13	15	0.01559			
CPT-11-016	8	19	874.3	11	0.012581			
CPT-11-016	19	24	736.1	5	0.006793			
CPT-11-016	24	29	721.03	5	0.006935			
CPT-11-016	29	34	912.6	5	0.005479			
CPT-11-016	34	39	835.17	5	0.005987			
CPT-11-016	39	44	1189.99	5	0.004202			
CPT-11-016	44	49	776.36	5	0.00644			
CPT-11-016	49	54	808.12	5	0.006187			
CPT-11-016	54	59	1067.12	5	0.004686	Vs30=	964	ft/sec
CPT-11-016	59	64	942.63	5	0.005304		294	m/sec
CPT-11-016	64	69	915.29	5	0.005463			
CPT-11-016	69	74	1176.56	5	0.00425			
CPT-11-016	74	79	1765.74	5	0.002832			
CPT-11-016	79	84	1489.91	5	0.003356			
CPT-11-016	84	89	1479.46	5	0.00338			
CPT-11-016	89	94	1216.5	5	0.00411			
CPT-11-016	94	99	782.35	5	0.006391			

PSH Deaggregation on NEHRP D soil
Unnamed 122.361° W, 37.590 N.

Peak Horiz. Ground Accel.>=0.6794 g
Ann. Exceedance Rate .103E-02. Mean Return Time 975 years
Mean (R,M,ε_0) 6.2 km, 7.47, 0.83
Modal (R,M,ε_0) = 3.6 km, 8.00, 0.55 (from peak R,M bin)
Modal (R,M,ε*) = 3.6 km, 8.00, 1 to 2 sigma (from peak R,M,ε bin)
Binning: DeltaR 10. km, deltaM=0.2, Deltaε=1.0



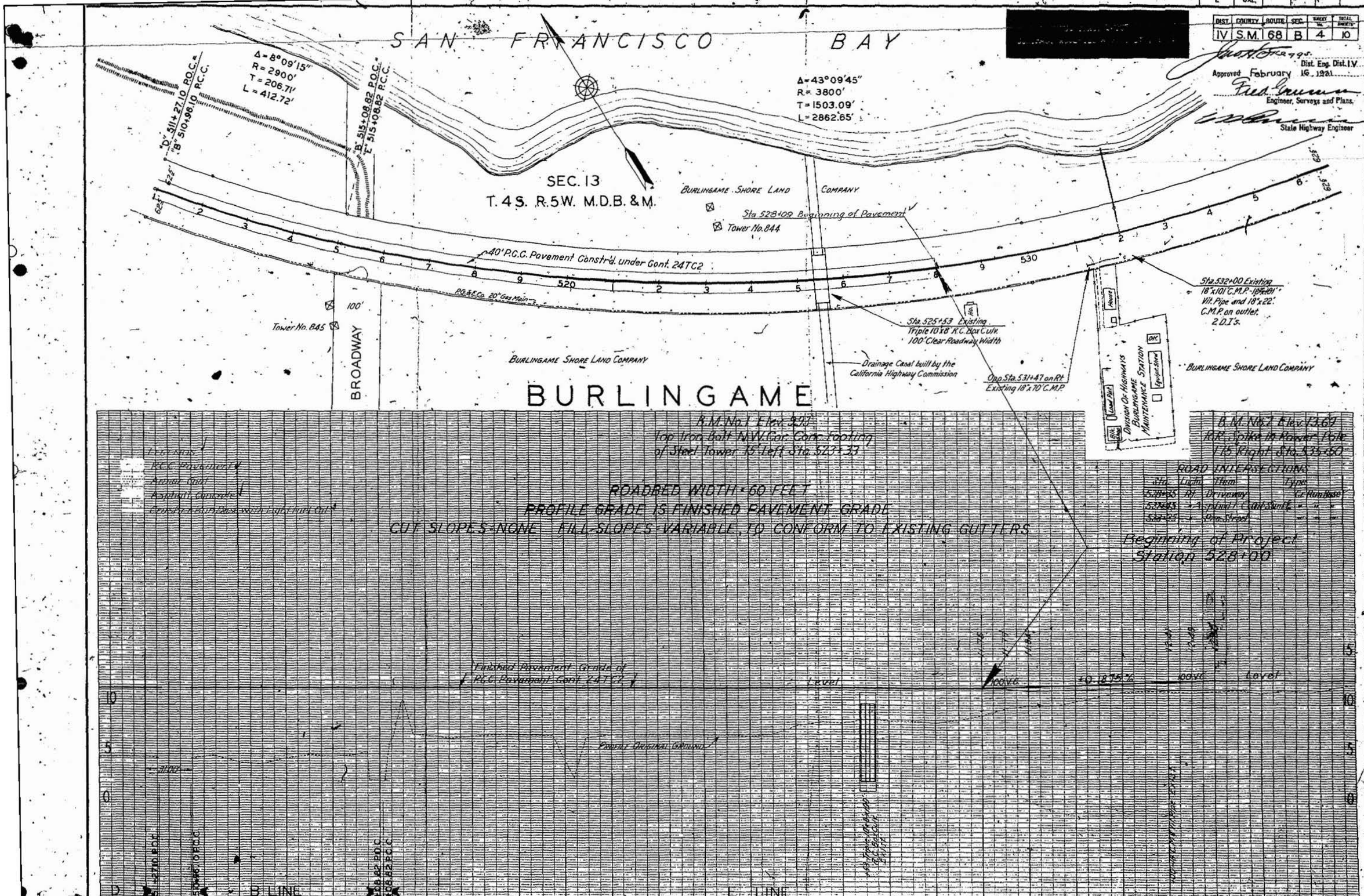
GMT 2012 Jan 22 17:16:24 **Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on soil with average vs= 250. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted**

DIST.	COUNTY	ROUTE	SEC.	SHEET No.	TOTAL SHEETS
IV	S.M.	68	B	4	10

DIST. No.	STATE	FED. AID PROJ. No.	YEAR	SHEET No.	TOTAL SHEETS
2	CAL.				

[redacted]

Dist. Eng. Dist. IV.
Approved February 16, 1921.
Engineer, Surveys and Plans.
State Highway Engineer



FED. ROAD DIST. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
2	CAL.		48 49	54	

DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
IV	S M	82	Burl	2	18

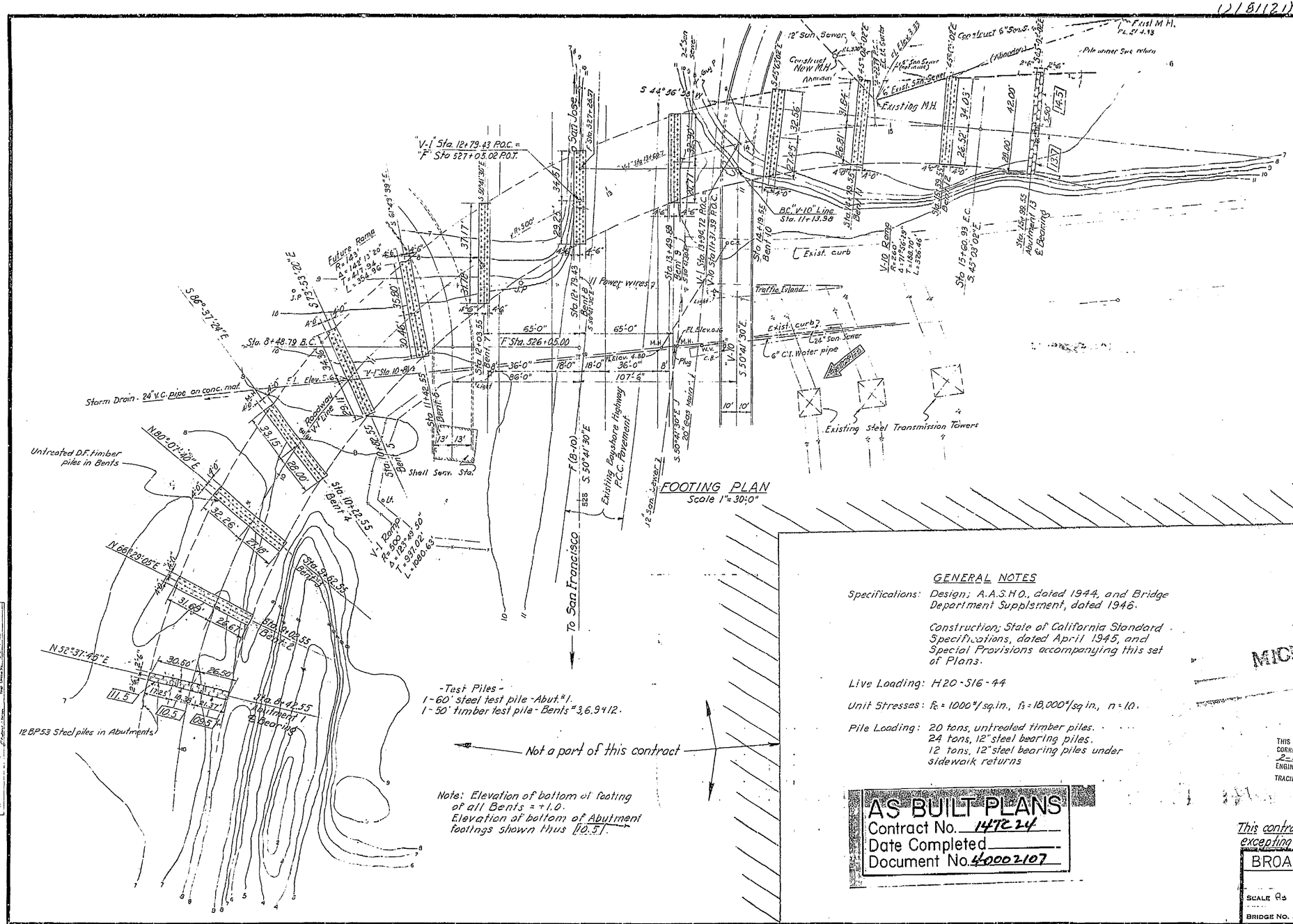
Bridge Engineer

Date approved March 11, 1941

121 B1(21)

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
STATE OF CALIFORNIA

BRIDGE DEPARTMENT



FOOTING PLAN
Scale 1" = 30'-0"

-Test Piles-
1-60' steel test pile - Abut. #1.
1-50' timber test pile - Bents #3, 6, 9 & 12.

Note: Elevation of bottom of footing of all Bents = +1.0.
Elevation of bottom of Abutment footings shown thus [10.5].

GENERAL NOTES

Specifications: Design; A.A.S.H.O., dated 1944, and Bridge Department Supplement, dated 1948.

Construction; State of California Standard Specifications, dated April 1945, and Special Provisions accompanying this set of Plans.

Live Loading: H20-S16-44

Unit Stresses: $f_c = 1000^{\#}/sq.in.$, $f_s = 18{,}000^{\#}/sq.in.$, $n = 10$.

Pile Loading: 20 tons, untreated timber piles.
24 tons, 12" steel bearing piles.
12 tons, 12" steel bearing piles under sidewalk returns

MICROFILMED

THIS SET OF PLANS HAS BEEN CORRECTED TO CORRESPOND TO THE "AS BUILT" PRINTS, DATED 2-4-49, AS SUBMITTED BY RESIDENT ENGINEER W.N.S.
TRACINGS CORRECTED BY SDM DATE 9-2-49.

AS BUILT PLANS
Contract No. 147224
Date Completed
Document No. 40002107

This contract is for superstructure only, excepting anchor bolts.

Submitted by: Edward R. Bergman
DESIGN — Chief Bridge Engineer
DETAILS — Bridge Engineer
QUANTITIES — Bridge Engineer
SPECIFICATIONS — Bridge Engineer
Approval Recommended by: W. H. Wheeler, Chief Engineer

DESIGN	R. J.	R. E.	11-46
DETAILS	W. C.	R. E.	11-46
QUANTITIES		R. E.	11-46
SPECIFICATIONS		R. E.	11-46

Scale: 1" = 30'-0"
Checked by: J. T. Hoffman
Approved by: W. H. Wheeler, Chief Engineer

BROADWAY OVERCROSSING
FOOTING PLAN

SCALE As shown	FILE NO.
BRIDGE NO. 35-96	DRAWING NO. C-1908-75

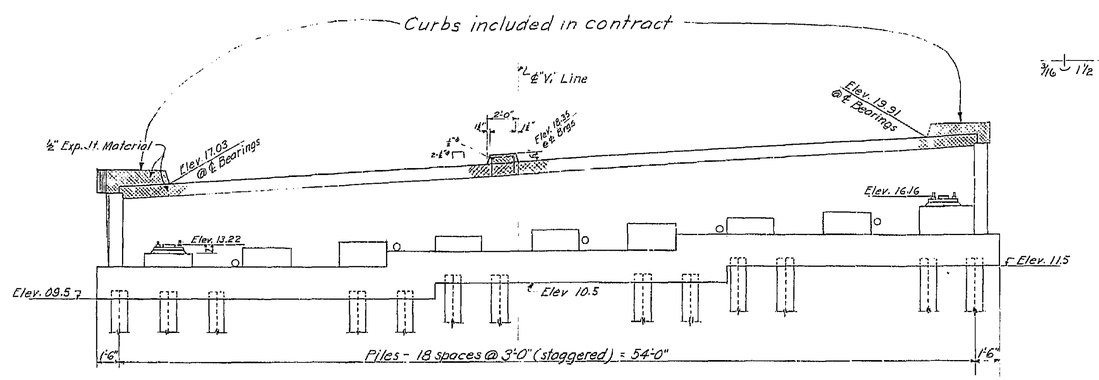
ClibPDF - www.fastio.com

FED. AID PROJ. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
2	CAL.		48	114	54

(1181(21))

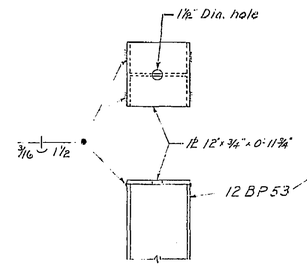
DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
11	M	60	Bur	9	13

March 12, 1947



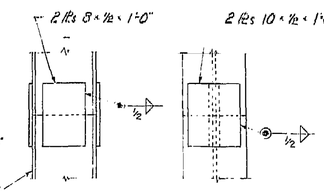
Note:- Top of Bearings are on straight grade between end bearings.

ELEVATION
Scale: ¼" = 1'-0"

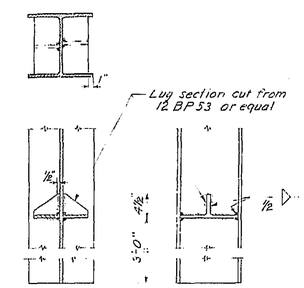


PILE CAP
Scale: 1" = 1'-0"

Pile caps to be placed on all piles after cutoff.



PILE FIELD SPLICE
Scale: 1" = 1'-0"

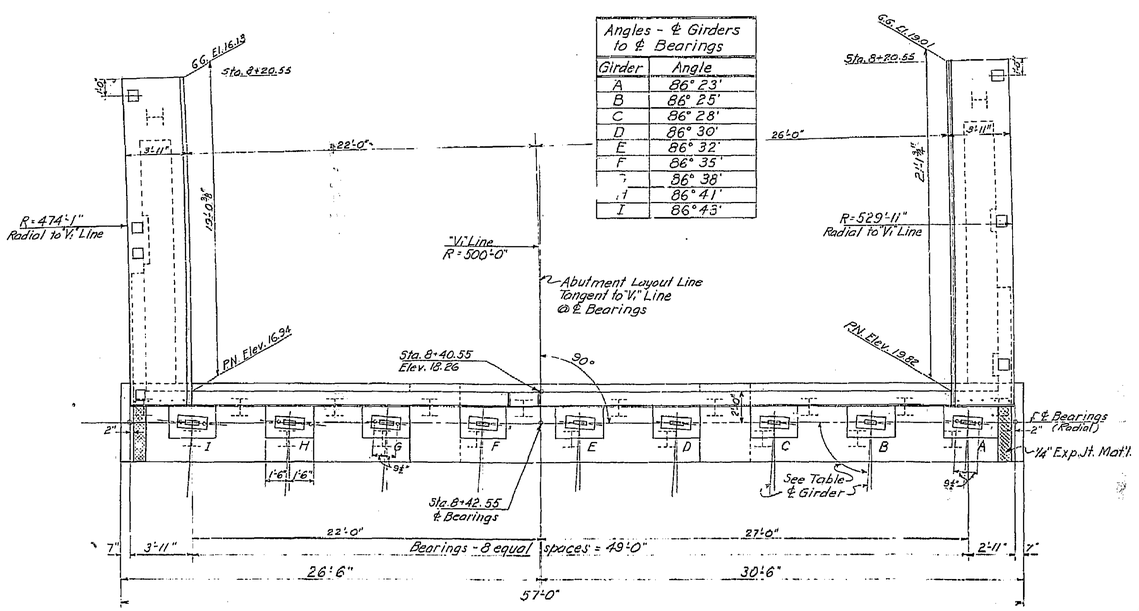


PILE LUG
Scale: 1" = 1'-0"

Notes:
1. Weld splice plates to top pile before placing top pile in position.
2. Place top pile in position and hammer sufficiently to secure good bearing on bottom pile.
3. Weld splice plate to bottom pile and butt weld any opening remaining between piles.
4. All piles to be flame cut, using steel yoke to secure square and even cut.
5. Lug to be used when ordered by the Engineer.

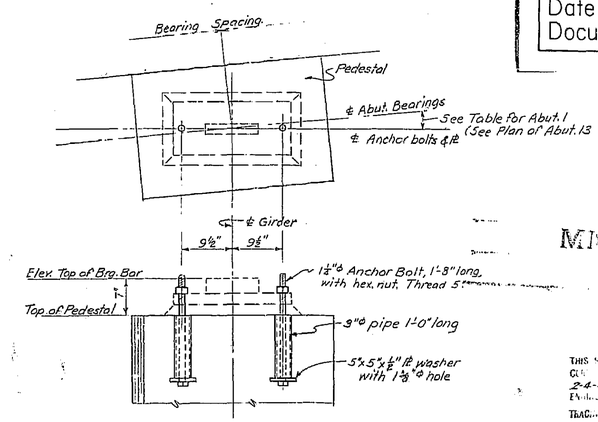
AS BUILT PLANS
Contract No. 14TC24
Date Completed
Document No. 40002107

Angles - ℄ Girders to ℄ Bearings	
Girder	Angle
A	86° 23'
B	86° 25'
C	86° 28'
D	86° 30'
E	86° 32'
F	86° 35'
G	86° 38'
H	86° 41'
I	86° 43'



Note: For details not shown see Sheet 4.
Railing not shown. For details & rail post spacing see Sh. 11.

PLAN
Scale: ¼" = 1'-0"



ANCHOR BOLT DETAILS
Scale: 1" = 1'-0"
Anchor bolts to be placed by others.

Abutments, excepting curb and railing, not a part of this contract.

MICROFILMED

THIS SET OF PLANS [illegible] FROM ORIGINAL TO 1-0 [illegible] PLANS, DATED 2-4-49 [illegible] SUBMITTED BY RESIDENT ENGINEER [illegible] H.N.S. TRACED BY: S.O.M. DATE: 9-2-49

This contract is for superstructure only, excepting anchor bolts.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING

ABUTMENT NO. 1

SCALE	BRIDGE	FILE	DRAWING
As Shown	35-96		C-1909-176

BRIDGE DEPARTMENT

Submitted by: Charles R. Hansen

DESIGN	By R.C.F.	10-46	Checked	R.S.B. 11-46
DETAILS	By R.W.K.	10-46	Checked	R.S.B. 11-46
QUANTITIES	By [illegible]	11-46	Checked	R.S.B. 11-46
SPECIFICATIONS	By [illegible]		Date Last Mod.	
Approx. Recommended by: C.F. Hansen			Bridge Engr.	R.S.B. 11-46
			Bridge Engr.	

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W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Axial\BWYWAbutment.cpt

AXIALLY LOADING PILE ANALYSIS PROGRAM - APILEplus
VERSION 5.0 - (C) COPYRIGHT ENSOFT,INC.,1987-2008.

Broadway Overcrossing Replacement West Abutment

DESIGNER : Madhu Thummaluru

DATE : 06/13/2012

PILE PROPERTIES :

PERIMETER OF PILE WITH NONCIRCULAR SECTION= 64.00 IN.
TIP AREA OF PILE WITH NONCIRCULAR SECTION = 1.78 SQF
OUTSIDE DIAMETER OF CIRCULAR PILE = 16.00 IN.
INTERNAL DIAMETER OF CIRCULAR PILE = 0.00 IN.
PILE LENGTH = 80.00 FT.
MODULUS OF ELASTICITY = 0.337E+07 PSI

LENGTH OF SURFACE SECTION WITH ZERO SKIN FRICTION = 0.00 FT.
INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.00	57.60	0.00	0.00
2.50	CLAY	0.00	57.60	0.00	0.00
2.50	CLAY	0.00	27.60	0.00	0.00
8.50	CLAY	0.00	27.60	0.00	0.00
8.50	SAND	0.00	62.60	31.00	0.00
10.00	SAND	0.00	62.60	31.00	0.00
10.00	CLAY	0.00	52.60	0.00	0.00
16.00	CLAY	0.00	52.60	0.00	0.00
16.00	CLAY	0.00	57.60	0.00	0.00
19.00	CLAY	0.00	57.60	0.00	0.00
19.00	CLAY	0.00	62.60	0.00	0.00
24.00	CLAY	0.00	62.60	0.00	0.00
24.00	CLAY	0.00	67.60	0.00	0.00
29.00	CLAY	0.00	67.60	0.00	0.00
29.00	CLAY	0.00	62.60	0.00	0.00
39.00	CLAY	0.00	62.60	0.00	0.00
39.00	CLAY	0.00	62.60	0.00	0.00
44.00	CLAY	0.00	62.60	0.00	0.00
44.00	CLAY	0.00	57.60	0.00	0.00
48.50	CLAY	0.00	57.60	0.00	0.00
48.50	SAND	0.00	77.60	42.00	0.00
50.50	SAND	0.00	77.60	42.00	0.00
50.50	SAND	0.00	77.60	44.00	0.00

55.00	SAND	0.00	77.60	44.00	0.00
55.00	CLAY	0.00	62.60	0.00	0.00
58.50	CLAY	0.00	62.60	0.00	0.00
58.50	CLAY	0.00	57.60	0.00	0.00
63.00	CLAY	0.00	57.60	0.00	0.00
63.00	CLAY	0.00	72.60	0.00	0.00
69.00	CLAY	0.00	72.60	0.00	0.00
69.00	SAND	0.00	77.60	44.00	0.00
84.50	SAND	0.00	77.60	44.00	0.00
84.50	CLAY	0.00	67.60	0.00	0.00
94.00	CLAY	0.00	67.60	0.00	0.00

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08	0.10E+08	1.50	1.50	0.00	0.00	0.00
0.10E+08	0.10E+08	1.50	1.50	0.00	0.00	0.00
0.10E+08	0.10E+08	0.16	0.16	0.00	0.00	0.00
0.10E+08	0.10E+08	0.16	0.16	0.00	0.00	0.00
0.10E-05	0.10E-05	0.00	0.00	7.00	0.00	0.00
0.10E-05	0.10E-05	0.00	0.00	7.00	0.00	0.00
0.10E+08	0.10E+08	0.85	0.85	0.00	0.00	0.00
0.10E+08	0.10E+08	0.85	0.85	0.00	0.00	0.00
0.10E+08	0.10E+08	1.50	1.50	0.00	0.00	0.00
0.10E+08	0.10E+08	1.50	1.50	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	0.38	0.38	0.00	0.00	0.00
0.10E+08	0.10E+08	0.38	0.38	0.00	0.00	0.00
0.10E+08	0.10E+08	1.35	1.35	0.00	0.00	0.00
0.10E+08	0.10E+08	1.35	1.35	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	1.30	1.30	0.00	0.00	0.00
0.10E+08	0.10E+08	1.30	1.30	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	67.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	67.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	79.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	79.00	0.00	0.00
0.10E+08	0.10E+08	1.75	1.75	0.00	0.00	0.00
0.10E+08	0.10E+08	1.75	1.75	0.00	0.00	0.00
0.10E+08	0.10E+08	2.50	2.50	0.00	0.00	0.00
0.10E+08	0.10E+08	2.50	2.50	0.00	0.00	0.00
0.10E+08	0.10E+08	2.50	2.50	0.00	0.00	0.00
0.10E+08	0.10E+08	2.50	2.50	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	100.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	100.00	0.00	0.00
0.10E+08	0.10E+08	4.00	4.00	0.00	0.00	0.00
0.10E+08	0.10E+08	4.00	4.00	0.00	0.00	0.00

SET MAXIMUM UNIT FRICTION AND MAXIMUM UNIT BEARING

TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO
LIMIT THE COMPUTED DATA.

****
* COMPUTATION RESULT *
****

	**********			**********			**********		
	* FED. HWY. METHOD *			* ARMY CORPS METHOD *			* LAMBDA 2 METHOD *		
	**********			**********			**********		
PILE PENETR- ATION FT.	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC- ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC- ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC- ITY KIP
0.0	0.0	21.5	21.5	0.0	21.5	21.5	0.0	21.5	21.5
1.0	0.0	15.2	15.2	4.0	15.2	19.2	4.7	15.2	19.9
2.0	4.0	8.9	12.9	8.0	8.9	16.9	8.0	8.9	16.9
3.0	12.0	2.6	14.6	12.0	2.6	14.6	10.9	2.6	13.4
4.0	16.4	2.6	19.0	14.4	2.6	17.0	10.9	2.6	13.5
5.0	17.3	2.6	19.8	15.3	2.6	17.8	11.1	2.6	13.6
6.0	18.1	2.3	20.4	16.1	4.2	20.3	11.3	2.3	13.6
7.0	19.0	3.1	22.1	17.0	8.2	25.2	11.5	3.1	14.6
8.0	19.8	6.3	26.2	17.8	11.5	29.3	11.8	6.3	18.2
9.0	20.7	9.6	30.3	18.7	14.7	33.4	11.8	9.6	21.4
10.0	21.3	13.6	34.9	18.7	13.6	32.3	12.3	13.6	25.9
11.0	24.3	13.6	37.9	20.6	13.6	34.2	13.6	13.6	27.2
12.0	28.8	13.6	42.4	24.3	13.6	37.9	14.9	13.6	28.5
13.0	33.3	14.8	48.1	28.0	14.8	42.9	16.2	14.8	31.0
14.0	37.9	17.9	55.7	31.8	17.9	49.7	17.4	17.9	35.3
15.0	42.4	20.9	63.3	35.5	20.9	56.5	18.6	20.9	39.6
16.0	46.9	23.1	70.0	39.3	23.1	62.3	19.9	23.1	43.0
17.0	53.2	20.7	73.9	43.1	20.7	63.8	22.7	20.7	43.4
18.0	61.2	18.4	79.6	47.1	18.4	65.5	25.5	18.4	43.9
19.0	69.2	16.0	85.2	51.1	16.0	67.1	28.4	16.0	44.4
20.0	75.9	16.0	91.9	55.1	16.0	71.1	30.6	16.0	46.6
21.0	81.2	14.8	96.0	59.1	14.8	74.0	32.8	14.8	47.7
22.0	86.5	11.9	98.5	63.1	11.9	75.1	35.1	11.9	47.0
23.0	91.9	9.0	100.9	67.1	9.0	76.1	37.4	9.0	46.4
24.0	97.2	6.1	103.3	71.1	6.1	77.2	39.8	6.1	45.9
25.0	100.9	6.1	107.0	74.1	6.1	80.2	41.3	6.1	47.3
26.0	102.9	7.9	110.8	76.2	7.9	84.1	42.8	7.9	50.7
27.0	104.9	12.5	117.4	78.2	12.5	90.7	44.4	12.5	56.9
28.0	107.0	17.0	124.0	80.2	17.0	97.3	46.0	17.0	63.1
29.0	109.0	21.6	130.6	82.3	21.6	103.9	47.7	21.6	69.3
30.0	113.6	21.6	135.2	85.3	21.6	106.9	50.9	21.6	72.5
31.0	120.8	21.6	142.4	89.5	21.6	111.1	54.2	21.6	75.8
32.0	128.0	21.6	149.6	93.6	21.6	115.2	57.4	21.6	79.0
33.0	135.2	21.6	156.8	97.8	21.6	119.4	60.8	21.6	82.4
34.0	142.4	21.6	164.0	101.9	21.6	123.5	64.1	21.6	85.7
35.0	149.6	21.6	171.2	106.0	21.6	127.6	67.6	21.6	89.2
36.0	156.8	25.6	182.4	110.2	25.6	135.8	71.0	25.6	96.6
37.0	164.0	35.7	199.7	114.3	35.7	150.1	74.6	35.7	110.3
38.0	171.2	45.9	217.1	118.5	45.9	164.3	78.1	45.9	124.0
39.0	178.4	56.0	234.4	122.6	56.0	178.6	81.7	56.0	137.7

40.0	185.6	56.0	241.6	129.3	56.0	185.3	88.6	56.0	144.6
41.0	192.9	51.9	244.8	138.7	51.9	190.6	95.5	51.9	147.4
42.0	200.1	41.5	241.6	148.0	41.5	189.5	102.5	41.5	144.0
43.0	207.3	31.2	238.5	157.3	31.2	188.5	109.5	31.2	140.7
44.0	214.6	20.8	235.4	166.7	20.8	187.5	116.5	20.8	137.3
45.0	221.7	20.8	242.5	173.4	20.8	194.2	120.4	20.8	141.2
46.0	228.6	127.2	355.8	177.6	69.2	246.8	124.2	18.4	142.6
47.0	235.5	401.6	637.1	181.7	191.8	373.5	128.1	12.3	140.4
48.0	242.5	721.4	963.9	185.9	331.5	517.4	132.1	6.1	138.2
49.0	249.4	1101.5	1350.9	190.1	497.4	687.5	136.0	0.0	136.0
50.0	267.0	1210.2	1477.3	192.1	540.8	733.0	138.1	0.0	138.1
51.0	295.7	1311.3	1607.0	192.1	584.3	776.4	140.3	0.0	140.3
52.0	325.6	1161.9	1487.5	192.1	519.5	711.6	142.5	3.3	145.8
53.0	356.8	783.9	1140.7	192.1	355.7	547.8	144.8	11.5	156.3
54.0	388.8	406.0	794.7	192.1	191.8	384.0	147.1	19.8	166.8
55.0	421.5	28.0	449.5	192.1	28.0	220.1	149.5	28.0	177.5
56.0	442.5	29.4	471.9	194.5	29.4	223.9	154.5	29.4	183.9
57.0	451.4	32.9	484.3	199.1	32.9	232.1	159.6	32.9	192.6
58.0	460.2	36.5	496.7	203.8	36.5	240.3	164.8	36.5	201.2
59.0	469.1	40.0	509.1	208.5	40.0	248.5	170.0	40.0	210.0
60.0	478.2	40.0	518.2	214.1	40.0	254.1	176.3	40.0	216.3
61.0	487.6	40.0	527.6	220.8	40.0	260.8	182.7	40.0	222.7
62.0	496.9	40.0	536.9	227.5	40.0	267.5	189.2	40.0	229.2
63.0	506.3	40.0	546.3	234.1	40.0	274.1	195.6	40.0	235.6
64.0	515.6	40.0	555.6	240.8	40.0	280.8	202.2	40.0	242.2
65.0	525.0	40.0	565.0	247.5	40.0	287.5	208.8	40.0	248.8
66.0	534.3	188.0	722.3	254.1	103.4	357.5	215.4	35.3	250.8
67.0	543.6	562.4	1106.1	260.8	263.7	524.5	222.1	23.6	245.7
68.0	553.0	936.9	1489.9	267.5	424.0	691.4	228.9	11.8	240.6
69.0	562.3	1311.3	1873.6	274.1	584.3	858.4	235.7	0.0	235.7
70.0	588.7	1311.3	1900.0	277.5	584.3	861.7	238.8	0.0	238.8
71.0	632.4	1311.3	1943.7	277.5	584.3	861.7	242.0	0.0	242.0
72.0	676.9	1311.3	1988.2	277.5	584.3	861.7	245.2	0.0	245.2
73.0	722.3	1311.3	2033.6	277.5	584.3	861.7	248.5	0.0	248.5
74.0	768.4	1311.3	2079.7	277.5	584.3	861.7	251.9	0.0	251.9
75.0	815.3	1311.3	2126.6	277.5	584.3	861.7	255.3	0.0	255.3
76.0	863.0	1311.3	2174.3	277.5	584.3	861.7	258.8	0.0	258.8
77.0	911.5	1311.3	2222.8	277.5	584.3	861.7	262.3	0.0	262.3
78.0	960.8	1311.3	2272.1	277.5	584.3	861.7	265.9	0.0	265.9
79.0	1010.9	1311.3	2322.2	277.5	584.3	861.7	269.5	0.0	269.5
80.0	1061.8	1311.3	2373.1	277.5	584.3	861.7	273.2	0.0	273.2

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.9019E+01	0.4872E-02	0.8046E+00	0.1000E-03
0.9139E+02	0.4969E-01	0.8046E+01	0.1000E-02
0.3661E+03	0.2304E+00	0.4023E+02	0.5000E-02
0.5923E+03	0.4203E+00	0.8046E+02	0.1000E-01
0.1278E+04	0.1164E+01	0.3414E+03	0.5000E-01
0.1459E+04	0.1410E+01	0.4145E+03	0.1000E+00
0.1822E+04	0.2215E+01	0.7861E+03	0.5000E+00
0.2064E+04	0.2985E+01	0.1028E+04	0.1000E+01
0.2338E+04	0.4290E+01	0.1302E+04	0.2000E+01

AXIALLY LOADING PILE ANALYSIS PROGRAM - APILEplus
VERSION 5.0 - (C) COPYRIGHT ENSOFT,INC.,1987-2008.

Broadway Overcrossing Replacement Bent 2

DESIGNER : Madhu Thummaluru

DATE : 06/13/2012

PILE PROPERTIES :

PERIMETER OF PILE WITH NONCIRCULAR SECTION= 0.00 IN.
TIP AREA OF PILE WITH NONCIRCULAR SECTION = 0.00 SQF
OUTSIDE DIAMETER OF CIRCULAR PILE = 24.00 IN.
INTERNAL DIAMETER OF CIRCULAR PILE = 23.00 IN.
PILE LENGTH = 90.00 FT.
MODULUS OF ELASTICITY = 0.263E+07 PSI

LENGTH OF SURFACE SECTION WITH ZERO SKIN FRICTION = 3.50 FT.
INCREMENT OF PILE LENGTH USED IN COMPUTATION = 0.25 FT.

SOIL INFORMATIONS:

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	SAND	0.00	72.60	28.00	0.00
1.50	SAND	0.00	72.60	28.00	0.00
1.50	CLAY	0.00	62.60	0.00	0.00
3.50	CLAY	0.00	62.60	0.00	0.00
3.50	CLAY	0.00	27.60	0.00	0.00
10.50	CLAY	0.00	27.60	0.00	0.00
10.50	SAND	0.00	67.60	36.00	0.00
17.00	SAND	0.00	67.60	36.00	0.00
17.00	SAND	0.00	77.60	40.00	0.00
22.50	SAND	0.00	77.60	40.00	0.00
22.50	CLAY	0.00	67.60	0.00	0.00
27.00	CLAY	0.00	67.60	0.00	0.00
27.00	CLAY	0.00	57.60	0.00	0.00
36.00	CLAY	0.00	57.60	0.00	0.00
36.00	SAND	0.00	72.60	40.00	0.00
46.00	SAND	0.00	72.60	40.00	0.00
46.00	CLAY	0.00	57.60	0.00	0.00
51.00	CLAY	0.00	57.60	0.00	0.00
51.00	SAND	0.00	67.60	36.00	0.00
61.00	SAND	0.00	67.60	36.00	0.00
61.00	CLAY	0.00	47.60	0.00	0.00
67.00	CLAY	0.00	47.60	0.00	0.00
67.00	CLAY	0.00	72.60	0.00	0.00
72.50	CLAY	0.00	72.60	0.00	0.00
72.50	CLAY	0.00	67.60	0.00	0.00
81.50	CLAY	0.00	67.60	0.00	0.00
81.50	CLAY	0.00	62.60	0.00	0.00
100.00	CLAY	0.00	62.60	0.00	0.00

MAXIMUM MAXIMUM UNDISTURB REMOLDED

UNIT FRICTION KSF	UNIT BEARING KSF	SHEAR STRENGTH KSF	SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08	0.10E+08	0.00	0.00	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	0.00	0.00	0.00
0.10E+08	0.10E+08	0.30	0.30	0.00	0.00	0.00
0.10E+08	0.10E+08	0.30	0.30	0.00	0.00	0.00
0.10E+08	0.10E+08	0.45	0.45	0.00	0.00	0.00
0.10E+08	0.10E+08	0.45	0.45	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	19.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	19.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	35.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	35.00	0.00	0.00
0.10E+08	0.10E+08	2.50	2.50	0.00	0.00	0.00
0.10E+08	0.10E+08	2.50	2.50	0.00	0.00	0.00
0.10E+08	0.10E+08	2.75	2.75	0.00	0.00	0.00
0.10E+08	0.10E+08	2.75	2.75	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	37.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	37.00	0.00	0.00
0.10E+08	0.10E+08	1.25	1.25	0.00	0.00	0.00
0.10E+08	0.10E+08	1.25	1.25	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	26.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	26.00	0.00	0.00
0.10E+08	0.10E+08	1.75	1.75	0.00	0.00	0.00
0.10E+08	0.10E+08	1.75	1.75	0.00	0.00	0.00
0.10E+08	0.10E+08	4.75	4.75	0.00	0.00	0.00
0.10E+08	0.10E+08	4.75	4.75	0.00	0.00	0.00
0.10E+08	0.10E+08	4.00	4.00	0.00	0.00	0.00
0.10E+08	0.10E+08	4.00	4.00	0.00	0.00	0.00
0.10E+08	0.10E+08	2.00	2.00	0.00	0.00	0.00
0.10E+08	0.10E+08	2.00	2.00	0.00	0.00	0.00

SET MAXIMUM UNIT FRICTION AND MAXIMUM UNIT BEARING
TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO
LIMIT THE COMPUTED DATA.

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* COMPUTATION RESULT *
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********** ********** **********
* FED. HWY. METHOD * * ARMY CORPS METHOD * * LAMBDA 2 METHOD *
********** ********** **********

PILE PENETR-ATION FT.	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP
0.0	0.0	0.0*	0.0	0.0	0.0*	0.0	0.0	0.0*	0.0
0.3	0.0	0.1*	0.1	0.0	0.1*	0.1	0.0	0.0*	0.0
0.5	0.0	0.1*	0.1	0.0	0.2*	0.2	0.0	0.0*	0.0
0.8	0.0	0.2*	0.2	0.0	0.3*	0.3	0.0	0.0*	0.0
1.0	0.0	0.2*	0.2	0.0	0.4*	0.4	0.0	0.0*	0.0
1.3	0.0	0.3*	0.3	0.0	0.5*	0.5	0.0	0.0*	0.0
1.5	0.0	0.3*	0.3	0.0	0.6*	0.6	0.0	0.0*	0.0
1.8	0.0	0.9*	0.9	0.0	0.9*	0.9	0.0	0.9*	0.9
2.0	0.0	1.1*	1.1	0.0	1.1*	1.1	0.0	1.1*	1.1
2.3	0.0	1.3*	1.3	0.0	1.3*	1.3	0.0	1.3*	1.3
2.5	0.0	1.4*	1.4	0.0	1.4*	1.4	0.0	1.4*	1.4
2.8	0.0	1.6*	1.6	0.0	1.6*	1.6	0.0	1.6*	1.6
3.0	0.0	1.9*	1.9	0.0	1.9*	1.9	0.0	1.9*	1.9
3.3	0.0	2.1*	2.1	0.0	2.1*	2.1	0.0	2.1*	2.1
3.5	0.2	2.3*	2.5	0.2	2.3*	2.5	0.0	2.3*	2.3

3.8	0.8	2.9*	3.7	0.8	2.9*	3.7	1.2	2.9*	4.1
4.0	1.5	3.2*	4.7	1.5	3.2*	4.7	2.4	3.2*	5.6
4.3	2.2	3.5*	5.7	2.2	3.5*	5.7	3.0	3.5*	6.5
4.5	2.9	3.8*	6.7	2.9	3.8*	6.7	3.6	3.8*	7.4
4.8	3.7	4.1*	7.7	3.7	4.1*	7.7	4.2	4.1*	8.3
5.0	4.4	4.4*	8.7	4.4	4.4*	8.7	4.7	4.4*	9.1
5.3	5.1	4.7*	9.8	5.1	4.7*	9.8	5.3	4.7*	10.0
5.5	5.8	5.0*	10.8	5.8	5.0*	10.8	5.8	5.0*	10.8
5.8	6.5	5.3*	11.8	6.5	5.3*	11.8	6.3	5.3*	11.6
6.0	7.2	5.6*	12.8	7.2	5.6*	12.8	6.9	5.6*	12.5
6.3	7.9	5.9*	13.8	7.9	5.9*	13.8	7.4	5.9*	13.3
6.5	8.6	6.2*	14.8	8.6	6.2*	14.8	7.9	6.2*	14.1
6.8	9.3	6.5*	15.8	9.3	6.5*	15.8	8.4	6.5*	14.9
7.0	10.0	6.8*	16.9	10.0	6.8*	16.9	8.9	6.8*	15.8
7.3	10.7	7.2*	17.9	10.7	7.2*	17.9	9.4	7.2*	16.6
7.5	11.4	7.5*	18.9	11.4	7.5*	18.9	9.9	7.5*	17.4
7.8	12.1	7.8*	19.9	12.1	7.8*	19.9	10.4	7.8*	18.2
8.0	12.8	8.1	21.0	12.8	8.1	21.0	10.9	8.0	18.8
8.3	13.5	8.4	22.0	13.5	8.4	22.0	11.4	7.2	18.5
8.5	14.3	8.8	23.0	14.3	8.8	23.0	11.9	6.4	18.2
8.8	15.0	9.1	24.1	15.0	9.1	24.1	12.3	5.6	17.9
9.0	15.7	9.4	25.1	15.7	9.4	25.1	12.8	4.8	17.6
9.3	16.4	9.7	26.1	16.4	9.7	26.1	13.3	4.0	17.3
9.5	17.1	10.1	27.2	17.1	10.1	27.2	13.8	3.2	16.9
9.8	17.8	10.4	28.2	17.8	10.4	28.2	14.2	2.4	16.6
10.0	18.5	10.7	29.2	18.5	10.7	29.2	14.7	1.6	16.3
10.3	19.2	11.1	30.3	19.2	11.1	30.3	15.2	0.8	16.0
10.5	19.9	11.4	31.3	19.9	11.4	31.3	15.6	0.0	15.6
10.8	20.6	16.5	37.1	20.3	16.7	37.0	15.8	0.0	15.8
11.0	21.3	16.7	38.0	20.3	17.0	37.2	15.9	0.0	15.9
11.3	22.0	17.0	38.9	20.3	17.2	37.5	16.1	0.0	16.1
11.5	22.7	17.2	39.9	20.3	17.5	37.7	16.3	0.0	16.3
11.8	23.4	17.4	40.9	20.3	17.7	38.0	16.4	0.0	16.4
12.0	24.2	17.7	41.9	20.3	18.0	38.2	16.6	0.0	16.6
12.3	25.0	17.9	42.9	20.3	18.2	38.5	16.8	0.0	16.8
12.5	25.9	18.1	44.0	20.3	18.4	38.7	17.0	0.0	17.0
12.8	26.7	18.4	45.1	20.3	18.7	38.9	17.2	0.0	17.2
13.0	27.6	18.6	46.2	20.3	18.9	39.2	17.4	0.0	17.4
13.3	28.5	18.8	47.3	20.3	19.2	39.4	17.6	0.0	17.6
13.5	29.4	19.1	48.5	20.3	19.4	39.7	17.9	0.0	17.9
13.8	30.4	19.3	49.7	20.3	19.7	39.9	18.1	0.0	18.1
14.0	31.3	19.5	50.9	20.3	19.9	40.2	18.3	0.0	18.3
14.3	32.3	19.8	52.1	20.3	20.1	40.4	18.6	0.0	18.6
14.5	33.4	20.0	53.4	20.3	20.4	40.6	18.8	0.0	18.8
14.8	34.4	20.2	54.6	20.3	20.6	40.9	19.1	0.0	19.1
15.0	35.5	20.5	56.0	20.3	20.9	41.1	19.3	0.0	19.3
15.3	36.6	20.7	57.3	20.3	21.1	41.4	19.6	0.0	19.6
15.5	37.7	20.9	58.7	20.3	21.3	41.6	19.9	0.0	19.9
15.8	38.9	21.2	60.0	20.3	21.6	41.9	20.1	0.0	20.1
16.0	40.1	21.4	61.5	20.3	21.8	42.1	20.4	0.0	20.4
16.3	41.3	21.6	62.9	20.3	22.1	42.3	20.7	0.0	20.7
16.5	42.5	21.8	64.4	20.3	22.3	42.6	21.0	0.0	21.0
16.8	43.8	22.1	65.9	20.3	22.6	42.8	21.3	0.0	21.3
17.0	45.0	22.3	67.4	20.3	22.8	43.1	21.6	0.0	21.6
17.3	46.8	37.6	84.4	20.3	30.4	50.6	22.0	0.0	22.0
17.5	48.9	38.2	87.2	20.3	30.8	51.1	22.3	0.0	22.3
17.8	51.2	38.8	90.0	20.3	31.2	51.5	22.6	0.0	22.6
18.0	53.4	39.4	92.8	20.3	31.7	51.9	23.0	0.0	23.0
18.3	55.8	40.0	95.8	20.3	32.1	52.4	23.3	0.0	23.3
18.5	58.1	40.6	98.7	20.3	32.5	52.8	23.6	0.0	23.6
18.8	60.5	41.2	101.7	20.3	33.0	53.2	24.0	4.4	28.4
19.0	63.0	41.8	104.8	20.3	33.4	53.7	24.3	8.8	33.2
19.3	65.5	42.4*	107.9	20.3	33.9*	54.1	24.7	10.4*	35.0

19.5	66.9	43.0*	109.9	20.3	34.3*	54.6	25.0	10.4*	35.4
19.8	67.3	43.6*	110.9	20.3	34.7*	55.0	25.3	10.4*	35.7
20.0	67.7	44.2*	111.9	20.3	35.2*	55.4	25.7	10.4*	36.0
20.3	68.1	44.8*	112.8	20.3	35.6*	55.9	26.0	10.4*	36.4
20.5	68.4	45.4*	113.8	20.3	36.0*	56.3	26.4	10.4*	36.7
20.8	68.8	46.0*	114.8	20.3	36.5*	56.7	26.7	10.4*	37.1
21.0	69.2	46.6*	115.8	20.3	36.9*	57.2	27.0	10.4*	37.4
21.3	69.6	47.2*	116.8	20.3	37.4*	57.6	27.4	10.4*	37.7
21.5	70.1	47.8*	117.8	20.3	37.8*	58.1	27.7	10.4*	38.1
21.8	70.5	48.4*	118.8	20.3	38.2*	58.5	28.1	10.4*	38.4
22.0	70.9	49.0*	119.9	20.3	38.7*	58.9	28.4	10.4*	38.8
22.3	71.3	49.6*	120.9	20.3	39.1*	59.4	28.7	10.4*	39.1
22.5	71.8	50.2*	121.9	20.3	39.5*	59.8	29.1	10.4*	39.4
22.8	73.0	17.7*	90.7	21.2	17.7*	39.0	29.4	17.7*	47.2
23.0	74.9	19.3*	94.3	23.2	19.3*	42.5	29.8	19.3*	49.1
23.3	76.9	20.9*	97.9	25.2	20.9*	46.1	30.1	20.9*	51.0
23.5	78.9	22.6*	101.4	27.1	22.6*	49.7	30.4	22.6*	53.0
23.8	80.8	24.2*	105.0	29.1	24.2*	53.3	38.7	24.2*	62.9
24.0	82.8	25.8*	108.6	31.1	25.8*	56.9	40.4	25.8*	66.2
24.3	84.8	27.4*	112.2	33.0	27.4*	60.5	42.0	27.4*	69.5
24.5	86.7	29.1*	115.8	35.0	29.1*	64.1	43.7	29.1*	72.8
24.8	88.7	30.7*	119.4	37.0	30.7*	67.7	45.3	30.7*	76.1
25.0	90.7	32.4*	123.0	38.9	32.4*	71.3	47.0	32.4*	79.3
25.3	92.6	34.0*	126.6	40.9	34.0*	74.9	48.6	34.0*	82.6
25.5	94.6	35.7*	130.3	42.8	35.7*	78.5	50.2	35.7*	85.8
25.8	96.5	37.3*	133.9	44.8	37.3*	82.1	51.8	37.3*	89.1
26.0	98.5	39.0*	137.5	46.8	39.0*	85.8	53.3	39.0*	92.3
26.3	100.5	40.7*	141.1	48.7	40.7*	89.4	54.9	40.7*	95.6
26.5	102.4	42.3*	144.8	50.7	42.3*	93.0	56.5	42.3*	98.8
26.8	104.4	44.0*	148.4	52.7	44.0*	96.7	58.0	44.0*	102.0
27.0	106.4	45.7*	152.1	54.6	45.7*	100.3	59.5	45.7*	105.2
27.3	108.4	48.1*	156.4	56.7	48.1*	104.8	61.2	48.1*	109.3
27.5	110.4	49.9*	160.3	58.8	49.9*	108.7	62.8	49.9*	112.7
27.8	112.4	51.7*	164.1	61.0	51.7*	112.7	64.4	51.7*	116.1
28.0	114.5	53.5*	168.0	63.2	53.5*	116.7	66.0	53.5*	119.5
28.3	116.5	55.4*	171.9	65.3	55.4*	120.7	67.6	55.4*	123.0
28.5	118.5	57.2*	175.7	67.5	57.2*	124.7	69.2	57.2*	126.4
28.8	120.5	59.0*	179.6	69.6	59.0*	128.7	70.7	59.0*	129.7
29.0	122.6	60.9*	183.4	71.8	60.9*	132.7	72.3	60.9*	133.1
29.3	124.6	62.7*	187.3	74.0	62.7*	136.7	73.8	62.7*	136.5
29.5	126.6	64.6*	191.2	76.1	64.6*	140.7	75.3	64.6*	139.9
29.8	128.7	66.4*	195.1	78.3	66.4*	144.7	76.8	66.4*	143.3
30.0	130.7	68.3*	199.0	80.4	68.3*	148.7	78.3	68.3*	146.6
30.3	132.7	70.1*	202.9	82.6	70.1*	152.7	79.8	70.1*	150.0
30.5	134.8	72.0*	206.7	84.8	72.0*	156.8	81.3	72.0*	153.3
30.8	136.8	73.9*	210.6	86.9	73.9*	160.8	82.8	73.9*	156.6
31.0	138.8	75.7*	214.5	89.1	75.7*	164.8	84.3	75.7*	160.0
31.3	140.8	77.6*	218.4	91.2	77.6*	168.8	85.7	77.6*	163.3
31.5	142.9	77.8	220.6	93.4	77.8	171.2	87.2	77.8	164.9
31.8	144.9	77.8	222.7	95.6	77.8	173.3	88.6	77.8	166.3
32.0	146.9	77.8	224.7	97.7	77.8	175.5	90.0	77.8	167.8
32.3	149.0	85.1	234.1	99.9	85.1	185.0	91.4	72.9	164.3
32.5	151.0	87.0	238.0	102.0	87.0	189.1	92.8	68.0	160.9
32.8	153.0	88.9	241.9	104.2	88.9	193.1	94.2	63.2	157.4
33.0	155.1	90.8	245.9	106.4	90.8	197.2	95.6	58.3	154.0
33.3	157.1	92.7	249.8	108.5	92.7	201.2	97.0	53.5	150.5
33.5	159.1	94.6	253.7	110.7	94.6	205.3	98.4	48.6	147.0
33.8	161.1	96.5	257.7	112.8	96.5	209.4	99.8	43.7	143.5
34.0	163.2	98.4	261.6	115.0	98.4	213.4	101.1	38.9	140.0
34.3	165.2	100.3	265.6	117.2	100.3	217.5	102.5	34.0	136.5
34.5	167.2	102.3	269.5	119.3	102.3	221.6	103.8	29.2	133.0
34.8	169.3	104.2	273.5	121.5	104.2	225.7	105.2	24.3	129.5
35.0	171.3	106.1	277.4	123.6	106.1	229.8	106.5	19.4	125.9

35.3	173.3	108.0	281.4	125.8	108.0	233.8	107.8	14.6	122.4
35.5	175.4	110.0	285.3	128.0	110.0	237.9	109.1	9.7	118.8
35.8	177.4	111.9	289.3	130.1	111.9	242.0	110.4	4.9	115.3
36.0	179.4	113.8	293.3	132.3	113.8	246.1	111.7	0.0	111.7
36.3	183.0	173.2	356.2	133.4	155.6	289.0	112.1	0.0	112.1
36.5	188.2	173.7	361.9	133.4	156.1	289.4	112.4	0.0	112.4
36.8	193.5	174.3	367.7	133.4	156.5	289.8	112.8	0.0	112.8
37.0	198.8	174.8	373.6	133.4	156.9	290.2	113.2	0.0	113.2
37.3	204.1	175.4	379.5	133.4	157.3	290.6	113.6	0.0	113.6
37.5	209.5	175.9	385.4	133.4	157.7	291.1	113.9	0.0	113.9
37.8	214.9	176.5	391.4	133.4	158.1	291.5	114.3	0.0	114.3
38.0	220.4	177.1	397.4	133.4	158.5	291.9	114.7	0.0	114.7
38.3	225.9	177.6	403.5	133.4	158.9	292.3	115.1	0.0	115.1
38.5	231.4	178.2	409.6	133.4	159.3	292.7	115.5	0.0	115.5
38.8	237.0	178.7	415.8	133.4	159.7	293.1	115.9	0.0	115.9
39.0	242.7	179.3	422.0	133.4	160.2	293.5	116.3	0.0	116.3
39.3	248.4	179.9	428.2	133.4	160.6	293.9	116.7	0.0	116.7
39.5	254.1	180.4	434.5	133.4	161.0	294.3	117.1	0.0	117.1
39.8	259.9	181.0	440.8	133.4	161.4	294.7	117.5	0.0	117.5
40.0	265.7	181.5	447.2	133.4	161.8	295.1	117.9	0.0	117.9
40.3	271.5	182.1	453.6	133.4	161.8	295.1	118.4	0.0	118.4
40.5	277.4	182.6	460.1	133.4	161.8	295.1	118.8	0.0	118.8
40.8	283.4	183.2	466.6	133.4	161.8	295.1	119.2	0.0	119.2
41.0	289.4	183.8	473.2	133.4	161.8	295.1	119.6	0.0	119.6
41.3	295.4	184.3	479.8	133.4	161.8	295.1	120.1	0.0	120.1
41.5	301.5	184.9	486.4	133.4	157.7	291.1	120.5	0.0	120.5
41.8	307.6	185.4	493.1	133.4	157.7	291.1	121.0	0.0	121.0
42.0	313.8	186.0	499.8	133.4	157.7	291.1	121.4	0.0	121.4
42.3	320.0	186.6	506.6	133.4	157.7	291.1	121.9	2.2	124.1
42.5	326.3	187.1	513.4	133.4	157.7	291.1	122.3	4.4	126.7
42.8	332.6	187.7	520.3	133.4	157.7	291.1	122.8	6.6	129.4
43.0	338.9	188.2	527.2	133.4	157.7	291.1	123.2	8.8	132.1
43.3	345.3	188.8	534.1	133.4	157.7	291.1	123.7	11.0	134.8
43.5	351.8	189.3	541.1	133.4	157.7	291.1	124.2	13.3	137.4
43.8	358.2	189.9	548.2	133.4	157.7	291.1	124.7	15.5	140.1
44.0	364.8	190.5	555.2	133.4	157.7	291.1	125.1	17.7	142.8
44.3	371.3	191.0	562.4	133.4	157.7	291.1	125.6	19.9	145.5
44.5	378.0	191.6	569.5	133.4	157.7	291.1	126.1	22.1	148.2
44.8	384.6	192.1	576.7	133.4	157.7	291.1	126.6	24.3	150.9
45.0	391.3	192.7	584.0	133.4	157.7	291.1	127.1	26.5	153.6
45.3	398.0	193.3	591.3	133.4	144.1	277.4	127.6	28.7	156.3
45.5	404.8	164.0	568.8	133.4	107.8	241.2	128.1	30.9	159.0
45.8	411.7	99.9	511.6	133.4	71.6	204.9	128.6	33.1	161.7
46.0	418.5	35.3	453.9	133.4	35.3	168.7	129.1	35.3	164.4
46.3	422.8	35.3	458.2	134.0	35.3	169.3	129.9	35.3	165.3
46.5	424.5	35.3	459.9	135.2	35.3	170.5	130.8	35.3	166.1
46.8	426.2	35.3	461.5	136.4	35.3	171.8	131.7	35.3	167.0
47.0	427.9	35.3	463.2	137.7	35.3	173.0	132.5	35.3	167.9
47.3	429.6	62.9	492.5	138.9	59.6	198.5	133.4	33.1	166.5
47.5	431.3	90.5	521.7	140.1	83.8	224.0	134.2	30.9	165.2
47.8	432.9	118.0	551.0	141.3	108.1	249.4	135.1	28.7	163.8
48.0	434.6	121.9	556.5	142.6	121.9	264.4	135.9	26.5	162.4
48.3	436.3	123.3	559.6	143.8	123.3	267.1	136.8	24.3	161.1
48.5	438.0	124.8	562.8	145.0	124.8	269.8	137.6	22.1	159.7
48.8	439.7	126.2	565.9	146.2	126.2	272.5	138.5	19.9	158.4
49.0	441.4	127.7	569.0	147.5	127.7	275.2	139.3	17.7	157.0
49.3	443.0	129.2	572.2	148.7	129.2	277.9	140.2	15.5	155.6
49.5	444.7	130.6	575.3	149.9	130.6	280.5	141.0	13.3	154.3
49.8	446.4	132.1	578.5	151.2	132.1	283.2	141.9	11.0	152.9
50.0	448.1	133.6	581.7	152.4	133.6	285.9	142.7	8.8	151.6
50.3	449.8	135.0	584.8	153.6	135.0	288.7	143.6	6.6	150.2
50.5	451.5	136.5	588.0	154.8	136.5	291.4	144.4	4.4	148.8
50.8	453.1	138.0	591.2	156.1	138.0	294.1	145.3	2.2	147.5

51.0	454.8	139.5	594.3	157.3	139.5	296.8	146.6	0.0	146.6
51.3	458.0	175.5	633.5	157.9	171.2	329.1	147.3	0.0	147.3
51.5	462.7	175.5	638.2	157.9	171.2	329.1	148.0	0.0	148.0
51.8	467.5	175.5	642.9	157.9	171.2	329.1	148.7	0.0	148.7
52.0	472.2	175.5	647.7	157.9	171.2	329.1	149.4	0.0	149.4
52.3	477.0	175.5	652.5	157.9	171.2	329.1	150.1	0.0	150.1
52.5	481.8	175.5	657.3	157.9	171.2	329.1	150.8	0.0	150.8
52.8	486.6	175.5	662.1	157.9	171.2	329.1	151.5	0.0	151.5
53.0	491.5	175.5	667.0	157.9	171.2	329.1	152.2	0.0	152.2
53.3	496.4	175.5	671.9	157.9	171.2	329.1	152.9	0.0	152.9
53.5	501.3	175.5	676.8	157.9	171.2	329.1	153.6	0.0	153.6
53.8	506.2	175.5	681.7	157.9	171.2	329.1	154.4	0.0	154.4
54.0	511.2	175.5	686.7	157.9	171.2	329.1	155.1	0.0	155.1
54.3	516.2	175.5	691.7	157.9	171.2	329.1	155.8	0.0	155.8
54.5	521.2	175.5	696.7	157.9	171.2	329.1	156.6	0.0	156.6
54.8	526.2	175.5	701.7	157.9	171.2	329.1	157.3	0.0	157.3
55.0	531.3	175.5	706.8	157.9	171.2	329.1	158.1	0.0	158.1
55.3	536.4	175.5	711.9	157.9	171.2	329.1	158.8	0.0	158.8
55.5	541.5	175.5	717.0	157.9	171.2	329.1	159.6	0.0	159.6
55.8	546.6	175.5	722.1	157.9	171.2	329.1	160.3	0.0	160.3
56.0	551.8	175.5	727.3	157.9	171.2	329.1	161.1	0.0	161.1
56.3	557.0	175.5	732.5	157.9	171.2	329.1	161.8	0.0	161.8
56.5	562.2	175.5	737.7	157.9	171.2	329.1	162.6	0.0	162.6
56.8	567.4	175.5	742.9	157.9	171.2	329.1	163.4	0.0	163.4
57.0	572.7	175.5	748.2	157.9	171.2	329.1	164.2	0.0	164.2
57.3	578.0	175.5	753.5	157.9	171.2	329.1	164.9	3.1	168.0
57.5	583.3	175.5	758.8	157.9	171.2	329.1	165.7	6.2	171.9
57.8	588.7	175.5	764.1	157.9	171.2	329.1	166.5	9.3	175.8
58.0	594.0	175.5	769.5	157.9	171.2	329.1	167.3	12.4	179.7
58.3	599.4	175.5	774.9	157.9	171.2	329.1	168.1	15.5	183.6
58.5	604.8	175.5	780.3	157.9	171.2	329.1	168.9	18.6	187.4
58.8	610.3	175.5	785.7	157.9	171.2	329.1	169.7	21.6	191.3
59.0	615.7	175.5	791.2	157.9	171.2	329.1	170.5	24.7	195.2
59.3	621.2	175.5	796.7	157.9	171.2	329.1	171.3	27.8	199.1
59.5	626.7	175.5	802.2	157.9	171.2	329.1	172.1	30.9	203.0
59.8	632.3	175.5	807.8	157.9	166.3	324.2	172.9	34.0	207.0
60.0	637.8	156.2	794.0	157.9	143.0	300.9	173.8	37.1	210.9
60.3	643.4	129.5	772.9	157.9	119.6	277.5	174.6	40.2	214.8
60.5	649.1	102.8	751.9	157.9	96.2	254.1	175.4	43.3	218.7
60.8	654.7	76.2	730.8	157.9	72.8	230.8	176.2	46.4	222.6
61.0	660.4	49.5	709.8	157.9	49.5	207.4	177.1	49.5	226.6
61.3	664.2	49.5	713.7	158.6	49.5	208.1	178.7	49.5	228.2
61.5	666.3	49.5	715.8	160.0	49.5	209.4	180.3	49.5	229.8
61.8	668.3	49.5	717.8	161.3	49.5	210.8	181.9	49.5	231.4
62.0	670.4	49.5	719.9	162.7	49.5	212.2	183.5	49.5	233.0
62.3	672.4	49.5	721.9	164.1	49.5	213.6	185.1	49.5	234.6
62.5	674.5	49.5	724.0	165.5	49.5	214.9	186.8	49.5	236.2
62.8	676.6	49.5	726.0	166.8	49.5	216.3	188.4	49.5	237.9
63.0	678.6	49.5	728.1	168.2	49.5	217.7	190.0	49.5	239.5
63.3	680.7	54.8	735.4	169.6	54.8	224.4	191.6	54.8	246.4
63.5	682.7	60.1	742.8	171.0	60.1	231.0	193.3	60.1	253.4
63.8	684.8	65.4	750.2	172.3	65.4	237.7	194.9	65.4	260.3
64.0	686.8	70.7	757.5	173.7	70.7	244.4	196.5	70.7	267.2
64.3	688.9	76.0	764.9	175.1	76.0	251.1	198.2	76.0	274.2
64.5	690.9	81.3	772.2	176.5	81.3	257.7	199.8	81.3	281.1
64.8	693.0	86.6	779.6	177.8	86.6	264.4	201.5	86.6	288.1
65.0	695.1	91.9	786.9	179.2	91.9	271.1	203.1	91.9	295.0
65.3	697.1	97.2	794.3	180.6	97.2	277.8	204.8	97.2	302.0
65.5	699.2	102.5	801.7	182.0	102.5	284.5	206.4	102.5	308.9
65.8	701.2	107.8	809.0	183.3	107.8	291.1	208.1	107.8	315.9
66.0	703.3	113.1	816.4	184.7	113.1	297.8	209.7	113.1	322.8
66.3	705.3	118.4	823.7	186.1	118.4	304.5	211.4	118.4	329.8
66.5	707.4	123.7	831.1	187.5	123.7	311.2	213.1	123.7	336.8

66.8	709.4	129.0	838.4	188.8	129.0	317.8	214.7	129.0	343.7
67.0	711.5	134.3	845.8	190.2	134.3	324.5	216.4	134.3	350.7
67.3	714.0	134.3	848.3	192.8	134.3	327.1	219.4	134.3	353.7
67.5	717.0	134.3	851.3	196.5	134.3	330.8	222.4	134.3	356.7
67.8	720.0	134.3	854.3	200.2	134.3	334.5	225.4	134.3	359.7
68.0	723.0	134.3	857.3	203.9	134.3	338.3	228.4	134.3	362.7
68.3	725.9	134.3	860.3	207.7	134.3	342.0	231.4	134.3	365.7
68.5	728.9	134.3	863.2	211.4	134.3	345.7	234.4	134.3	368.7
68.8	731.9	133.0	864.9	215.1	133.0	348.1	237.4	133.0	370.4
69.0	734.9	131.7	866.6	218.9	131.7	350.5	240.4	131.7	372.1
69.3	737.9	130.3	868.2	222.6	130.3	352.9	243.5	130.3	373.8
69.5	740.9	129.0	869.9	226.3	129.0	355.3	246.5	129.0	375.5
69.8	743.9	127.7	871.5	230.1	127.7	357.7	249.5	127.7	377.2
70.0	746.8	126.4	873.2	233.8	126.4	360.1	252.5	126.4	378.9
70.3	749.8	125.0	874.8	237.5	125.0	362.6	255.6	125.0	380.6
70.5	752.8	123.7	876.5	241.3	123.7	365.0	258.6	123.7	382.3
70.8	755.8	122.4	878.2	245.0	122.4	367.4	261.7	122.4	384.1
71.0	758.8	121.0	879.8	248.7	121.1	369.8	264.7	121.0	385.8
71.3	761.8	119.7	881.5	252.4	119.7	372.2	267.8	119.7	387.5
71.5	764.7	118.4	883.1	256.2	118.4	374.6	270.8	118.4	389.2
71.8	767.7	117.1	884.8	259.9	117.1	377.0	273.9	117.1	391.0
72.0	770.7	115.7	886.5	263.6	115.7	379.4	277.0	115.7	392.7
72.3	773.7	114.4	888.1	267.4	114.4	381.8	280.0	114.4	394.5
72.5	776.7	113.1	889.8	271.1	113.1	384.2	283.1	113.1	396.2
72.8	779.4	113.1	892.5	274.5	113.1	387.6	285.9	113.1	399.0
73.0	781.9	113.1	895.0	277.7	113.1	390.8	288.6	113.1	401.7
73.3	784.5	113.1	897.6	280.8	113.1	393.9	291.4	113.1	404.5
73.5	787.0	113.1	900.1	284.0	113.1	397.1	294.1	113.1	407.2
73.8	789.5	113.1	902.6	287.1	113.1	400.2	296.9	113.1	410.0
74.0	792.0	113.1	905.1	290.2	113.1	403.3	299.7	113.1	412.8
74.3	794.5	113.1	907.6	293.4	113.1	406.5	302.4	113.1	415.5
74.5	797.0	113.1	910.1	296.5	113.1	409.6	305.2	113.1	418.3
74.8	799.5	113.1	912.6	299.7	113.1	412.8	308.0	113.1	421.1
75.0	802.1	113.1	915.1	302.8	113.1	415.9	310.8	113.1	423.9
75.3	804.6	113.1	917.7	306.0	113.1	419.0	313.6	113.1	426.7
75.5	807.1	113.1	920.2	309.1	113.1	422.2	316.3	113.1	429.4
75.8	809.6	113.1	922.7	312.2	113.1	425.3	319.1	113.1	432.2
76.0	812.1	113.1	925.2	315.4	113.1	428.5	321.9	113.1	435.0
76.3	814.6	113.1	927.7	318.5	113.1	431.6	324.7	113.1	437.8
76.5	817.1	113.1	930.2	321.7	113.1	434.8	327.5	113.1	440.6
76.8	819.6	113.1	932.7	324.8	113.1	437.9	330.3	113.1	443.4
77.0	822.2	113.1	935.3	327.9	113.1	441.0	333.2	113.1	446.3
77.3	824.7	113.1	937.8	331.1	113.1	444.2	336.0	113.1	449.1
77.5	827.2	113.1	940.3	334.2	113.1	447.3	338.8	113.1	451.9
77.8	829.7	109.6	939.3	337.4	109.6	446.9	341.6	109.6	451.2
78.0	832.2	106.0	938.2	340.5	106.0	446.5	344.4	106.0	450.5
78.3	834.7	102.5	937.2	343.7	102.5	446.1	347.3	102.5	449.8
78.5	837.2	99.0	936.2	346.8	99.0	445.8	350.1	99.0	449.1
78.8	839.8	95.4	935.2	349.9	95.4	445.4	352.9	95.4	448.4
79.0	842.3	91.9	934.2	353.1	91.9	445.0	355.8	91.9	447.7
79.3	844.8	88.4	933.1	356.2	88.4	444.6	358.6	88.4	447.0
79.5	847.3	84.8	932.1	359.4	84.8	444.2	361.5	84.8	446.3
79.8	849.8	81.3	931.1	362.5	81.3	443.8	364.3	81.3	445.6
80.0	852.3	77.8	930.1	365.6	77.8	443.4	367.2	77.8	444.9
80.3	854.8	74.2	929.0	368.8	74.2	443.0	370.1	74.2	444.3
80.5	857.3	70.7	928.0	371.9	70.7	442.6	372.9	70.7	443.6
80.8	859.9	67.1	927.0	375.1	67.2	442.2	375.8	67.2	442.9
81.0	862.4	63.6	926.0	378.2	63.6	441.8	378.7	63.6	442.3
81.3	864.9	60.1	925.0	381.4	60.1	441.4	381.5	60.1	441.6
81.5	867.4	56.5	923.9	384.5	56.5	441.0	384.4	56.5	441.0
81.8	869.7	56.5	926.3	386.8	56.5	443.4	386.4	56.5	443.0
82.0	871.9	56.5	928.4	388.4	56.5	445.0	388.4	56.5	445.0
82.3	874.0	56.5	930.5	390.0	56.5	446.5	390.4	56.5	447.0

82.5	876.1	56.5	932.7	391.6	56.5	448.1	392.4	56.5	449.0
82.8	878.3	56.5	934.8	393.1	56.5	449.7	394.5	56.5	451.0
83.0	880.4	56.5	936.9	394.7	56.5	451.2	396.5	56.5	453.0
83.3	882.5	56.5	939.1	396.3	56.5	452.8	398.5	56.5	455.1
83.5	884.7	56.5	941.2	397.8	56.5	454.4	400.5	56.5	457.1
83.8	886.8	56.5	943.4	399.4	56.5	456.0	402.6	56.5	459.1
84.0	888.9	56.5	945.5	401.0	56.5	457.5	404.6	56.5	461.1
84.3	891.1	56.5	947.6	402.6	56.5	459.1	406.6	56.5	463.2
84.5	893.2	56.5	949.8	404.1	56.5	460.7	408.7	56.5	465.2
84.8	895.4	56.5	951.9	405.7	56.5	462.2	410.7	56.5	467.3
85.0	897.5	56.5	954.0	407.3	56.5	463.8	412.8	56.5	469.3
85.3	899.6	56.5	956.2	408.8	56.5	465.4	414.8	56.5	471.4
85.5	901.8	56.5	958.3	410.4	56.5	467.0	416.9	56.5	473.4
85.8	903.9	56.5	960.4	412.0	56.5	468.5	418.9	56.5	475.5
86.0	906.0	56.5	962.6	413.6	56.5	470.1	421.0	56.5	477.5
86.3	908.2	56.5	964.7	415.1	56.5	471.7	423.1	56.5	479.6
86.5	910.3	56.5	966.9	416.7	56.5	473.2	425.1	56.5	481.7
86.8	912.4	56.5	969.0	418.3	56.5	474.8	427.2	56.5	483.7
87.0	914.6	56.5	971.1	419.8	56.5	476.4	429.3	56.5	485.8
87.3	916.7	56.5	973.3	421.4	56.5	478.0	431.3	56.5	487.9
87.5	918.9	56.5	975.4	423.0	56.5	479.5	433.4	56.5	490.0
87.8	921.0	56.5	977.5	424.5	56.5	481.1	435.5	56.5	492.1
88.0	923.1	56.5	979.7	426.1	56.5	482.7	437.6	56.5	494.2
88.3	925.3	56.5	981.8	427.7	56.5	484.2	439.7	56.5	496.2
88.5	927.4	56.5	983.9	429.3	56.5	485.8	441.8	56.5	498.3
88.8	929.5	56.5	986.1	430.8	56.5	487.4	443.9	56.5	500.4
89.0	931.7	56.5	988.2	432.4	56.5	488.9	446.0	56.5	502.5
89.3	933.8	56.5	990.4	434.0	56.5	490.5	448.1	56.5	504.6
89.5	935.9	56.5	992.5	435.5	56.5	492.1	450.2	56.5	506.8
89.8	938.1	56.5	994.6	437.1	56.5	493.7	452.3	56.5	508.9
90.0	940.2	56.5	996.8	438.7	56.5	495.2	454.4	56.5	511.0

TIP LOAD KIP	TIP MOVEMENT IN.
0.0000E+00	0.0000E+00
0.3534E+01	0.1200E-01
0.7068E+01	0.2400E-01
0.1414E+02	0.4800E-01
0.2827E+02	0.3120E+00
0.4241E+02	0.1008E+01
0.5089E+02	0.1752E+01
0.5655E+02	0.2400E+01
0.5655E+02	0.3600E+01
0.5655E+02	0.4800E+01

LOAD VERSUS SETTLEMENT CURVE
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TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.2000E+01	0.9211E-03	0.2945E-01	0.1000E-03
0.2000E+02	0.9211E-02	0.2945E+00	0.1000E-02
0.9998E+02	0.4606E-01	0.1473E+01	0.5000E-02
0.1976E+03	0.9192E-01	0.2945E+01	0.1000E-01
0.6926E+03	0.3773E+00	0.1424E+02	0.5000E-01
0.8281E+03	0.5149E+00	0.1692E+02	0.1000E+00
0.9083E+03	0.9825E+00	0.3209E+02	0.5000E+00
0.9185E+03	0.1492E+01	0.4225E+02	0.1000E+01
0.9293E+03	0.2501E+01	0.5306E+02	0.2000E+01

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AXIALLY LOADING PILE ANALYSIS PROGRAM - APILEplus
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Broadway Overcrossing Replacement East Abutment

DESIGNER : Madhu Thummaluru

DATE : 06/13/2012

PILE PROPERTIES :

PERIMETER OF PILE WITH NONCIRCULAR SECTION= 64.00 IN.
TIP AREA OF PILE WITH NONCIRCULAR SECTION = 1.78 SQF
OUTSIDE DIAMETER OF CIRCULAR PILE = 16.00 IN.
INTERNAL DIAMETER OF CIRCULAR PILE = 0.00 IN.
PILE LENGTH = 80.00 FT.
MODULUS OF ELASTICITY = 0.337E+07 PSI

LENGTH OF SURFACE SECTION WITH ZERO SKIN FRICTION = 0.00 FT.
INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.00	57.60	0.00	0.00
1.00	CLAY	0.00	57.60	0.00	0.00
1.00	CLAY	0.00	27.60	0.00	0.00
7.00	CLAY	0.00	27.60	0.00	0.00
7.00	CLAY	0.00	62.60	0.00	0.00
10.50	CLAY	0.00	62.60	0.00	0.00
10.50	CLAY	0.00	62.60	0.00	0.00
15.00	CLAY	0.00	62.60	0.00	0.00
15.00	CLAY	0.00	67.60	0.00	0.00
22.50	CLAY	0.00	67.60	0.00	0.00
22.50	CLAY	0.00	52.60	0.00	0.00
29.00	CLAY	0.00	52.60	0.00	0.00
29.00	CLAY	0.00	47.60	0.00	0.00
35.00	CLAY	0.00	47.60	0.00	0.00
35.00	SAND	0.00	62.60	1.00	0.00
36.50	SAND	0.00	62.60	1.00	0.00
36.50	SAND	0.00	62.60	40.00	0.00
40.50	SAND	0.00	62.60	40.00	0.00
40.50	SAND	0.00	62.60	36.00	0.00
44.00	SAND	0.00	62.60	36.00	0.00
44.00	CLAY	0.00	62.60	0.00	0.00
55.00	CLAY	0.00	62.60	0.00	0.00
55.00	SAND	0.00	82.60	44.00	0.00
56.50	SAND	0.00	82.60	44.00	0.00
56.50	SAND	0.00	77.60	42.00	0.00

65.50	SAND	0.00	77.60	42.00	0.00
65.50	CLAY	0.00	62.60	0.00	0.00
80.00	CLAY	0.00	62.60	0.00	0.00
80.00	CLAY	0.00	72.60	0.00	0.00
85.50	CLAY	0.00	72.60	0.00	0.00
85.50	SAND	0.00	67.60	44.00	0.00
89.00	SAND	0.00	67.60	44.00	0.00
89.00	CLAY	0.00	67.60	0.00	0.00
94.00	CLAY	0.00	67.60	0.00	0.00
94.00	CLAY	0.00	62.60	0.00	0.00
96.50	CLAY	0.00	62.60	0.00	0.00

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08	0.10E+08	0.75	0.75	0.00	0.00	0.00
0.10E+08	0.10E+08	0.75	0.75	0.00	0.00	0.00
0.10E+08	0.10E+08	0.20	0.20	0.00	0.00	0.00
0.10E+08	0.10E+08	0.20	0.20	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	2.25	2.25	0.00	0.00	0.00
0.10E+08	0.10E+08	2.25	2.25	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E-05	0.10E-05	0.00	0.00	1.00	0.00	0.00
0.10E-05	0.10E-05	0.00	0.00	1.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	41.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	41.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	26.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	26.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	100.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	100.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	38.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	38.00	0.00	0.00
0.10E+08	0.10E+08	2.25	2.25	0.00	0.00	0.00
0.10E+08	0.10E+08	2.25	2.25	0.00	0.00	0.00
0.10E+08	0.10E+08	3.00	3.00	0.00	0.00	0.00
0.10E+08	0.10E+08	3.00	3.00	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	100.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	100.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00

SET MAXIMUM UNIT FRICTION AND MAXIMUM UNIT BEARING
TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO
LIMIT THE COMPUTED DATA.

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* COMPUTATION RESULT *
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	********** FED. HWY. METHOD **********			********** ARMY CORPS METHOD **********			********** LAMBDA 2 METHOD **********		
PILE PENETR-ATION FT.	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP
0.0	0.0	5.8	5.8	0.0	5.8	5.8	0.0	5.8	5.8
1.0	0.0	3.2	3.2	3.5	3.2	6.7	2.6	3.2	5.8
2.0	0.5	3.2	3.7	5.8	3.2	9.0	3.0	3.2	6.2
3.0	1.5	3.2	4.7	6.8	3.2	10.0	3.5	3.2	6.7
4.0	2.4	4.7	7.1	7.9	4.7	12.6	4.0	4.7	8.7
5.0	3.4	8.5	11.9	9.0	8.5	17.4	4.5	8.5	13.0
6.0	4.4	12.2	16.6	10.0	12.2	22.3	5.1	12.2	17.3
7.0	5.4	16.0	21.4	11.1	16.0	27.1	5.6	16.0	21.6
8.0	7.9	16.0	23.9	13.6	16.0	29.6	7.6	16.0	23.6
9.0	11.8	16.0	27.8	17.6	16.0	33.6	9.4	16.0	25.4
10.0	15.8	16.0	31.8	21.6	16.0	37.6	11.2	16.0	27.2
11.0	19.8	16.0	35.8	25.6	16.0	41.6	12.8	16.0	28.8
12.0	23.8	18.3	42.1	29.6	18.3	48.0	14.4	18.3	32.7
13.0	27.8	24.2	52.0	33.6	24.2	57.9	15.9	24.2	40.1
14.0	31.7	30.1	61.8	37.6	30.1	67.8	17.4	30.1	47.5
15.0	35.7	36.0	71.7	41.6	36.0	77.6	18.8	36.0	54.8
16.0	41.7	36.0	77.7	46.6	36.0	82.6	22.3	36.0	58.3
17.0	49.7	36.0	85.7	52.6	36.0	88.6	26.2	36.0	62.2
18.0	57.7	36.0	93.7	58.6	36.0	94.6	30.3	36.0	66.3
19.0	65.7	36.0	101.7	64.6	36.0	100.6	34.3	36.0	70.3
20.0	73.6	38.3	112.0	70.6	38.3	109.0	38.5	38.3	76.8
21.0	81.6	44.2	125.8	76.6	44.2	120.9	42.7	44.2	86.9
22.0	89.6	50.1	139.7	82.6	50.1	132.8	46.9	50.1	97.0
23.0	97.6	56.0	153.6	88.6	56.0	144.6	51.2	56.0	107.2
24.0	107.2	56.0	163.2	96.3	56.0	152.3	57.3	56.0	113.3
25.0	118.4	56.0	174.4	105.6	56.0	161.6	63.6	56.0	119.6
26.0	129.5	51.3	180.9	115.0	51.3	166.3	69.8	51.3	121.2
27.0	140.7	39.6	180.3	124.3	39.6	163.9	76.2	39.6	115.7
28.0	151.9	27.8	179.7	133.6	27.8	161.4	82.5	27.8	110.3
29.0	163.1	16.0	179.1	143.0	16.0	159.0	88.9	16.0	104.9
30.0	170.7	16.0	186.7	149.6	16.0	165.6	91.6	16.0	107.6
31.0	174.6	16.0	190.6	153.6	16.0	169.6	94.3	16.0	110.3
32.0	178.6	14.1	192.8	157.6	14.3	172.0	97.1	14.1	111.2
33.0	182.6	9.4	192.0	161.6	10.1	171.8	99.9	9.4	109.3
34.0	186.6	54.5	241.1	165.6	38.8	204.4	102.7	4.7	107.4
35.0	190.6	178.4	369.0	169.6	117.8	287.4	102.7	0.0	102.7
36.0	190.6	311.0	501.5	169.6	200.9	370.6	102.7	0.0	102.7
37.0	190.6	447.5	638.1	169.6	284.1	453.8	108.5	0.0	108.5
38.0	200.6	429.9	630.5	169.6	272.1	441.7	110.0	0.0	110.0

39.0	220.6	363.6	584.3	169.6	241.7	411.3	111.5	0.0	111.5
40.0	241.3	295.2	536.5	169.6	211.2	380.9	113.1	0.0	113.1
41.0	262.5	199.2	461.7	169.6	161.6	331.3	114.8	1.9	116.6
42.0	280.0	139.9	419.9	169.6	113.1	282.7	116.5	6.6	123.0
43.0	293.7	78.8	372.6	169.6	64.5	234.2	118.2	11.3	129.5
44.0	307.8	16.0	323.8	169.6	16.0	185.6	120.0	16.0	136.0
45.0	316.9	16.0	332.9	171.6	16.0	187.6	123.3	16.0	139.3
46.0	320.8	16.0	336.8	175.6	16.0	191.6	126.7	16.0	142.7
47.0	324.8	16.0	340.8	179.6	16.0	195.6	130.1	16.0	146.1
48.0	328.8	16.0	344.8	183.6	16.0	199.6	133.6	16.0	149.6
49.0	332.8	16.0	348.8	187.6	16.0	203.6	137.1	16.0	153.1
50.0	336.8	16.0	352.8	191.6	16.0	207.6	140.7	16.0	156.7
51.0	340.7	16.0	356.7	195.6	16.0	211.6	144.3	16.0	160.3
52.0	344.7	166.8	511.5	199.6	80.9	280.5	148.0	14.1	162.1
53.0	348.7	548.3	897.0	203.6	245.1	448.7	151.7	9.4	161.1
54.0	352.7	899.8	1252.4	207.6	392.4	600.1	155.4	4.7	160.1
55.0	356.7	1205.3	1562.0	211.6	514.0	725.6	159.2	0.0	159.2
56.0	375.0	1129.4	1504.4	213.6	471.4	685.0	161.6	0.0	161.6
57.0	408.3	1053.4	1461.7	213.6	428.8	642.4	164.0	0.0	164.0
58.0	441.8	1053.4	1495.3	213.6	428.8	642.4	166.5	0.0	166.5
59.0	475.7	1053.4	1529.1	213.6	428.8	642.4	169.0	0.0	169.0
60.0	510.3	1053.4	1563.7	213.6	428.8	642.4	171.6	0.0	171.6
61.0	545.6	1053.4	1599.1	213.6	428.8	642.4	174.3	0.0	174.3
62.0	581.8	1053.4	1635.2	213.6	428.8	642.4	177.0	0.0	177.0
63.0	618.7	935.0	1553.7	213.6	383.0	596.7	179.7	4.2	183.9
64.0	656.4	635.3	1291.7	213.6	267.4	481.0	182.6	14.8	197.4
65.0	694.9	335.7	1030.5	213.6	151.7	365.3	185.5	25.4	210.9
66.0	734.1	36.0	770.1	213.6	36.0	249.6	188.4	36.0	224.4
67.0	757.9	36.0	793.9	216.6	36.0	252.6	194.8	36.0	230.8
68.0	765.9	36.0	801.9	222.6	36.0	258.6	201.2	36.0	237.2
69.0	773.9	36.0	809.9	228.6	36.0	264.6	207.6	36.0	243.6
70.0	781.9	36.0	817.9	234.6	36.0	270.6	214.1	36.0	250.1
71.0	789.8	36.0	825.8	240.6	36.0	276.6	220.6	36.0	256.6
72.0	797.8	36.0	833.8	246.6	36.0	282.6	227.2	36.0	263.2
73.0	805.8	36.0	841.8	252.6	36.0	288.6	233.9	36.0	269.9
74.0	813.8	36.0	849.8	258.6	36.0	294.6	240.6	36.0	276.6
75.0	821.8	36.0	857.8	264.6	36.0	300.6	247.3	36.0	283.3
76.0	829.8	36.0	865.8	270.6	36.0	306.6	254.1	36.0	290.1
77.0	837.8	37.4	875.2	276.6	37.4	314.0	260.9	37.4	298.3
78.0	845.7	40.9	886.7	282.6	40.9	323.6	267.8	40.9	308.7
79.0	853.7	44.5	898.2	288.6	44.5	333.1	274.7	44.5	319.1
80.0	861.7	48.0	909.7	294.6	48.0	342.6	281.6	48.0	329.6

LOAD VERSUS SETTLEMENT CURVE

****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.2619E+01	0.1434E-02	0.2945E-01	0.1000E-03
0.2639E+02	0.1439E-01	0.2945E+00	0.1000E-02
0.1306E+03	0.7253E-01	0.1473E+01	0.5000E-02
0.2399E+03	0.1400E+00	0.2945E+01	0.1000E-01
0.6948E+03	0.5101E+00	0.1250E+02	0.5000E-01
0.8575E+03	0.7079E+00	0.1517E+02	0.1000E+00
0.9076E+03	0.1161E+01	0.2878E+02	0.5000E+00
0.9165E+03	0.1670E+01	0.3765E+02	0.1000E+01
0.9265E+03	0.2682E+01	0.4768E+02	0.2000E+01

W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Axial\BWYEAbutment WW.cpt

AXIALLY LOADING PILE ANALYSIS PROGRAM - APILEplus
VERSION 5.0 - (C) COPYRIGHT ENSOFT,INC.,1987-2008.

Broadway Overcrossing Replacement East Abutment Return wall (Abut 3 RW)

DESIGNER : Madhu Thummaluru

DATE : 06/21/2012

PILE PROPERTIES :

PERIMETER OF PILE WITH NONCIRCULAR SECTION= 64.00 IN.
TIP AREA OF PILE WITH NONCIRCULAR SECTION = 1.78 SQF
OUTSIDE DIAMETER OF CIRCULAR PILE = 16.00 IN.
INTERNAL DIAMETER OF CIRCULAR PILE = 0.00 IN.
PILE LENGTH = 80.00 FT.
MODULUS OF ELASTICITY = 0.337E+07 PSI

LENGTH OF SURFACE SECTION WITH ZERO SKIN FRICTION = 0.00 FT.
INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.00	57.60	0.00	0.00
1.00	CLAY	0.00	57.60	0.00	0.00
1.00	CLAY	0.00	27.60	0.00	0.00
7.00	CLAY	0.00	27.60	0.00	0.00
7.00	CLAY	0.00	62.60	0.00	0.00
10.50	CLAY	0.00	62.60	0.00	0.00
10.50	CLAY	0.00	62.60	0.00	0.00
15.00	CLAY	0.00	62.60	0.00	0.00
15.00	CLAY	0.00	67.60	0.00	0.00
22.50	CLAY	0.00	67.60	0.00	0.00
22.50	CLAY	0.00	52.60	0.00	0.00
29.00	CLAY	0.00	52.60	0.00	0.00
29.00	CLAY	0.00	47.60	0.00	0.00
35.00	CLAY	0.00	47.60	0.00	0.00
35.00	SAND	0.00	62.60	1.00	0.00
36.50	SAND	0.00	62.60	1.00	0.00
36.50	SAND	0.00	62.60	40.00	0.00

40.50	SAND	0.00	62.60	40.00	0.00
40.50	SAND	0.00	62.60	36.00	0.00
44.00	SAND	0.00	62.60	36.00	0.00
44.00	CLAY	0.00	62.60	0.00	0.00
55.00	CLAY	0.00	62.60	0.00	0.00
55.00	SAND	0.00	82.60	44.00	0.00
56.50	SAND	0.00	82.60	44.00	0.00
56.50	SAND	0.00	77.60	42.00	0.00
65.50	SAND	0.00	77.60	42.00	0.00
65.50	CLAY	0.00	62.60	0.00	0.00
80.00	CLAY	0.00	62.60	0.00	0.00
80.00	CLAY	0.00	72.60	0.00	0.00
85.50	CLAY	0.00	72.60	0.00	0.00
85.50	SAND	0.00	67.60	44.00	0.00
89.00	SAND	0.00	67.60	44.00	0.00
89.00	CLAY	0.00	67.60	0.00	0.00
94.00	CLAY	0.00	67.60	0.00	0.00
94.00	CLAY	0.00	62.60	0.00	0.00
96.50	CLAY	0.00	62.60	0.00	0.00

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08	0.10E+08	0.75	0.75	0.00	0.00	0.00
0.10E+08	0.10E+08	0.75	0.75	0.00	0.00	0.00
0.10E+08	0.10E+08	0.20	0.20	0.00	0.00	0.00
0.10E+08	0.10E+08	0.20	0.20	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	2.25	2.25	0.00	0.00	0.00
0.10E+08	0.10E+08	2.25	2.25	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E-05	0.10E-05	0.00	0.00	1.00	0.00	0.00
0.10E-05	0.10E-05	0.00	0.00	1.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	41.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	41.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	26.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	26.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	100.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	100.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	38.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	38.00	0.00	0.00
0.10E+08	0.10E+08	2.25	2.25	0.00	0.00	0.00
0.10E+08	0.10E+08	2.25	2.25	0.00	0.00	0.00
0.10E+08	0.10E+08	3.00	3.00	0.00	0.00	0.00
0.10E+08	0.10E+08	3.00	3.00	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	100.00	0.00	0.00

0.10E+08	0.10E+08	0.00	0.00	100.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00
0.10E+08	0.10E+08	3.50	3.50	0.00	0.00	0.00

SET MAXIMUM UNIT FRICTION AND MAXIMUM UNIT BEARING
TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO
LIMIT THE COMPUTED DATA.

****
* COMPUTATION RESULT *
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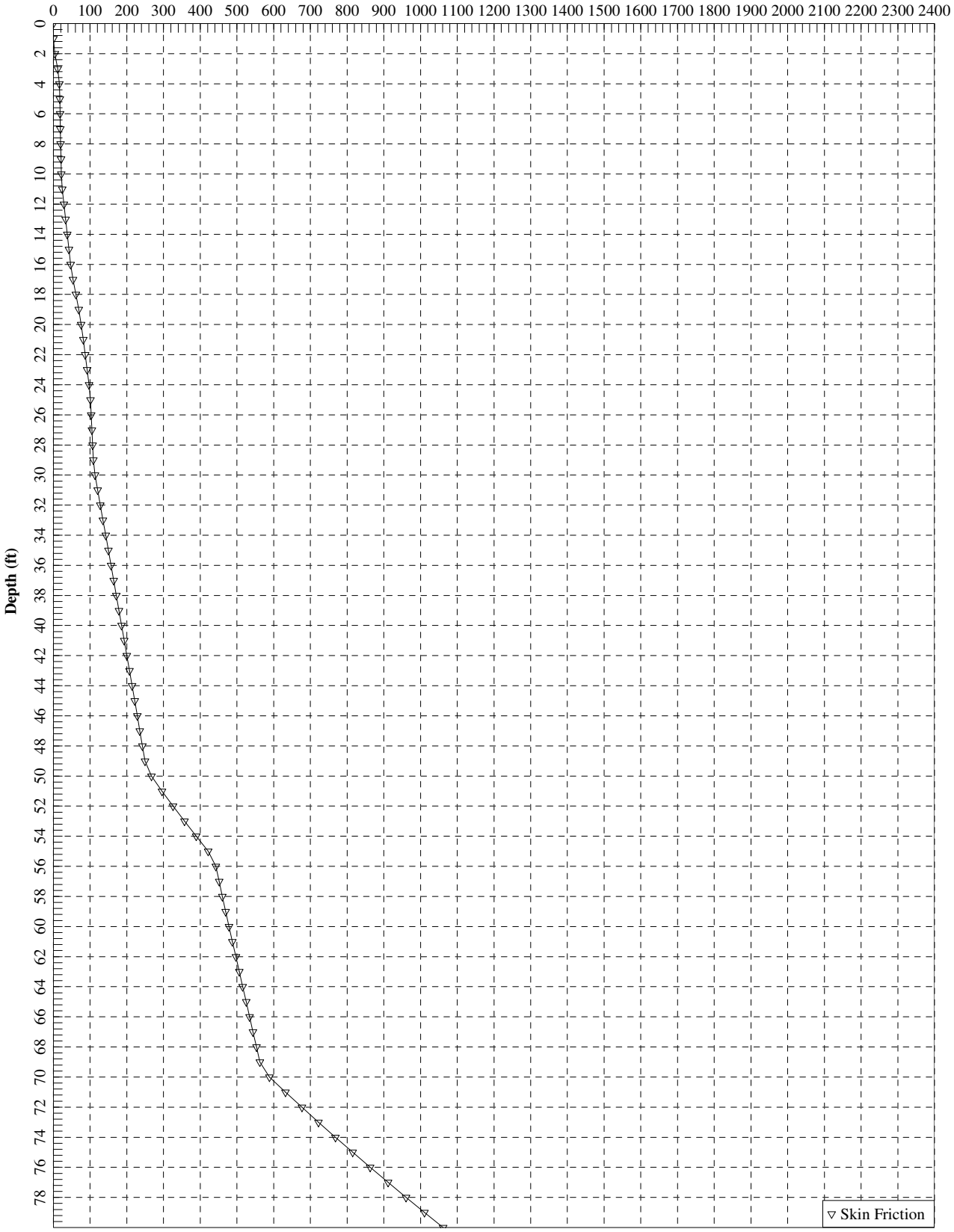
	FED. HWY. METHOD			ARMY CORPS METHOD			LAMBDA 2 METHOD		
PILE PENETR-ATION FT.	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC-ITY KIP
0.0	0.0	5.8	5.8	0.0	5.8	5.8	0.0	5.8	5.8
1.0	0.0	3.2	3.2	3.5	3.2	6.7	2.6	3.2	5.8
2.0	0.5	3.2	3.7	5.8	3.2	9.0	3.0	3.2	6.2
3.0	1.5	3.2	4.7	6.8	3.2	10.0	3.5	3.2	6.7
4.0	2.4	4.7	7.1	7.9	4.7	12.6	4.0	4.7	8.7
5.0	3.4	8.5	11.9	9.0	8.5	17.4	4.5	8.5	13.0
6.0	4.4	12.2	16.6	10.0	12.2	22.3	5.1	12.2	17.3
7.0	5.4	16.0	21.4	11.1	16.0	27.1	5.6	16.0	21.6
8.0	7.9	16.0	23.9	13.6	16.0	29.6	7.6	16.0	23.6
9.0	11.8	16.0	27.8	17.6	16.0	33.6	9.4	16.0	25.4
10.0	15.8	16.0	31.8	21.6	16.0	37.6	11.2	16.0	27.2
11.0	19.8	16.0	35.8	25.6	16.0	41.6	12.8	16.0	28.8
12.0	23.8	18.3	42.1	29.6	18.3	48.0	14.4	18.3	32.7
13.0	27.8	24.2	52.0	33.6	24.2	57.9	15.9	24.2	40.1
14.0	31.7	30.1	61.8	37.6	30.1	67.8	17.4	30.1	47.5
15.0	35.7	36.0	71.7	41.6	36.0	77.6	18.8	36.0	54.8
16.0	41.7	36.0	77.7	46.6	36.0	82.6	22.3	36.0	58.3
17.0	49.7	36.0	85.7	52.6	36.0	88.6	26.2	36.0	62.2
18.0	57.7	36.0	93.7	58.6	36.0	94.6	30.3	36.0	66.3
19.0	65.7	36.0	101.7	64.6	36.0	100.6	34.3	36.0	70.3
20.0	73.6	38.3	112.0	70.6	38.3	109.0	38.5	38.3	76.8
21.0	81.6	44.2	125.8	76.6	44.2	120.9	42.7	44.2	86.9
22.0	89.6	50.1	139.7	82.6	50.1	132.8	46.9	50.1	97.0
23.0	97.6	56.0	153.6	88.6	56.0	144.6	51.2	56.0	107.2
24.0	107.2	56.0	163.2	96.3	56.0	152.3	57.3	56.0	113.3
25.0	118.4	56.0	174.4	105.6	56.0	161.6	63.6	56.0	119.6
26.0	129.5	51.3	180.9	115.0	51.3	166.3	69.8	51.3	121.2
27.0	140.7	39.6	180.3	124.3	39.6	163.9	76.2	39.6	115.7
28.0	151.9	27.8	179.7	133.6	27.8	161.4	82.5	27.8	110.3
29.0	163.1	16.0	179.1	143.0	16.0	159.0	88.9	16.0	104.9
30.0	170.7	16.0	186.7	149.6	16.0	165.6	91.6	16.0	107.6
31.0	174.6	16.0	190.6	153.6	16.0	169.6	94.3	16.0	110.3
32.0	178.6	14.1	192.8	157.6	14.3	172.0	97.1	14.1	111.2
33.0	182.6	9.4	192.0	161.6	10.1	171.8	99.9	9.4	109.3
34.0	186.6	54.5	241.1	165.6	38.8	204.4	102.7	4.7	107.4

35.0	190.6	178.4	369.0	169.6	117.8	287.4	102.7	0.0	102.7
36.0	190.6	311.0	501.5	169.6	200.9	370.6	102.7	0.0	102.7
37.0	190.6	447.5	638.1	169.6	284.1	453.8	108.5	0.0	108.5
38.0	200.6	429.9	630.5	169.6	272.1	441.7	110.0	0.0	110.0
39.0	220.6	363.6	584.3	169.6	241.7	411.3	111.5	0.0	111.5
40.0	241.3	295.2	536.5	169.6	211.2	380.9	113.1	0.0	113.1
41.0	262.5	199.2	461.7	169.6	161.6	331.3	114.8	1.9	116.6
42.0	280.0	139.9	419.9	169.6	113.1	282.7	116.5	6.6	123.0
43.0	293.7	78.8	372.6	169.6	64.5	234.2	118.2	11.3	129.5
44.0	307.8	16.0	323.8	169.6	16.0	185.6	120.0	16.0	136.0
45.0	316.9	16.0	332.9	171.6	16.0	187.6	123.3	16.0	139.3
46.0	320.8	16.0	336.8	175.6	16.0	191.6	126.7	16.0	142.7
47.0	324.8	16.0	340.8	179.6	16.0	195.6	130.1	16.0	146.1
48.0	328.8	16.0	344.8	183.6	16.0	199.6	133.6	16.0	149.6
49.0	332.8	16.0	348.8	187.6	16.0	203.6	137.1	16.0	153.1
50.0	336.8	16.0	352.8	191.6	16.0	207.6	140.7	16.0	156.7
51.0	340.7	16.0	356.7	195.6	16.0	211.6	144.3	16.0	160.3
52.0	344.7	166.8	511.5	199.6	80.9	280.5	148.0	14.1	162.1
53.0	348.7	548.3	897.0	203.6	245.1	448.7	151.7	9.4	161.1
54.0	352.7	899.8	1252.4	207.6	392.4	600.1	155.4	4.7	160.1
55.0	356.7	1205.3	1562.0	211.6	514.0	725.6	159.2	0.0	159.2
56.0	375.0	1129.4	1504.4	213.6	471.4	685.0	161.6	0.0	161.6
57.0	408.3	1053.4	1461.7	213.6	428.8	642.4	164.0	0.0	164.0
58.0	441.8	1053.4	1495.3	213.6	428.8	642.4	166.5	0.0	166.5
59.0	475.7	1053.4	1529.1	213.6	428.8	642.4	169.0	0.0	169.0
60.0	510.3	1053.4	1563.7	213.6	428.8	642.4	171.6	0.0	171.6
61.0	545.6	1053.4	1599.1	213.6	428.8	642.4	174.3	0.0	174.3
62.0	581.8	1053.4	1635.2	213.6	428.8	642.4	177.0	0.0	177.0
63.0	618.7	935.0	1553.7	213.6	383.0	596.7	179.7	4.2	183.9
64.0	656.4	635.3	1291.7	213.6	267.4	481.0	182.6	14.8	197.4
65.0	694.9	335.7	1030.5	213.6	151.7	365.3	185.5	25.4	210.9
66.0	734.1	36.0	770.1	213.6	36.0	249.6	188.4	36.0	224.4
67.0	757.9	36.0	793.9	216.6	36.0	252.6	194.8	36.0	230.8
68.0	765.9	36.0	801.9	222.6	36.0	258.6	201.2	36.0	237.2
69.0	773.9	36.0	809.9	228.6	36.0	264.6	207.6	36.0	243.6
70.0	781.9	36.0	817.9	234.6	36.0	270.6	214.1	36.0	250.1
71.0	789.8	36.0	825.8	240.6	36.0	276.6	220.6	36.0	256.6
72.0	797.8	36.0	833.8	246.6	36.0	282.6	227.2	36.0	263.2
73.0	805.8	36.0	841.8	252.6	36.0	288.6	233.9	36.0	269.9
74.0	813.8	36.0	849.8	258.6	36.0	294.6	240.6	36.0	276.6
75.0	821.8	36.0	857.8	264.6	36.0	300.6	247.3	36.0	283.3
76.0	829.8	36.0	865.8	270.6	36.0	306.6	254.1	36.0	290.1
77.0	837.8	37.4	875.2	276.6	37.4	314.0	260.9	37.4	298.3
78.0	845.7	40.9	886.7	282.6	40.9	323.6	267.8	40.9	308.7
79.0	853.7	44.5	898.2	288.6	44.5	333.1	274.7	44.5	319.1
80.0	861.7	48.0	909.7	294.6	48.0	342.6	281.6	48.0	329.6

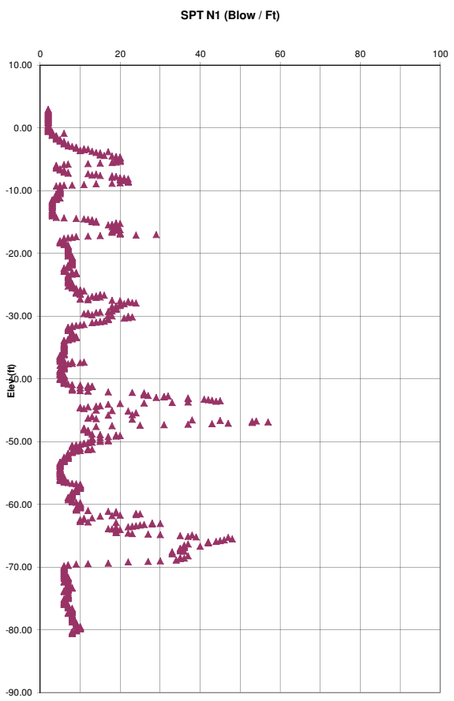
LOAD VERSUS SETTLEMENT CURVE
****

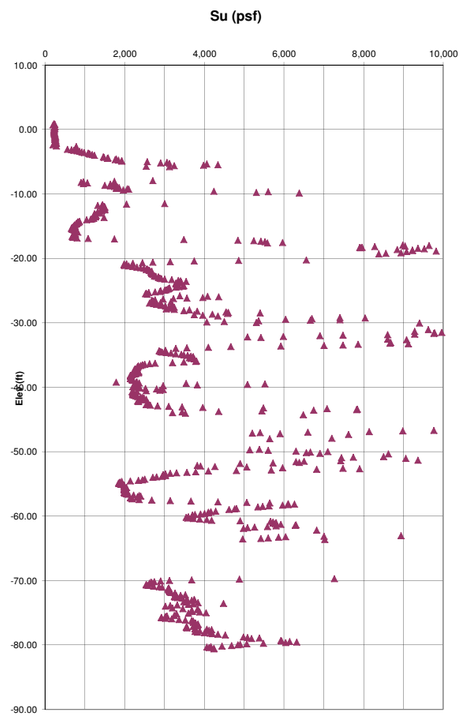
TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.2619E+01	0.1434E-02	0.2945E-01	0.1000E-03
0.2639E+02	0.1439E-01	0.2945E+00	0.1000E-02
0.1306E+03	0.7253E-01	0.1473E+01	0.5000E-02
0.2399E+03	0.1400E+00	0.2945E+01	0.1000E-01
0.6948E+03	0.5101E+00	0.1250E+02	0.5000E-01
0.8575E+03	0.7079E+00	0.1517E+02	0.1000E+00
0.9076E+03	0.1161E+01	0.2878E+02	0.5000E+00
0.9165E+03	0.1670E+01	0.3765E+02	0.1000E+01
0.9265E+03	0.2682E+01	0.4768E+02	0.2000E+01

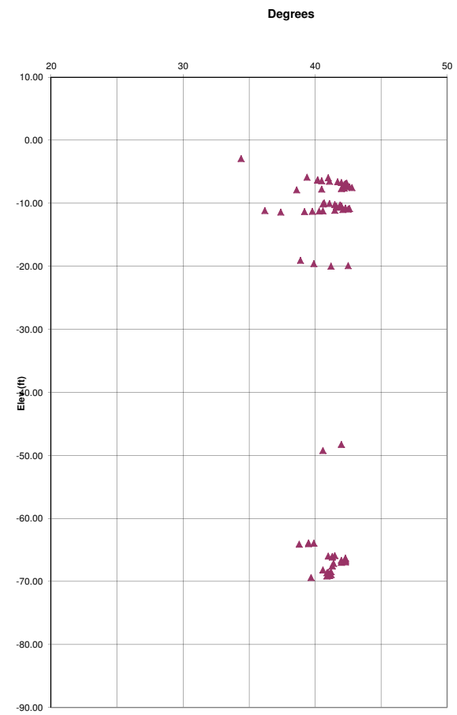
Broadway Overcrossing (Replace) - Abutment 1 - Class 140 (Modified) 16" Pile - Boring R-11-014
Axial Capacity (kips)

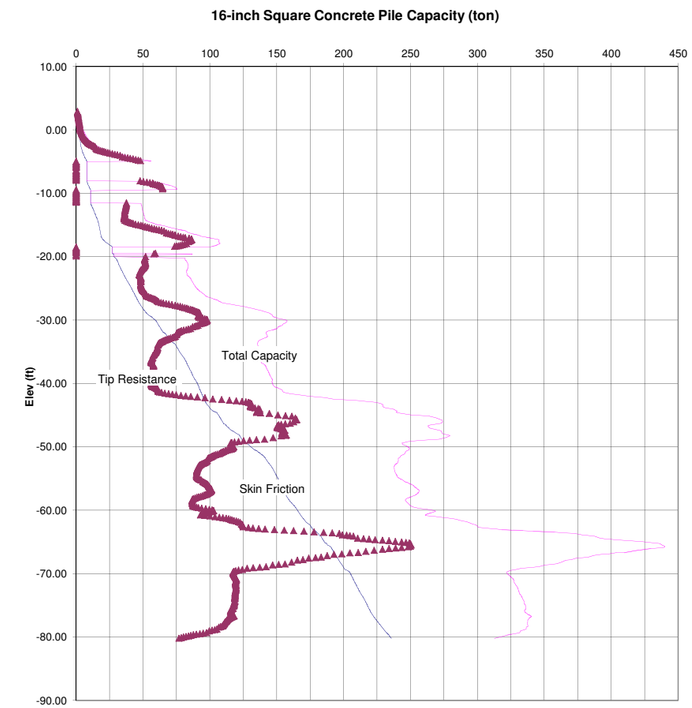


CPT-11-016
Broadway OC
Abutment 1





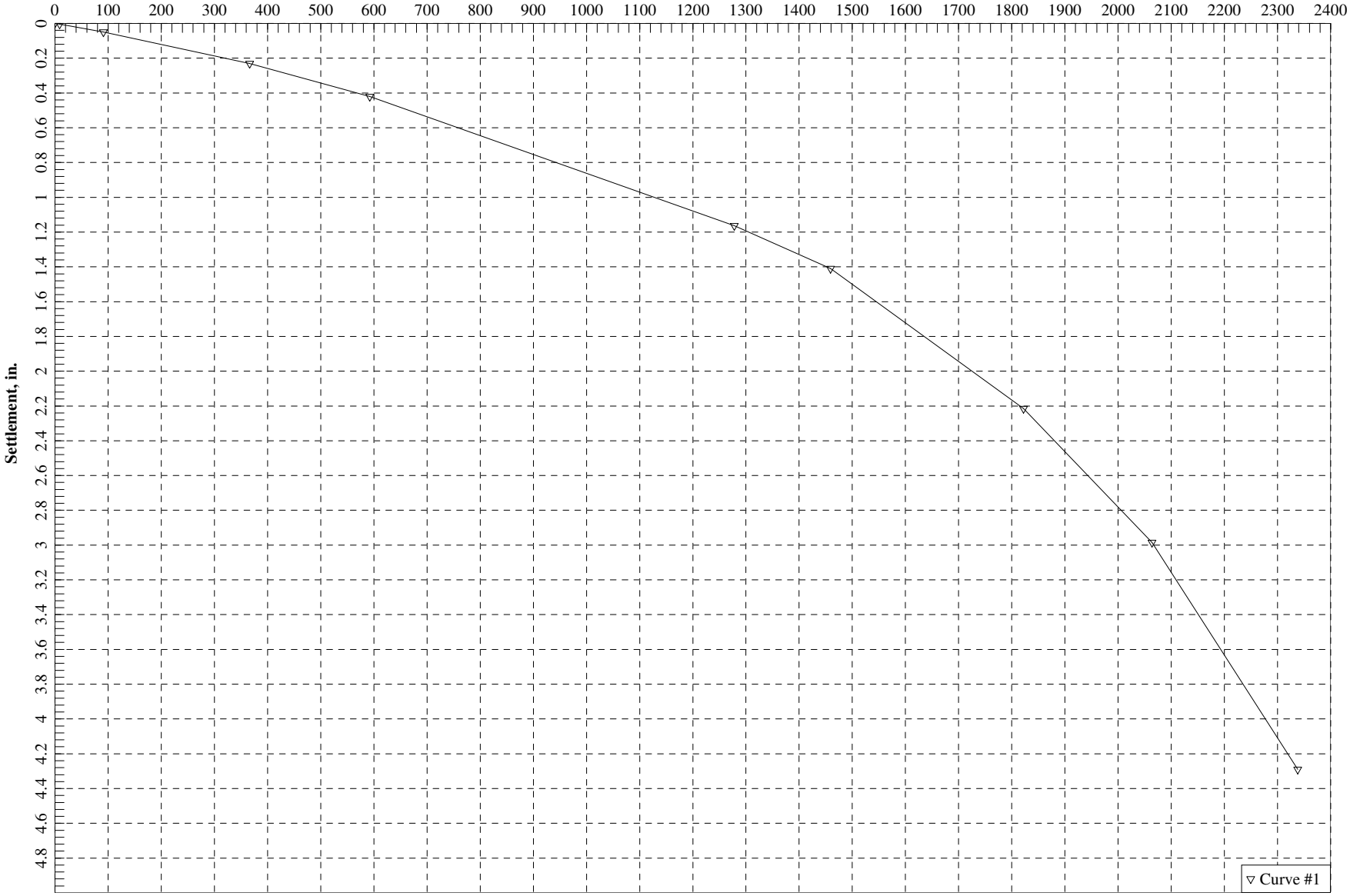




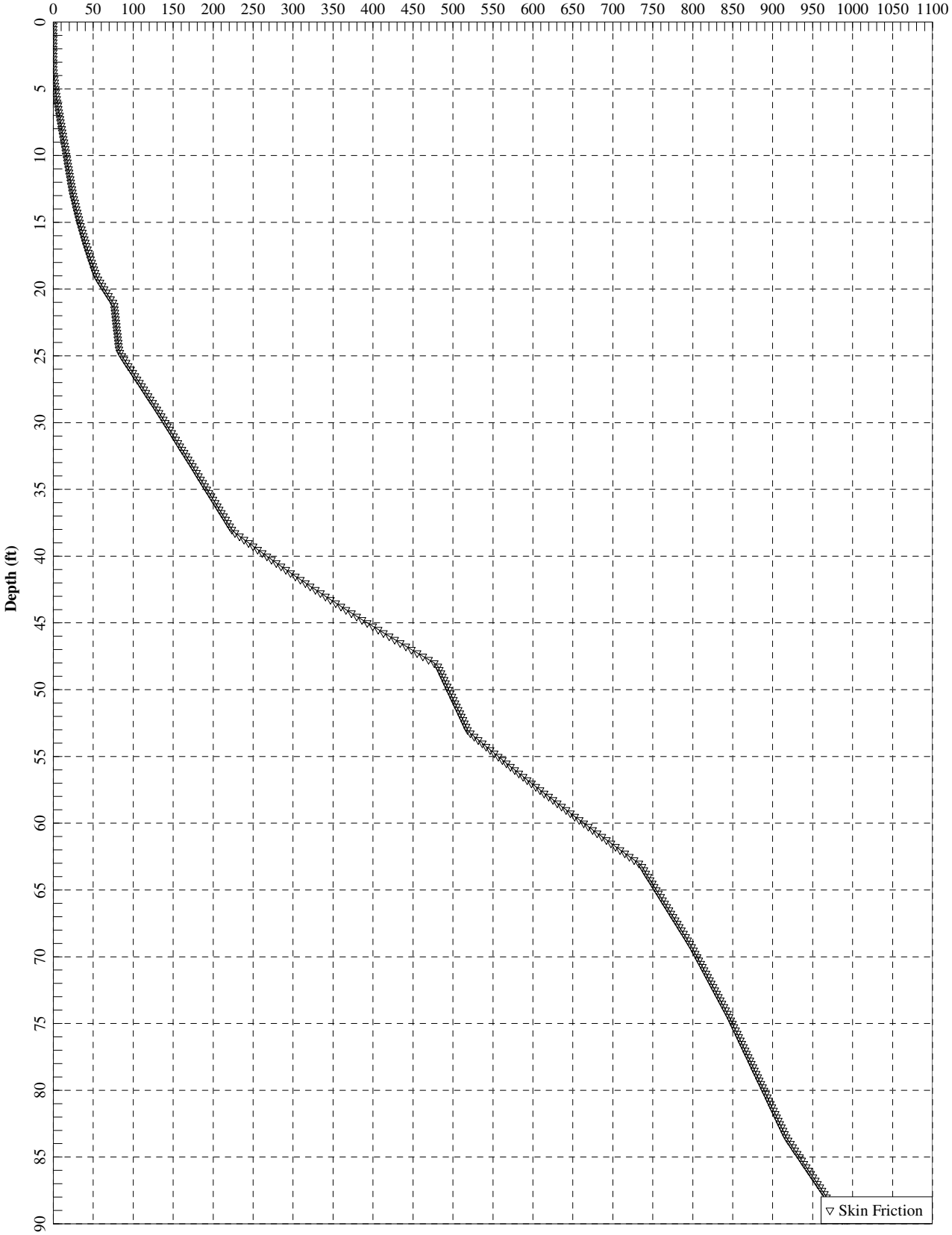
Pile Analysis for Abutment 1 (CPT-11-016)

1. Pile Design procedure based on FHWA-TS-78-209 "Guidelines for Cone Pentration Test, Performance and Design," July 1978.

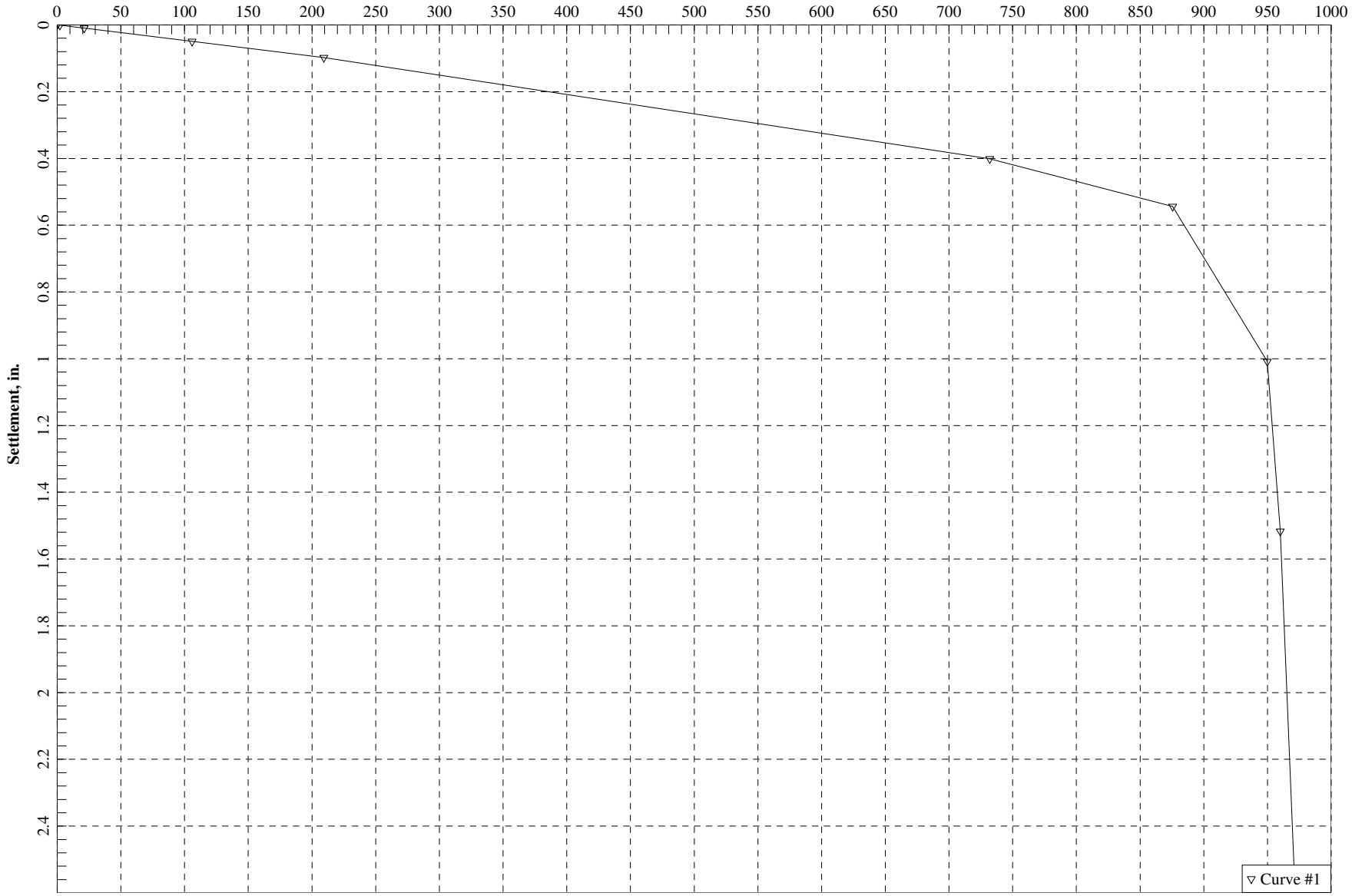
Broadway Overcrossing (Replace) - Abutment 1 - Class 140 (Modified) 16 in Pile
Axial Load (kips)



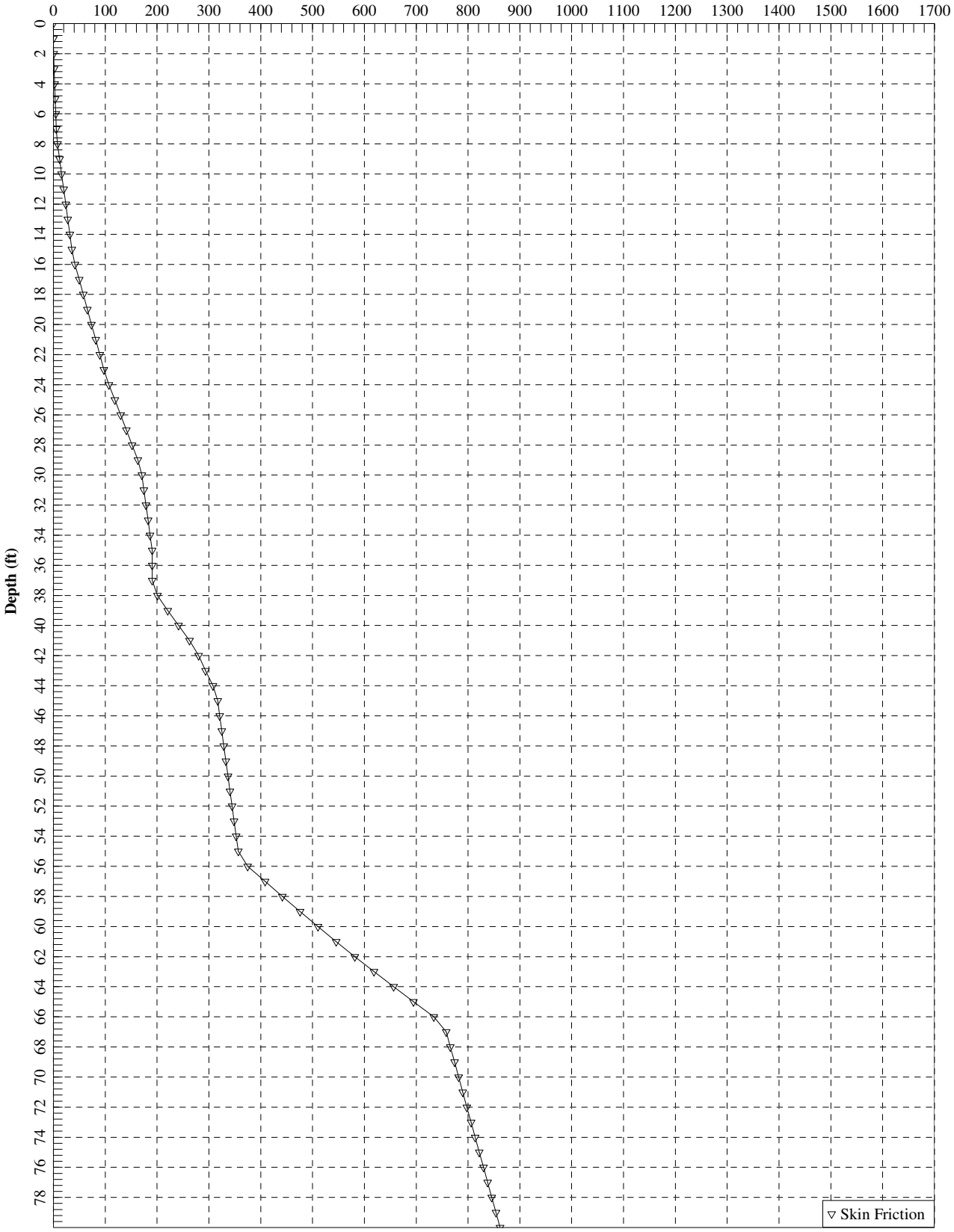
Broadway Overcrossing (Replace) - Bent 2 - CISS - 24" Pile
Axial Capacity (kips)



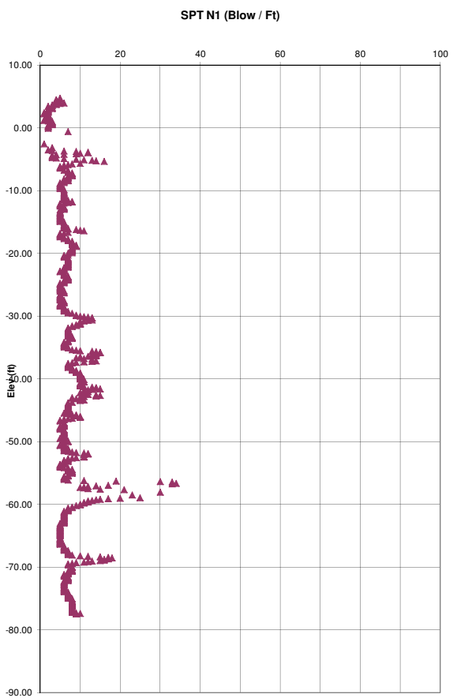
Broadway Overcrossing (Replace) - Bent 2 - 24" CISS Pile
Axial Load (kips)

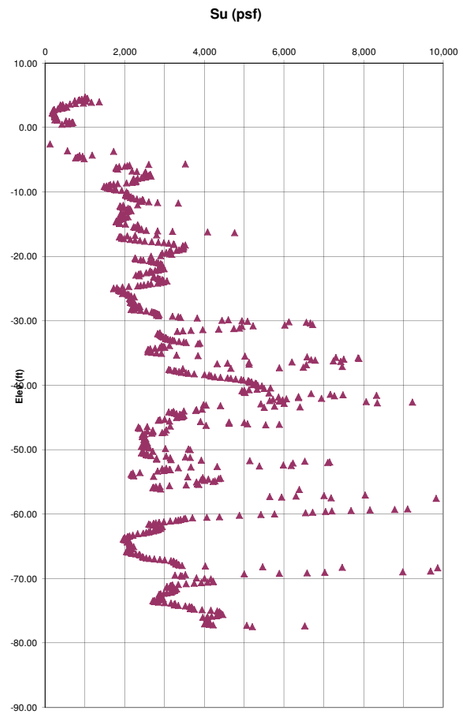


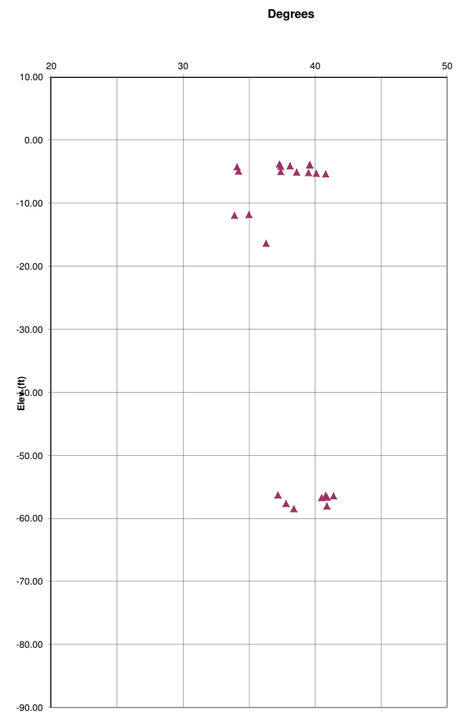
Broadway Overcrossing (Replace) - Abutment 3 - Class 140 (Modified) 16" Pile - Boring R-11-013
Axial Capacity (kips)

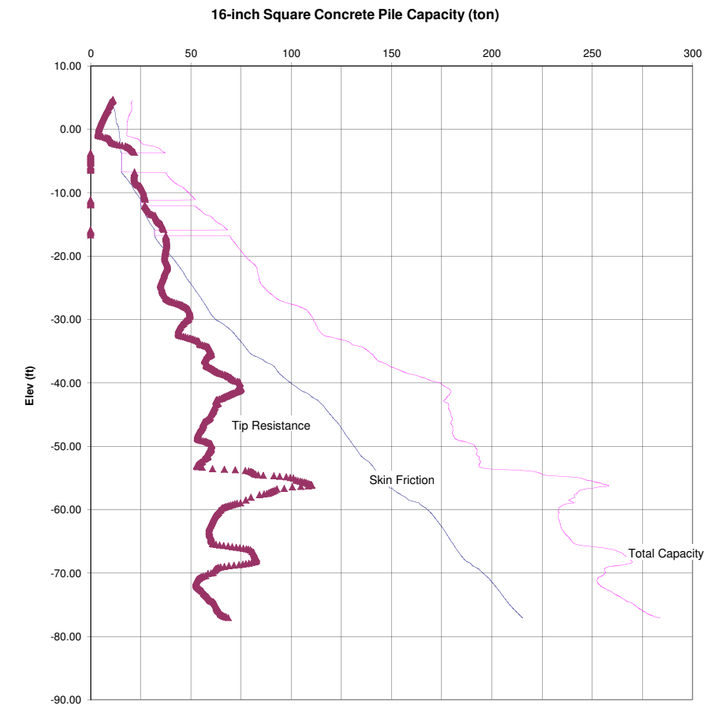


CPT-11-012
Broadway OC (Replace)
Abutment 3





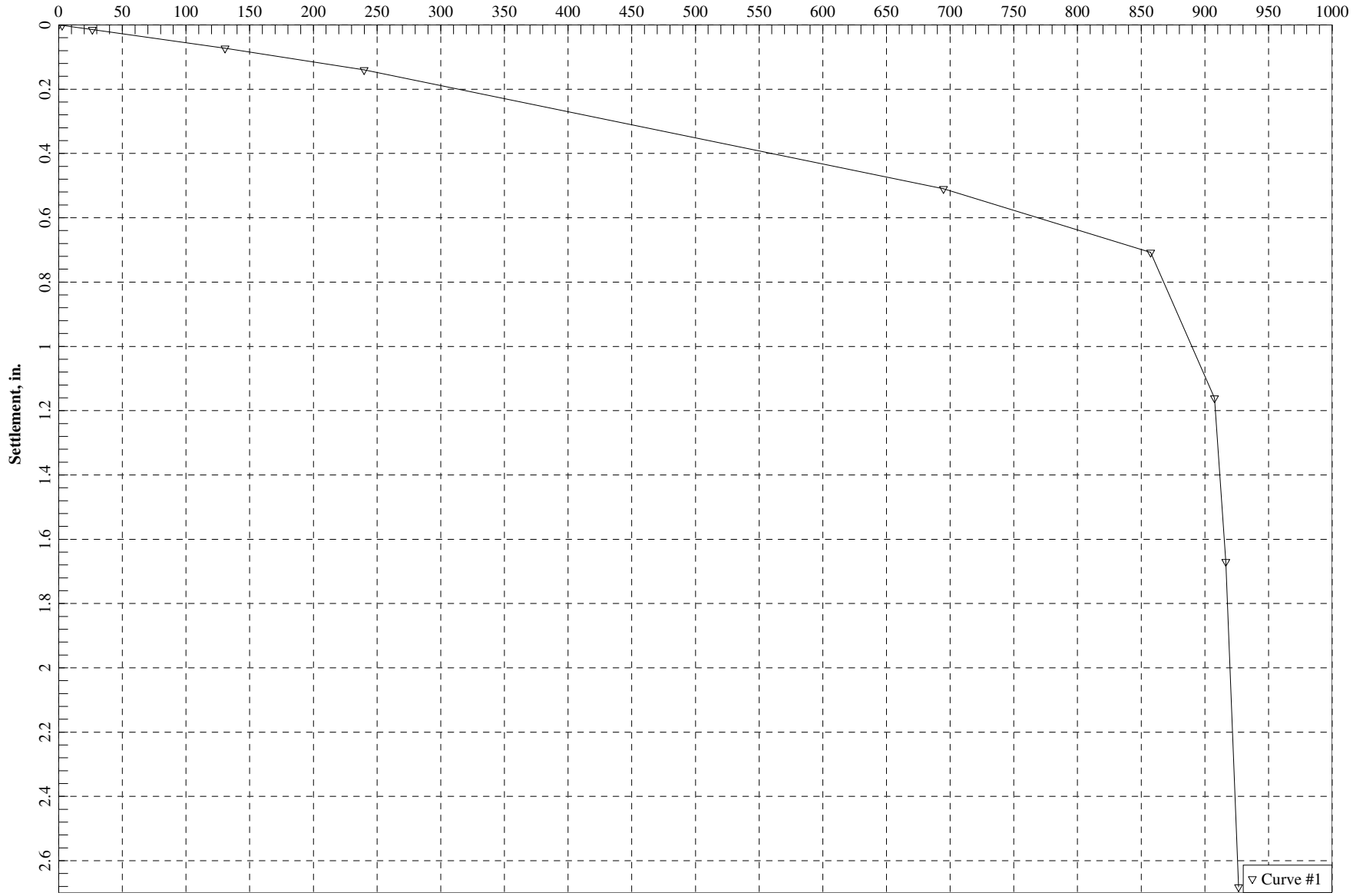




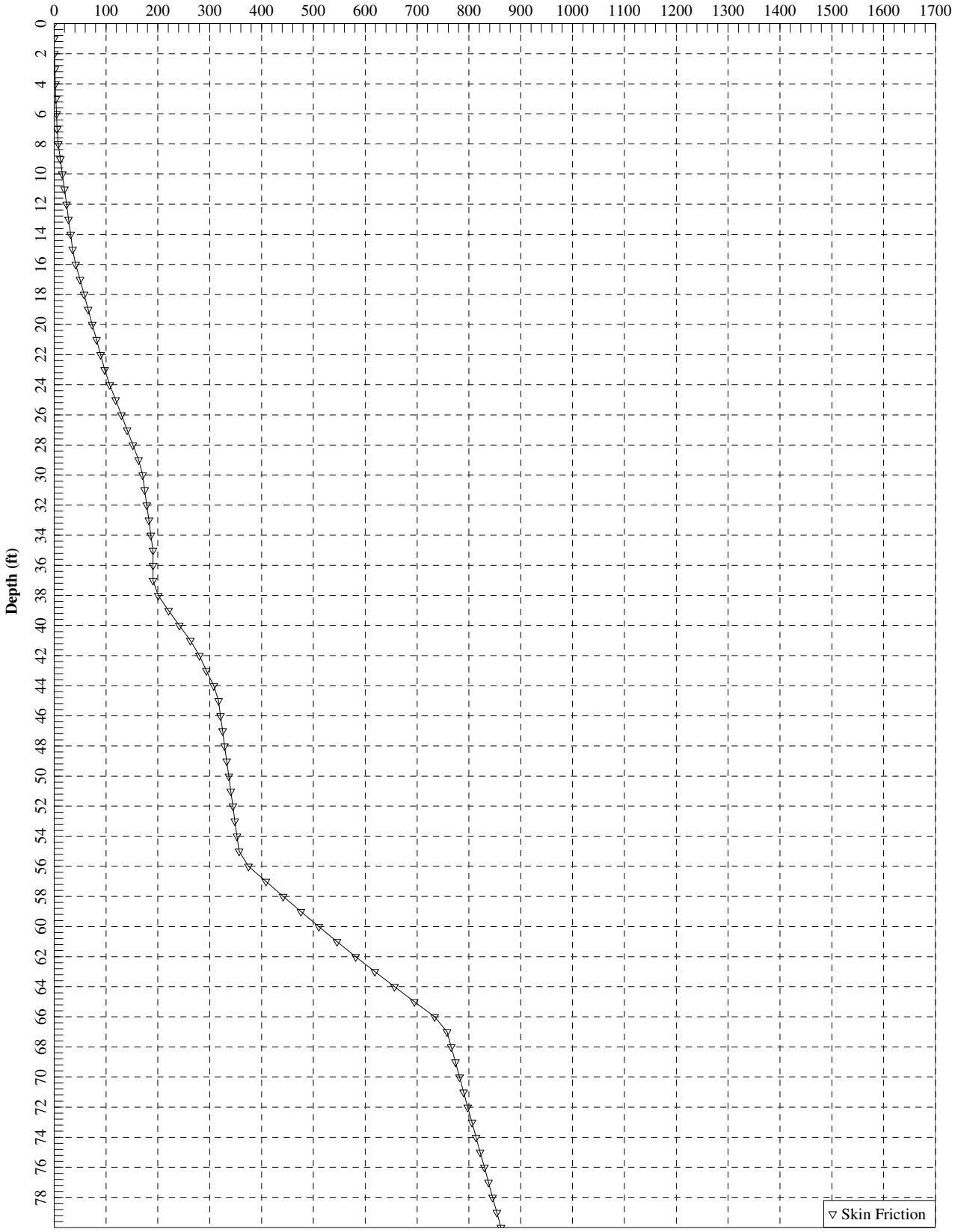
Pile Analysis for Abutment 3 (CPT-11-012)

1. Pile Design procedure based on FHWA-TS-78-209 "Guidelines for Cone Pentration Test, Performance and Design," July 1978.

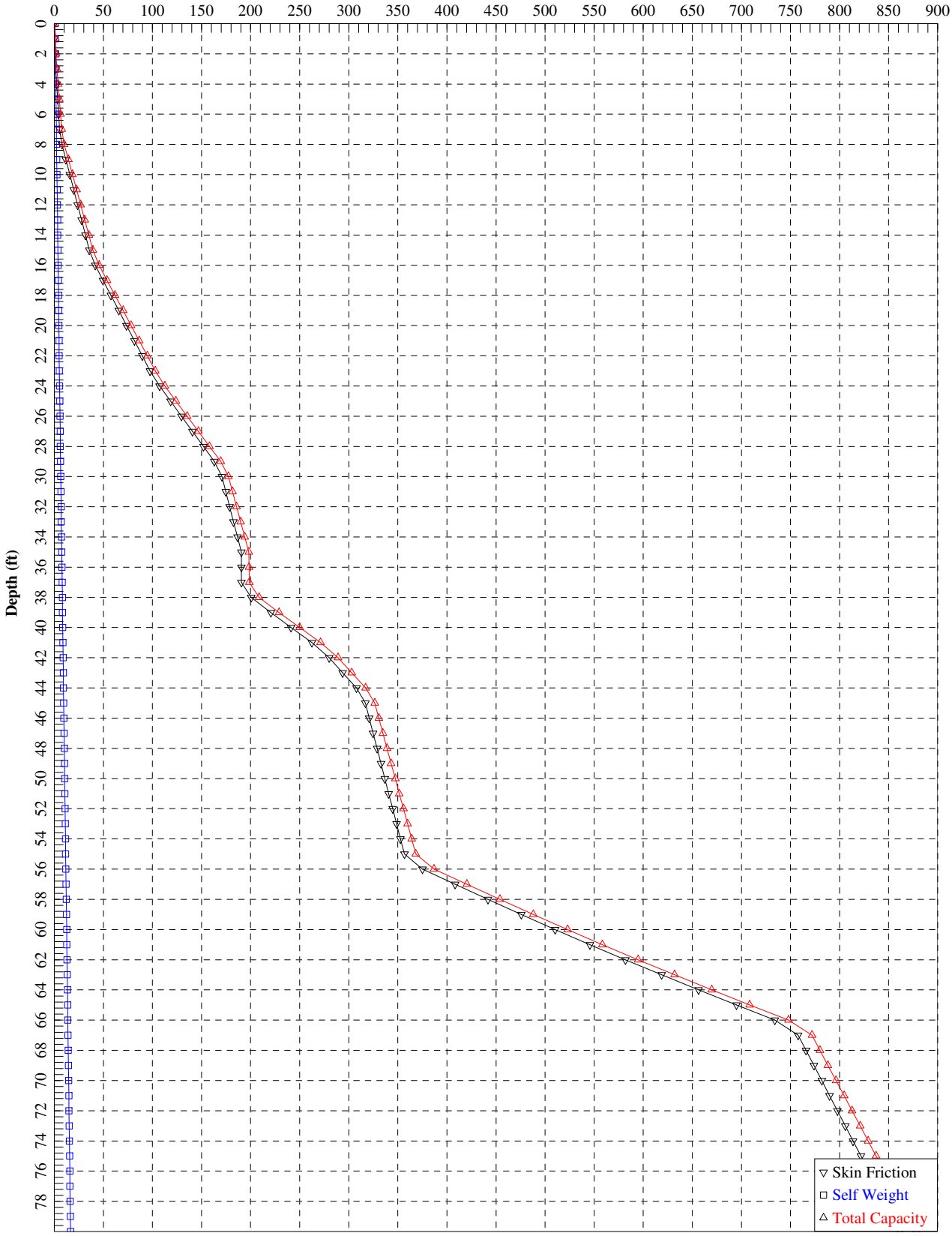
Broadway Overcrossing (Replace) - Abutment 3 - Class 140 (Modified) - 16" Pile
Axial Load (kips)



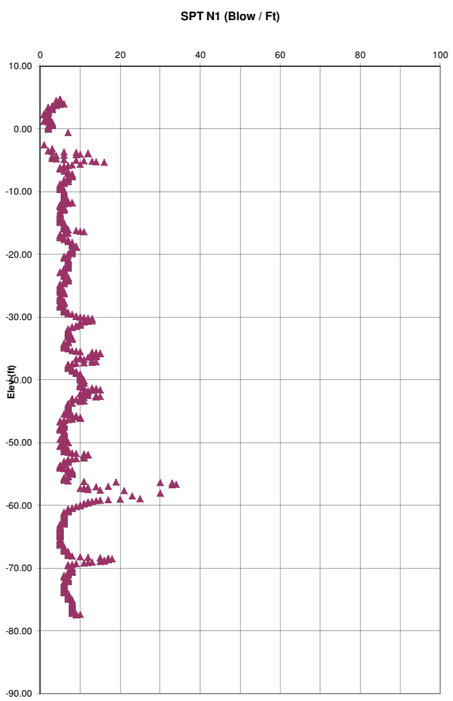
Broadway Overcrossing (Replace) - Abutment 3 RW - Class 140 (Modified) 16" Pile
Axial Capacity (kips)

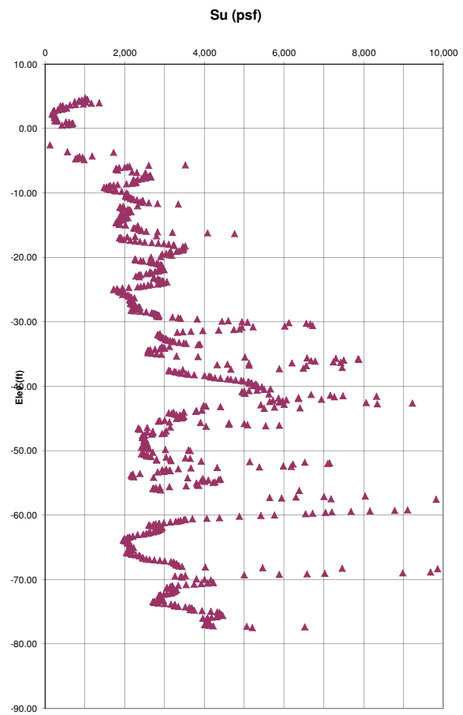


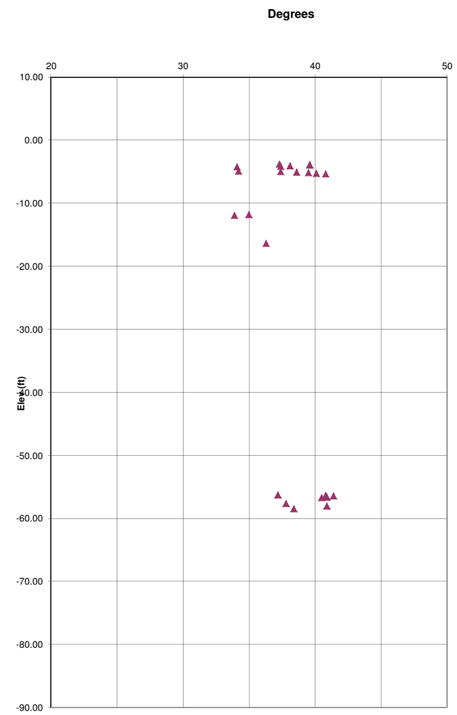
Broadway Overcrossing (Replace) - Abutment 3 RW - Class 140 (Modified) 16" Pile
Axial Capacity (kips) - Tension

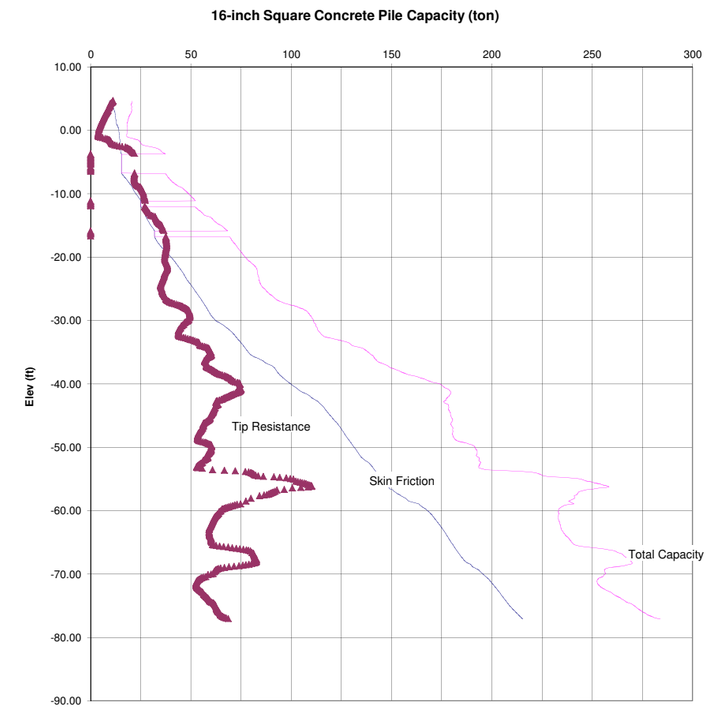


CPT-11-012
Broadway OC (Replace)
Abutment 3 Return walls



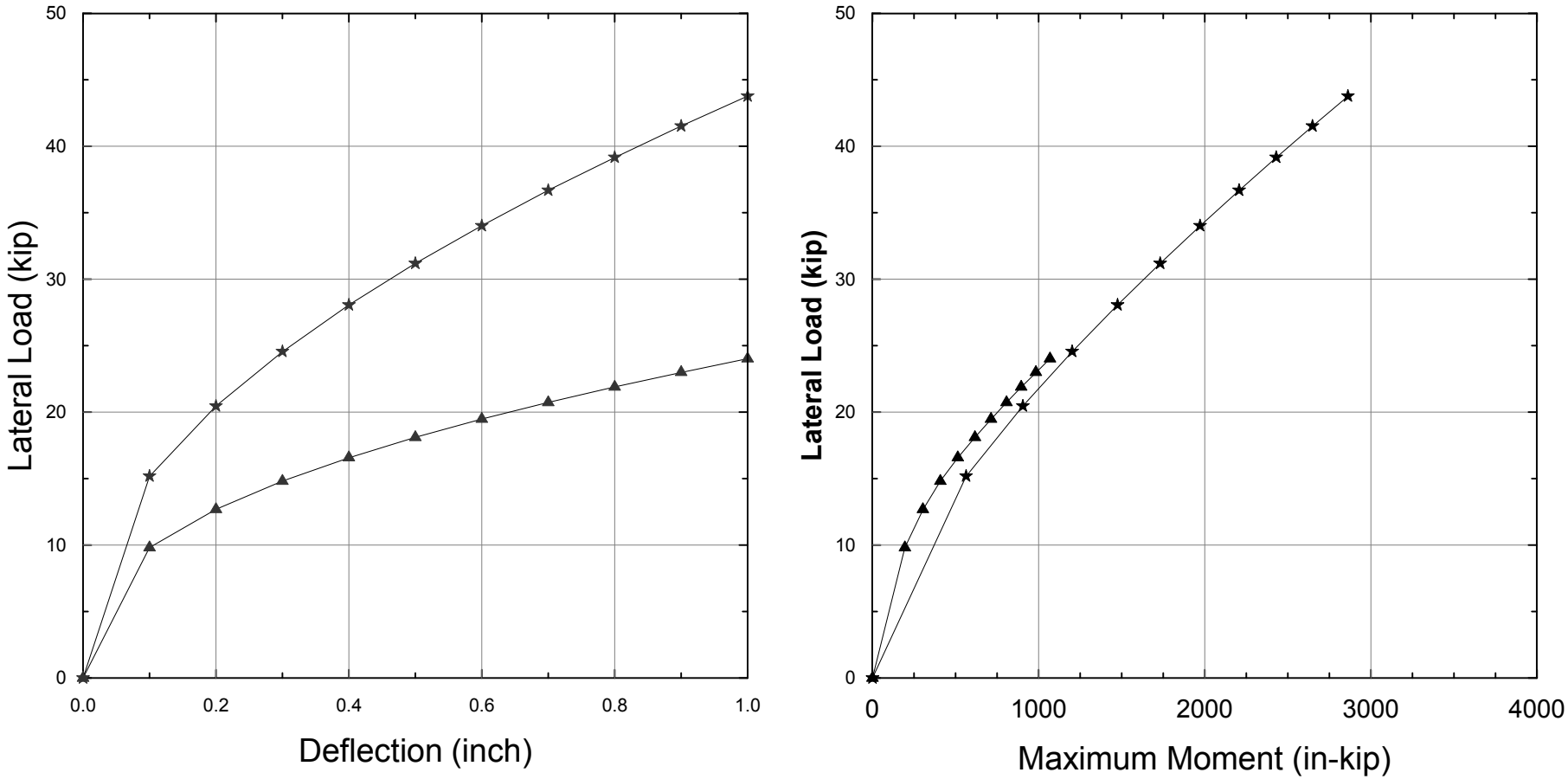






Pile Analysis for Abutment 3 Wingwalls (CPT-11-012)

1. Pile Design procedure based on FHWA-TS-78-209 "Guidelines for Cone Pentration Test, Performance and Design," July 1978.



Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**Broadway OC (Replace)** **Abutment 1 Pile Lateral Resistance** **Class 140 PCPS Pile**	Figure I-1
	URS		

W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\Broadway OC (Replace)_Bent.grf

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Madhu Thummaluru
URS Corporation

Files Used for Analysis

Path to file locations:
W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\
Name of input data file: West Abutment_16 in PCPS_Fixed.lpd
Name of output file: West Abutment_16 in PCPS_Fixed.lpo
Name of plot output file: West Abutment_16 in PCPS_Fixed.lpp
Name of runtime file: West Abutment_16 in PCPS_Fixed.lpr

Time and Date of Analysis

Date: June 13, 2012 Time: 15:38:49

Problem Title

Broadway OC (Replace) West Abutment 16 inch PCPS Class 140

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- Additional p-y curves computed at specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 624.00 in

Depth of ground surface below top of pile = -72.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	16.00000000	5461.3000	256.0000	3600000.
2	624.0000	16.00000000	5461.3000	256.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 18 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -72.000 in
Distance from top of pile to bottom of layer = 0.100 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 0.100 in
Distance from top of pile to bottom of layer = 36.000 in

Layer 3 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 36.000 in
Distance from top of pile to bottom of layer = 108.000 in

Layer 4 is liquefiable sand, by Rollins et al, 2004
Distance from top of pile to top of layer = 108.000 in
Distance from top of pile to bottom of layer = 126.000 in

Layer 5 is stiff clay without free water
Distance from top of pile to top of layer = 126.000 in
Distance from top of pile to bottom of layer = 198.000 in

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 198.000 in
Distance from top of pile to bottom of layer = 234.000 in

```
Layer  7 is stiff clay without free water
Distance from top of pile to top of layer    =      234.000 in
Distance from top of pile to bottom of layer =      294.000 in

Layer  8 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer    =      294.000 in
Distance from top of pile to bottom of layer =      354.000 in

Layer  9 is stiff clay without free water
Distance from top of pile to top of layer    =      354.000 in
Distance from top of pile to bottom of layer =      474.000 in

Layer 10 is stiff clay without free water
Distance from top of pile to top of layer    =      474.000 in
Distance from top of pile to bottom of layer =      534.000 in

Layer 11 is stiff clay without free water
Distance from top of pile to top of layer    =      534.000 in
Distance from top of pile to bottom of layer =      586.000 in

Layer 12 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      586.000 in
Distance from top of pile to bottom of layer =      612.000 in
p-y subgrade modulus k for top of soil layer =      200.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      200.000 lbs/in**3

Layer 13 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      612.000 in
Distance from top of pile to bottom of layer =      666.000 in
p-y subgrade modulus k for top of soil layer =      200.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      200.000 lbs/in**3

Layer 14 is stiff clay without free water
Distance from top of pile to top of layer    =      666.000 in
Distance from top of pile to bottom of layer =      708.000 in

Layer 15 is stiff clay without free water
Distance from top of pile to top of layer    =      708.000 in
Distance from top of pile to bottom of layer =      762.000 in

Layer 16 is stiff clay without free water
Distance from top of pile to top of layer    =      762.000 in
Distance from top of pile to bottom of layer =      832.000 in

Layer 17 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      832.000 in
Distance from top of pile to bottom of layer =     1020.000 in
p-y subgrade modulus k for top of soil layer =      250.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      250.000 lbs/in**3

Layer 18 is stiff clay without free water
Distance from top of pile to top of layer    =     1020.000 in
Distance from top of pile to bottom of layer =     1134.000 in


(Depth of lowest layer extends  510.00 in below pile tip)


--------------------------------------------------------------------------------
                   Effective Unit Weight of Soil vs. Depth
--------------------------------------------------------------------------------

Effective unit weight of soil with depth defined using 36 points
```

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-72.00	0.06940
2	0.10	0.06940
3	0.10	0.03330
4	36.00	0.03330
5	36.00	0.01600
6	108.00	0.01600
7	108.00	0.03620
8	126.00	0.03620
9	126.00	0.03040
10	198.00	0.03040
11	198.00	0.03330
12	234.00	0.03330
13	234.00	0.03620
14	294.00	0.03620
15	294.00	0.03910
16	354.00	0.03910
17	354.00	0.03620
18	474.00	0.03620
19	474.00	0.03620
20	534.00	0.03620
21	534.00	0.03330
22	586.00	0.03330
23	586.00	0.04490
24	612.00	0.04490
25	612.00	0.04490
26	666.00	0.04490
27	666.00	0.03620
28	708.00	0.03620
29	708.00	0.03330
30	762.00	0.03330
31	762.00	0.04200
32	832.00	0.04200
33	832.00	0.04490
34	1020.00	0.04490
35	1020.00	0.03910
36	1134.00	0.03910

Shear Strength of Soils

Shear strength parameters with depth defined using 36 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-72.000	6.94000	0.00	0.00700	0.0
2	0.100	6.94000	0.00	0.00700	0.0
3	0.100	6.94000	0.00	0.00700	0.0
4	36.000	6.94000	0.00	0.00700	0.0
5	36.000	1.11000	0.00	0.02000	0.0
6	108.000	1.11000	0.00	0.02000	0.0
7	108.000	0.00000	0.00	------	------
8	126.000	0.00000	0.00	------	------
9	126.000	5.90000	0.00	0.01000	0.0
10	198.000	5.90000	0.00	0.01000	0.0
11	198.000	10.42000	0.00	0.00700	0.0

12	234.000	10.42000	0.00	0.00700	0.0
13	234.000	6.94000	0.00	0.00700	0.0
14	294.000	6.94000	0.00	0.00700	0.0
15	294.000	2.64000	0.00	0.02000	0.0
16	354.000	2.64000	0.00	0.02000	0.0
17	354.000	9.38000	0.00	0.00700	0.0
18	474.000	9.38000	0.00	0.00700	0.0
19	474.000	24.31000	0.00	0.00500	0.0
20	534.000	24.31000	0.00	0.00500	0.0
21	534.000	9.03000	0.00	0.00700	0.0
22	586.000	9.03000	0.00	0.00700	0.0
23	586.000	0.00000	42.00	------	------
24	612.000	0.00000	42.00	------	------
25	612.000	0.00000	44.00	------	------
26	666.000	0.00000	44.00	------	------
27	666.000	12.15000	0.00	0.00700	0.0
28	708.000	12.15000	0.00	0.00700	0.0
29	708.000	17.36000	0.00	0.00500	0.0
30	762.000	17.36000	0.00	0.00500	0.0
31	762.000	17.36000	0.00	0.00500	0.0
32	832.000	17.36000	0.00	0.00500	0.0
33	832.000	0.00000	44.00	------	------
34	1020.000	0.00000	44.00	------	------
35	1020.000	27.78000	0.00	0.00400	0.0
36	1134.000	27.78000	0.00	0.00400	0.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 10

Load Case Number 1

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.100 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 120000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.200 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 120000.000 lbs

```
Load Case Number  3

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.300 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  4

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.400 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  5

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.500 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  6

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.600 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  7

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.700 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  8

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.800 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  9

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.900 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number 10

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           1.000 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs


--------------------------------------------------------------------------------
                    Output of p-y Curves at Specified Depths
--------------------------------------------------------------------------------
```

p-y curves are generated and printed for verification at 10 depths.

Depth No.	Depth Below Pile Head in	Depth Below Ground Surface in
1	15.000	87.000
2	90.000	162.000
3	135.000	207.000
4	180.000	252.000
5	234.000	306.000
6	282.000	354.000
7	342.000	414.000
8	432.000	504.000
9	522.000	594.000
10	579.000	651.000

Depth of ground surface below top of pile = -72.00 in

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	15.000 in
Depth below ground surface	=	87.000 in
Equivalent Depth	=	87.153 in
Diameter	=	16.000 in
Undrained cohesion, c	=	6.94000 lbs/in**2
Average Eff. Unit Weight	=	0.06322 lbs/in**3
Epsilon-50	=	0.00700
Pct	=	723.696 lbs/in
Pcd	=	999.360 lbs/in
Pu	=	723.696 lbs/in
y50	=	0.280 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lbs/in
0.0000	0.0000
4.4800E-05	40.6964
0.0002240	60.8553
0.0004480	72.3696
0.0022400	108.2178
0.0044800	128.6934
0.0224000	192.4415
0.0448000	228.8528
0.1120000	287.7671
0.2240000	342.2147
0.3360000	378.7228
0.4480000	406.9641
1.1200	511.7303
2.2400	608.5533
4.4800	723.6960
5.0400	723.6960
5.6000	723.6960

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```
Soil Layer Number           =          3
Depth below pile head       =       90.000 in
Depth below ground surface  =      162.000 in
Equivalent Depth            =      441.907 in
Pile Diameter               =       16.000 in
Cohesion, c                 =        1.110 lbs/in**2
Avg Eff Unit Weight         =      0.04360 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      0.80000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0064000	15.9840
0.2000000	50.3464
0.4000000	63.4325
0.6000000	72.6121
0.8000000	79.9200
1.0000000	86.0912
1.2000	91.4856
1.4000	96.3093
1.6000	100.6929
1.8000	104.7248
2.0000	108.4681
2.2000	111.9695
2.4000	115.2646
6.4000	159.8400
12.0000	159.8400
16.0000	159.8400

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number           =          5
Depth below pile head       =      135.000 in
Depth below ground surface  =      207.000 in
Equivalent Depth            =      158.359 in
Diameter                    =       16.000 in
Undrained cohesion, c       =      5.90000 lbs/in**2
Average Eff. Unit Weight    =      0.03998 lbs/in**3
Epsilon-50                  =      0.01000
Pct                         =      851.664 lbs/in
Pcd                         =      849.600 lbs/in
Pu                          =      849.600 lbs/in
y50                         =        0.400 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	47.7765
0.0003200	71.4426
0.0006400	84.9600

0.0032000	127.0448
0.0064000	151.0826
0.0320000	225.9212
0.0640000	268.6671
0.1600000	337.8310
0.3200000	401.7510
0.4800000	444.6106
0.6400000	477.7652
1.6000	600.7579
3.2000	714.4256
6.4000	849.6000
7.2000	849.6000
8.0000	849.6000

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	5	
Depth below pile head	=	180.000	in
Depth below ground surface	=	252.000	in
Equivalent Depth	=	203.359	in
Diameter	=	16.000	in
Undrained cohesion, c	=	5.90000	lbs/in**2
Average Eff. Unit Weight	=	0.03827	lbs/in**3
Epsilon-50	=	0.01000	
Pct	=	1007.634	lbs/in
Pcd	=	849.600	lbs/in
Pu	=	849.600	lbs/in
y50	=	0.400	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	47.7765
0.0003200	71.4426
0.0006400	84.9600
0.0032000	127.0448
0.0064000	151.0826
0.0320000	225.9212
0.0640000	268.6671
0.1600000	337.8310
0.3200000	401.7510
0.4800000	444.6106
0.6400000	477.7652
1.6000	600.7579
3.2000	714.4256
6.4000	849.6000
7.2000	849.6000
8.0000	849.6000

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	7	
Depth below pile head	=	234.000	in

```
Depth below ground surface =      306.000 in
Equivalent Depth           =      244.117 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      8.68000 lbs/in**2
Average Eff. Unit Weight   =      0.03722 lbs/in**3
Epsilon-50                 =      0.00700
Pct                        =     1621.500 lbs/in
Pcd                        =     1249.920 lbs/in
Pu                         =     1249.920 lbs/in
y50                        =        0.280 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
4.4800E-05	70.2882
0.0002240	105.1053
0.0004480	124.9920
0.0022400	186.9066
0.0044800	222.2707
0.0224000	332.3722
0.0448000	395.2594
0.1120000	497.0124
0.2240000	591.0507
0.3360000	654.1051
0.4480000	702.8817
1.1200	883.8269
2.2400	1051.0532
4.4800	1249.9200
5.0400	1249.9200
5.6000	1249.9200

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          7
Depth below pile head      =      282.000 in
Depth below ground surface =      354.000 in
Equivalent Depth           =      292.117 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      6.94000 lbs/in**2
Average Eff. Unit Weight   =      0.03708 lbs/in**3
Epsilon-50                 =      0.00700
Pct                        =     1520.097 lbs/in
Pcd                        =      999.360 lbs/in
Pu                         =      999.360 lbs/in
y50                        =        0.280 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
4.4800E-05	56.1981
0.0002240	84.0358
0.0004480	99.9360
0.0022400	149.4392
0.0044800	177.7141
0.0224000	265.7446
0.0448000	316.0254
0.1120000	397.3809
0.2240000	472.5682

0.3360000	522.9827
0.4480000	561.9814
1.1200	706.6542
2.2400	840.3582
4.4800	999.3600
5.0400	999.3600
5.6000	999.3600

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```
Soil Layer Number           =          8
Depth below pile head       =      342.000 in
Depth below ground surface  =      414.000 in
Equivalent Depth            =      739.809 in
Pile Diameter               =       16.000 in
Cohesion, c                 =        2.640 lbs/in**2
Avg Eff Unit Weight         =      0.03729 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      0.80000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0064000	38.0160
0.2000000	119.7429
0.4000000	150.8666
0.6000000	172.6991
0.8000000	190.0800
1.0000000	204.7575
1.2000	217.5873
1.4000	229.0599
1.6000	239.4858
1.8000	249.0753
2.0000	257.9783
2.2000	266.3058
2.4000	274.1428
6.4000	380.1600
12.0000	380.1600
16.0000	380.1600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          9
Depth below pile head      =      432.000 in
Depth below ground surface =      504.000 in
Equivalent Depth           =      332.858 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      9.38000 lbs/in**2
Average Eff. Unit Weight   =      0.03717 lbs/in**3
Epsilon-50                 =      0.00700
Pct                        =     2209.282 lbs/in
Pcd                        =     1350.720 lbs/in
```

```
Pu                          =     1350.720 lbs/in
y50                         =        0.280 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
4.4800E-05	75.9566
0.0002240	113.5816
0.0004480	135.0720
0.0022400	201.9798
0.0044800	240.1958
0.0224000	359.1764
0.0448000	427.1352
0.1120000	537.0940
0.2240000	638.7161
0.3360000	706.8555
0.4480000	759.5657
1.1200	955.1033
2.2400	1135.8156
4.4800	1350.7200
5.0400	1350.7200
5.6000	1350.7200

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number           =         10
Depth below pile head       =      522.000 in
Depth below ground surface  =      594.000 in
Equivalent Depth            =      231.107 in
Diameter                    =       16.000 in
Undrained cohesion, c       =     24.31000 lbs/in**2
Average Eff. Unit Weight    =      0.03702 lbs/in**3
Epsilon-50                  =      0.00500
Pct                         =     4112.875 lbs/in
Pcd                         =     3500.640 lbs/in
Pu                          =     3500.640 lbs/in
y50                         =        0.200 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	196.8555
0.0001600	294.3676
0.0003200	350.0640
0.0016000	523.4678
0.0032000	622.5116
0.0160000	930.8720
0.0320000	1106.9996
0.0800000	1391.9783
0.1600000	1655.3505
0.2400000	1831.9464
0.3200000	1968.5545
0.8000000	2475.3263
1.6000	2943.6756
3.2000	3500.6400

3.6000	3500.6400
4.0000	3500.6400

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	11	
Depth below pile head	=	579.000	in
Depth below ground surface	=	651.000	in
Equivalent Depth	=	591.138	in
Diameter	=	16.000	in
Undrained cohesion, c	=	9.03000	lbs/in**2
Average Eff. Unit Weight	=	0.03675	lbs/in**3
Epsilon-50	=	0.00700	
Pct	=	3450.000	lbs/in
Pcd	=	1300.320	lbs/in
Pu	=	1300.320	lbs/in
y50	=	0.280	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lbs/in
0.0000	0.0000
4.4800E-05	73.1224
0.0002240	109.3434
0.0004480	130.0320
0.0022400	194.4432
0.0044800	231.2332
0.0224000	345.7743
0.0448000	411.1973
0.1120000	517.0532
0.2240000	614.8834
0.3360000	680.4803
0.4480000	731.2237
1.1200	919.4651
2.2400	1093.4344
4.4800	1300.3200
5.0400	1300.3200
5.6000	1300.3200

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
5	y= 0.100000	S= 0.000	120000.	0.1000000	-563648.	15175.9603
5	y= 0.200000	S= 0.000	120000.	0.2000000	-904948.	20451.2409

```
  5  y=  0.300000 S=     0.000     120000.   0.3000000   -1202230.  24549.4010
  5  y=  0.400000 S=     0.000     120000.   0.4000000   -1475194.  28055.4415
  5  y=  0.500000 S=     0.000     120000.   0.5000000   -1731554.  31183.5873
  5  y=  0.600000 S=     0.000     120000.   0.6000000   -1972984.  34020.2890
  5  y=  0.700000 S=     0.000     120000.   0.7000000   -2207572.  36680.5881
  5  y=  0.800000 S=     0.000     120000.   0.8000000   -2430610.  39151.3622
  5  y=  0.900000 S=     0.000     120000.   0.9000000   -2649442.  41512.6467
  5  y=  1.000000 S=     0.000     120000.   1.0000000   -2862767.  43769.2646

The analysis ended normally.
```

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Madhu Thummaluru
URS Corporation

Files Used for Analysis

Path to file locations:
W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\
Name of input data file: West Abutment_16 in PCPS_Free.lpd
Name of output file: West Abutment_16 in PCPS_Free.lpo
Name of plot output file: West Abutment_16 in PCPS_Free.lpp
Name of runtime file: West Abutment_16 in PCPS_Free.lpr

Time and Date of Analysis

Date: June 13, 2012 Time: 15:41:03

Problem Title

Broadway OC (Replace) West Abutment 16 inch PCPS Class 140

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- Additional p-y curves computed at specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 624.00 in

Depth of ground surface below top of pile = -72.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	16.00000000	5461.3000	256.0000	3600000.
2	624.0000	16.00000000	5461.3000	256.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 18 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -72.000 in
Distance from top of pile to bottom of layer = 0.100 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 0.100 in
Distance from top of pile to bottom of layer = 36.000 in

Layer 3 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 36.000 in
Distance from top of pile to bottom of layer = 108.000 in

Layer 4 is liquefiable sand, by Rollins et al, 2004
Distance from top of pile to top of layer = 108.000 in
Distance from top of pile to bottom of layer = 126.000 in

Layer 5 is stiff clay without free water
Distance from top of pile to top of layer = 126.000 in
Distance from top of pile to bottom of layer = 198.000 in

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 198.000 in
Distance from top of pile to bottom of layer = 234.000 in

```
Layer  7 is stiff clay without free water
Distance from top of pile to top of layer    =      234.000 in
Distance from top of pile to bottom of layer =      294.000 in

Layer  8 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer    =      294.000 in
Distance from top of pile to bottom of layer =      354.000 in

Layer  9 is stiff clay without free water
Distance from top of pile to top of layer    =      354.000 in
Distance from top of pile to bottom of layer =      474.000 in

Layer 10 is stiff clay without free water
Distance from top of pile to top of layer    =      474.000 in
Distance from top of pile to bottom of layer =      534.000 in

Layer 11 is stiff clay without free water
Distance from top of pile to top of layer    =      534.000 in
Distance from top of pile to bottom of layer =      588.000 in

Layer 12 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      588.000 in
Distance from top of pile to bottom of layer =      612.000 in
p-y subgrade modulus k for top of soil layer =      200.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      200.000 lbs/in**3

Layer 13 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      612.000 in
Distance from top of pile to bottom of layer =      666.000 in
p-y subgrade modulus k for top of soil layer =      200.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      200.000 lbs/in**3

Layer 14 is stiff clay without free water
Distance from top of pile to top of layer    =      666.000 in
Distance from top of pile to bottom of layer =      708.000 in

Layer 15 is stiff clay without free water
Distance from top of pile to top of layer    =      708.000 in
Distance from top of pile to bottom of layer =      762.000 in

Layer 16 is stiff clay without free water
Distance from top of pile to top of layer    =      762.000 in
Distance from top of pile to bottom of layer =      834.000 in

Layer 17 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      834.000 in
Distance from top of pile to bottom of layer =     1020.000 in
p-y subgrade modulus k for top of soil layer =      250.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      250.000 lbs/in**3

Layer 18 is stiff clay without free water
Distance from top of pile to top of layer    =     1020.000 in
Distance from top of pile to bottom of layer =     1134.000 in


(Depth of lowest layer extends  510.00 in below pile tip)


--------------------------------------------------------------------------------
                   Effective Unit Weight of Soil vs. Depth
--------------------------------------------------------------------------------

Effective unit weight of soil with depth defined using 36 points
```

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-72.00	0.06940
2	0.10	0.06940
3	0.10	0.03330
4	36.00	0.03330
5	36.00	0.01600
6	108.00	0.01600
7	108.00	0.03620
8	126.00	0.03620
9	126.00	0.03040
10	198.00	0.03040
11	198.00	0.03330
12	234.00	0.03330
13	234.00	0.03620
14	294.00	0.03620
15	294.00	0.03910
16	354.00	0.03910
17	354.00	0.03620
18	474.00	0.03620
19	474.00	0.03620
20	534.00	0.03620
21	534.00	0.03330
22	588.00	0.03330
23	588.00	0.04490
24	612.00	0.04490
25	612.00	0.04490
26	666.00	0.04490
27	666.00	0.03620
28	708.00	0.03620
29	708.00	0.03330
30	762.00	0.03330
31	762.00	0.04200
32	834.00	0.04200
33	834.00	0.04490
34	1020.00	0.04490
35	1020.00	0.03910
36	1134.00	0.03910

Shear Strength of Soils

Shear strength parameters with depth defined using 36 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-72.000	6.94000	0.00	0.00700	0.0
2	0.100	6.94000	0.00	0.00700	0.0
3	0.100	6.94000	0.00	0.00700	0.0
4	36.000	6.94000	0.00	0.00700	0.0
5	36.000	1.11000	0.00	0.02000	0.0
6	108.000	1.11000	0.00	0.02000	0.0
7	108.000	0.00000	0.00	------	------
8	126.000	0.00000	0.00	------	------
9	126.000	5.90000	0.00	0.01000	0.0
10	198.000	5.90000	0.00	0.01000	0.0
11	198.000	10.42000	0.00	0.00700	0.0

12	234.000	10.42000	0.00	0.00700	0.0
13	234.000	6.94000	0.00	0.00700	0.0
14	294.000	6.94000	0.00	0.00700	0.0
15	294.000	2.64000	0.00	0.02000	0.0
16	354.000	2.64000	0.00	0.02000	0.0
17	354.000	9.38000	0.00	0.00700	0.0
18	474.000	9.38000	0.00	0.00700	0.0
19	474.000	24.31000	0.00	0.00500	0.0
20	534.000	24.31000	0.00	0.00500	0.0
21	534.000	9.03000	0.00	0.00700	0.0
22	588.000	9.03000	0.00	0.00700	0.0
23	588.000	0.00000	42.00	------	------
24	612.000	0.00000	42.00	------	------
25	612.000	0.00000	44.00	------	------
26	666.000	0.00000	44.00	------	------
27	666.000	12.15000	0.00	0.00700	0.0
28	708.000	12.15000	0.00	0.00700	0.0
29	708.000	17.36000	0.00	0.00500	0.0
30	762.000	17.36000	0.00	0.00500	0.0
31	762.000	17.36000	0.00	0.00500	0.0
32	834.000	17.36000	0.00	0.00500	0.0
33	834.000	0.00000	44.00	------	------
34	1020.000	0.00000	44.00	------	------
35	1020.000	27.78000	0.00	0.00400	0.0
36	1134.000	27.78000	0.00	0.00400	0.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 10

Load Case Number 1

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.100 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 120000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.200 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 120000.000 lbs

```
Load Case Number  3

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.300 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  4

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.400 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  5

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.500 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  6

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.600 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  7

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.700 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  8

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.800 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  9

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.900 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number 10

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           1.000 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs


--------------------------------------------------------------------------------
                    Output of p-y Curves at Specified Depths
--------------------------------------------------------------------------------
```

p-y curves are generated and printed for verification at 10 depths.

Depth No.	Depth Below Pile Head in	Depth Below Ground Surface in
1	15.000	87.000
2	90.000	162.000
3	135.000	207.000
4	180.000	252.000
5	234.000	306.000
6	282.000	354.000
7	342.000	414.000
8	432.000	504.000
9	522.000	594.000
10	579.000	651.000

Depth of ground surface below top of pile = -72.00 in

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	2
Depth below pile head	=	15.000 in
Depth below ground surface	=	87.000 in
Equivalent Depth	=	87.153 in
Diameter	=	16.000 in
Undrained cohesion, c	=	6.94000 lbs/in**2
Average Eff. Unit Weight	=	0.06322 lbs/in**3
Epsilon-50	=	0.00700
Pct	=	723.696 lbs/in
Pcd	=	999.360 lbs/in
Pu	=	723.696 lbs/in
y50	=	0.280 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lbs/in
0.0000	0.0000
4.4800E-05	40.6964
0.0002240	60.8553
0.0004480	72.3696
0.0022400	108.2178
0.0044800	128.6934
0.0224000	192.4415
0.0448000	228.8528
0.1120000	287.7671
0.2240000	342.2147
0.3360000	378.7228
0.4480000	406.9641
1.1200	511.7303
2.2400	608.5533
4.4800	723.6960
5.0400	723.6960
5.6000	723.6960

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```
Soil Layer Number           =          3
Depth below pile head       =       90.000 in
Depth below ground surface  =      162.000 in
Equivalent Depth            =      441.907 in
Pile Diameter               =       16.000 in
Cohesion, c                 =        1.110 lbs/in**2
Avg Eff Unit Weight         =      0.04360 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      0.80000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0064000	15.9840
0.2000000	50.3464
0.4000000	63.4325
0.6000000	72.6121
0.8000000	79.9200
1.0000000	86.0912
1.2000	91.4856
1.4000	96.3093
1.6000	100.6929
1.8000	104.7248
2.0000	108.4681
2.2000	111.9695
2.4000	115.2646
6.4000	159.8400
12.0000	159.8400
16.0000	159.8400

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number           =          5
Depth below pile head       =      135.000 in
Depth below ground surface  =      207.000 in
Equivalent Depth            =      158.359 in
Diameter                    =       16.000 in
Undrained cohesion, c       =      5.90000 lbs/in**2
Average Eff. Unit Weight    =      0.03998 lbs/in**3
Epsilon-50                  =      0.01000
Pct                         =      851.664 lbs/in
Pcd                         =      849.600 lbs/in
Pu                          =      849.600 lbs/in
y50                         =        0.400 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	47.7765
0.0003200	71.4426
0.0006400	84.9600

0.0032000	127.0448
0.0064000	151.0826
0.0320000	225.9212
0.0640000	268.6671
0.1600000	337.8310
0.3200000	401.7510
0.4800000	444.6106
0.6400000	477.7652
1.6000	600.7579
3.2000	714.4256
6.4000	849.6000
7.2000	849.6000
8.0000	849.6000

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          5
Depth below pile head      =      180.000 in
Depth below ground surface =      252.000 in
Equivalent Depth           =      203.359 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      5.90000 lbs/in**2
Average Eff. Unit Weight   =      0.03827 lbs/in**3
Epsilon-50                 =      0.01000
Pct                        =     1007.634 lbs/in
Pcd                        =      849.600 lbs/in
Pu                         =      849.600 lbs/in
y50                        =        0.400 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	47.7765
0.0003200	71.4426
0.0006400	84.9600
0.0032000	127.0448
0.0064000	151.0826
0.0320000	225.9212
0.0640000	268.6671
0.1600000	337.8310
0.3200000	401.7510
0.4800000	444.6106
0.6400000	477.7652
1.6000	600.7579
3.2000	714.4256
6.4000	849.6000
7.2000	849.6000
8.0000	849.6000

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          7
Depth below pile head      =      234.000 in
Depth below ground surface =      306.000 in
Equivalent Depth           =      244.117 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      8.68000 lbs/in**2
Average Eff. Unit Weight   =      0.03722 lbs/in**3
Epsilon-50                 =      0.00700
Pct                        =     1621.500 lbs/in
```

```
Pcd                        =     1249.920 lbs/in
Pu                         =     1249.920 lbs/in
y50                        =        0.280 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
4.4800E-05	70.2882
0.0002240	105.1053
0.0004480	124.9920
0.0022400	186.9066
0.0044800	222.2707
0.0224000	332.3722
0.0448000	395.2594
0.1120000	497.0124
0.2240000	591.0507
0.3360000	654.1051
0.4480000	702.8817
1.1200	883.8269
2.2400	1051.0532
4.4800	1249.9200
5.0400	1249.9200
5.6000	1249.9200

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          7
Depth below pile head      =      282.000 in
Depth below ground surface =      354.000 in
Equivalent Depth           =      292.117 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      6.94000 lbs/in**2
Average Eff. Unit Weight   =      0.03708 lbs/in**3
Epsilon-50                 =      0.00700
Pct                        =     1520.097 lbs/in
Pcd                        =      999.360 lbs/in
Pu                         =      999.360 lbs/in
y50                        =        0.280 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
4.4800E-05	56.1981
0.0002240	84.0358
0.0004480	99.9360
0.0022400	149.4392
0.0044800	177.7141
0.0224000	265.7446
0.0448000	316.0254
0.1120000	397.3809
0.2240000	472.5682
0.3360000	522.9827
0.4480000	561.9814
1.1200	706.6542
2.2400	840.3582
4.4800	999.3600
5.0400	999.3600
5.6000	999.3600

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```
Soil Layer Number           =          8
Depth below pile head       =      342.000 in
Depth below ground surface  =      414.000 in
Equivalent Depth            =      739.809 in
Pile Diameter               =       16.000 in
Cohesion, c                 =        2.640 lbs/in**2
Avg Eff Unit Weight         =      0.03729 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      0.80000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0064000	38.0160
0.2000000	119.7429
0.4000000	150.8666
0.6000000	172.6991
0.8000000	190.0800
1.0000000	204.7575
1.2000	217.5873
1.4000	229.0599
1.6000	239.4858
1.8000	249.0753
2.0000	257.9783
2.2000	266.3058
2.4000	274.1428
6.4000	380.1600
12.0000	380.1600
16.0000	380.1600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number           =          9
Depth below pile head       =      432.000 in
Depth below ground surface  =      504.000 in
Equivalent Depth            =      332.858 in
Diameter                    =       16.000 in
Undrained cohesion, c       =      9.38000 lbs/in**2
Average Eff. Unit Weight    =      0.03717 lbs/in**3
Epsilon-50                  =      0.00700
Pct                         =     2209.282 lbs/in
Pcd                         =     1350.720 lbs/in
Pu                          =     1350.720 lbs/in
y50                         =        0.280 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
4.4800E-05	75.9566
0.0002240	113.5816
0.0004480	135.0720
0.0022400	201.9798
0.0044800	240.1958
0.0224000	359.1764
0.0448000	427.1352

0.1120000	537.0940
0.2240000	638.7161
0.3360000	706.8555
0.4480000	759.5657
1.1200	955.1033
2.2400	1135.8156
4.8000	1350.7200
5.0400	1350.7200
5.6000	1350.7200

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =         10
Depth below pile head      =      522.000 in
Depth below ground surface =      594.000 in
Equivalent Depth           =      231.107 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     24.31000 lbs/in**2
Average Eff. Unit Weight   =      0.03702 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     4112.875 lbs/in
Pcd                        =     3500.640 lbs/in
Pu                         =     3500.640 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	196.8555
0.0001600	294.3676
0.0003200	350.0640
0.0016000	523.4678
0.0032000	622.5116
0.0160000	930.8720
0.0320000	1106.9996
0.0800000	1391.9783
0.1600000	1655.3505
0.2400000	1831.9464
0.3200000	1968.5545
0.8000000	2475.3263
1.6000	2943.6756
3.2000	3500.6400
3.6000	3500.6400
4.0000	3500.6400

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =         11
Depth below pile head      =      579.000 in
Depth below ground surface =      651.000 in
Equivalent Depth           =      591.138 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      9.03000 lbs/in**2
Average Eff. Unit Weight   =      0.03675 lbs/in**3
Epsilon-50                 =      0.00700
Pct                        =     3450.000 lbs/in
Pcd                        =     1300.320 lbs/in
```

```
Pu                          =     1300.320 lbs/in
y50                         =        0.280 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
4.4800E-05	73.1224
0.0002240	109.3434
0.0004480	130.0320
0.0022400	194.4432
0.0044800	231.2332
0.0224000	345.7743
0.0448000	411.1973
0.1120000	517.0532
0.2240000	614.8834
0.3360000	680.4803
0.4480000	731.2237
1.1200	919.4651
2.2400	1093.4344
4.4800	1300.3200
5.0400	1300.3200
5.6000	1300.3200

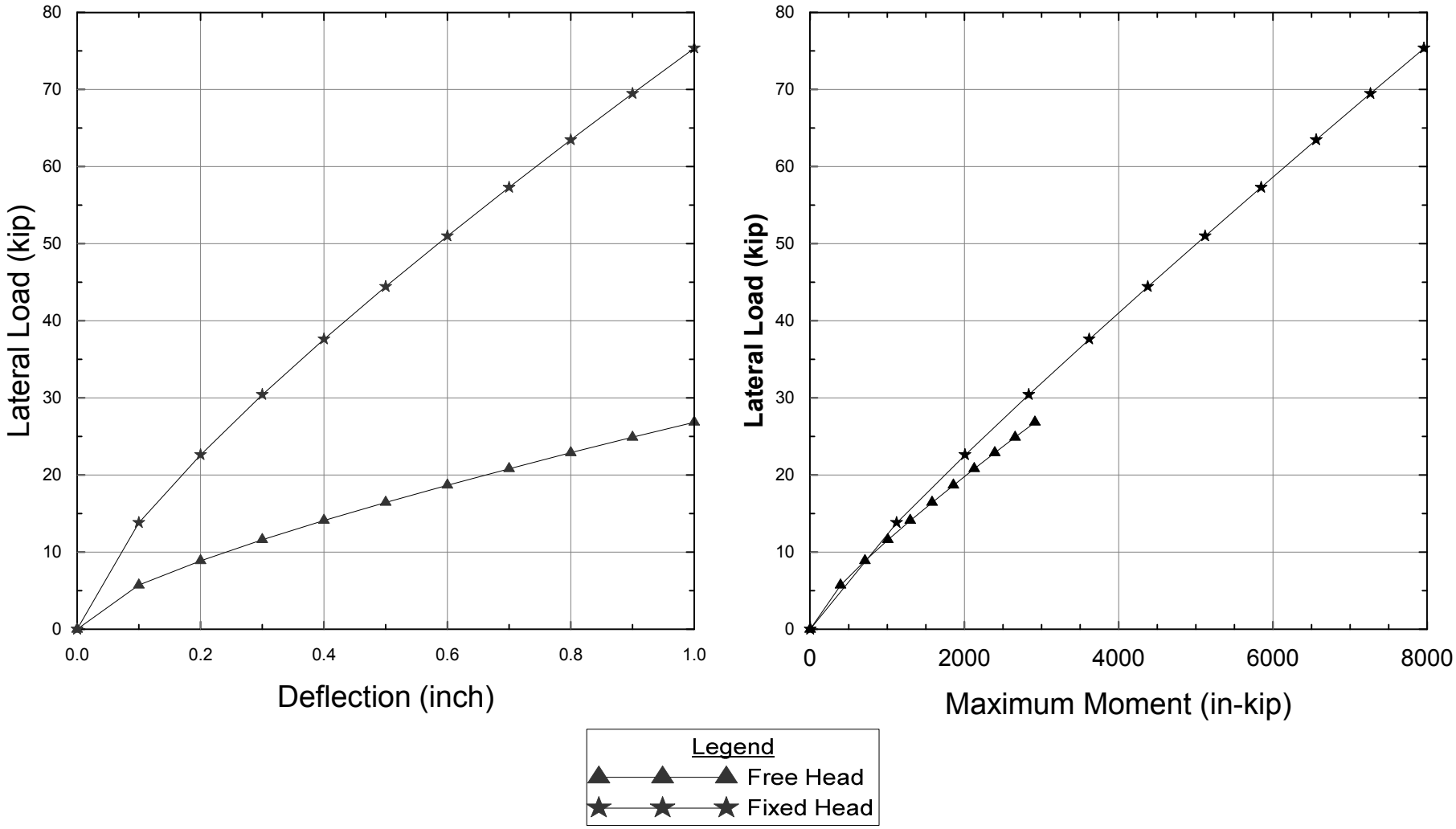
Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
4	y= 0.100000	M= 0.000	120000.	0.1000000	195340.	9807.4415
4	y= 0.200000	M= 0.000	120000.	0.2000000	304463.	12679.7118
4	y= 0.300000	M= 0.000	120000.	0.3000000	408354.	14806.7430
4	y= 0.400000	M= 0.000	120000.	0.4000000	513731.	16568.1044
4	y= 0.500000	M= 0.000	120000.	0.5000000	617291.	18099.7339
4	y= 0.600000	M= 0.000	120000.	0.6000000	714454.	19471.7172
4	y= 0.700000	M= 0.000	120000.	0.7000000	807271.	20729.1264
4	y= 0.800000	M= 0.000	120000.	0.8000000	895759.	21886.8742
4	y= 0.900000	M= 0.000	120000.	0.9000000	984135.	22982.8821
4	y= 1.000000	M= 0.000	120000.	1.0000000	1068624.	24012.0743

The analysis ended normally.



Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**Broadway OC (Replace)** **Bent 2 Pile Lateral Resistance** **Class 200 CISS Pile**	Figure I-2
	URS		

W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\Broadway OC (Replace)_Bent.grf

```
================================================================================

                 LPILE Plus for Windows, Version 5.0 (5.0.47)

                Analysis of Individual Piles and Drilled Shafts
               Subjected to Lateral Loading Using the p-y Method

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                              All Rights Reserved

================================================================================

This program is licensed to:

Madhu Thummaluru
URS Corporation

--------------------------------------------------------------------------------
                            Files Used for Analysis
--------------------------------------------------------------------------------

Path to file locations:
W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\
Name of input data file:     Bent_24 in CISS_Fixed.lpd
Name of output file:         Bent_24 in CISS_Fixed.lpo
Name of plot output file:    Bent_24 in CISS_Fixed.lpp
Name of runtime file:        Bent_24 in CISS_Fixed.lpr


-------------------------------------------------------------------------------
                          Time and Date of Analysis
-------------------------------------------------------------------------------

               Date:  June 13, 2012     Time:  19:00:30


-------------------------------------------------------------------------------
                                Problem Title
-------------------------------------------------------------------------------

Broadway OC (Replace) Bent 24 inch CISS Class 200


-------------------------------------------------------------------------------
                                Program Options
-------------------------------------------------------------------------------

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- Additional p-y curves computed at specified depths
```

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 552.00 in

Depth of ground surface below top of pile = 0.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	2549.0000	452.4000	29000000.
2	552.0000	24.00000000	2549.0000	452.4000	29000000.

Soil and Rock Layering Information

The soil profile is modelled using 14 layers

Layer 1 is liquefiable sand, by Rollins et al, 2004
Distance from top of pile to top of layer = 0.000 in
Distance from top of pile to bottom of layer = 18.000 in

Layer 2 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 18.000 in
Distance from top of pile to bottom of layer = 42.000 in

Layer 3 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 42.000 in
Distance from top of pile to bottom of layer = 126.000 in

Layer 4 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 126.000 in
Distance from top of pile to bottom of layer = 204.000 in
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 5 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 204.000 in
Distance from top of pile to bottom of layer = 270.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

```
Layer  6 is stiff clay without free water
Distance from top of pile to top of layer    =      270.000 in
Distance from top of pile to bottom of layer =      324.000 in

Layer  7 is stiff clay without free water
Distance from top of pile to top of layer    =      324.000 in
Distance from top of pile to bottom of layer =      432.000 in

Layer  8 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      432.000 in
Distance from top of pile to bottom of layer =      552.000 in
p-y subgrade modulus k for top of soil layer =      125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      125.000 lbs/in**3

Layer  9 is stiff clay without free water
Distance from top of pile to top of layer    =      552.000 in
Distance from top of pile to bottom of layer =      612.000 in

Layer 10 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      612.000 in
Distance from top of pile to bottom of layer =      732.000 in
p-y subgrade modulus k for top of soil layer =       60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =       60.000 lbs/in**3

Layer 11 is stiff clay without free water
Distance from top of pile to top of layer    =      732.000 in
Distance from top of pile to bottom of layer =      804.000 in

Layer 12 is stiff clay without free water
Distance from top of pile to top of layer    =      804.000 in
Distance from top of pile to bottom of layer =      870.000 in

Layer 13 is stiff clay without free water
Distance from top of pile to top of layer    =      870.000 in
Distance from top of pile to bottom of layer =      978.000 in

Layer 14 is stiff clay without free water
Distance from top of pile to top of layer    =      978.000 in
Distance from top of pile to bottom of layer =     1104.000 in


(Depth of lowest layer extends  552.00 in below pile tip)


--------------------------------------------------------------------------------
                    Effective Unit Weight of Soil vs. Depth
--------------------------------------------------------------------------------

Effective unit weight of soil with depth defined using 28 points

Point        Depth X    Eff. Unit Weight
 No.           in          lbs/in**3
-----      ----------   ----------------
  1             0.00        0.03330
  2            18.00        0.03330
  3            18.00        0.03620
  4            42.00        0.03620
  5            42.00        0.01600
  6           126.00        0.01600
  7           126.00        0.03910
  8           204.00        0.03910
  9           204.00        0.04490
 10           270.00        0.04490
```

11	270.00	0.03910
12	324.00	0.03910
13	324.00	0.03330
14	432.00	0.03330
15	432.00	0.04200
16	552.00	0.04200
17	552.00	0.03330
18	612.00	0.03330
19	612.00	0.03910
20	732.00	0.03910
21	732.00	0.02750
22	804.00	0.02750
23	804.00	0.04200
24	870.00	0.04200
25	870.00	0.03910
26	978.00	0.03910
27	978.00	0.03620
28	1104.00	0.03620

Shear Strength of Soils

Shear strength parameters with depth defined using 28 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	0.000	0.00000	0.00	------	------
2	18.000	0.00000	0.00	------	------
3	18.000	3.47000	0.00	0.02000	0.0
4	42.000	3.47000	0.00	0.02000	0.0
5	42.000	2.78000	0.00	0.02000	0.0
6	126.000	2.78000	0.00	0.02000	0.0
7	126.000	0.00000	36.00	------	------
8	204.000	0.00000	36.00	------	------
9	204.000	0.00000	40.00	------	------
10	270.000	0.00000	40.00	------	------
11	270.000	17.36000	0.00	0.00500	0.0
12	324.000	17.36000	0.00	0.00500	0.0
13	324.000	19.10000	0.00	0.00500	0.0
14	432.000	19.10000	0.00	0.00500	0.0
15	432.000	0.00000	40.00	------	------
16	552.000	0.00000	40.00	------	------
17	552.000	8.68000	0.00	0.00700	0.0
18	612.000	8.68000	0.00	0.00700	0.0
19	612.000	0.00000	36.00	------	------
20	732.000	0.00000	36.00	------	------
21	732.000	12.15000	0.00	0.00700	0.0
22	804.000	12.15000	0.00	0.00700	0.0
23	804.000	32.99000	0.00	0.00400	0.0
24	870.000	32.99000	0.00	0.00400	0.0
25	870.000	27.78000	0.00	0.00400	0.0
26	978.000	27.78000	0.00	0.00400	0.0
27	978.000	13.89000	0.00	0.00500	0.0
28	1104.000	13.89000	0.00	0.00500	0.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.

(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 10

Load Case Number 1

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.100 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 365000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.200 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 365000.000 lbs

Load Case Number 3

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.300 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 365000.000 lbs

Load Case Number 4

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.400 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 365000.000 lbs

Load Case Number 5

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.500 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 365000.000 lbs

Load Case Number 6

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.600 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 365000.000 lbs

Load Case Number 7

```
Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.700 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      365000.000 lbs

Load Case Number  8

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.800 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      365000.000 lbs

Load Case Number  9

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.900 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      365000.000 lbs

Load Case Number 10

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           1.000 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      365000.000 lbs



--------------------------------------------------------------------------------
                    Output of p-y Curves at Specified Depths
--------------------------------------------------------------------------------



p-y curves are generated and printed for verification at  7 depths.

Depth      Depth Below Pile Head      Depth Below Ground Surface
 No.                 in                          in
-----      ---------------------      --------------------------
  1                21.000                      21.000
  2                54.000                      54.000
  3               108.000                     108.000
  4               189.000                     189.000
  5               261.000                     261.000
  6               321.000                     321.000
  7               402.000                     402.000

Depth of ground surface below top of pile =       0.00 in



p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number           =          2
Depth below pile head       =       21.000 in
Depth below ground surface  =       21.000 in
Equivalent Depth            =       15.056 in
Pile Diameter               =       24.000 in
Cohesion, c                 =        3.470 lbs/in**2
Avg Eff Unit Weight         =      0.03371 lbs/in**3
E50 parameter               =      0.02000
```

```
Default J parameter         =        0.500
Y50                         =      1.20000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0096000	30.3267
0.3000000	95.5231
0.6000000	120.3516
0.9000000	137.7682
1.2000	151.6335
1.5000	163.3422
1.8000	173.5770
2.1000	182.7292
2.4000	191.0462
2.7000	198.6961
3.0000	205.7983
3.3000	212.4415
3.6000	218.6934
9.6000	303.2670
18.0000	303.2670
24.0000	303.2670

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```
Soil Layer Number           =          3
Depth below pile head       =       54.000 in
Depth below ground surface  =       54.000 in
Equivalent Depth            =       54.673 in
Pile Diameter               =       24.000 in
Cohesion, c                 =        2.780 lbs/in**2
Avg Eff Unit Weight         =      0.03074 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      1.20000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0096000	31.5065
0.3000000	99.2392
0.6000000	125.0335
0.9000000	143.1277
1.2000	157.5324
1.5000	169.6966
1.8000	180.3296
2.1000	189.8377
2.4000	198.4784
2.7000	206.4258
3.0000	213.8044
3.3000	220.7060
3.6000	227.2010
9.6000	315.0648
18.0000	315.0648
24.0000	315.0648

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3	
Depth below pile head	=	108.000	in
Depth below ground surface	=	108.000	in
Equivalent Depth	=	108.673	in
Pile Diameter	=	24.000	in
Cohesion, c	=	2.780	lbs/in**2
Avg Eff Unit Weight	=	0.02337	lbs/in**3
E50 parameter	=	0.02000	
Default J parameter	=	0.500	
Y50	=	1.20000	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lbs/in
0.0000	0.0000
0.0096000	41.0861
0.3000000	129.4130
0.6000000	163.0502
0.9000000	186.6459
1.2000	205.4304
1.5000	221.2932
1.8000	235.1591
2.1000	247.5582
2.4000	258.8261
2.7000	269.1900
3.0000	278.8120
3.3000	287.8120
3.6000	296.2819
9.6000	410.8608
18.0000	410.8608
24.0000	410.8608

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	189.000	in
Depth below ground surface	=	189.000	in
Equivalent Depth (see note)	=	165.280	in
Pile Diameter	=	24.000	in
Angle of Friction	=	36.000	deg.
Avg. Eff. Unit Weight	=	0.02791	pci
k	=	60.000	pci
A (static)	=	0.8800	
B (static)	=	0.5000	
Pst	=	2871.113	lbs/in
Psd	=	7748.738	lbs/in
Ps	=	2871.113	lbs/in
Cbar	=	2505.9233	
n	=	1.6447	
m	=	2182.0457	
yk	=	0.0299	in
pm	=	1435.556	lbs/in
ym	=	0.4000	in
pu	=	2526.579	lbs/in

```
yu                          =       0.9000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in
0.0000	0.0000
0.0333333	316.8678
0.0666667	482.9524
0.1000000	617.9706
0.1333333	736.0893
0.1666667	843.0471
0.2000000	941.8766
0.2333333	1034.4218
0.2666667	1121.9068
0.3000000	1205.1955
0.3333333	1284.9258
0.3666667	1361.5852
0.4000000	1435.5564
0.6500000	1981.0678
0.9000000	2526.5792
24.9000	2526.5792
48.9000	2526.5792

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```
Soil Layer Number           =            5
Depth below pile head       =      261.000 in
Depth below ground surface  =      261.000 in
Equivalent Depth (see note) =      208.671 in
Pile Diameter               =       24.000 in
Angle of Friction           =       40.000 deg.
Avg. Eff. Unit Weight       =      0.03227 pci
k                           =      125.000 pci
A (static)                  =       0.8800
B (static)                  =       0.5000
Pst                         =     7204.457 lbs/in
Psd                         =    21049.508 lbs/in
Ps                          =     7204.457 lbs/in
Cbar                        =    6288.0908
n                           =       1.6447
m                           =    5475.3875
yk                          =       0.0265 in
pm                          =     3602.229 lbs/in
ym                          =       0.4000 in
pu                          =     6339.922 lbs/in
yu                          =       0.9000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in
0.0000	0.0000

0.0333333	795.1134
0.0666667	1211.8680
0.1000000	1550.6679
0.1333333	1847.0623
0.1666667	2115.4504
0.2000000	2363.4425
0.2333333	2595.6653
0.2666667	2815.1905
0.3000000	3024.1862
0.3333333	3224.2527
0.3666667	3416.6133
0.4000000	3602.2286
0.6500000	4971.0755
0.9000000	6339.9224
24.9000	6339.9224
48.9000	6339.9224

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	6	
Depth below pile head	=	321.000	in
Depth below ground surface	=	321.000	in
Equivalent Depth	=	271.236	in
Diameter	=	24.000	in
Undrained cohesion, c	=	17.36000	lbs/in**2
Average Eff. Unit Weight	=	0.03371	lbs/in**3
Epsilon-50	=	0.00500	
Pct	=	3823.663	lbs/in
Pcd	=	3749.760	lbs/in
Pu	=	3749.760	lbs/in
y50	=	0.300	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lbs/in
0.0000	0.0000
4.8000E-05	210.8645
0.0002400	315.3160
0.0004800	374.9760
0.0024000	560.7199
0.0048000	666.8121
0.0240000	997.1167
0.0480000	1185.7782
0.1200000	1491.0372
0.2400000	1773.1520
0.3600000	1962.3153
0.4800000	2108.6450
1.2000	2651.4807
2.4000	3153.1597
4.8000	3749.7600
5.4000	3749.7600
6.0000	3749.7600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          7
Depth below pile head      =      402.000 in
Depth below ground surface =      402.000 in
Equivalent Depth           =      335.277 in
Diameter                   =       24.000 in
Undrained cohesion, c      =     19.10000 lbs/in**2
Average Eff. Unit Weight   =      0.03367 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     4848.000 lbs/in
Pcd                        =     4125.600 lbs/in
Pu                         =     4125.600 lbs/in
y50                        =        0.300 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
4.8000E-05	231.9995
0.0002400	346.9202
0.0004800	412.5600
0.0024000	616.9211
0.0048000	733.6470
0.0240000	1097.0581
0.0480000	1304.6293
0.1200000	1640.4845
0.2400000	1950.8758
0.3600000	2158.9990
0.4800000	2319.9954
1.2000	2917.2397
2.4000	3469.2023
4.8000	4125.6000
5.4000	4125.6000
6.0000	4125.6000

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
5	y= 0.100000	S= 0.000	365000.	0.1000000	-1122535.	13812.0547
5	y= 0.200000	S= 0.000	365000.	0.2000000	-2008561.	22609.6510
5	y= 0.300000	S= 0.000	365000.	0.3000000	-2833277.	30405.1055
5	y= 0.400000	S= 0.000	365000.	0.4000000	-3619603.	37613.0590
5	y= 0.500000	S= 0.000	365000.	0.5000000	-4379669.	44430.4389
5	y= 0.600000	S= 0.000	365000.	0.6000000	-5120961.	50973.0162
5	y= 0.700000	S= 0.000	365000.	0.7000000	-5847200.	57300.5150
5	y= 0.800000	S= 0.000	365000.	0.8000000	-6561323.	63454.4076

```
  5  y=  0.900000 S=     0.000     365000.   0.9000000   -7264686.  69458.5819
  5  y=  1.000000 S=     0.000     365000.   1.0000000   -7959668.  75346.2053

The analysis ended normally.
```

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Madhu Thummaluru
URS Corporation

Files Used for Analysis

Path to file locations:
W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\
Name of input data file: Bent_24 in CISS_Free.lpd
Name of output file: Bent_24 in CISS_Free.lpo
Name of plot output file: Bent_24 in CISS_Free.lpp
Name of runtime file: Bent_24 in CISS_Free.lpr

Time and Date of Analysis

Date: June 13, 2012 Time: 19:09:46

Problem Title

Broadway OC (Replace) Bent 24 inch CISS Class 200

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- Additional p-y curves computed at specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 552.00 in

Depth of ground surface below top of pile = 0.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	24.00000000	2549.0000	452.4000	29000000.
2	552.0000	24.00000000	2549.0000	452.4000	29000000.

Soil and Rock Layering Information

The soil profile is modelled using 14 layers

Layer 1 is liquefiable sand, by Rollins et al, 2004
Distance from top of pile to top of layer = 0.000 in
Distance from top of pile to bottom of layer = 18.000 in

Layer 2 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 18.000 in
Distance from top of pile to bottom of layer = 42.000 in

Layer 3 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 42.000 in
Distance from top of pile to bottom of layer = 126.000 in

Layer 4 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 126.000 in
Distance from top of pile to bottom of layer = 204.000 in
p-y subgrade modulus k for top of soil layer = 60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 60.000 lbs/in**3

Layer 5 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 204.000 in
Distance from top of pile to bottom of layer = 270.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

```
Layer  6 is stiff clay without free water
Distance from top of pile to top of layer    =      270.000 in
Distance from top of pile to bottom of layer =      324.000 in

Layer  7 is stiff clay without free water
Distance from top of pile to top of layer    =      324.000 in
Distance from top of pile to bottom of layer =      432.000 in

Layer  8 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      432.000 in
Distance from top of pile to bottom of layer =      552.000 in
p-y subgrade modulus k for top of soil layer =      125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      125.000 lbs/in**3

Layer  9 is stiff clay without free water
Distance from top of pile to top of layer    =      552.000 in
Distance from top of pile to bottom of layer =      612.000 in

Layer 10 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      612.000 in
Distance from top of pile to bottom of layer =      732.000 in
p-y subgrade modulus k for top of soil layer =       60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =       60.000 lbs/in**3

Layer 11 is stiff clay without free water
Distance from top of pile to top of layer    =      732.000 in
Distance from top of pile to bottom of layer =      804.000 in

Layer 12 is stiff clay without free water
Distance from top of pile to top of layer    =      804.000 in
Distance from top of pile to bottom of layer =      870.000 in

Layer 13 is stiff clay without free water
Distance from top of pile to top of layer    =      870.000 in
Distance from top of pile to bottom of layer =      978.000 in

Layer 14 is stiff clay without free water
Distance from top of pile to top of layer    =      978.000 in
Distance from top of pile to bottom of layer =     1104.000 in


(Depth of lowest layer extends  552.00 in below pile tip)


--------------------------------------------------------------------------------
                    Effective Unit Weight of Soil vs. Depth
--------------------------------------------------------------------------------

Effective unit weight of soil with depth defined using 28 points

Point        Depth X    Eff. Unit Weight
 No.           in          lbs/in**3
-----      ----------   ----------------
  1             0.00        0.03330
  2            18.00        0.03330
  3            18.00        0.03620
  4            42.00        0.03620
  5            42.00        0.01600
  6           126.00        0.01600
  7           126.00        0.03910
  8           204.00        0.03910
  9           204.00        0.04490
 10           270.00        0.04490
```

11	270.00	0.03910
12	324.00	0.03910
13	324.00	0.03330
14	432.00	0.03330
15	432.00	0.04200
16	552.00	0.04200
17	552.00	0.03330
18	612.00	0.03330
19	612.00	0.03910
20	732.00	0.03910
21	732.00	0.02750
22	804.00	0.02750
23	804.00	0.04200
24	870.00	0.04200
25	870.00	0.03910
26	978.00	0.03910
27	978.00	0.03620
28	1104.00	0.03620

Shear Strength of Soils

Shear strength parameters with depth defined using 28 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	0.000	0.00000	0.00	------	------
2	18.000	0.00000	0.00	------	------
3	18.000	3.47000	0.00	0.02000	0.0
4	42.000	3.47000	0.00	0.02000	0.0
5	42.000	2.78000	0.00	0.02000	0.0
6	126.000	2.78000	0.00	0.02000	0.0
7	126.000	0.00000	36.00	------	------
8	204.000	0.00000	36.00	------	------
9	204.000	0.00000	40.00	------	------
10	270.000	0.00000	40.00	------	------
11	270.000	17.36000	0.00	0.00500	0.0
12	324.000	17.36000	0.00	0.00500	0.0
13	324.000	19.10000	0.00	0.00500	0.0
14	432.000	19.10000	0.00	0.00500	0.0
15	432.000	0.00000	40.00	------	------
16	552.000	0.00000	40.00	------	------
17	552.000	8.68000	0.00	0.00700	0.0
18	612.000	8.68000	0.00	0.00700	0.0
19	612.000	0.00000	36.00	------	------
20	732.000	0.00000	36.00	------	------
21	732.000	12.15000	0.00	0.00700	0.0
22	804.000	12.15000	0.00	0.00700	0.0
23	804.000	32.99000	0.00	0.00400	0.0
24	870.000	32.99000	0.00	0.00400	0.0
25	870.000	27.78000	0.00	0.00400	0.0
26	978.000	27.78000	0.00	0.00400	0.0
27	978.000	13.89000	0.00	0.00500	0.0
28	1104.000	13.89000	0.00	0.00500	0.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.

(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 10

Load Case Number 1

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.100 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 140000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.200 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 140000.000 lbs

Load Case Number 3

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.300 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 140000.000 lbs

Load Case Number 4

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.400 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 140000.000 lbs

Load Case Number 5

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.500 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 140000.000 lbs

Load Case Number 6

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.600 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 140000.000 lbs

Load Case Number 7

```
Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.700 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  8

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.800 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  9

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.900 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number 10

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           1.000 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs



--------------------------------------------------------------------------------
                   Output of p-y Curves at Specified Depths
--------------------------------------------------------------------------------



p-y curves are generated and printed for verification at  7 depths.

Depth      Depth Below Pile Head      Depth Below Ground Surface
 No.                in                          in
-----      ---------------------      --------------------------
  1               21.000                      21.000
  2               54.000                      54.000
  3              108.000                     108.000
  4              189.000                     189.000
  5              261.000                     261.000
  6              321.000                     321.000
  7              402.000                     402.000

Depth of ground surface below top of pile =       0.00 in



p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number           =          2
Depth below pile head       =       21.000 in
Depth below ground surface  =       21.000 in
Equivalent Depth            =       15.056 in
Pile Diameter               =       24.000 in
Cohesion, c                 =        3.470 lbs/in**2
Avg Eff Unit Weight         =      0.03371 lbs/in**3
E50 parameter               =      0.02000
```

```
Default J parameter         =        0.500
Y50                         =      1.20000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0096000	30.3267
0.3000000	95.5231
0.6000000	120.3516
0.9000000	137.7682
1.2000	151.6335
1.5000	163.3422
1.8000	173.5770
2.1000	182.7292
2.4000	191.0462
2.7000	198.6961
3.0000	205.7983
3.3000	212.4415
3.6000	218.6934
9.6000	303.2670
18.0000	303.2670
24.0000	303.2670

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```
Soil Layer Number           =          3
Depth below pile head       =       54.000 in
Depth below ground surface  =       54.000 in
Equivalent Depth            =       54.673 in
Pile Diameter               =       24.000 in
Cohesion, c                 =        2.780 lbs/in**2
Avg Eff Unit Weight         =      0.03074 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      1.20000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0096000	31.5065
0.3000000	99.2392
0.6000000	125.0335
0.9000000	143.1277
1.2000	157.5324
1.5000	169.6966
1.8000	180.3296
2.1000	189.8377
2.4000	198.4784
2.7000	206.4258
3.0000	213.8044
3.3000	220.7060
3.6000	227.2010
9.6000	315.0648
18.0000	315.0648
24.0000	315.0648

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3	
Depth below pile head	=	108.000	in
Depth below ground surface	=	108.000	in
Equivalent Depth	=	108.673	in
Pile Diameter	=	24.000	in
Cohesion, c	=	2.780	lbs/in**2
Avg Eff Unit Weight	=	0.02337	lbs/in**3
E50 parameter	=	0.02000	
Default J parameter	=	0.500	
Y50	=	1.20000	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lbs/in
0.0000	0.0000
0.0096000	41.0861
0.3000000	129.4130
0.6000000	163.0502
0.9000000	186.6459
1.2000	205.4304
1.5000	221.2932
1.8000	235.1591
2.1000	247.5582
2.4000	258.8261
2.7000	269.1900
3.0000	278.8120
3.3000	287.8120
3.6000	296.2819
9.6000	410.8608
18.0000	410.8608
24.0000	410.8608

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	4	
Depth below pile head	=	189.000	in
Depth below ground surface	=	189.000	in
Equivalent Depth (see note)	=	165.280	in
Pile Diameter	=	24.000	in
Angle of Friction	=	36.000	deg.
Avg. Eff. Unit Weight	=	0.02791	pci
k	=	60.000	pci
A (static)	=	0.8800	
B (static)	=	0.5000	
Pst	=	2871.113	lbs/in
Psd	=	7748.738	lbs/in
Ps	=	2871.113	lbs/in
Cbar	=	2505.9233	
n	=	1.6447	
m	=	2182.0457	
yk	=	0.0299	in
pm	=	1435.556	lbs/in
ym	=	0.4000	in
pu	=	2526.579	lbs/in

```
yu                          =       0.9000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in
0.0000	0.0000
0.0333333	316.8678
0.0666667	482.9524
0.1000000	617.9706
0.1333333	736.0893
0.1666667	843.0471
0.2000000	941.8766
0.2333333	1034.4218
0.2666667	1121.9068
0.3000000	1205.1955
0.3333333	1284.9258
0.3666667	1361.5852
0.4000000	1435.5564
0.6500000	1981.0678
0.9000000	2526.5792
24.9000	2526.5792
48.9000	2526.5792

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```
Soil Layer Number           =            5
Depth below pile head       =      261.000 in
Depth below ground surface  =      261.000 in
Equivalent Depth (see note) =      208.671 in
Pile Diameter               =       24.000 in
Angle of Friction           =       40.000 deg.
Avg. Eff. Unit Weight       =      0.03227 pci
k                           =      125.000 pci
A (static)                  =       0.8800
B (static)                  =       0.5000
Pst                         =     7204.457 lbs/in
Psd                         =    21049.508 lbs/in
Ps                          =     7204.457 lbs/in
Cbar                        =    6288.0908
n                           =       1.6447
m                           =    5475.3875
yk                          =       0.0265 in
pm                          =     3602.229 lbs/in
ym                          =       0.4000 in
pu                          =     6339.922 lbs/in
yu                          =       0.9000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in
0.0000	0.0000

0.0333333	795.1134
0.0666667	1211.8680
0.1000000	1550.6679
0.1333333	1847.0623
0.1666667	2115.4504
0.2000000	2363.4425
0.2333333	2595.6653
0.2666667	2815.1905
0.3000000	3024.1862
0.3333333	3224.2527
0.3666667	3416.6133
0.4000000	3602.2286
0.6500000	4971.0755
0.9000000	6339.9224
24.9000	6339.9224
48.9000	6339.9224

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	6	
Depth below pile head	=	321.000	in
Depth below ground surface	=	321.000	in
Equivalent Depth	=	271.236	in
Diameter	=	24.000	in
Undrained cohesion, c	=	17.36000	lbs/in**2
Average Eff. Unit Weight	=	0.03371	lbs/in**3
Epsilon-50	=	0.00500	
Pct	=	3823.663	lbs/in
Pcd	=	3749.760	lbs/in
Pu	=	3749.760	lbs/in
y50	=	0.300	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lbs/in
0.0000	0.0000
4.8000E-05	210.8645
0.0002400	315.3160
0.0004800	374.9760
0.0024000	560.7199
0.0048000	666.8121
0.0240000	997.1167
0.0480000	1185.7782
0.1200000	1491.0372
0.2400000	1773.1520
0.3600000	1962.3153
0.4800000	2108.6450
1.2000	2651.4807
2.4000	3153.1597
4.8000	3749.7600
5.4000	3749.7600
6.0000	3749.7600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          7
Depth below pile head      =      402.000 in
Depth below ground surface =      402.000 in
Equivalent Depth           =      335.277 in
Diameter                   =       24.000 in
Undrained cohesion, c      =     19.10000 lbs/in**2
Average Eff. Unit Weight   =      0.03367 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     4848.000 lbs/in
Pcd                        =     4125.600 lbs/in
Pu                         =     4125.600 lbs/in
y50                        =        0.300 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
4.8000E-05	231.9995
0.0002400	346.9202
0.0004800	412.5600
0.0024000	616.9211
0.0048000	733.6470
0.0240000	1097.0581
0.0480000	1304.6293
0.1200000	1640.4845
0.2400000	1950.8758
0.3600000	2158.9990
0.4800000	2319.9954
1.2000	2917.2397
2.4000	3469.2023
4.8000	4125.6000
5.4000	4125.6000
6.0000	4125.6000

Summary of Pile Response(s)

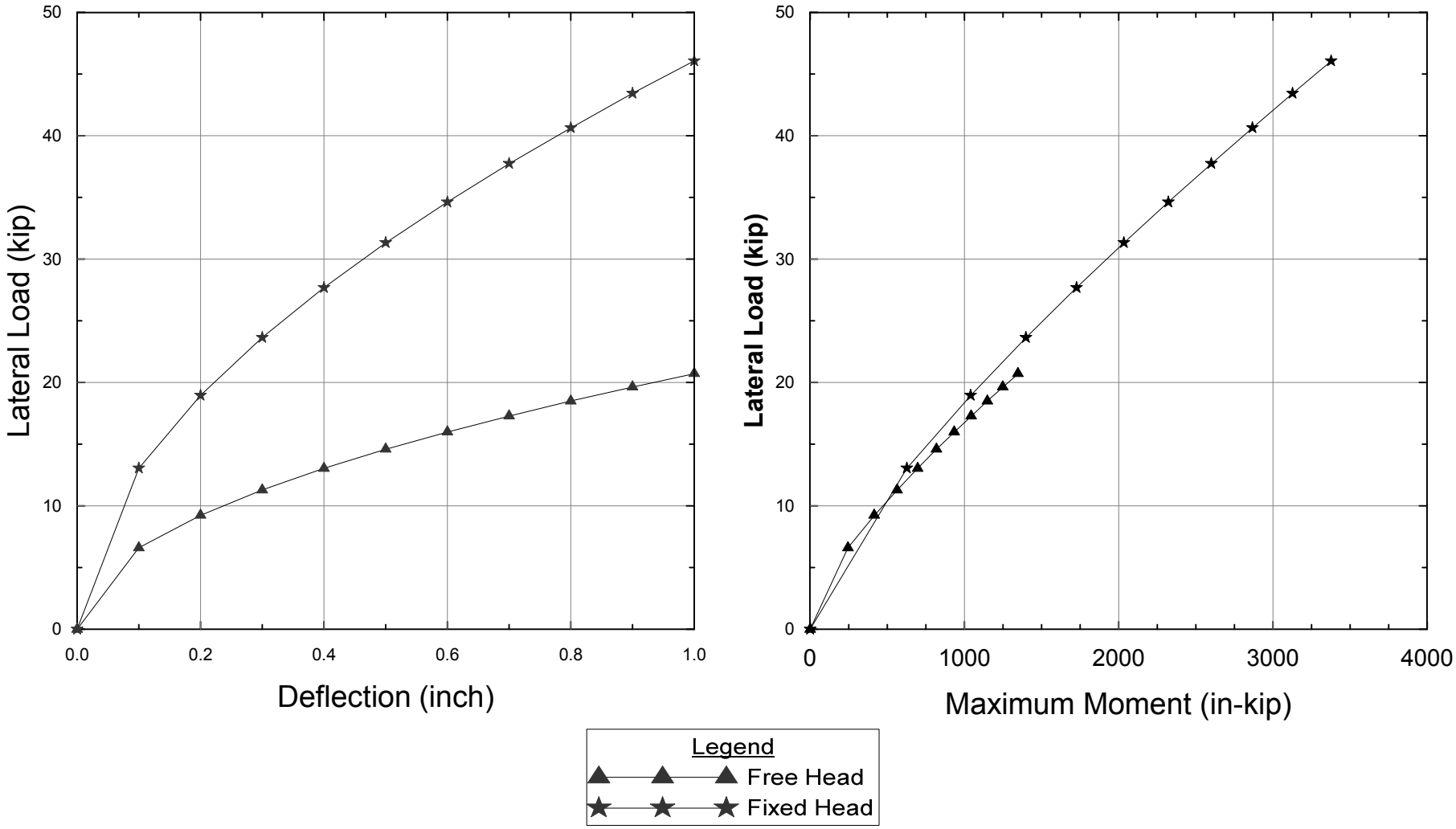
Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
4	y= 0.100000	M= 0.000	140000.	0.1000000	395058.	5727.1133
4	y= 0.200000	M= 0.000	140000.	0.2000000	709985.	8885.1077
4	y= 0.300000	M= 0.000	140000.	0.3000000	1009420.	11609.5802
4	y= 0.400000	M= 0.000	140000.	0.4000000	1299643.	14105.2684
4	y= 0.500000	M= 0.000	140000.	0.5000000	1581788.	16448.5890
4	y= 0.600000	M= 0.000	140000.	0.6000000	1858450.	-19046.7126
4	y= 0.700000	M= 0.000	140000.	0.7000000	2128086.	-21885.0802
4	y= 0.800000	M= 0.000	140000.	0.8000000	2395068.	-24654.6332

```
  4  y=  0.900000 M=     0.000     140000.   0.9000000    2657110. -27346.7124
  4  y=  1.000000 M=     0.000     140000.   1.0000000    2914819. -29969.9550

The analysis ended normally.
```



Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**Broadway OC (Replace)** **Abutment 3 Pile Lateral Resistance** **Class 140 PCPS Pile**	Figure I-3
	URS		

W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\Broadway OC (Replace)_Bent.grf

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Madhu Thummaluru
URS Corporation

Files Used for Analysis

Path to file locations:
W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\
Name of input data file: East Abutment_16 in PCPS_Fixed.lpd
Name of output file: East Abutment_16 in PCPS_Fixed.lpo
Name of plot output file: East Abutment_16 in PCPS_Fixed.lpp
Name of runtime file: East Abutment_16 in PCPS_Fixed.lpr

Time and Date of Analysis

Date: June 13, 2012 Time: 15:52:05

Problem Title

Broadway OC (Replace) East Abutment 16 inch PCPS Class 140

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- Additional p-y curves computed at specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in

Depth of ground surface below top of pile = -66.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	16.00000000	5461.3000	256.0000	3600000.
2	720.0000	16.00000000	5461.3000	256.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 19 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -66.000 in
Distance from top of pile to bottom of layer = 0.100 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 0.100 in
Distance from top of pile to bottom of layer = 12.000 in

Layer 3 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 12.000 in
Distance from top of pile to bottom of layer = 84.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 84.000 in
Distance from top of pile to bottom of layer = 126.000 in

Layer 5 is stiff clay without free water
Distance from top of pile to top of layer = 126.000 in
Distance from top of pile to bottom of layer = 180.000 in

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 282.000 in

```
Layer  7 is stiff clay without free water
Distance from top of pile to top of layer    =      282.000 in
Distance from top of pile to bottom of layer =      348.000 in

Layer  8 is stiff clay without free water
Distance from top of pile to top of layer    =      348.000 in
Distance from top of pile to bottom of layer =      420.000 in

Layer  9 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      420.000 in
Distance from top of pile to bottom of layer =      438.000 in
p-y subgrade modulus k for top of soil layer =        0.100 lbs/in**3
p-y subgrade modulus k for bottom of layer   =        0.100 lbs/in**3

Layer 10 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      438.000 in
Distance from top of pile to bottom of layer =      486.000 in
p-y subgrade modulus k for top of soil layer =      125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      125.000 lbs/in**3

Layer 11 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      486.000 in
Distance from top of pile to bottom of layer =      528.000 in
p-y subgrade modulus k for top of soil layer =       60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =       60.000 lbs/in**3

Layer 12 is stiff clay without free water
Distance from top of pile to top of layer    =      528.000 in
Distance from top of pile to bottom of layer =      660.000 in

Layer 13 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      660.000 in
Distance from top of pile to bottom of layer =      678.000 in
p-y subgrade modulus k for top of soil layer =      175.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      175.000 lbs/in**3

Layer 14 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      678.000 in
Distance from top of pile to bottom of layer =      786.000 in
p-y subgrade modulus k for top of soil layer =      125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      125.000 lbs/in**3

Layer 15 is stiff clay without free water
Distance from top of pile to top of layer    =      786.000 in
Distance from top of pile to bottom of layer =      960.000 in

Layer 16 is stiff clay without free water
Distance from top of pile to top of layer    =      960.000 in
Distance from top of pile to bottom of layer =     1026.000 in

Layer 17 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =     1026.000 in
Distance from top of pile to bottom of layer =     1068.000 in
p-y subgrade modulus k for top of soil layer =      175.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      175.000 lbs/in**3

Layer 18 is stiff clay without free water
Distance from top of pile to top of layer    =     1068.000 in
Distance from top of pile to bottom of layer =     1128.000 in

Layer 19 is stiff clay without free water
Distance from top of pile to top of layer    =     1128.000 in
Distance from top of pile to bottom of layer =     1158.000 in
```

(Depth of lowest layer extends 438.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 38 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-66.00	0.06940
2	0.10	0.06940
3	0.10	0.03330
4	12.00	0.03330
5	12.00	0.01600
6	84.00	0.01600
7	84.00	0.03620
8	126.00	0.03620
9	126.00	0.03620
10	180.00	0.03620
11	180.00	0.03910
12	282.00	0.03910
13	282.00	0.03040
14	348.00	0.03040
15	348.00	0.02750
16	420.00	0.02750
17	420.00	0.03620
18	438.00	0.03620
19	438.00	0.03620
20	486.00	0.03620
21	486.00	0.03620
22	528.00	0.03620
23	528.00	0.03620
24	660.00	0.03620
25	660.00	0.03620
26	678.00	0.03620
27	678.00	0.04780
28	786.00	0.04780
29	786.00	0.03620
30	960.00	0.03620
31	960.00	0.04200
32	1026.00	0.04200
33	1026.00	0.03910
34	1068.00	0.03910
35	1068.00	0.03910
36	1128.00	0.03910
37	1128.00	0.03620
38	1158.00	0.03620

Shear Strength of Soils

Shear strength parameters with depth defined using 38 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %

1	-66.000	6.94000	0.00	0.00700	0.0
2	0.100	6.94000	0.00	0.00700	0.0
3	0.100	6.94000	0.00	0.00700	0.0
4	12.000	6.94000	0.00	0.00700	0.0
5	12.000	1.39000	0.00	0.02000	0.0
6	84.000	1.39000	0.00	0.02000	0.0
7	84.000	6.94000	0.00	0.01000	0.0
8	126.000	6.94000	0.00	0.01000	0.0
9	126.000	6.94000	0.00	0.01000	0.0
10	180.000	6.94000	0.00	0.01000	0.0
11	180.000	13.89000	0.00	0.00500	0.0
12	282.000	13.89000	0.00	0.00500	0.0
13	282.000	24.31000	0.00	0.00500	0.0
14	348.000	24.31000	0.00	0.00500	0.0
15	348.000	6.94000	0.00	0.01000	0.0
16	420.000	6.94000	0.00	0.01000	0.0
17	420.000	0.00000	0.10	------	------
18	438.000	0.00000	0.10	------	------
19	438.000	0.00000	40.00	------	------
20	486.000	0.00000	40.00	------	------
21	486.000	0.00000	36.00	------	------
22	528.000	0.00000	36.00	------	------
23	528.000	6.94000	0.00	0.01000	0.0
24	660.000	6.94000	0.00	0.01000	0.0
25	660.000	0.00000	44.00	------	------
26	678.000	0.00000	44.00	------	------
27	678.000	0.00000	42.00	------	------
28	786.000	0.00000	42.00	------	------
29	786.000	15.63000	0.00	0.00500	0.0
30	960.000	15.63000	0.00	0.00500	0.0
31	960.000	20.83000	0.00	0.00500	0.0
32	1026.000	20.83000	0.00	0.00500	0.0
33	1026.000	0.00000	44.00	------	------
34	1068.000	0.00000	44.00	------	------
35	1068.000	24.31000	0.00	0.00500	0.0
36	1128.000	24.31000	0.00	0.00500	0.0
37	1128.000	24.31000	0.00	0.00500	0.0
38	1158.000	24.31000	0.00	0.00500	0.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 10

```
Load Case Number  1

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.100 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  2

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.200 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  3

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.300 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  4

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.400 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  5

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.500 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  6

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.600 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  7

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.700 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  8

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.800 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  9

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.900 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs
```

Load Case Number 10

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 1.000 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 140000.000 lbs

Output of p-y Curves at Specified Depths

---

p-y curves are generated and printed for verification at 10 depths.

Depth No.	Depth Below Pile Head in	Depth Below Ground Surface in
1	24.000	90.000
2	78.000	144.000
3	135.000	201.000
4	183.000	249.000
5	261.000	327.000
6	345.000	411.000
7	414.000	480.000
8	459.000	525.000
9	492.000	558.000
10	537.000	603.000

Depth of ground surface below top of pile = -66.00 in

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number = 3
Depth below pile head = 24.000 in
Depth below ground surface = 90.000 in
Equivalent Depth = 198.175 in
Pile Diameter = 16.000 in
Cohesion, c = 1.390 lbs/in**2
Avg Eff Unit Weight = 0.05751 lbs/in**3
E50 parameter = 0.02000
Default J parameter = 0.500
Y50 = 0.80000 in
p-multiplier = 1.00000
y-multiplier = 1.00000

y, in	p, lbs/in
0.0000	0.0000
0.0064000	20.0160
0.2000000	63.0464
0.4000000	79.4335
0.6000000	90.9287
0.8000000	100.0800
1.0000000	107.8079
1.2000	114.5630
1.4000	120.6035

1.6000	126.0929
1.8000	131.1419
2.0000	135.8295
2.2000	140.2140
2.4000	144.3403
6.4000	200.1600
12.0000	200.1600
16.0000	200.1600

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```
Soil Layer Number           =          3
Depth below pile head       =       78.000 in
Depth below ground surface  =      144.000 in
Equivalent Depth            =      252.175 in
Pile Diameter               =       16.000 in
Cohesion, c                 =        1.390 lbs/in**2
Avg Eff Unit Weight         =      0.04194 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      0.80000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0064000	20.0160
0.2000000	63.0464
0.4000000	79.4335
0.6000000	90.9287
0.8000000	100.0800
1.0000000	107.8079
1.2000	114.5630
1.4000	120.6035
1.6000	126.0929
1.8000	131.1419
2.0000	135.8295
2.2000	140.2140
2.4000	144.3403
6.4000	200.1600
12.0000	200.1600
16.0000	200.1600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          5
Depth below pile head      =      135.000 in
Depth below ground surface =      201.000 in
Equivalent Depth           =      138.769 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      6.94000 lbs/in**2
Average Eff. Unit Weight   =      0.03971 lbs/in**3
Epsilon-50                 =      0.01000
Pct                        =      902.818 lbs/in
Pcd                        =      999.360 lbs/in
Pu                         =      902.818 lbs/in
y50                        =        0.400 in
```

```
p-multiplier               =      1.00000
y-multiplier               =      1.00000

        y, in            p, lbs/in
----------------    -----------------
         0.0000           0.0000
     6.4000E-05          50.7692
      0.0003200          75.9177
      0.0006400          90.2818
      0.0032000         135.0028
      0.0064000         160.5463
      0.0320000         240.0728
      0.0640000         285.4963
      0.1600000         358.9925
      0.3200000         426.9165
      0.4800000         472.4608
      0.6400000         507.6921
         1.6000         638.3890
         3.2000         759.1768
         6.4000         902.8184
         7.2000         902.8184
         8.0000         902.8184
```

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          6
Depth below pile head      =      183.000 in
Depth below ground surface =      249.000 in
Equivalent Depth           =      142.465 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     13.89000 lbs/in**2
Average Eff. Unit Weight   =      0.03907 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     1745.195 lbs/in
Pcd                        =     2000.160 lbs/in
Pu                         =     1745.195 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000

        y, in            p, lbs/in
----------------    -----------------
         0.0000           0.0000
     3.2000E-05          98.1395
      0.0001600         146.7529
      0.0003200         174.5195
      0.0016000         260.9676
      0.0032000         310.3445
      0.0160000         464.0733
      0.0320000         551.8792
      0.0800000         693.9514
      0.1600000         825.2520
      0.2400000         913.2914
      0.3200000         981.3955
      0.8000000        1234.0395
         1.6000        1467.5285
         3.2000        1745.1954
         3.6000        1745.1954
         4.0000        1745.1954
```

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          6
Depth below pile head      =      261.000 in
Depth below ground surface =      327.000 in
Equivalent Depth           =      220.465 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     13.89000 lbs/in**2
Average Eff. Unit Weight   =      0.03908 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     2335.689 lbs/in
Pcd                        =     2000.160 lbs/in
Pu                         =     2000.160 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	112.4773
0.0001600	168.1927
0.0003200	200.0160
0.0016000	299.0937
0.0032000	355.6843
0.0160000	531.8721
0.0320000	632.5061
0.0800000	795.3344
0.1600000	945.8173
0.2400000	1046.7189
0.3200000	1124.7726
0.8000000	1414.3267
1.6000	1681.9274
3.2000	2000.1600
3.6000	2000.1600
4.0000	2000.1600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          7
Depth below pile head      =      345.000 in
Depth below ground surface =      411.000 in
Equivalent Depth           =      214.647 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     24.31000 lbs/in**2
Average Eff. Unit Weight   =      0.03775 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     3905.552 lbs/in
Pcd                        =     3500.640 lbs/in
Pu                         =     3500.640 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000

3.2000E-05	196.8555
0.0001600	294.3676
0.0003200	350.0640
0.0016000	523.4678
0.0032000	622.5116
0.0160000	930.8720
0.0320000	1106.9996
0.0800000	1391.9783
0.1600000	1655.3505
0.2400000	1831.9464
0.3200000	1968.5545
0.8000000	2475.3263
1.6000	2943.6756
3.2000	3500.6400
3.6000	3500.6400
4.0000	3500.6400

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          8
Depth below pile head      =      414.000 in
Depth below ground surface =      480.000 in
Equivalent Depth           =      650.712 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      6.94000 lbs/in**2
Average Eff. Unit Weight   =      0.03629 lbs/in**3
Epsilon-50                 =      0.01000
Pct                        =     2968.946 lbs/in
Pcd                        =      999.360 lbs/in
Pu                         =      999.360 lbs/in
y50                        =        0.400 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	56.1981
0.0003200	84.0358
0.0006400	99.9360
0.0032000	149.4392
0.0064000	177.7141
0.0320000	265.7446
0.0640000	316.0254
0.1600000	397.3809
0.3200000	472.5682
0.4800000	522.9827
0.6400000	561.9814
1.6000	706.6542
3.2000	840.3582
6.4000	999.3600
7.2000	999.3600
8.0000	999.3600

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```
Soil Layer Number           =          10
Depth below pile head       =      459.000 in
Depth below ground surface  =      525.000 in
```

```
Equivalent Depth (see note) =      242.850 in
Pile Diameter               =       16.000 in
Angle of Friction           =       40.000 deg.
Avg. Eff. Unit Weight       =      0.03619 pci
k                           =      125.000 pci
A (static)                  =       0.8800
B (static)                  =       0.5000
Pst                         =    10483.834 lbs/in
Psd                         =    31656.388 lbs/in
Ps                          =    10483.834 lbs/in
Cbar                        =   11708.4973
n                           =       1.6447
m                           =   11951.5710
yk                          =       0.0880 in
pm                          =     5241.917 lbs/in
ym                          =       0.2667 in
pu                          =     9225.774 lbs/in
yu                          =       0.6000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in	
0.0000	0.0000	
0.0222222	674.5830	*
0.0444444	1349.1660	*
0.0666667	2023.7491	*
0.0888889	2687.8215	
0.1111111	3078.3764	
0.1333333	3439.2513	
0.1555556	3777.1789	
0.1777778	4096.6293	
0.2000000	4400.7571	
0.2222222	4691.8914	
0.2444444	4971.8121	
0.2666667	5241.9171	
0.4333333	7233.8456	
0.6000000	9225.7741	
16.6000	9225.7741	
32.6000	9225.7741	

* p value(s) computed using p = k * Eff x * y

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```
Soil Layer Number           =           11
Depth below pile head       =      492.000 in
Depth below ground surface  =      558.000 in
Equivalent Depth (see note) =      300.178 in
Pile Diameter               =       16.000 in
Angle of Friction           =       36.000 deg.
Avg. Eff. Unit Weight       =      0.03619 pci
k                           =       60.000 pci
A (static)                  =       0.8800
B (static)                  =       0.5000
```

```
Pst                          =    11200.925 lbs/in
Psd                          =    19772.033 lbs/in
Ps                           =    11200.925 lbs/in
Cbar                         =   12509.3547
n                            =       1.6447
m                            =   12769.0546
yk                           =       0.3946 in
pm                           =     5600.463 lbs/in
ym                           =       0.2667 in
pu                           =     9856.814 lbs/in
yu                           =       0.6000 in
p-multiplier                 =      1.00000
y-multiplier                 =      1.00000
```

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in	
0.0000	0.0000	
0.0222222	400.2367	*
0.0444444	800.4734	*
0.0666667	1200.7102	*
0.0888889	1600.9469	*
0.1111111	2001.1836	*
0.1333333	2401.4203	*
0.1555556	2801.6570	*
0.1777778	3201.8938	*
0.2000000	3602.1305	*
0.2222222	4002.3672	*
0.2444444	4402.6039	*
0.2666667	4802.8406	*
0.4333333	7728.6383	
0.6000000	9856.8141	
16.6000	9856.8141	
32.6000	9856.8141	

* p value(s) computed using p = k * Eff x * y

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =         12
Depth below pile head      =      537.000 in
Depth below ground surface =      603.000 in
Equivalent Depth           =     1528.013 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      6.94000 lbs/in**2
Average Eff. Unit Weight   =      0.03619 lbs/in**3
Epsilon-50                 =      0.01000
Pct                        =     6520.034 lbs/in
Pcd                        =      999.360 lbs/in
Pu                         =      999.360 lbs/in
y50                        =        0.400 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in

0.0000	0.0000
6.4000E-05	56.1981
0.0003200	84.0358
0.0006400	99.9360
0.0032000	149.4392
0.0064000	177.7141
0.0320000	265.7446
0.0640000	316.0254
0.1600000	397.3809
0.3200000	472.5682
0.4800000	522.9827
0.6400000	561.9814
1.6000	706.6542
3.2000	840.3582
6.4000	999.3600
7.2000	999.3600
8.0000	999.3600

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
5	y= 0.100000	S= 0.000	140000.	0.1000000	-626915.	13045.3800
5	y= 0.200000	S= 0.000	140000.	0.2000000	-1041205.	18959.2280
5	y= 0.300000	S= 0.000	140000.	0.3000000	-1399669.	23640.2001
5	y= 0.400000	S= 0.000	140000.	0.4000000	-1727082.	27681.8580
5	y= 0.500000	S= 0.000	140000.	0.5000000	-2033871.	31314.8833
5	y= 0.600000	S= 0.000	140000.	0.6000000	-2322374.	34624.9620
5	y= 0.700000	S= 0.000	140000.	0.7000000	-2601330.	37738.6871
5	y= 0.800000	S= 0.000	140000.	0.8000000	-2866667.	40636.2650
5	y= 0.900000	S= 0.000	140000.	0.9000000	-3127957.	43430.0672
5	y= 1.000000	S= 0.000	140000.	1.0000000	-3377440.	46055.8024

The analysis ended normally.

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Madhu Thummaluru
URS Corporation

Files Used for Analysis

Path to file locations:
W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\
Name of input data file: East Abutment_16 in PCPS_Free.lpd
Name of output file: East Abutment_16 in PCPS_Free.lpo
Name of plot output file: East Abutment_16 in PCPS_Free.lpp
Name of runtime file: East Abutment_16 in PCPS_Free.lpr

Time and Date of Analysis

Date: June 13, 2012 Time: 16:06:31

Problem Title

Broadway OC (Replace) East Abutment 16 inch PCPS Class 140

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- Additional p-y curves computed at specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in

Depth of ground surface below top of pile = -66.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	16.00000000	5461.3000	256.0000	3600000.
2	720.0000	16.00000000	5461.3000	256.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 19 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -66.000 in
Distance from top of pile to bottom of layer = 0.100 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 0.100 in
Distance from top of pile to bottom of layer = 12.000 in

Layer 3 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 12.000 in
Distance from top of pile to bottom of layer = 84.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 84.000 in
Distance from top of pile to bottom of layer = 126.000 in

Layer 5 is stiff clay without free water
Distance from top of pile to top of layer = 126.000 in
Distance from top of pile to bottom of layer = 180.000 in

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 282.000 in

```
Layer  7 is stiff clay without free water
Distance from top of pile to top of layer    =      282.000 in
Distance from top of pile to bottom of layer =      348.000 in

Layer  8 is stiff clay without free water
Distance from top of pile to top of layer    =      348.000 in
Distance from top of pile to bottom of layer =      420.000 in

Layer  9 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      420.000 in
Distance from top of pile to bottom of layer =      438.000 in
p-y subgrade modulus k for top of soil layer =        0.100 lbs/in**3
p-y subgrade modulus k for bottom of layer   =        0.100 lbs/in**3

Layer 10 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      438.000 in
Distance from top of pile to bottom of layer =      486.000 in
p-y subgrade modulus k for top of soil layer =      125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      125.000 lbs/in**3

Layer 11 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      486.000 in
Distance from top of pile to bottom of layer =      528.000 in
p-y subgrade modulus k for top of soil layer =       60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =       60.000 lbs/in**3

Layer 12 is stiff clay without free water
Distance from top of pile to top of layer    =      528.000 in
Distance from top of pile to bottom of layer =      660.000 in

Layer 13 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      660.000 in
Distance from top of pile to bottom of layer =      678.000 in
p-y subgrade modulus k for top of soil layer =      175.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      175.000 lbs/in**3

Layer 14 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      678.000 in
Distance from top of pile to bottom of layer =      786.000 in
p-y subgrade modulus k for top of soil layer =      125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      125.000 lbs/in**3

Layer 15 is stiff clay without free water
Distance from top of pile to top of layer    =      786.000 in
Distance from top of pile to bottom of layer =      960.000 in

Layer 16 is stiff clay without free water
Distance from top of pile to top of layer    =      960.000 in
Distance from top of pile to bottom of layer =     1026.000 in

Layer 17 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =     1026.000 in
Distance from top of pile to bottom of layer =     1068.000 in
p-y subgrade modulus k for top of soil layer =      175.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      175.000 lbs/in**3

Layer 18 is stiff clay without free water
Distance from top of pile to top of layer    =     1068.000 in
Distance from top of pile to bottom of layer =     1128.000 in

Layer 19 is stiff clay without free water
Distance from top of pile to top of layer    =     1128.000 in
Distance from top of pile to bottom of layer =     1158.000 in
```

(Depth of lowest layer extends 438.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 38 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-66.00	0.06940
2	0.10	0.06940
3	0.10	0.03330
4	12.00	0.03330
5	12.00	0.01600
6	84.00	0.01600
7	84.00	0.03620
8	126.00	0.03620
9	126.00	0.03620
10	180.00	0.03620
11	180.00	0.03910
12	282.00	0.03910
13	282.00	0.03040
14	348.00	0.03040
15	348.00	0.02750
16	420.00	0.02750
17	420.00	0.03620
18	438.00	0.03620
19	438.00	0.03620
20	486.00	0.03620
21	486.00	0.03620
22	528.00	0.03620
23	528.00	0.03620
24	660.00	0.03620
25	660.00	0.03620
26	678.00	0.03620
27	678.00	0.04780
28	786.00	0.04780
29	786.00	0.03620
30	960.00	0.03620
31	960.00	0.04200
32	1026.00	0.04200
33	1026.00	0.03910
34	1068.00	0.03910
35	1068.00	0.03910
36	1128.00	0.03910
37	1128.00	0.03620
38	1158.00	0.03620

Shear Strength of Soils

Shear strength parameters with depth defined using 38 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-66.000	6.94000	0.00	0.00700	0.0

2	0.100	6.94000	0.00	0.00700	0.0
3	0.100	6.94000	0.00	0.00700	0.0
4	12.000	6.94000	0.00	0.00700	0.0
5	12.000	1.39000	0.00	0.02000	0.0
6	84.000	1.39000	0.00	0.02000	0.0
7	84.000	6.94000	0.00	0.01000	0.0
8	126.000	6.94000	0.00	0.01000	0.0
9	126.000	6.94000	0.00	0.01000	0.0
10	180.000	6.94000	0.00	0.01000	0.0
11	180.000	13.89000	0.00	0.00500	0.0
12	282.000	13.89000	0.00	0.00500	0.0
13	282.000	24.31000	0.00	0.00500	0.0
14	348.000	24.31000	0.00	0.00500	0.0
15	348.000	6.94000	0.00	0.01000	0.0
16	420.000	6.94000	0.00	0.01000	0.0
17	420.000	0.00000	0.10	------	------
18	438.000	0.00000	0.10	------	------
19	438.000	0.00000	40.00	------	------
20	486.000	0.00000	40.00	------	------
21	486.000	0.00000	36.00	------	------
22	528.000	0.00000	36.00	------	------
23	528.000	6.94000	0.00	0.01000	0.0
24	660.000	6.94000	0.00	0.01000	0.0
25	660.000	0.00000	44.00	------	------
26	678.000	0.00000	44.00	------	------
27	678.000	0.00000	42.00	------	------
28	786.000	0.00000	42.00	------	------
29	786.000	15.63000	0.00	0.00500	0.0
30	960.000	15.63000	0.00	0.00500	0.0
31	960.000	20.83000	0.00	0.00500	0.0
32	1026.000	20.83000	0.00	0.00500	0.0
33	1026.000	0.00000	44.00	------	------
34	1068.000	0.00000	44.00	------	------
35	1068.000	24.31000	0.00	0.00500	0.0
36	1128.000	24.31000	0.00	0.00500	0.0
37	1128.000	24.31000	0.00	0.00500	0.0
38	1158.000	24.31000	0.00	0.00500	0.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 10

Load Case Number 1

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.100 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 140000.000 lbs

```
Load Case Number  2

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.200 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  3

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.300 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  4

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.400 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  5

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.500 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  6

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.600 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  7

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.700 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  8

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.800 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  9

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.900 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number 10

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           1.000 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs
```

Output of p-y Curves at Specified Depths

---

p-y curves are generated and printed for verification at 10 depths.

Depth No.	Depth Below Pile Head in	Depth Below Ground Surface in
1	24.000	90.000
2	78.000	144.000
3	135.000	201.000
4	183.000	249.000
5	261.000	327.000
6	345.000	411.000
7	414.000	480.000
8	459.000	525.000
9	492.000	558.000
10	537.000	603.000

Depth of ground surface below top of pile = -66.00 in

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3
Depth below pile head	=	24.000 in
Depth below ground surface	=	90.000 in
Equivalent Depth	=	198.175 in
Pile Diameter	=	16.000 in
Cohesion, c	=	1.390 lbs/in**2
Avg Eff Unit Weight	=	0.05751 lbs/in**3
E50 parameter	=	0.02000
Default J parameter	=	0.500
Y50	=	0.80000 in
p-multiplier	=	1.00000
y-multiplier	=	1.00000

y, in	p, lbs/in
0.0000	0.0000
0.0064000	20.0160
0.2000000	63.0464
0.4000000	79.4335
0.6000000	90.9287
0.8000000	100.0800
1.0000000	107.8079
1.2000	114.5630
1.4000	120.6035
1.6000	126.0929
1.8000	131.1419
2.0000	135.8295
2.2000	140.2140
2.4000	144.3403
6.4000	200.1600
12.0000	200.1600
16.0000	200.1600

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number	=	3
Depth below pile head	=	78.000 in

```
Depth below ground surface  =      144.000 in
Equivalent Depth            =      252.175 in
Pile Diameter               =       16.000 in
Cohesion, c                 =        1.390 lbs/in**2
Avg Eff Unit Weight         =      0.04194 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      0.80000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0064000	20.0160
0.2000000	63.0464
0.4000000	79.4335
0.6000000	90.9287
0.8000000	100.0800
1.0000000	107.8079
1.2000	114.5630
1.4000	120.6035
1.6000	126.0929
1.8000	131.1419
2.0000	135.8295
2.2000	140.2140
2.4000	144.3403
6.4000	200.1600
12.0000	200.1600
16.0000	200.1600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          5
Depth below pile head      =      135.000 in
Depth below ground surface =      201.000 in
Equivalent Depth           =      138.769 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      6.94000 lbs/in**2
Average Eff. Unit Weight   =      0.03971 lbs/in**3
Epsilon-50                 =      0.01000
Pct                        =      902.818 lbs/in
Pcd                        =      999.360 lbs/in
Pu                         =      902.818 lbs/in
y50                        =        0.400 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	50.7692
0.0003200	75.9177
0.0006400	90.2818
0.0032000	135.0028
0.0064000	160.5463
0.0320000	240.0728
0.0640000	285.4963
0.1600000	358.9925
0.3200000	426.9165
0.4800000	472.4608
0.6400000	507.6921
1.6000	638.3890

3.2000	759.1768
6.4000	902.8184
7.2000	902.8184
8.0000	902.8184

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          6
Depth below pile head      =      183.000 in
Depth below ground surface =      249.000 in
Equivalent Depth           =      142.465 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     13.89000 lbs/in**2
Average Eff. Unit Weight   =      0.03907 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     1745.195 lbs/in
Pcd                        =     2000.160 lbs/in
Pu                         =     1745.195 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	98.1395
0.0001600	146.7529
0.0003200	174.5195
0.0016000	260.9676
0.0032000	310.3445
0.0160000	464.0733
0.0320000	551.8792
0.0800000	693.9514
0.1600000	825.2520
0.2400000	913.2914
0.3200000	981.3955
0.8000000	1234.0395
1.6000	1467.5285
3.2000	1745.1954
3.6000	1745.1954
4.0000	1745.1954

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          6
Depth below pile head      =      261.000 in
Depth below ground surface =      327.000 in
Equivalent Depth           =      220.465 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     13.89000 lbs/in**2
Average Eff. Unit Weight   =      0.03908 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     2335.689 lbs/in
Pcd                        =     2000.160 lbs/in
Pu                         =     2000.160 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000

3.2000E-05	112.4773
0.0001600	168.1927
0.0003200	200.0160
0.0016000	299.0937
0.0032000	355.6843
0.0160000	531.8721
0.0320000	632.5061
0.0800000	795.3344
0.1600000	945.8173
0.2400000	1046.7189
0.3200000	1124.7726
0.8000000	1414.3267
1.6000	1681.9274
3.2000	2000.1600
3.6000	2000.1600
4.0000	2000.1600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          7
Depth below pile head      =      345.000 in
Depth below ground surface =      411.000 in
Equivalent Depth           =      214.647 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     24.31000 lbs/in**2
Average Eff. Unit Weight   =      0.03775 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     3905.552 lbs/in
Pcd                        =     3500.640 lbs/in
Pu                         =     3500.640 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	196.8555
0.0001600	294.3676
0.0003200	350.0640
0.0016000	523.4678
0.0032000	622.5116
0.0160000	930.8720
0.0320000	1106.9996
0.0800000	1391.9783
0.1600000	1655.3505
0.2400000	1831.9464
0.3200000	1968.5545
0.8000000	2475.3263
1.6000	2943.6756
3.2000	3500.6400
3.6000	3500.6400
4.0000	3500.6400

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          8
Depth below pile head      =      414.000 in
Depth below ground surface =      480.000 in
Equivalent Depth           =      650.712 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      6.94000 lbs/in**2
Average Eff. Unit Weight   =      0.03629 lbs/in**3
```

```
Epsilon-50                  =      0.01000
Pct                         =     2968.946 lbs/in
Pcd                         =      999.360 lbs/in
Pu                          =      999.360 lbs/in
y50                         =        0.400 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	56.1981
0.0003200	84.0358
0.0006400	99.9360
0.0032000	149.4392
0.0064000	177.7141
0.0320000	265.7446
0.0640000	316.0254
0.1600000	397.3809
0.3200000	472.5682
0.4800000	522.9827
0.6400000	561.9814
1.6000	706.6542
3.2000	840.3582
6.4000	999.3600
7.2000	999.3600
8.0000	999.3600

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```
Soil Layer Number           =           10
Depth below pile head       =      459.000 in
Depth below ground surface  =      525.000 in
Equivalent Depth (see note) =      242.850 in
Pile Diameter               =       16.000 in
Angle of Friction           =       40.000 deg.
Avg. Eff. Unit Weight       =      0.03619 pci
k                           =      125.000 pci
A (static)                  =       0.8800
B (static)                  =       0.5000
Pst                         =    10483.834 lbs/in
Psd                         =    31656.388 lbs/in
Ps                          =    10483.834 lbs/in
Cbar                        =   11708.4973
n                           =       1.6447
m                           =   11951.5710
yk                          =       0.0880 in
pm                          =     5241.917 lbs/in
ym                          =       0.2667 in
pu                          =     9225.774 lbs/in
yu                          =       0.6000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in	
0.0000	0.0000	
0.0222222	674.5830	*
0.0444444	1349.1660	*
0.0666667	2023.7491	*
0.0888889	2687.8215	

0.1111111	3078.3764
0.1333333	3439.2513
0.1555556	3777.1789
0.1777778	4096.6293
0.2000000	4400.7571
0.2222222	4691.8914
0.2444444	4971.8121
0.2666667	5241.9171
0.4333333	7233.8456
0.6000000	9225.7741
16.6000	9225.7741
32.6000	9225.7741

* p value(s) computed using p = k * Eff x * y

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	11	
Depth below pile head	=	492.000	in
Depth below ground surface	=	558.000	in
Equivalent Depth (see note)	=	300.178	in
Pile Diameter	=	16.000	in
Angle of Friction	=	36.000	deg.
Avg. Eff. Unit Weight	=	0.03619	pci
k	=	60.000	pci
A (static)	=	0.8800	
B (static)	=	0.5000	
Pst	=	11200.925	lbs/in
Psd	=	19772.033	lbs/in
Ps	=	11200.925	lbs/in
Cbar	=	12509.3547	
n	=	1.6447	
m	=	12769.0546	
yk	=	0.3946	in
pm	=	5600.463	lbs/in
ym	=	0.2667	in
pu	=	9856.814	lbs/in
yu	=	0.6000	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in	
0.0000	0.0000	
0.0222222	400.2367	*
0.0444444	800.4734	*
0.0666667	1200.7102	*
0.0888889	1600.9469	*
0.1111111	2001.1836	*
0.1333333	2401.4203	*
0.1555556	2801.6570	*
0.1777778	3201.8938	*
0.2000000	3602.1305	*
0.2222222	4002.3672	*
0.2444444	4402.6039	*
0.2666667	4802.8406	*
0.4333333	7728.6383	
0.6000000	9856.8141	
16.6000	9856.8141	
32.6000	9856.8141	

* p value(s) computed using p = k * Eff x * y

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number	=	12	
Depth below pile head	=	537.000	in
Depth below ground surface	=	603.000	in
Equivalent Depth	=	1528.013	in
Diameter	=	16.000	in
Undrained cohesion, c	=	6.94000	lbs/in**2
Average Eff. Unit Weight	=	0.03619	lbs/in**3
Epsilon-50	=	0.01000	
Pct	=	6520.034	lbs/in
Pcd	=	999.360	lbs/in
Pu	=	999.360	lbs/in
y50	=	0.400	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	56.1981
0.0003200	84.0358
0.0006400	99.9360
0.0032000	149.4392
0.0064000	177.7141
0.0320000	265.7446
0.0640000	316.0254
0.1600000	397.3809
0.3200000	472.5682
0.4800000	522.9827
0.6400000	561.9814
1.6000	706.6542
3.2000	840.3582
6.4000	999.3600
7.2000	999.3600
8.0000	999.3600

Summary of Pile Response(s)

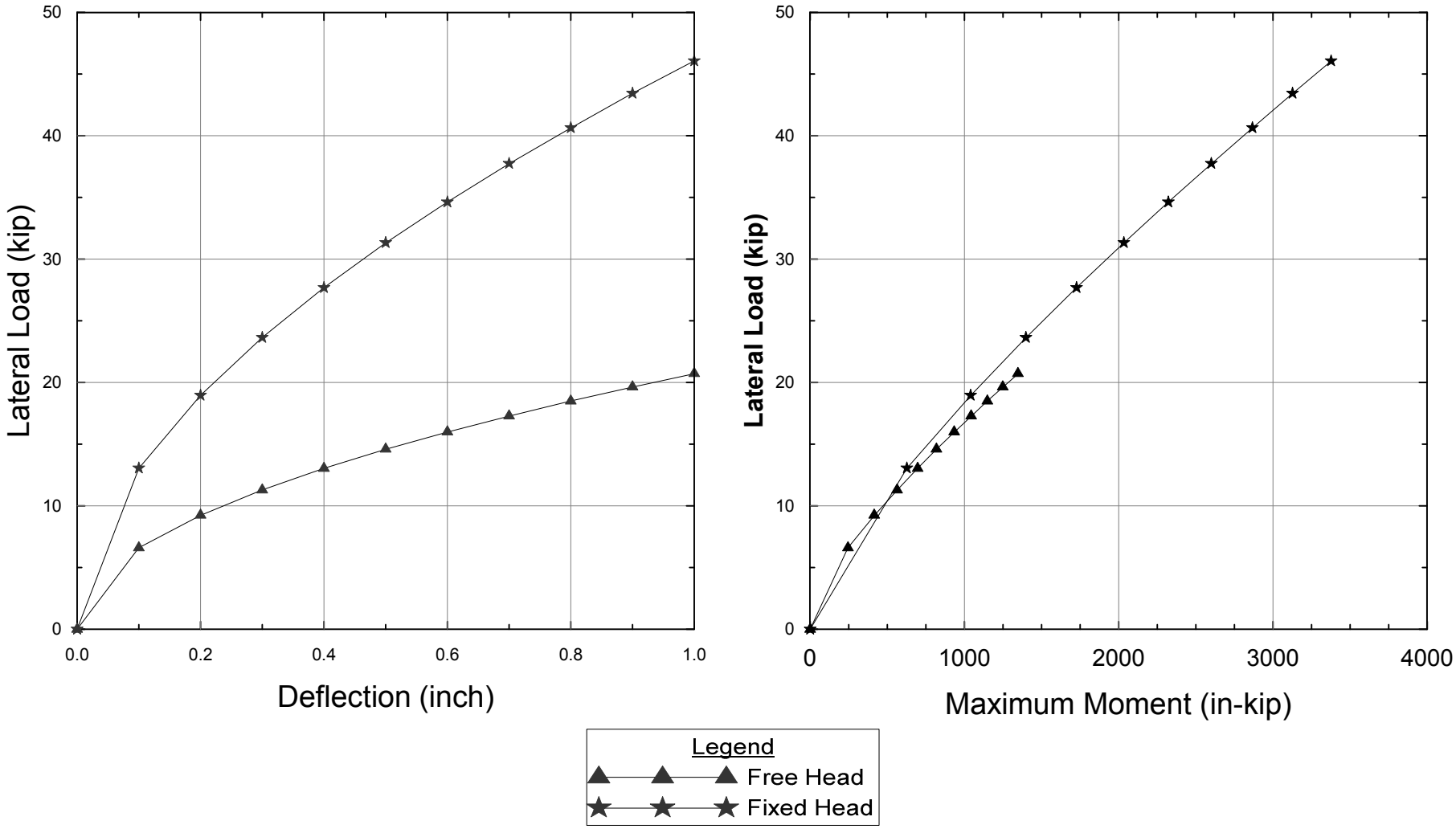
Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
4	y= 0.100000	M= 0.000	140000.	0.1000000	245578.	6596.9617
4	y= 0.200000	M= 0.000	140000.	0.2000000	416423.	9231.9544
4	y= 0.300000	M= 0.000	140000.	0.3000000	564119.	11289.3521
4	y= 0.400000	M= 0.000	140000.	0.4000000	696622.	13038.1831
4	y= 0.500000	M= 0.000	140000.	0.5000000	819000.	14587.8564
4	y= 0.600000	M= 0.000	140000.	0.6000000	934698.	15986.6110
4	y= 0.700000	M= 0.000	140000.	0.7000000	1044181.	17281.0342
4	y= 0.800000	M= 0.000	140000.	0.8000000	1148780.	18493.9543

```
  4  y=  0.900000 M=     0.000     140000.   0.9000000    1249188.  19634.3159
  4  y=  1.000000 M=     0.000     140000.   1.0000000    1347781.  20712.1260

The analysis ended normally.
```



Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**Broadway OC (Replace)** **Abutment 3 RW Pile Lateral Resistance** **Class 140 PCPS Pile**	Figure I-4
URS			

W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\Broadway OC (Replace)_East Abutment WW.grf

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Madhu Thummaluru
URS Corporation

Files Used for Analysis

Path to file locations:
W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\
Name of input data file: East Abutment Return wall_16 in PCPS_Fixed.lpd
Name of output file: East Abutment Return wall_16 in PCPS_Fixed.lpo
Name of plot output file: East Abutment Return wall_16 in PCPS_Fixed.lpp
Name of runtime file: East Abutment Return wall_16 in PCPS_Fixed.lpr

---

Time and Date of Analysis

Date: June 21, 2012 Time: 13:18:07

Problem Title

Broadway OC (Replace) East Abutment_Return wall (Abut 3 RW) 16 inch PCPS Class 140

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- Additional p-y curves computed at specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in

Depth of ground surface below top of pile = -66.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	16.00000000	5461.3000	256.0000	3600000.
2	720.0000	16.00000000	5461.3000	256.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 19 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -66.000 in
Distance from top of pile to bottom of layer = 0.100 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 0.100 in
Distance from top of pile to bottom of layer = 12.000 in

Layer 3 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 12.000 in
Distance from top of pile to bottom of layer = 84.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 84.000 in
Distance from top of pile to bottom of layer = 126.000 in

Layer 5 is stiff clay without free water
Distance from top of pile to top of layer = 126.000 in
Distance from top of pile to bottom of layer = 180.000 in

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 282.000 in

```
Layer  7 is stiff clay without free water
Distance from top of pile to top of layer    =      282.000 in
Distance from top of pile to bottom of layer =      348.000 in

Layer  8 is stiff clay without free water
Distance from top of pile to top of layer    =      348.000 in
Distance from top of pile to bottom of layer =      420.000 in

Layer  9 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      420.000 in
Distance from top of pile to bottom of layer =      438.000 in
p-y subgrade modulus k for top of soil layer =        0.100 lbs/in**3
p-y subgrade modulus k for bottom of layer   =        0.100 lbs/in**3

Layer 10 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      438.000 in
Distance from top of pile to bottom of layer =      486.000 in
p-y subgrade modulus k for top of soil layer =      125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      125.000 lbs/in**3

Layer 11 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      486.000 in
Distance from top of pile to bottom of layer =      528.000 in
p-y subgrade modulus k for top of soil layer =       60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =       60.000 lbs/in**3

Layer 12 is stiff clay without free water
Distance from top of pile to top of layer    =      528.000 in
Distance from top of pile to bottom of layer =      660.000 in

Layer 13 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      660.000 in
Distance from top of pile to bottom of layer =      678.000 in
p-y subgrade modulus k for top of soil layer =      175.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      175.000 lbs/in**3

Layer 14 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      678.000 in
Distance from top of pile to bottom of layer =      786.000 in
p-y subgrade modulus k for top of soil layer =      125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      125.000 lbs/in**3

Layer 15 is stiff clay without free water
Distance from top of pile to top of layer    =      786.000 in
Distance from top of pile to bottom of layer =      960.000 in

Layer 16 is stiff clay without free water
Distance from top of pile to top of layer    =      960.000 in
Distance from top of pile to bottom of layer =     1026.000 in

Layer 17 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =     1026.000 in
Distance from top of pile to bottom of layer =     1068.000 in
p-y subgrade modulus k for top of soil layer =      175.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      175.000 lbs/in**3

Layer 18 is stiff clay without free water
Distance from top of pile to top of layer    =     1068.000 in
Distance from top of pile to bottom of layer =     1128.000 in

Layer 19 is stiff clay without free water
Distance from top of pile to top of layer    =     1128.000 in
Distance from top of pile to bottom of layer =     1158.000 in
```

(Depth of lowest layer extends 438.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 38 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-66.00	0.06940
2	0.10	0.06940
3	0.10	0.03330
4	12.00	0.03330
5	12.00	0.01600
6	84.00	0.01600
7	84.00	0.03620
8	126.00	0.03620
9	126.00	0.03620
10	180.00	0.03620
11	180.00	0.03910
12	282.00	0.03910
13	282.00	0.03040
14	348.00	0.03040
15	348.00	0.02750
16	420.00	0.02750
17	420.00	0.03620
18	438.00	0.03620
19	438.00	0.03620
20	486.00	0.03620
21	486.00	0.03620
22	528.00	0.03620
23	528.00	0.03620
24	660.00	0.03620
25	660.00	0.03620
26	678.00	0.03620
27	678.00	0.04780
28	786.00	0.04780
29	786.00	0.03620
30	960.00	0.03620
31	960.00	0.04200
32	1026.00	0.04200
33	1026.00	0.03910
34	1068.00	0.03910
35	1068.00	0.03910
36	1128.00	0.03910
37	1128.00	0.03620
38	1158.00	0.03620

Shear Strength of Soils

Shear strength parameters with depth defined using 38 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-66.000	6.94000	0.00	0.00700	0.0

2	0.100	6.94000	0.00	0.00700	0.0
3	0.100	6.94000	0.00	0.00700	0.0
4	12.000	6.94000	0.00	0.00700	0.0
5	12.000	1.39000	0.00	0.02000	0.0
6	84.000	1.39000	0.00	0.02000	0.0
7	84.000	6.94000	0.00	0.01000	0.0
8	126.000	6.94000	0.00	0.01000	0.0
9	126.000	6.94000	0.00	0.01000	0.0
10	180.000	6.94000	0.00	0.01000	0.0
11	180.000	13.89000	0.00	0.00500	0.0
12	282.000	13.89000	0.00	0.00500	0.0
13	282.000	24.31000	0.00	0.00500	0.0
14	348.000	24.31000	0.00	0.00500	0.0
15	348.000	6.94000	0.00	0.01000	0.0
16	420.000	6.94000	0.00	0.01000	0.0
17	420.000	0.00000	0.10	------	------
18	438.000	0.00000	0.10	------	------
19	438.000	0.00000	40.00	------	------
20	486.000	0.00000	40.00	------	------
21	486.000	0.00000	36.00	------	------
22	528.000	0.00000	36.00	------	------
23	528.000	6.94000	0.00	0.01000	0.0
24	660.000	6.94000	0.00	0.01000	0.0
25	660.000	0.00000	44.00	------	------
26	678.000	0.00000	44.00	------	------
27	678.000	0.00000	42.00	------	------
28	786.000	0.00000	42.00	------	------
29	786.000	15.63000	0.00	0.00500	0.0
30	960.000	15.63000	0.00	0.00500	0.0
31	960.000	20.83000	0.00	0.00500	0.0
32	1026.000	20.83000	0.00	0.00500	0.0
33	1026.000	0.00000	44.00	------	------
34	1068.000	0.00000	44.00	------	------
35	1068.000	24.31000	0.00	0.00500	0.0
36	1128.000	24.31000	0.00	0.00500	0.0
37	1128.000	24.31000	0.00	0.00500	0.0
38	1158.000	24.31000	0.00	0.00500	0.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 10

Load Case Number 1

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.100 in

```
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  2

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.200 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  3

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.300 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  4

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.400 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  5

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.500 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  6

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.600 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  7

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.700 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  8

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.800 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number  9

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.900 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      140000.000 lbs

Load Case Number 10

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           1.000 in
```

```
Slope at pile head          =          0.000 in/in
Axial load at pile head     =      140000.000 lbs

--------------------------------------------------------------------------
                   Output of p-y Curves at Specified Depths
--------------------------------------------------------------------------



p-y curves are generated and printed for verification at 10 depths.

Depth      Depth Below Pile Head      Depth Below Ground Surface
 No.                 in                          in
-----      ---------------------      --------------------------
  1                24.000                      90.000
  2                78.000                     144.000
  3               135.000                     201.000
  4               183.000                     249.000
  5               261.000                     327.000
  6               345.000                     411.000
  7               414.000                     480.000
  8               459.000                     525.000
  9               492.000                     558.000
 10               537.000                     603.000

Depth of ground surface below top of pile =     -66.00 in

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number           =          3
Depth below pile head       =       24.000 in
Depth below ground surface  =       90.000 in
Equivalent Depth            =      198.175 in
Pile Diameter               =       16.000 in
Cohesion, c                 =        1.390 lbs/in**2
Avg Eff Unit Weight         =      0.05751 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      0.80000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000

        y, in            p, lbs/in
----------------    -----------------
         0.0000           0.0000
      0.0064000          20.0160
      0.2000000          63.0464
      0.4000000          79.4335
      0.6000000          90.9287
      0.8000000         100.0800
      1.0000000         107.8079
         1.2000         114.5630
         1.4000         120.6035
         1.6000         126.0929
         1.8000         131.1419
         2.0000         135.8295
         2.2000         140.2140
         2.4000         144.3403
         6.4000         200.1600
        12.0000         200.1600
        16.0000         200.1600
```

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```
Soil Layer Number           =          3
Depth below pile head       =       78.000 in
Depth below ground surface  =      144.000 in
Equivalent Depth            =      252.175 in
Pile Diameter               =       16.000 in
Cohesion, c                 =        1.390 lbs/in**2
Avg Eff Unit Weight         =      0.04194 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      0.80000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0064000	20.0160
0.2000000	63.0464
0.4000000	79.4335
0.6000000	90.9287
0.8000000	100.0800
1.0000000	107.8079
1.2000	114.5630
1.4000	120.6035
1.6000	126.0929
1.8000	131.1419
2.0000	135.8295
2.2000	140.2140
2.4000	144.3403
6.4000	200.1600
12.0000	200.1600
16.0000	200.1600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number           =          5
Depth below pile head       =      135.000 in
Depth below ground surface  =      201.000 in
Equivalent Depth            =      138.769 in
Diameter                    =       16.000 in
Undrained cohesion, c       =      6.94000 lbs/in**2
Average Eff. Unit Weight    =      0.03971 lbs/in**3
Epsilon-50                  =      0.01000
Pct                         =      902.818 lbs/in
Pcd                         =      999.360 lbs/in
Pu                          =      902.818 lbs/in
y50                         =        0.400 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	50.7692
0.0003200	75.9177
0.0006400	90.2818
0.0032000	135.0028
0.0064000	160.5463
0.0320000	240.0728
0.0640000	285.4963
0.1600000	358.9925

0.3200000	426.9165
0.4800000	472.4608
0.6400000	507.6921
1.6000	638.3890
3.2000	759.1768
6.4000	902.8184
7.2000	902.8184
8.0000	902.8184

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          6
Depth below pile head      =      183.000 in
Depth below ground surface =      249.000 in
Equivalent Depth           =      142.465 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     13.89000 lbs/in**2
Average Eff. Unit Weight   =      0.03907 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     1745.195 lbs/in
Pcd                        =     2000.160 lbs/in
Pu                         =     1745.195 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	98.1395
0.0001600	146.7529
0.0003200	174.5195
0.0016000	260.9676
0.0032000	310.3445
0.0160000	464.0733
0.0320000	551.8792
0.0800000	693.9514
0.1600000	825.2520
0.2400000	913.2914
0.3200000	981.3955
0.8000000	1234.0395
1.6000	1467.5285
3.2000	1745.1954
3.6000	1745.1954
4.0000	1745.1954

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          6
Depth below pile head      =      261.000 in
Depth below ground surface =      327.000 in
Equivalent Depth           =      220.465 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     13.89000 lbs/in**2
Average Eff. Unit Weight   =      0.03908 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     2335.689 lbs/in
Pcd                        =     2000.160 lbs/in
Pu                         =     2000.160 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	112.4773
0.0001600	168.1927
0.0003200	200.0160
0.0016000	299.0937
0.0032000	355.6843
0.0160000	531.8721
0.0320000	632.5061
0.0800000	795.3344
0.1600000	945.8173
0.2400000	1046.7189
0.3200000	1124.7726
0.8000000	1414.3267
1.6000	1681.9274
3.2000	2000.1600
3.6000	2000.1600
4.0000	2000.1600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          7
Depth below pile head      =      345.000 in
Depth below ground surface =      411.000 in
Equivalent Depth           =      214.647 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     24.31000 lbs/in**2
Average Eff. Unit Weight   =      0.03775 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     3905.552 lbs/in
Pcd                        =     3500.640 lbs/in
Pu                         =     3500.640 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	196.8555
0.0001600	294.3676
0.0003200	350.0640
0.0016000	523.4678
0.0032000	622.5116
0.0160000	930.8720
0.0320000	1106.9996
0.0800000	1391.9783
0.1600000	1655.3505
0.2400000	1831.9464
0.3200000	1968.5545
0.8000000	2475.3263
1.6000	2943.6756
3.2000	3500.6400
3.6000	3500.6400
4.0000	3500.6400

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          8
Depth below pile head      =      414.000 in
Depth below ground surface =      480.000 in
```

```
Equivalent Depth           =      650.712 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      6.94000 lbs/in**2
Average Eff. Unit Weight   =      0.03629 lbs/in**3
Epsilon-50                 =      0.01000
Pct                        =     2968.946 lbs/in
Pcd                        =      999.360 lbs/in
Pu                         =      999.360 lbs/in
y50                        =        0.400 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	56.1981
0.0003200	84.0358
0.0006400	99.9360
0.0032000	149.4392
0.0064000	177.7141
0.0320000	265.7446
0.0640000	316.0254
0.1600000	397.3809
0.3200000	472.5682
0.4800000	522.9827
0.6400000	561.9814
1.6000	706.6542
3.2000	840.3582
6.4000	999.3600
7.2000	999.3600
8.0000	999.3600

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```
Soil Layer Number          =           10
Depth below pile head      =      459.000 in
Depth below ground surface =      525.000 in
Equivalent Depth (see note) =     242.850 in
Pile Diameter              =       16.000 in
Angle of Friction          =       40.000 deg.
Avg. Eff. Unit Weight      =      0.03619 pci
k                          =      125.000 pci
A (static)                 =       0.8800
B (static)                 =       0.5000
Pst                        =    10483.834 lbs/in
Psd                        =    31656.388 lbs/in
Ps                         =    10483.834 lbs/in
Cbar                       =   11708.4973
n                          =       1.6447
m                          =   11951.5710
yk                         =       0.0880 in
pm                         =     5241.917 lbs/in
ym                         =       0.2667 in
pu                         =     9225.774 lbs/in
yu                         =       0.6000 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in
0.0000	0.0000

0.0222222	674.5830	*
0.0444444	1349.1660	*
0.0666667	2023.7491	*
0.0888889	2687.8215	
0.1111111	3078.3764	
0.1333333	3439.2513	
0.1555556	3777.1789	
0.1777778	4096.6293	
0.2000000	4400.7571	
0.2222222	4691.8914	
0.2444444	4971.8121	
0.2666667	5241.9171	
0.4333333	7233.8456	
0.6000000	9225.7741	
16.6000	9225.7741	
32.6000	9225.7741	

* p value(s) computed using p = k * Eff x * y

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	11	
Depth below pile head	=	492.000	in
Depth below ground surface	=	558.000	in
Equivalent Depth (see note)	=	300.178	in
Pile Diameter	=	16.000	in
Angle of Friction	=	36.000	deg.
Avg. Eff. Unit Weight	=	0.03619	pci
k	=	60.000	pci
A (static)	=	0.8800	
B (static)	=	0.5000	
Pst	=	11200.925	lbs/in
Psd	=	19772.033	lbs/in
Ps	=	11200.925	lbs/in
Cbar	=	12509.3547	
n	=	1.6447	
m	=	12769.0546	
yk	=	0.3946	in
pm	=	5600.463	lbs/in
ym	=	0.2667	in
pu	=	9856.814	lbs/in
yu	=	0.6000	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in	
0.0000	0.0000	
0.0222222	400.2367	*
0.0444444	800.4734	*
0.0666667	1200.7102	*
0.0888889	1600.9469	*
0.1111111	2001.1836	*
0.1333333	2401.4203	*
0.1555556	2801.6570	*
0.1777778	3201.8938	*
0.2000000	3602.1305	*
0.2222222	4002.3672	*
0.2444444	4402.6039	*
0.2666667	4802.8406	*
0.4333333	7728.6383	

```
      0.6000000        9856.8141
        16.6000        9856.8141
        32.6000        9856.8141

* p value(s) computed using p = k * Eff x * y

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

Soil Layer Number          =         12
Depth below pile head      =      537.000 in
Depth below ground surface =      603.000 in
Equivalent Depth           =     1528.013 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      6.94000 lbs/in**2
Average Eff. Unit Weight   =      0.03619 lbs/in**3
Epsilon-50                 =      0.01000
Pct                        =     6520.034 lbs/in
Pcd                        =      999.360 lbs/in
Pu                         =      999.360 lbs/in
y50                        =        0.400 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000

        y, in            p, lbs/in
----------------    -----------------
         0.0000           0.0000
     6.4000E-05          56.1981
      0.0003200          84.0358
      0.0006400          99.9360
      0.0032000         149.4392
      0.0064000         177.7141
      0.0320000         265.7446
      0.0640000         316.0254
      0.1600000         397.3809
      0.3200000         472.5682
      0.4800000         522.9827
      0.6400000         561.9814
         1.6000         706.6542
         3.2000         840.3582
         6.4000         999.3600
         7.2000         999.3600
         8.0000         999.3600
--------------------------------------------------------------------------------
                           Summary of Pile Response(s)
--------------------------------------------------------------------------------

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad

Load  Pile-Head    Pile-Head       Axial    Pile-Head    Maximum     Maximum
Type  Condition    Condition       Load     Deflection    Moment      Shear
          1            2            lbs         in        in-lbs       lbs
---- ------------ ------------ ----------- ----------- ----------- -----------
  5  y=  0.100000 S=     0.000     140000.   0.1000000    -626915.  13045.3800
  5  y=  0.200000 S=     0.000     140000.   0.2000000   -1041205.  18959.2280
  5  y=  0.300000 S=     0.000     140000.   0.3000000   -1399669.  23640.2001
  5  y=  0.400000 S=     0.000     140000.   0.4000000   -1727082.  27681.8580
  5  y=  0.500000 S=     0.000     140000.   0.5000000   -2033871.  31314.8833
```

```
  5  y=  0.600000 S=     0.000     140000.   0.6000000   -2322374.  34624.9620
  5  y=  0.700000 S=     0.000     140000.   0.7000000   -2601330.  37738.6871
  5  y=  0.800000 S=     0.000     140000.   0.8000000   -2866667.  40636.2650
  5  y=  0.900000 S=     0.000     140000.   0.9000000   -3127957.  43430.0672
  5  y=  1.000000 S=     0.000     140000.   1.0000000   -3377440.  46055.8024

The analysis ended normally.
```

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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==========

This program is licensed to:

Madhu Thummaluru
URS Corporation

Files Used for Analysis

Path to file locations:
W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\
Name of input data file: East Abutment Return wall_16 in PCPS_Free.lpd
Name of output file: East Abutment Return wall_16 in PCPS_Free.lpo
Name of plot output file: East Abutment Return wall_16 in PCPS_Free.lpp
Name of runtime file: East Abutment Return wall_16 in PCPS_Free.lpr

---

Time and Date of Analysis

Date: June 21, 2012 Time: 13:19:57

Problem Title

Broadway OC (Replace) East Abutment Return walls (Abut 3 RW) 16 inch PCPS Class 140

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis for fixed-length pile or shaft only
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile
- Additional p-y curves computed at specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 720.00 in

Depth of ground surface below top of pile = -66.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	16.00000000	5461.3000	256.0000	3600000.
2	720.0000	16.00000000	5461.3000	256.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 19 layers

Layer 1 is stiff clay without free water
Distance from top of pile to top of layer = -66.000 in
Distance from top of pile to bottom of layer = 0.100 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 0.100 in
Distance from top of pile to bottom of layer = 12.000 in

Layer 3 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = 12.000 in
Distance from top of pile to bottom of layer = 84.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 84.000 in
Distance from top of pile to bottom of layer = 126.000 in

Layer 5 is stiff clay without free water
Distance from top of pile to top of layer = 126.000 in
Distance from top of pile to bottom of layer = 180.000 in

Layer 6 is stiff clay without free water
Distance from top of pile to top of layer = 180.000 in
Distance from top of pile to bottom of layer = 282.000 in

```
Layer  7 is stiff clay without free water
Distance from top of pile to top of layer    =      282.000 in
Distance from top of pile to bottom of layer =      348.000 in

Layer  8 is stiff clay without free water
Distance from top of pile to top of layer    =      348.000 in
Distance from top of pile to bottom of layer =      420.000 in

Layer  9 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      420.000 in
Distance from top of pile to bottom of layer =      438.000 in
p-y subgrade modulus k for top of soil layer =        0.100 lbs/in**3
p-y subgrade modulus k for bottom of layer   =        0.100 lbs/in**3

Layer 10 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      438.000 in
Distance from top of pile to bottom of layer =      486.000 in
p-y subgrade modulus k for top of soil layer =      125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      125.000 lbs/in**3

Layer 11 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      486.000 in
Distance from top of pile to bottom of layer =      528.000 in
p-y subgrade modulus k for top of soil layer =       60.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =       60.000 lbs/in**3

Layer 12 is stiff clay without free water
Distance from top of pile to top of layer    =      528.000 in
Distance from top of pile to bottom of layer =      660.000 in

Layer 13 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      660.000 in
Distance from top of pile to bottom of layer =      678.000 in
p-y subgrade modulus k for top of soil layer =      175.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      175.000 lbs/in**3

Layer 14 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =      678.000 in
Distance from top of pile to bottom of layer =      786.000 in
p-y subgrade modulus k for top of soil layer =      125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      125.000 lbs/in**3

Layer 15 is stiff clay without free water
Distance from top of pile to top of layer    =      786.000 in
Distance from top of pile to bottom of layer =      960.000 in

Layer 16 is stiff clay without free water
Distance from top of pile to top of layer    =      960.000 in
Distance from top of pile to bottom of layer =     1026.000 in

Layer 17 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer    =     1026.000 in
Distance from top of pile to bottom of layer =     1068.000 in
p-y subgrade modulus k for top of soil layer =      175.000 lbs/in**3
p-y subgrade modulus k for bottom of layer   =      175.000 lbs/in**3

Layer 18 is stiff clay without free water
Distance from top of pile to top of layer    =     1068.000 in
Distance from top of pile to bottom of layer =     1128.000 in

Layer 19 is stiff clay without free water
Distance from top of pile to top of layer    =     1128.000 in
Distance from top of pile to bottom of layer =     1158.000 in
```

(Depth of lowest layer extends 438.00 in below pile tip)

Effective Unit Weight of Soil vs. Depth

Effective unit weight of soil with depth defined using 38 points

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-66.00	0.06940
2	0.10	0.06940
3	0.10	0.03330
4	12.00	0.03330
5	12.00	0.01600
6	84.00	0.01600
7	84.00	0.03620
8	126.00	0.03620
9	126.00	0.03620
10	180.00	0.03620
11	180.00	0.03910
12	282.00	0.03910
13	282.00	0.03040
14	348.00	0.03040
15	348.00	0.02750
16	420.00	0.02750
17	420.00	0.03620
18	438.00	0.03620
19	438.00	0.03620
20	486.00	0.03620
21	486.00	0.03620
22	528.00	0.03620
23	528.00	0.03620
24	660.00	0.03620
25	660.00	0.03620
26	678.00	0.03620
27	678.00	0.04780
28	786.00	0.04780
29	786.00	0.03620
30	960.00	0.03620
31	960.00	0.04200
32	1026.00	0.04200
33	1026.00	0.03910
34	1068.00	0.03910
35	1068.00	0.03910
36	1128.00	0.03910
37	1128.00	0.03620
38	1158.00	0.03620

Shear Strength of Soils

Shear strength parameters with depth defined using 38 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-66.000	6.94000	0.00	0.00700	0.0

2	0.100	6.94000	0.00	0.00700	0.0
3	0.100	6.94000	0.00	0.00700	0.0
4	12.000	6.94000	0.00	0.00700	0.0
5	12.000	1.39000	0.00	0.02000	0.0
6	84.000	1.39000	0.00	0.02000	0.0
7	84.000	6.94000	0.00	0.01000	0.0
8	126.000	6.94000	0.00	0.01000	0.0
9	126.000	6.94000	0.00	0.01000	0.0
10	180.000	6.94000	0.00	0.01000	0.0
11	180.000	13.89000	0.00	0.00500	0.0
12	282.000	13.89000	0.00	0.00500	0.0
13	282.000	24.31000	0.00	0.00500	0.0
14	348.000	24.31000	0.00	0.00500	0.0
15	348.000	6.94000	0.00	0.01000	0.0
16	420.000	6.94000	0.00	0.01000	0.0
17	420.000	0.00000	0.10	------	------
18	438.000	0.00000	0.10	------	------
19	438.000	0.00000	40.00	------	------
20	486.000	0.00000	40.00	------	------
21	486.000	0.00000	36.00	------	------
22	528.000	0.00000	36.00	------	------
23	528.000	6.94000	0.00	0.01000	0.0
24	660.000	6.94000	0.00	0.01000	0.0
25	660.000	0.00000	44.00	------	------
26	678.000	0.00000	44.00	------	------
27	678.000	0.00000	42.00	------	------
28	786.000	0.00000	42.00	------	------
29	786.000	15.63000	0.00	0.00500	0.0
30	960.000	15.63000	0.00	0.00500	0.0
31	960.000	20.83000	0.00	0.00500	0.0
32	1026.000	20.83000	0.00	0.00500	0.0
33	1026.000	0.00000	44.00	------	------
34	1068.000	0.00000	44.00	------	------
35	1068.000	24.31000	0.00	0.00500	0.0
36	1128.000	24.31000	0.00	0.00500	0.0
37	1128.000	24.31000	0.00	0.00500	0.0
38	1158.000	24.31000	0.00	0.00500	0.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 10

Load Case Number 1

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.100 in

```
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  2

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.200 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  3

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.300 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  4

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.400 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  5

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.500 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  6

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.600 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  7

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.700 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  8

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.800 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number  9

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.900 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      140000.000 lbs

Load Case Number 10

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           1.000 in
```

Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 140000.000 lbs

Output of p-y Curves at Specified Depths

---

p-y curves are generated and printed for verification at 10 depths.

Depth No.	Depth Below Pile Head in	Depth Below Ground Surface in
1	24.000	90.000
2	78.000	144.000
3	135.000	201.000
4	183.000	249.000
5	261.000	327.000
6	345.000	411.000
7	414.000	480.000
8	459.000	525.000
9	492.000	558.000
10	537.000	603.000

Depth of ground surface below top of pile = -66.00 in

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

Soil Layer Number = 3
Depth below pile head = 24.000 in
Depth below ground surface = 90.000 in
Equivalent Depth = 198.175 in
Pile Diameter = 16.000 in
Cohesion, c = 1.390 lbs/in**2
Avg Eff Unit Weight = 0.05751 lbs/in**3
E50 parameter = 0.02000
Default J parameter = 0.500
Y50 = 0.80000 in
p-multiplier = 1.00000
y-multiplier = 1.00000

y, in	p, lbs/in
0.0000	0.0000
0.0064000	20.0160
0.2000000	63.0464
0.4000000	79.4335
0.6000000	90.9287
0.8000000	100.0800
1.0000000	107.8079
1.2000	114.5630
1.4000	120.6035
1.6000	126.0929
1.8000	131.1419
2.0000	135.8295
2.2000	140.2140
2.4000	144.3403
6.4000	200.1600
12.0000	200.1600
16.0000	200.1600

p-y Curve Computed Using the Soft Clay Criteria for Static Loading Conditions

```
Soil Layer Number           =          3
Depth below pile head       =       78.000 in
Depth below ground surface  =      144.000 in
Equivalent Depth            =      252.175 in
Pile Diameter               =       16.000 in
Cohesion, c                 =        1.390 lbs/in**2
Avg Eff Unit Weight         =      0.04194 lbs/in**3
E50 parameter               =      0.02000
Default J parameter         =        0.500
Y50                         =      0.80000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
0.0064000	20.0160
0.2000000	63.0464
0.4000000	79.4335
0.6000000	90.9287
0.8000000	100.0800
1.0000000	107.8079
1.2000	114.5630
1.4000	120.6035
1.6000	126.0929
1.8000	131.1419
2.0000	135.8295
2.2000	140.2140
2.4000	144.3403
6.4000	200.1600
12.0000	200.1600
16.0000	200.1600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number           =          5
Depth below pile head       =      135.000 in
Depth below ground surface  =      201.000 in
Equivalent Depth            =      138.769 in
Diameter                    =       16.000 in
Undrained cohesion, c       =      6.94000 lbs/in**2
Average Eff. Unit Weight    =      0.03971 lbs/in**3
Epsilon-50                  =      0.01000
Pct                         =      902.818 lbs/in
Pcd                         =      999.360 lbs/in
Pu                          =      902.818 lbs/in
y50                         =        0.400 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	50.7692
0.0003200	75.9177
0.0006400	90.2818
0.0032000	135.0028
0.0064000	160.5463
0.0320000	240.0728
0.0640000	285.4963
0.1600000	358.9925

0.3200000	426.9165
0.4800000	472.4608
0.6400000	507.6921
1.6000	638.3890
3.2000	759.1768
6.4000	902.8184
7.2000	902.8184
8.0000	902.8184

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          6
Depth below pile head      =      183.000 in
Depth below ground surface =      249.000 in
Equivalent Depth           =      142.465 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     13.89000 lbs/in**2
Average Eff. Unit Weight   =      0.03907 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     1745.195 lbs/in
Pcd                        =     2000.160 lbs/in
Pu                         =     1745.195 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	98.1395
0.0001600	146.7529
0.0003200	174.5195
0.0016000	260.9676
0.0032000	310.3445
0.0160000	464.0733
0.0320000	551.8792
0.0800000	693.9514
0.1600000	825.2520
0.2400000	913.2914
0.3200000	981.3955
0.8000000	1234.0395
1.6000	1467.5285
3.2000	1745.1954
3.6000	1745.1954
4.0000	1745.1954

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          6
Depth below pile head      =      261.000 in
Depth below ground surface =      327.000 in
Equivalent Depth           =      220.465 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     13.89000 lbs/in**2
Average Eff. Unit Weight   =      0.03908 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     2335.689 lbs/in
Pcd                        =     2000.160 lbs/in
Pu                         =     2000.160 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	112.4773
0.0001600	168.1927
0.0003200	200.0160
0.0016000	299.0937
0.0032000	355.6843
0.0160000	531.8721
0.0320000	632.5061
0.0800000	795.3344
0.1600000	945.8173
0.2400000	1046.7189
0.3200000	1124.7726
0.8000000	1414.3267
1.6000	1681.9274
3.2000	2000.1600
3.6000	2000.1600
4.0000	2000.1600

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          7
Depth below pile head      =      345.000 in
Depth below ground surface =      411.000 in
Equivalent Depth           =      214.647 in
Diameter                   =       16.000 in
Undrained cohesion, c      =     24.31000 lbs/in**2
Average Eff. Unit Weight   =      0.03775 lbs/in**3
Epsilon-50                 =      0.00500
Pct                        =     3905.552 lbs/in
Pcd                        =     3500.640 lbs/in
Pu                         =     3500.640 lbs/in
y50                        =        0.200 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
3.2000E-05	196.8555
0.0001600	294.3676
0.0003200	350.0640
0.0016000	523.4678
0.0032000	622.5116
0.0160000	930.8720
0.0320000	1106.9996
0.0800000	1391.9783
0.1600000	1655.3505
0.2400000	1831.9464
0.3200000	1968.5545
0.8000000	2475.3263
1.6000	2943.6756
3.2000	3500.6400
3.6000	3500.6400
4.0000	3500.6400

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =          8
Depth below pile head      =      414.000 in
Depth below ground surface =      480.000 in
Equivalent Depth           =      650.712 in
```

```
Diameter                    =       16.000 in
Undrained cohesion, c       =      6.94000 lbs/in**2
Average Eff. Unit Weight    =      0.03629 lbs/in**3
Epsilon-50                  =      0.01000
Pct                         =     2968.946 lbs/in
Pcd                         =      999.360 lbs/in
Pu                          =      999.360 lbs/in
y50                         =        0.400 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	56.1981
0.0003200	84.0358
0.0006400	99.9360
0.0032000	149.4392
0.0064000	177.7141
0.0320000	265.7446
0.0640000	316.0254
0.1600000	397.3809
0.3200000	472.5682
0.4800000	522.9827
0.6400000	561.9814
1.6000	706.6542
3.2000	840.3582
6.4000	999.3600
7.2000	999.3600
8.0000	999.3600

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

```
Soil Layer Number           =           10
Depth below pile head       =      459.000 in
Depth below ground surface  =      525.000 in
Equivalent Depth (see note) =      242.850 in
Pile Diameter               =       16.000 in
Angle of Friction           =       40.000 deg.
Avg. Eff. Unit Weight       =      0.03619 pci
k                           =      125.000 pci
A (static)                  =       0.8800
B (static)                  =       0.5000
Pst                         =    10483.834 lbs/in
Psd                         =    31656.388 lbs/in
Ps                          =    10483.834 lbs/in
Cbar                        =   11708.4973
n                           =       1.6447
m                           =   11951.5710
yk                          =       0.0880 in
pm                          =     5241.917 lbs/in
ym                          =       0.2667 in
pu                          =     9225.774 lbs/in
yu                          =       0.6000 in
p-multiplier                =      1.00000
y-multiplier                =      1.00000
```

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in
0.0000	0.0000
0.0222222	674.5830 *

0.0444444	1349.1660	*
0.0666667	2023.7491	*
0.0888889	2687.8215	
0.1111111	3078.3764	
0.1333333	3439.2513	
0.1555556	3777.1789	
0.1777778	4096.6293	
0.2000000	4400.7571	
0.2222222	4691.8914	
0.2444444	4971.8121	
0.2666667	5241.9171	
0.4333333	7233.8456	
0.6000000	9225.7741	
16.6000	9225.7741	
32.6000	9225.7741	

* p value(s) computed using p = k * Eff x * y

p-y Curve in Sand Computed Using Reese Criteria for Static Loading Conditions

Soil Layer Number	=	11	
Depth below pile head	=	492.000	in
Depth below ground surface	=	558.000	in
Equivalent Depth (see note)	=	300.178	in
Pile Diameter	=	16.000	in
Angle of Friction	=	36.000	deg.
Avg. Eff. Unit Weight	=	0.03619	pci
k	=	60.000	pci
A (static)	=	0.8800	
B (static)	=	0.5000	
Pst	=	11200.925	lbs/in
Psd	=	19772.033	lbs/in
Ps	=	11200.925	lbs/in
Cbar	=	12509.3547	
n	=	1.6447	
m	=	12769.0546	
yk	=	0.3946	in
pm	=	5600.463	lbs/in
ym	=	0.2667	in
pu	=	9856.814	lbs/in
yu	=	0.6000	in
p-multiplier	=	1.00000	
y-multiplier	=	1.00000	

This p-y curve is computed using the equivalent depth.

y, in	p, lbs/in	
0.0000	0.0000	
0.0222222	400.2367	*
0.0444444	800.4734	*
0.0666667	1200.7102	*
0.0888889	1600.9469	*
0.1111111	2001.1836	*
0.1333333	2401.4203	*
0.1555556	2801.6570	*
0.1777778	3201.8938	*
0.2000000	3602.1305	*
0.2222222	4002.3672	*
0.2444444	4402.6039	*
0.2666667	4802.8406	*
0.4333333	7728.6383	
0.6000000	9856.8141	

16.6000	9856.8141
32.6000	9856.8141

* p value(s) computed using p = k * Eff x * y

p-y Curve Computed Using Static Criteria for Stiff Clay without Free Water

```
Soil Layer Number          =         12
Depth below pile head      =      537.000 in
Depth below ground surface =      603.000 in
Equivalent Depth           =     1528.013 in
Diameter                   =       16.000 in
Undrained cohesion, c      =      6.94000 lbs/in**2
Average Eff. Unit Weight   =      0.03619 lbs/in**3
Epsilon-50                 =      0.01000
Pct                        =     6520.034 lbs/in
Pcd                        =      999.360 lbs/in
Pu                         =      999.360 lbs/in
y50                        =        0.400 in
p-multiplier               =      1.00000
y-multiplier               =      1.00000
```

y, in	p, lbs/in
0.0000	0.0000
6.4000E-05	56.1981
0.0003200	84.0358
0.0006400	99.9360
0.0032000	149.4392
0.0064000	177.7141
0.0320000	265.7446
0.0640000	316.0254
0.1600000	397.3809
0.3200000	472.5682
0.4800000	522.9827
0.6400000	561.9814
1.6000	706.6542
3.2000	840.3582
6.4000	999.3600
7.2000	999.3600
8.0000	999.3600

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

```
Type 1 = Shear and Moment,          y = pile-head displacment in
Type 2 = Shear and Slope,           M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness,  V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment,     S = Pile-head Slope, radians
Type 5 = Deflection and Slope,      R = Rot. Stiffness of Pile-head in-lbs/rad
```

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
4	y= 0.100000	M= 0.000	140000.	0.1000000	245578.	6596.9617
4	y= 0.200000	M= 0.000	140000.	0.2000000	416423.	9231.9544
4	y= 0.300000	M= 0.000	140000.	0.3000000	564119.	11289.3521
4	y= 0.400000	M= 0.000	140000.	0.4000000	696622.	13038.1831
4	y= 0.500000	M= 0.000	140000.	0.5000000	819000.	14587.8564

```
  4  y=  0.600000 M=     0.000     140000.   0.6000000     934698.  15986.6110
  4  y=  0.700000 M=     0.000     140000.   0.7000000    1044181.  17281.0342
  4  y=  0.800000 M=     0.000     140000.   0.8000000    1148780.  18493.9543
  4  y=  0.900000 M=     0.000     140000.   0.9000000    1249188.  19634.3159
  4  y=  1.000000 M=     0.000     140000.   1.0000000    1347781.  20712.1260

The analysis ended normally.
```

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: 04 EA: 2358411 **Project Name: US101/Broadway IC** **OSFP Liaison: Paul Cotter** **Phone: 916-227-5671** **e-mail: Paul Cotter/HQ/Caltrans/CAGov@DOT**	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☐ 65% PS&E Unchecked Details ☐ PS&E (Review No. _) ☐ Construction Support ☒ Other: 100% PS&E	**Reviewer Name: Eduardo Ortega (Geotech)** **Caroline Chen (Geotech)** **Hossain Salimi (Seismic)** **Ron Karpowicz (Geology)** **Functional Unit: Geotechnical** **Cost Center: 327** **Phone Number: 510-286-4821** **e-mail: Eduardo_Ortega@dot.ca.gov** **Date of Review: 2/12/13**
	Structure Information (Use when necessary to document comments by individual structure) **Structure Name: FR Broadway OC (Replace)** **Br No: 35-0351** **FR SB US 101 On-Ramp Br No: 35-0352K** **FR Retaining Wall Nos. 15, 38, 39, 205, 209, 314, 315 and 316**		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	FR Ret. Walls		Prior to construction, the MSE retaining wall designer shall submit his calculations in order to review and approve that the design meets all requirements for internal retaining wall stability.	Will incorporate the language in the project Special Standard Provisions.	
2	Broadway OC (35-0351)		Broadway OC (35-0351): 1. Nominal resistance (compression) shown on Table 10-5 is not consistent with those presented on Tables 10-3 and 10-4 for Abutments and Abutment 3 RWs. 2. Table 10-5: For Abut 1, piles at specified tip elevation is very likely not to have nominal resistance (compression)	1. Have revised the nominal resistance (compression) values on Table 10-5 to be consistent with Tables 10-3 and 10-4. 2. Have updated nominal driving resistance to be consistent with nominal resistance (compression) of 240 kips.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓ = Comment Resolved (for Reviewer's use)

			of 280 kips. 3. Tables 10-3 and 10-4: Please remove the column showing Nominal Driving Resistance. 4. For CDSM zone: what are the recommendations about the limit of the recommended improving zone, spacing of grid, and depth of CDSM?	3. The format of Table 10-3 and 10-4 are consistent with Memo to Designers (MTD) 3-1 (July 2008). Will keep the column showing Nominal Driving Resistance per MTD 3-1. 4. Have included Figure 9C to present the limit of the recommended CDSM zone, spacing of grid and depth of CDSM.	
3	SB US 101 On-Ramp (35-0352K)		SB US 101 On-Ramp (35-0352K) 1. Nominal resistance (compression) shown on Table 10-5 is not consistent with those presented on Table 10-3 for Abutment 1. 2. Tables 10-3 and 10-4: Please remove the column showing Nominal Driving Resistance. 3. Table 10-5: Please round the nominal resistance (tension) up to the nearest 10 kips. 4. For CDSM zone: what are the recommendations about the limit of the recommended improving zone, spacing of grid, and depth of CDSM?	1. Have revised the nominal resistance (compression) values on Table 10-5 to be consistent with Tables 10-3 and 10-4. 2. Have updated nominal driving resistance to be consistent with nominal resistance (compression) of 240 kips. 3. The format of Table 10-3 and 10-4 are consistent with Memo to Designers (MTD) 3-1 (July 2008). Will keep the column showing Nominal Driving Resistance per MTD 3-1. 4. Have included Figure 9B to present the limit of the recommended CDSM zone, spacing of grid and depth of CDSM.	
4	FR Broadway OC Replace FR US 101 On Ramp FR Retaining Walls-Dated Nov 2012.		Our previous comments on the June 2012 submittal have been addressed satisfactorily.	Noted.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

Review Discipline:	Caltrans Geotechnical	By:	
Comments Due By:		**Date:**	September 6, 2012
Date Reviewed By:		**Next Meeting Date:**	

TECHNICAL COMMENT REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: Foundation Reports Structure Name: Broadway OC (Replace) Bridge No. 35-0351 Reports Updated: June 2012

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

AGCY	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
Caltrans Comment and Response Form									
General									
Caltrans -osfp geotech	Eduardo ortega	1		We have reviewed URS: Foundation Report Broadway Overcrossing (Bridge No. 35-0351) dated June 22, 2012. Foundation Report Southbound US 101 on-ramp (Bridge No. 35-0352K) dated June 25, 2012. Foundation Report Retaining Walls Nos. 15, 38, 39, 205, 209, 314, 315 and 316.	No comment.				
Broadway OC (Replace)									
		2		Our previous comments dated 3/20/12 were addressed satisfactorily. Based in our review, we have additional comments for this stage of the project:	No comment.				
		3		Section 4.2 states rotary wash drilling was used to advance the borings. But LOTBs shows auger drilling.	LOTBs have been revised.				
		4		Section 5.2.4: Borings by Caltrans conducted in 1970 and borings by others in 2002 were referenced in this section. Please include these as-built borings in the LOTB sheets.	As-built LOTB sheet from 1970 investigation of the existing southbound loop ramp has been included. However, boring logs from the 2002 investigations are not be included because the borings are more than 300 feet east of the replacement overcrossing structure.				

Review Discipline:	Caltrans Geotechnical	By:	
Comments Due By:		**Date:**	September 6, 2012
Date Reviewed By:		**Next Meeting Date:**	

TECHNICAL COMMENT REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: Foundation Reports Structure Name: Broadway OC (Replace) Bridge No. 35-0351 Reports Updated: June 2012

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

AGCY	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
		5		Section 10.2.1: • Table 10-2 has two columns both read Total Load Per Support under Service Limit State. Please correct the mistake. Please remove minus sign associated with the tension loads. • Please present foundation recommendations showing Required Factored Nominal Resistance and resistance factors used for each applicable limit state, and the design tips and specified tip elevations for each controlling case. Please refer to Memo To Designer 3-1 for details. • Table 10-3: The pile data presented here is not consistent with the data presented on the Plans (Sheet 6 of 32). • What is the estimated settlement under service load?	Table revised. Table of foundation recommendations has been added. Plans have been revised to be consistent with foundation report. Estimated settlement at both abutments and bent is approximately 0.1 inch.				
		6		Section 10.4, CDSM: Please specify horizontal extent of CDSM. Plans should show the extent of CDSM.	Figures 9A and 9B have been added showing the aerial extents of CDSM.				
		7		Please include soil profiles showing soil parameters used in the analyses.	Figure 7 has been added to show the soil profile and soil parameters used in the analyses.				

Review Discipline:	Caltrans Geotechnical	By:	
Comments Due By:		**Date:**	September 6, 2012
Date Reviewed By:		**Next Meeting Date:**	

TECHNICAL COMMENT REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: Foundation Reports Structure Name: Broadway OC (Replace) Bridge No. 35-0351 Reports Updated: June 2012

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

AGCY	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
		8		Piles may not be able to achieve the required capacity when driven to the specified tip elevation. If this happens during pile installation, piles should be allowed to set up for certain time and then re-struck. Please include appropriate statement accordingly.	The discussion about pile set up and re-strikes has been included in Section 10.3.				
		9		Add "(Replace)" to the bridge name on cover page.	Cover page has been updated as recommended.				
		10		LOTBs: Description of Borings R-11-014 and R-11-013 show values of UC, UU strength that are inconsistent with the lab results. Please check and correct. Please also check other LOTBs.	LOTBs have been revised.				

US101/BROADWAY INTERCHANGE RECONSTRUCTION PROJECT

PS&E Phase

Broadway On-Ramp (Bridge No. 35-0352K) Foundation Report

April 2, 2013

THE CITY OF BURLINGAME

SAN MATEO COUNTY Transportation Authority

Caltrans

URS

April 2, 2013
Project 28645286

File No. 04-SM-101-PM 16.3/17.1
EA 04-235844

Mr. Jim McKim
Project Manager
San Mateo County Transportation Authority
1250 San Carlos Avenue
San Carlos, CA 94070-1306

Subject: **Foundation Report**
Broadway On-Ramp
Caltrans Bridge No. 35-0352K
US101/Broadway Interchange Project
Burlingame, California

Dear Mr. McKim:

URS has completed a geotechnical investigation for the proposed on-ramp to southbound US101 at the Broadway Overcrossing as part of the US101/Broadway Interchange project in Burlingame, California. The report was prepared in accordance with Caltrans Guidelines for Foundation Investigation Reports, Version 2.0, dated December 2009.

The report presents our engineering opinions and recommendations regarding the geotechnical factors influencing the design and construction of the proposed bridge replacement. The opinions and recommendations have been based upon the results of our field investigation, laboratory testing, engineering judgment and local experience. Mr. Madhu Thummuluru, Senior Staff Engineer, Mr. Allen Moore, Project Geotechnical Engineer, and Ms. Anne-Marie Moore, Geotechnical Engineer, assisted with the preparation of this report. Mr. Mark Schmoll, Certified Engineering Geologist, prepared the site geology and geologic hazards portion of this report. Mr. Michael Larson, Senior Geotechnical Project Manager, provided peer review.

If any questions should arise, or if we can be of further service, please contact the undersigned at (408) 297-9585.

Sincerely,

REGISTERED PROFESSIONAL ENGINEER
STEPHEN HUANG
No. GE 002150
3/31/2014
GEOTECHNICAL
STATE OF CALIFORNIA

Stephen Huang, G.E. 2150
Geotechnical Task Leader

URS Corporation
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1.1 GENERAL

The proposed US101 Broadway Interchange project will replace the existing Broadway Overcrossing (Bridge No. 35-0096) with a wider structure, and reconfigure all northbound and southbound ramp connections to US101. In addition to the new overcrossing bridge, a new pile supported bridge (Bridge No. 35-0352K) will be constructed along a portion of the on-ramp to southbound US101, adjacent to the existing PG&E high voltage transmission towers, to reduce the potential for settlement of the existing towers due to new fill loads. The total length of the project is 0.75 mile. The purpose of the project is to reduce congestion, enhance safety, and improve performance of the interchange. It is also intended to relieve the weaving problems at the interchange by eliminating the collector-distributor roads and thus improving the traffic safety and operations.

A total of eight retaining walls are planned to minimize the right-of-way impacts to existing business properties and to support the ramp approaches and roadway embankments. The existing 6 x 6 feet double barrel box culvert at Easton Creek on the east side of northbound US 101 will be extended by approximately 50 feet to accommodate the construction of the new northbound US 101 on-ramps. The pedestrian overcrossing located approximately 50 feet south of the existing Broadway Overcrossing will remain. The new interchange will be constructed in several stages in order to keep traffic flowing.

Excessive settlement of the underlying mapped Bay Mud was identified as a major geotechnical and construction concern during the preliminary planning stages of the project, and the decision was made to use Cement Deep Soil Mixing (CDSM) ground improvement to reduce the magnitude of long-term settlement to tolerable levels. CDSM is currently proposed to a minimum depth of about 50 feet at the bridge abutments and in the vicinity of the PG&E transmission towers.

The subject of this foundation report (FR) is design and construction of the planned southbound US101 on-ramp bridge as part of the US101/Broadway Interchange Project in the City of Burlingame, California. The approximate location of the project site is shown on the Project Vicinity Map, Figure 1. The project alignment, including the location of the proposed bridge, is shown on the layout sheets included in Appendix A. Recommendations for other structures including the Broadway Overcrossing (replace), retaining walls, box culvert extension, and several overhead sign structures are presented in accompanying reports.

1.2 SCOPE OF INVESTIGATION

The geotechnical services provided for the Broadway Overcrossing (Replace) were as follows:

- Review existing subsurface information and as-built plans
- Geotechnical field investigation including two exploratory borings (R-11-015 and R-11-017) and one cone penetration tests (CPT-11-016). The locations of these explorations are shown on the Site and Exploration Location Plan, Figure 2.
- Laboratory testing to estimate pertinent engineering properties
    - Design recommendations and opinions were developed for the following topics:
- Pile foundation design recommendations

  - Vertical capacity
  - Tip elevations
- Resistance to lateral loads
- Pile foundation and approach fill settlement
- Abutment grading and approach fill construction, including effect on existing PG&E towers
- Earthquake information consistent with Caltrans Response Spectra Design Techniques
- Assessment of the potential for earthquake induced liquefaction, settlement, and lateral spreading
- Corrosion testing and analysis
- Address construction issues, including:
  - Earthwork for abutments and new bridge approaches
  - Installation of pile foundations, as applicable

This Foundation Report includes our observations of the site conditions, a summary of the subsurface conditions at the field exploration locations, and geotechnical laboratory test results. As part of the project, a soil corrosion evaluation was made by our subconsultant, V&A Consulting Engineers (V&A).

1.3 CALTRANS REVIEW COMMENTS

We reviewed comments prepared by Caltrans for the Southbound US 101 On-Ramp Foundation Report dated November 16, 2012. Our responses to these comments are incorporated into this report. Copies of the review comments and our responses are presented in Appendix K.

The proposed improvements to the US101/Broadway Interchange will include the construction of a new on-ramp to southbound US101. The portion of this on-ramp located about 3 to 6 feet laterally from the existing PG&E high voltage tower is to be a bridge structure to prevent surcharging, with resulting settlement, of the underlying compressible native clays that underlie the tower foundations. The bridge is to be approximately 80 feet long and supported on Class 90 precast prestressed (PCPS) concrete piles, vertical and batter. The proposed structure type will likely be a one-span cast-in-place reinforced concrete box girder. Bottom of pile cap is expected to be at Elevation 4.5 feet at the abutments and return walls (RW). Approach fills at the north end of the bridge will be supported by retaining walls RW15 and RW314, and approach fills at the south end of the bridge will be supported by retaining walls RW315 and RW316. Mechanically stabilized embankment (MSE) construction is currently planned for each of these retaining walls.

Approach fills are expected to be about 22 feet high at Abutment 1 and about 12 feet at Abutment 2. The ground surface at the base of the abutments will be relatively flat and match existing grade.

The new Broadway Overcrossing will be located approximately 100 feet to the north of the existing four-lane structure. The pedestrian overcrossing located approximately 50 feet south of the existing Broadway Overcrossing will remain. Most of the existing on-ramps and off-ramps will be realigned. In general, proposed ramps will have standard 12-foot-wide lanes and standard shoulders as required.

General Plans, No. 1 and No. 2, and the Foundation Plan for the southbound US101 on-ramp bridge (Broadway On-ramp) are included in Appendix A.

All project elevations reference NAVD88; stationing is based on NAD83.

The US101/Broadway Interchange is located on the western margin of the San Francisco Bay block within the central portion of the Coast Ranges geomorphic province of California. Northwest-southeast-trending valleys and ridges characterize the regional morphology of the Coast Ranges province. These topographic features are controlled by folds and faults that resulted from the collision of the Farallon and North American plates and subsequent predominantly strike-slip faulting along the San Andreas fault system between the Pacific and North American plates. The San Francisco Bay block is a relatively stable, seismic block bounded by the San Andreas and Hayward faults to the west and east, respectively.

The project site is located just east and northeast of the historic San Francisco bay margin. The historic tidal flats have been covered with artificial fill to create the present day topography. The artificial fill covers the majority of the project area and is mapped from about Rollins Road extending north to the edge of the bay (Witter, et al, 2006; Brabb, et al, 1998). A portion of the geology map covering the project area prepared by Brabb is included as Figure 3. Witter (2006) shows the artificial fill as being underlain by estuarine deposits (Bay Mud). South and southwest of Rollins Road, Quaternary deposits exposed at the surface are mapped by Witter (2006) as Holocene (less than 10,000 years old) alluvial fan deposits consisting of sand, silt and clayey silt, underlain by older Pleistocene alluvial fan and fluvial deposits consisting of gravel, sand and silt. Mapping by Brabb, (1998) classifies the deposits south of Rollins Road as the Pleistocene age Colma Formation consisting of fine to medium-grained sand with silt and clay. Bedrock consisting of Franciscan Complex sandstone outcrops are approximately 1 mile south of the site. The depth to bedrock at the site is unknown; however bedrock is at a depth of 270 feet at the west end of the San Mateo Bridge (Goldman, 1969) and is estimated to be in the range of 150 to 200 feet deep at the project site.

4.1 GENERAL

Prior to the start of drilling, boring and cone penetration test (CPT) locations were checked for conflict with underground utilities by contacting Underground Service Alert (USA) Network and a private utility locator. URS obtained drilling permits from the San Mateo County Department of Environmental Health. All explorations were backfilled with cement grout as required.

The locations of the borings and CPT advanced during this study are shown on Figure 2.

4.2 EXPLORATORY BORINGS

Truck-mounted rotary wash drilling equipment was used to advance two borings in the vicinity of the proposed bridge to depths of 81.5 and 101.5 feet between October 3 and 4, 2011. Samples of the soil encountered in the exploratory borings were collected with either a modified California sampler (1.96-inch inside diameter)), a standard split spoon sampler (1.38-inch inside diameter) or thin walled Shelby tube (2.97-inch inside diameter). The split spoon and modified California samplers were driven 18 inches into the soil with a 140 pound hammer free falling 30 inches, with blow counts being recorded for the last 12 inches of driving. When very dense or hard materials were encountered and the blow count exceeded 50 blows per 6 inches, refusal criteria were met. The amount of penetration was recorded along with the blow count. Shelby tubes were hydraulically pushed into the soil; the pressure required to push the sampler 30 inches was recorded on the boring log.

After the sampler was advanced to the desired depth, it was withdrawn from the borehole. The exposed soil was examined, classified, and the brass liners containing the samples were sealed to preserve the natural moisture. The samples were taken to our geotechnical laboratory for further examination and testing.

A representative of URS observed the drilling operations and soil sampling. Visual classifications of the soils encountered were made from cuttings and soil samples. The soil samples collected from the borings were sealed and labeled immediately to preserve their natural moisture content.

The Unified Soil Classification System, as well as guidelines summarizing soil consistency and relative density, are presented on the LOTB legend. The logging method is consistent with guidelines presented in Caltrans Soil & Rock Logging, Classification, and Presentation Manual, dated 2010. The LOTBs presented in Appendix B also illustrate the notation used for the size of samplers and the methods of advancing them.

4.3 LABORATORY TESTING

Soil classifications made in the field were verified in the laboratory after further examination and testing. Laboratory tests were performed on selected soil samples. These tests include grain size distribution and unconfined compressive strength. The results of these tests are presented at the corresponding sample locations on the LOTBs included in Appendix B.

Plasticity index (PI), water content, and dry unit weight were determined for selected samples from the borings; the results of these tests are presented in Appendix C. One dimensional

consolidation and unconsolidated undrained triaxal compression tests were performed on relatively undisturbed samples retrieved from our borings. The results of these tests are presented graphically in Appendix C.

4.4 CONE PENETRATION TESTS (CPTS)

CPT exploration consists of pushing a cone-tipped probe into the soil while simultaneously recording the cone tip resistance and side friction resistance to penetration. One CPT completed for this report was conducted on September 28, 2011, in general accordance with ASTM specifications (ASTM D3441-98) using an electric cone penetrometer. The CPT extended to a depth of 100 feet.

The CPT equipment consists of a cone assembly mounted at the end of a series of hollow rods. A set of hydraulic rams is used to push the cone and rods into the soil while a continuous record of cone and friction resistance versus depth is obtained in both analog and digital form at the ground surface. A specially designed all-wheel drive truck is used to transport and house the test equipment and to provide a 20-ton reaction to the thrust of the hydraulic rams.

The cone penetrometer assembly consists of a conical tip and a cylindrical friction sleeve. The conical tip has a 60-degree apex angle and a projected cross-sectional area of 2.3 in^2. The cylindrical friction sleeve has a surface area of 35 in^2. Both the conical tip and cylindrical friction sleeve have outer diameters of 1.75 inches. The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurement of cone tip and friction sleeve resistance during penetration. Continuous electric signals from the strain gauges are transmitted by a cable in the rods to analog and digital data recorders in the CPT truck.

Data obtained during a CPT consists of continuous stratigraphic information with close vertical resolution. Stratigraphic interpretation is based on relationships between cone tip resistance and friction resistance. The calculated friction ratio (CPT friction sleeve resistance divided by cone tip resistance) is used as an indicator of soil type. Granular soils typically have low friction ratios and high cone resistance, while cohesive or organic soils have high friction ratios and low cone resistance. These stratigraphic material categories form the basis for all subsequent calculations that utilize the CPT data. Soil interpretation presented on the CPT logs from this investigation was based on correlations developed by Robertson, 1990. CPT logs are presented on the LOTBs in Appendix B.

4.5 PORE PRESSURE DISSIPATION AND SHEAR WAVE VELOCITY TEST RESULTS FROM CPTS

Pore pressure dissipation tests were performed at CPT-11-016 to provide an estimate of the groundwater depth. Shear wave velocity tests were also performed at selected depths at CPT-11-016. The results of the pore pressure dissipation tests are presented on the LOTBs included in Appendix B and summarized on figures included in Appendix D. The results of shear wave velocity tests are shown graphically at the corresponding average test depths in Appendix D.

5.1 SITE TOPOGRAPHY AND SURFACE CONDITIONS

The project site is located in the City of Burlingame adjacent to and southwest of San Francisco Bay. The northeast side of the project where the new overpass will connect to Airport Boulevard lies next to the edge of the bay, and the southwest side of the project near the intersection of Broadway and Carolan Avenue is up to 1,200 feet south of the edge of the bay. The majority of the project lies northeast (offshore) of the historic limits of the shoreline of San Francisco Bay. Except for the elevated bridge embankments for the existing Broadway Overcrossing of US101, the ground surface is relatively flat, ranging in elevation from about 8 to 14 feet. The elevated bridge embankments range up to about Elevation 22 feet. Development at the project site includes the freeway, the Broadway Overcrossing, a pedestrian overcrossing, on-ramps, off-ramps, and channelization of Easton and Sanchez Creeks. Bayside Park, hotels and a gas station are located northeast of the freeway, and a PG&E substation, a gas station, businesses and an apartment complex lie southwest of the freeway. Vegetation within the on-ramp/off-ramp loops includes grasses, shrubs and a few mature trees.

There are three existing PG&E towers located just north of the existing Broadway Overcrossing western approach. Tower 1 is the northernmost tower and located closest to proposed southbound US101 on-ramp. The towers consist of metal cross braces connected to four tapered metal legs with base widths of 22 feet. Based on available plans, we understand that each tapered tower leg is supported on a concrete spread footing extending to a depth of about 15 feet below ground surface (bgs).

5.2 SUBSURFACE CONDITIONS

5.2.1 Field Exploration

Subsurface data collected for design of the Broadway Overcrossing Widen circa 1970 included three borings, B-1, B-2, and B-3, which extended to depths ranging from approximately 20 to 90 feet below ground surface (bgs). The as-built LOTB sheet prepared for the 1970 subsurface investigation is included in Appendix E.

URS drilled two rotary wash borings (R-11-015 and R-11-017), and advanced one CPT (CPT-11-016) to characterize conditions at the proposed bridge abutments. The borings were advanced to depths of 81.5 and 101.5 feet, and the CPT was advanced to a depth of 100 feet. The field exploration was performed between September 28 and October 4, 2011.

The locations of the borings and CPT are shown on Figure 2. The Log of Test Borings (LOTBs) presented in Appendix B provide detailed descriptions of the soils encountered.

5.2.2 Fills

Borings B-1, B-2, and B-3 from the 1970 investigation reportedly encountered 5 to 7 feet of fill consisting of very loose to slightly compact silty sand and sandy silt, and very soft sandy clay.

Boring R-11-015 encountered silty sand with gravel fill to a depth of 4 feet (Elevation 6.5 feet). Boring R-11-017 encountered silty clay fill to a depth of about 4 feet (Elevation 7 feet).

The consistency and make up of the fill were not evaluated at CPT-11-016 since the upper 8 feet of the exploration was hand augered to minimize the potential of damaging existing utilities.

5.2.3 Native Soils

Very soft and highly compressible organic fat clay, known locally as Bay Mud, was encountered below the fill in Boring R-11-015 to a depth of about 12 feet bgs (Elevation -1.5 feet). The Bay Mud is immediately underlain by stiff lean clay to a depth of about 16 feet and loose clayey sand and sandy silt to a depth of about 21 feet. Below the loose granular soils, the boring encountered medium stiff lean clay to a depth of about 26 feet, underlain by medium dense poorly graded sand to a depth of 27 feet. Stiff fat clay was encountered below the sand to a depth of about 39 feet, underlain by medium dense silty and clayey sand with gravel and silty gravel to a depth of about 44 feet. Below a depth of about 44 feet, the soil profile remains interbedded, consisting of alternating layers of medium dense to dense silty, clayey and poorly graded sand, very dense clayey gravel and medium stiff to very stiff lean and fat clay to the bottom of the boring at 81.5 feet bgs (Elevation -71 feet).

Bay Mud was encountered in Boring R-11-017 at depths of about 4 to 13 feet (Elevation 7 to -2 feet). Below the Bay Mud, this boring encountered predominantly medium stiff to very stiff lean clays with occasional interbeds of clayey sand and silty gravel to the maximum depth explored.

The record for CPT-11-016 suggests a predominantly fine-grained soil profile with Bay Mud likely extending to a depth of about 14 feet (Elevation -3 feet) and soft highly compressible fat clay between depths of about 23 to 28 feet (Elevation -12 to -17 feet). The CPT record also suggests the presence of sand and silty sand interbeds between depths of about 15 and 23 feet and between depths of about 75 and 81 feet.

The borings drilled in 1970 indicate that the thickness of the Bay Mud ranges from about 2 feet to as much as 14 feet and consists of soft to very soft, dark gray to black organic clay with peat layers and occasional shells and thin sand interbeds. Alluvium underlying the Bay Mud consisted of complexly interbedded medium dense to dense silty to clayey sand and silt and soft to very stiff lean clay. Fine to medium gravel interbeds were also common throughout the alluvium.

5.2.4 Groundwater

Free groundwater was first encountered at a depth of 12.5 feet (Elevation -2 feet) in Boring R-11-015 and at a depth of 14.5 feet (Elevation -3 feet) in Boring R-11-017. A final or stabilized groundwater level reading was not taken in either of these borings.

A pore pressure dissipation test performed at CPT-11-016 suggests groundwater at a depth of about 0.5 foot (Elevation 10.5 feet). Test results are included in Appendix D.

Free groundwater was reportedly encountered in Boring B-1 from the 1970 study at a depth of about 4 feet (Elevation 8.1 feet, datum not specified).

In cohesive soils, as generally encountered at the site, a fairly long time would be required for the groundwater to seep into the borehole and attain an equilibrium position with the long-term

hydrostatic groundwater table. Thus, the immediate readings obtained may or may not be representative of the actual groundwater table level.

Groundwater levels at the site are likely influenced by tidal fluctuations in the nearby San Francisco Bay, and by water levels in nearby Sanchez Creek and Easton Creek. In addition, seasonal fluctuations in the groundwater level should be anticipated throughout the year with variations in precipitation, evaporation, and surface runoff.

6.1 REGIONAL TECTONIC SETTING AND SEISMICITY

The project alignment lies between known active and potentially active geologic faults. In general, earthquakes occur as a result of movement along active faults. For the purpose of activity classification, faults are generally grouped into the following categories by the California Division of Mines and Geology (renamed the California Geological Survey, CGS) (Jennings, 1994):

- Holocene: displacement has occurred within the last 10,000 to 11,000 years.
- Late Quaternary: displacement has occurred within the last 700,000 years, but evidence of Holocene activity is lacking.
- Quaternary: evidence of displacement within the last 1.6 million years, but evidence of Holocene activity is lacking.
- Pre-quaternary: no recognized evidence of displacement in the last 1.6 million years.

Generally, faults with Holocene movement are considered to be "active" while faults with late Quaternary to Quaternary movement are considered to be "potentially active".

The closest active faults to the project site are the San Andreas, San Gregorio-Palo Colorado, Hayward and Monte Vista faults (Mualchin, 1996). The California Geological Survey (2000) has produced maps showing Alquist-Priolo Earthquake Fault Zones along faults with known Holocene activity that pose a potential surface faulting hazard. The Hayward, San Andreas and onshore section of the San Gregorio-Palo Colorado fault are included as Alquist-Priolo (A-P) zoned faults. The San Andreas fault is the closest fault, located about 2.5 miles west of the project site. The San Gregorio-Palo Colorado fault is located about 9.5 miles southwest of the site and the Hayward fault is located about 16 miles northeast of the site. The Monte Vista fault (west branch) is located about 14 miles southeast of the site. More distant active faults include the Calaveras fault and Greenville faults located 24.5 miles and 34 miles northeast of the site, respectively. Figure 4 shows active faults within the site region relative to the project. The project alignment does not cross any mapped A-P zoned faults.

The following are brief descriptions of the nearby active faults.

6.1.1 San Andreas Fault Zone

The dominant active fault structure in this region is the San Andreas fault. The fault extends from the Gulf of California, Mexico, to Point Delgada on the Mendocino Coast in northern California, a total distance of 746 miles. The San Andreas fault accommodates the majority of the motion between the Pacific and North American plates. This fault is the largest active fault in California and is responsible for the largest known earthquake in Northern California, the 1906 **M** 7.9 San Francisco earthquake (Wallace, 1990). Movement on the San Andreas fault is right-lateral strike-slip, with a total offset of some 348 miles (Irwin, 1990). In northern California, the San Andreas fault is clearly delineated, striking northwest, approximately parallel to the vector of plate motion between the Pacific and North American plates. Over most of its length, the San Andreas fault is a relatively simple, linear fault trace. Immediately south of the Bay, however, the fault splits into a number of branch faults or splays, including the Calaveras

and Hayward faults. In the Bay Area, the main trace of the San Andreas fault forms a linear depression along the Peninsula, occupied by the Crystal Springs and San Andreas Lake reservoirs. The 1906 earthquake resulted from rupture of the fault from San Juan Bautista north to Point Delgada, a distance of approximately 295 miles. The average amount of slip on the fault during this earthquake was 16.7 feet in the area to the north of the Golden Gate and 8.2 feet in the Santa Cruz Mountains (WGNCEP, 1996). The California Seismic Hazards Map (Mualchin, 1996) assigns a maximum credible earthquake magnitude of 8.0 for the San Andreas fault (North Coast segment).

6.1.2 San Gregorio-Palo Colorado Fault Zone

This northwest-striking fault is the principal active fault west of the San Andreas fault in the coastal region of central California. The fault extends from just offshore of Point Sur, northward to Bolinas Lagoon, where it merges with the North Coast segment of the San Andreas fault. The majority of the fault is located offshore, with only two short sections, at Seal Cove and Moss Beach, occurring on land. Because of the limited onshore extent of the fault, the fault is relatively poorly understood. Jennings (1994) shows the fault as two distinct segments, separated by a prominent step in Monterey Bay. Simpson *et al.* (1997) carried out one of the few paleoseismic investigations along the fault. They demonstrated late Holocene right-lateral movement on the Seal Cove section of the fault. The most recent surface faulting event on the fault occurred sometime after A.D. 1270 to A.D. 1400, but prior to 1775. Mualchin (1996) assigns a maximum credible earthquake magnitude of 7.5 for the San Gregorio-Palo Colorado fault.

6.1.3 Hayward Fault

The Hayward fault extends for 62 miles from the area of Mount Misery, east of San Jose, to Point Pinole on San Pablo Bay. At Point Pinole, the Hayward fault runs into San Pablo Bay. The northern continuation of this fault system is the Rodgers Creek fault. The two faults are separated by a 3 miles wide right step beneath San Pablo Bay. Systematic right-lateral geomorphic offsets and creep offset of cultural features have been well documented along the entire length of the fault (Lienkaemper, 1992). The last major earthquake on the Hayward fault, in October 1868, occurred along the southern segment of the fault. This M6.8 event caused toppling of buildings in Hayward and other localities within about 3 miles of the fault. The surface rupture associated with this earthquake is thought to have extended for approximately 19 miles, from Warm Springs to San Leandro, with a maximum reported displacement of 3.3 feet. The Hayward fault is considered the most likely source of the next major earthquake in the Bay Area (WGCEP, 1999). As well as undergoing displacement earthquake ruptures, the Hayward fault also moves by aseismic creep. Measurements along the fault over the last two decades show that the creep rate is 0.2 to 0.35 inch/year (Lienkaemper and Galehouse, 1997). Mualchin (1996) assigns a maximum credible earthquake magnitude of 7.5 for the Hayward fault.

6.1.4 Monte Vista Fault

The 34 mile long Monte Vista fault is one of the primary range-front faults and probably the most extensively studied fault in the Foothills thrust belt. The exposed fault strikes northwest and places Jurassic Franciscan Complex rocks, Miocene Santa Clara Formation, and Pleistocene alluvium over Pleistocene and older strata. To the south, the fault merges with the Shannon fault, while at its northern end it intersects the San Andreas, via the Hermit fault, between Woodside and Redwood City. Limited exploratory trenching indicates that the Monte Vista fault has had late Quaternary and possibly Holocene displacement. Recent geomorphic mapping by Hitchcock et al. (1994) shows that late Pleistocene fluvial terraces flanking Stevens Creek are deformed. The style of late Quaternary deformation affecting these terrace surfaces is consistent with reverse faulting on the Monte Vista fault. Hitchcock and Kelson (1999) estimated an average late Pleistocene slip rate of 0.007 ± 0.004 inch/year for the Monte Vista fault. Mualchin (1996) assigns a maximum credible earthquake magnitude of 6.5 for the Monte Vista fault (west branch).

6.2 GEOLOGIC HAZARDS

6.2.1 Fault-Related Ground Rupture

Surface fault rupture tends to recur along existing fault traces. The highest potential for surface faulting is along existing fault traces that have had Holocene fault displacement. The California Geological Survey (formerly Division of Mines and Geology) has produced maps showing Alquist-Priolo Earthquake Fault Zones along faults with known Holocene activity that pose a potential surface faulting hazard. There are no Alquist-Priolo zones mapped in the vicinity of the project site. The closest active fault to the site is the San Andreas fault, approximately 2.5 miles to the west; therefore, the potential for surface fault rupture at the site is considered remote.

6.2.2 Liquefaction Potential

Soil liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. In extreme cases, the soil particles can be suspended in groundwater, resulting in the deposit becoming mobile and fluid-like. Three conditions are generally required for liquefaction to occur: 1) a cohesionless soil of loose to medium dense relative density; 2) a saturated condition; and 3) rapid, large strain cyclic loading normally induced by earthquake ground shaking. Liquefaction can result in loss of foundation bearing capacity, differential settlements, and lateral spreading. Traditionally, a depth of 50 feet has been used as the depth of analysis for the evaluation of liquefaction.

In a regional study of the nine-county San Francisco Bay region for the U.S. Geological Survey, Witter et al. (2006) mapped the liquefaction susceptibility of the site soils in the project vicinity. The artificial fill overlying the Bay Mud found at the site is mapped as having “very high” liquefaction susceptibility. The Association of Bay Area Governments (ABAG, 2004) has also published a liquefaction susceptibility map based on mapping in the USGS Open File Report 00-444 by Knudsen et al (2000). The map also

shows the project site as having "very high" liquefaction susceptibility. A copy of this map is included as Figure 5.

Potentially liquefiable deposits were encountered in many of the recent borings, ranging in thickness from about 1 to 4.5 feet. We estimated post-liquefaction ground surface settlement for a peak ground acceleration (PGA) of 0.68g and design earthquake moment magnitude, M_{MAX}, of 7.9; a discussion of PGA and design earthquake magnitude is presented in more detail in Section 8 of this report. The measured driving resistance (blow counts) in the field were corrected for hammer type, sampler size, overburden pressure, rod length, and fines content. We assumed groundwater depths of 3½ to 7 feet below top of boring (corresponding to about Elevation 6 feet). Copies of these calculations are included in Appendix E. Results are summarized in the following table.

Table 6-1: Estimated Post-Liquefaction Ground Surface Settlement at Boring

Boring Number	Material Type (USCS)	Depth to Top of Layer (feet)	Layer Thickness (feet)	Estimated Ground Surface Settlement (inches)
R-11-015	ML	19	2	¾
R-11-015	SP-SM	26	1	¼

Potentially liquefiable materials appear to have been encountered in Borings B-1 and B-3 drilled for the 1970 study. Based on those boring logs, the deposits include approximately 3 to 5 feet of loose to very loose and slightly compact silty sand and sandy silt in the upper 3 to 8 feet and approximately 5 feet of slightly compact silty sand between depths of about 40 and 45 feet. Because the hammer efficiency was not included on the as-built LOTBs, we are not able to estimate the magnitude of post-liquefaction settlement that could be expected to occur at these boring locations.

We estimated post-liquefaction settlement at CPT-11-016 using the computer program LIQUEFY PRO for the same PGA, design earthquake, and groundwater depth. At CPT-11-016, the potentially liquefiable deposits were encountered between depths of about 17 to 22 feet. Copies of these calculations are included in Appendix F. Results are summarized in the following table.

Table 6-2: Estimated Post-Liquefaction Ground Surface Settlement at CPT

CPT Number	Estimated Ground Surface Settlement (inches)
CPT-11-016	½

Based on our analysis, the estimated ground surface settlement at the Broadway On-ramp bridge could be on the order of ½- to 1-inch.

6.2.3 Consolidation Settlement

Settlement occurs when soil is loaded by a structure or embankment fill placed on top of the soil. This settlement can occur quickly in unsaturated and free-draining soils, and it can occur gradually when pore pressures in saturated soils, increased by vertical loading, gradually dissipate over time.

The Bay Mud and fat clays that underlie the site are very soft to medium stiff, have moderate to high compressibilities, and are normally to slightly overconsolidated. On this basis, we expect that settlement of these clays under the weight of the proposed embankment fills, ranging to 22 feet high, will be excessive, up to 17 inches beneath the tallest approach fills and up to about 7 inches at the abutments.

Since the native clays have low to very low permeabilities, the total estimated settlements will not be realized during a reasonable construction period without implementation of a surcharge program with wick drains. Based on results of laboratory consolidation testing, we estimate that the settlement period to reach 90 to 95% consolidation of the Bay Mud and underlying fat clays would be about 3 to 4 years.

We anticipate that this settlement period could be shortened to 8 to 12 months with surcharging and wickdrains, however consideration would need to be given to the potential adverse affects of surcharge loads and resulting settlement on existing nearby structures and underground utilities which are to remain.

Alternatively, the strength and compressibility characteristics of these underlying clays can be improved with the use of cement deep soil mixing (CDSM) or equivalent, or the magnitudes of the predicted settlements could be reduced to tolerable amounts by using a very lightweight embankment fill alternative such as expanded polystyrene (EPS) blocks.

6.2.4 Subsidence and Seismic Compaction

Subsidence typically occurs as a result of subsurface fluid extraction (e.g. groundwater, petroleum) or compression of soft, geologically young sediments. Groundwater extraction for high volume municipal and agricultural use has the potential to cause future ground subsidence in the region. However, we are not aware of subsidence in the area. No active petroleum wells are present within many miles of the site (California Division of Oil, Gas and Geothermal Resources, 2001).

Compaction settlement, or seismic densification, occurs when loose granular soils above the water table increase in density as a result of earthquake shaking. The soil densification can result in differential settlement because of variations in soil composition, thickness, and initial density. Occasional layers of granular soil were encountered within the unsaturated fills. These granular deposits may be subject to cyclic densification during strong ground shaking, resulting in compaction settlement. Since CDSM treatment is planned at both abutments, settlement due to seismic compaction of the granular fills is not anticipated.

6.2.5 Landslide and Lateral Spreading

US101 is located on relatively flat ground along the project alignment and is not subject to landsliding; therefore, landsliding is not a potential hazard.

Liquefaction induced lateral spreading occurs on gentle slopes underlain by loose sands and shallow groundwater. When liquefaction occurs, the unsaturated overburden can slide as intact blocks over the lower liquefied deposit. Surface displacements proceed downslope or toward a steep free face, such as a stream bank, with the formation of fissures and scarps. The geologic conditions conducive to lateral spreading are frequently found along streams and other waterfronts in recent alluvial or deltaic deposits as well as loosely placed, saturated sandy fills (Youd and Hoose, 1976).

As discussed in the liquefaction section of this report, pockets of potentially liquefiable fill were encountered at several of the exploration locations; in addition, potentially liquefiable native sands were identified below the Bay Mud at several exploration locations. Therefore, in our opinion, liquefaction induced lateral spreading is a potential hazard at the site.

The U.S. Geological Survey published a map with digitized locations of historic post-earthquake ground effects (Youd and Hoose, 1978, and Tinsley and others, 1998); this data is shown on the geologic map in USGS Open File Report 00-444 by Knudsen et al (2000). Based on review of these digitized locations, no historic failures have been documented at the project site, but sand boils were noted at a location about one mile east of the site following the Loma Prieta earthquake in 1989. In addition, settlement and ground cracking were noted about one mile northwest of the site following the 1906 earthquake.

Use of CDSM or equivalent extending through the potentially liquefiable soils across the project area would, in our opinion, reduce the potential for lateral spreading to affect new structures, pavements and underground utilities at the site.

6.2.6 Scour

Because the proposed overcrossing structure is to be located outside waterways, scour is not an issue for foundation design.

6.2.7 Flooding

The project site is located within the FEMA 100-year flood zone (Zone A) as shown on the ABAG flood hazard map (2007). A copy of the ABAG flood hazard map is included as Figure 6.

Floodplain information on the project area is discussed in more detail in the Project Location Hydraulic Study Report (WRECO, 2011). The study identifies three areas of flooding potential as discussed below.

The most problematic flooding is in the vicinity of the northeastern landing of the Broadway Overcrossing. The source of this flooding is the relatively high tailwater elevation in the unlined channel northeast of the corner of Airport Boulevard and Bayshore Highway. The outfall from the storm drain system draining the flooded area is buried under the channel bottom. The

combination of the high tailwater elevation in the channel relative to the storm drain system and the buried outfall prevents adequate conveyance, which results in water frequently ponding in the vicinity of the intersection of Bayshore Highway and Airport Boulevard.

Another area believed to experience flooding due to high tides is between the Crowne Plaza Hotel parking lot and the northbound US101 off-ramp to Airport Boulevard.

A third area subject to flooding is where overbank flow from Easton Creek has historically flooded an area between Bayshore Highway and the on-ramp from Bayshore Highway to northbound US101. The Project has no impacts on the existing floodplains.

6.3 GEOLOGICAL PROFILES AND ENGINEERING PARAMETERS

The LOTBs presented in Appendix B include borings from previous investigations, and current field information and laboratory testing from our recent exploration at the proposed foundation support locations. Geotechnical engineering soil parameters used in our analyses were selected based on laboratory test results as well as engineering judgment and experience.

The undrained shear strength, internal friction angle (for granular soil), relative density, dry unit weight and moisture content are the geotechnical soil parameters used in our foundation design and analysis. Atterberg limits and particle size analysis tests were performed for classification of soils and to assess liquefaction potential. In general, unconfined compression strength tests were performed on cohesive soil samples to estimate the undrained shear strength. Some disturbance may occur while sampling cohesive soils; therefore unconfined compressive strengths in localized areas can be lower than the insitu field conditions. Consequently, engineering judgment and experience were applied in our interpretation of the laboratory test results. The relative density of cohesionless soils was estimated from vertical effective stress and Standard Penetration Resistance, N (blows per foot) based on correlations developed by Gibbs and Holtz (DM7.1 – 87, 1986). Where non-standard sampler sizes were used, such as the modified California sampler (2½ inch outside diameter), a correction factor was applied to the observed blows per foot to estimate the Standard Penetration resistance.

A generalized soil profile is presented in Figure 7 illustrating the layering of the various soil strata and summarizing the corresponding geotechnical parameters. It should be noted that this profile was developed based on extrapolation of available data from the borings drilled for this investigation and previous explorations by others and, therefore, may differ from actual conditions.

7.1 CORROSION EVALUATION

An assessment of the potential for corrosion of various buried foundation and pipe structures for the US101/Broadway Interchange project was performed by V&A. The results of their investigation are presented in Appendix G, and summarized below.

7.2 SUMMARY

V&A was retained by URS Corporation to perform a soil corrosivity investigation for the proposed US101/Broadway Interchange Replacement Project in the City of Burlingame, San Mateo County. The objective of this investigation was to provide recommendations for corrosion control of structural foundation materials under consideration for the proposed reinforced concrete box girder bridge adjacent to the existing PG&E high voltage towers. The structures being considered as part of this investigation are buried reinforced concrete structures and driven concrete piles.

The investigation was conducted in accordance with California Department of Transportation's Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch *Corrosion Guidelines*, Version 1.0, dated September 2003. These Guidelines consider representative soil or water samples to be corrosive to metallic or reinforced concrete structural elements if one or more of the following conditions exist:

1) The chloride concentration is 500 parts per million (ppm) or greater and/or
2) The sulfate concentration is 2,000 ppm or greater and/or
3) The pH is 5.5 or less.

Evaluation of the soil environment was made in terms of potential corrosion damage to buried metal and reinforced concrete structures. Soil resistivity measurements were conducted by V&A in the field during the initial stages of the work. Soil resistivity was determined to a depth of 15 feet at the three PG&E high voltage towers and to a depth of 100 feet below grade at the proposed Broadway overcrossing bridge abutment sites. In addition, fourteen soil samples taken during the geotechnical investigation by URS were sent to Cooper Testing Laboratory in Palo Alto, California, for chemical analysis. The soil samples were analyzed for as received and minimum (saturated) resistivity, pH, and water-soluble chloride and sulfate ion concentrations. All of these chemical properties affect the corrosion rate of buried reinforced concrete structures. The results of the analyses for three samples collected within 75 feet of the PG&E towers are summarized in the following table.

Table 7-1: Soil Corrosion Test Results Summary

Sample ID	Depth (ft)	Minimum Resistivity[1] (ohm-cm)	pH[2]	Chloride Content[3] (mg/kg)	Sulfate Content[4] (mg/kg)
R-11-014-1	5-6.5	1,328	7.6	181	8
R-11-017-1-2	5-7	561	7.7	451	272
R-11-018-2-2	10-11.5	131	8.0	4,965	786

The following information is provided as reference for the preceding Table 7-1:
1. Minimum resistivity by Caltrans Method 643
2. pH by Caltrans Method 643
3. Chloride by Caltrans Method 422-modified
4. Sulfate by Caltrans Method 417-modified

As shown in the preceding table, the three soil samples taken from URS boreholes R-11-014, R-11-017 and R-11-018 and analyzed at Cooper Testing Laboratory had minimum (saturated) resistivities that range from 131 to 1,328 ohm-cm. The soil pH values varied from 7.6 to 8.0. Water-soluble chlorides range from 181 to 4,965 mg/kg (ppm), and the water-soluble sulfate concentrations range from 8 to 786 mg/kg (ppm). The sample collected from R-11-018 is considered corrosive to buried reinforced concrete structures based on the chloride content. The other samples are non-corrosive to buried reinforced concrete structures as defined by the Caltrans *Corrosion Guidelines*.

7.3 CONCLUSIONS

- Three soil samples were taken within about 75 feet of the proposed box girder structure near the PG&E tower foundations at the Broadway On-ramp. Of these three, one sample taken from R-11-018-2-2 had a water-soluable chloride content of 4,965 mg/kg (ppm), which is considered corrosive to buried reinforced concrete structures per the Caltrans *Corrosion Guidelines*.
- The project site is located within 1,000 feet of salt water or brackish water.

7.4 RECOMMENDATIONS

7.4.1 General

Corrosion protection against a marine atmosphere is required by the *Corrosion Guidelines* for above-ground reinforced concrete structures at the proposed bridge location. Design of structures installed at this location should include corrosion mitigation measures as detailed below.

7.4.2 Buried Reinforced Concrete Structures and Driven Concrete Piles

Buried concrete structures and driven reinforced concrete piles should be constructed of durable concrete as described in ACI Standards 201.2R and 222R and Chapter 850.3, “Corrosion,” of the Caltrans *Highway Design Manual* (last updated September 28, 2011). Criteria for protecting reinforced concrete structures under corrosive conditions discussed in Caltrans Standard Special Provision (SSP) S8-C04, “Corrosion Control for Portland Cement Concrete” (a modification of Bridge Design Specifications, Section 8, “Reinforced Concrete”), should be followed. These recommendations include, but are not limited to, the following for reinforced concrete in corrosive soil:

- The following concrete compositional requiremets are recommended per the Caltrans Standard specifications updated July 28, 2011, Section 90-1.02H, "Concrete in Corrosive Environments":
  - The cementitious material used in the concrete must be a combination of Type II or Type V Portland cement and SCM (supplementary cementitious materials).
  - The concrete must contain at least 675 pounds of cementitious material per cubic yard.
  - The reduction of cementitious material content specified in Section 90-1.02E (2) is not allowed.
  - The specifications for SCM content in Section 90-1.02B (3) do not apply.
  - The cementitious material must be composed of one of the following by weight:
    - 25% natural pozzolan or fly ash with a CaO content of up to 10%, and 75% Portland cement,
    - 20% natural pozzolan or fly ash with a CaO content of up to 10%, 5% silica fume, and 75% Portland cement,
    - 12% silica fume, metakaolin, or UFFA (ultra-fine fly ash) and 88% Portland cement,
    - 50% GGBFS (ground granular blast furnace slag) and 50% Portland cement.
  - ♦ A maximum water-to-cementitious material ratio of 0.40 should be used in the concrete.
- Concrete sealant (silane) should not be allowed as an option for concrete in a corrosive environment.
- A minimum concrete cover of 3 inches for a 50-year design life, and 4 inches for a 75-year design life, should be applied over all steel reinforcement. This is based on a soil water-soluble chloride concentration of 5,000 to 10,000 mg/kg (ppm) for buried reinforced concrete above the groundwater table. This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete Cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.
- Sand and water used in concrete mixtures should contain a maximum of 100 mg/kg (ppm) of water-soluble chloride ions and water-soluble sulfate ions. Sand and water pH should be between 6.5 and 8.0. Potable water should be used in all concrete mixtures.

7.4.3 Reinforced Concrete Exposed to Marine Atmosphere

- Above-ground reinforced concrete structures within 1,000 feet of brackish or salt water are exposed to a corrosive marine atmosphere. The following minimum concrete cover over unprotected reinforcing steel is recommended for the concrete structures listed below:
  - 3 inches concrete cover for the following:
    - Footings and pile caps
    - Walls, columns, and cast-in-place piles

    - Cast-in-place “I” and “T” girders, box-girder webs, bent caps, diaphragms, and hinged joints
  - 2.5 inches of concrete cover for the top surface of deck slabs
  - 2 inches of concrete cover for the precast piles and pile extensions
  - 1.5 inches concrete cover for the following:
    - Bottom surface of deck slab
    - Box-girder bottom slabs
- This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, “Minimum Concrete cover for 75-Year Design Life”; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.

8.1 RESOURCES

The seismic design methodology adopted for this project is based on Caltrans Seismic Design Criteria (SDC), v 1.6, November 2010.

8.2 PEAK BEDROCK ACCELERATION

The closest active fault to this section of US101 is the San Andreas fault (SAN). This fault is designated with a Maximum Magnitude (M_{Max}) of 7.9 in the Caltrans 2007 fault database. The location of this fault is based on Caltrans ARS Online (2009). The horizontal distance from the site to the San Andreas fault is about 2.5 miles.

Table 8-1: Seismic Source Parameters

Fault	Type	M_{Max}	Distance* (miles)	Near Field Effects?
San Andreas (north coast segment)	strike-slip	7.9	2.5	Yes
San Gregario-Palo Colorado	strike-slip	7.2	9.5	No
Hayward (northern section)	strike-slip	7.3	16.0	No
Monte Vista-Shannon	reverse	6.7	14.0	No

*The distances are based on Caltrans ARS Online (2009).

Figure 4 shows the locations of these faults relative to the project site.

For design, a site PGA of 0.68 g was estimated using Caltrans ARS Online tool; this value of PGA corresponds to a site specific average shear wave velocity of 820 feet per second (fps).

8.3 FAULT TYPE, NEAR-FIELD, AND SPECTRAL ACCELERATION INCREASES

The 2007 fault database that accompanies the 2007 Caltrans Deterministic PGA Map indicates that the nearby active faults have strike-slip displacement. Therefore, in accordance with Caltrans design procedures referenced above, no increase in design spectral accelerations is required for fault type. However, since the project site is located less than 9.3 miles from the nearest active fault, the design spectral accelerations should be modified to account for near-field effects as shown in the following table:

Period (sec)	Increase in Spectral Acceleration (%)
< 0.5	0
0.5 – 1.0	0 – 20 (determined by linear interpolation)
≥1	20

Since the fundamental period of the proposed structure is not known at this time, the spectral acceleration has not been adjusted for the effect of fundamental period. If the fundamental period of the structure is determined to be greater than 1.5 seconds, then an adjustment should be made in accordance with Caltrans design procedures.

8.4 DESIGN ACCELERATON RESPONSE SPECTRA

The design response spectrum for the site is estimated with spectral acceleration values generated using Caltrans ARS Online (2009). This method was developed by Caltrans Geo Research Group in partnership with United States Geological Survey (USGS), Pacific Earthquake Engineering Research (PEER) and California Department of Conservation. This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in Appendix B of Caltrans SDC.

The deterministic spectrum is determined as the average of median response spectra calculated using the Campbell-Bozorgnia (2008) and Chiou-Youngs (2008) ground motion prediction equations developed under the "Next Generation Attenuation" project coordinated through the PEER-Lifelines program. These equations are applied to all faults considered to be active in the last 750,000 years (late-Quaternary age) that are capable of producing a moment magnitude earthquake of 6.0 or greater. The probabilistic spectrum is obtained from the USGS (2008) National Hazard Map for 5% probability of exceedance in 50 years. Caltrans design spectrum is based on the larger of the deterministic and probabilistic spectral values. Both the deterministic and probabilistic spectra account for soil effects through incorporation of the parameter V_{s30}, the average shear wave velocity in the upper 100 feet of the soil profile. As discussed in Section 4, shear wave velocity tests were conducted in CPT-11-016. Based on these tests, V_{s30} was estimated to be 820 feet per second. Appendix H presents a summary of the seismic response spectra analysis results.

The input values we selected for Caltrans ARS Online included:

- V_{s30} of 820 feet per second
- Maximum Moment Magnitude (M_{Max}) 7.9 (San Andreas fault)
- No ARS increase for fault-type or long period structure
- ARS increase for near-field effects

The calculated spectra using the Caltrans ARS Online tool for both deterministic and probabilistic methods are presented as the blue curve on Figure 8A. Since the average shear wave velocity at the site is less than 1,000 feet per second, Caltrans requires that the calculated spectra be determined using the USGS Deaggregation tool; this curve is plotted in red on Figure 8A. In cases where the calculated spectra for the two curves (Caltrans and USGS) differ by 10 percent or more for periods of less than 0.5 second, Caltrans requires that the USGS calculated spectra be used for design.

As shown on Figure 8A, the calculated spectral value for the 0.5 second period is about 1.3g based on Caltrans ARS and just over 1.4g based on the USGS deaggregation. Therefore, in accordance with Caltrans requirements, the USGS calculated spectra should be used for design (Figure 8B). Appendix G of this report presents the ground motion evaluation for this site

including output pages of the ARS Online tool, the estimates of V_{s30} based on in-situ measurements and the results of the USGS deaggregation tool.

Based on the plan titled "Special Footing for Type BH Towers at Broadway Burlingame Overpass" dated February 19, 1947, it appears that the three existing PG&E high voltage line towers located just north of the existing Broadway Overcrossing are supported on 6-foot-square concrete pad footings embedded 15 feet bgs. A copy of this detail is included in Appendix H along with the typical details for concrete pad footings dated 1929. No other information regarding design or construction of these tower foundations has been made available to us.

The existing Broadway Overcrossing consists of four lanes and spans across US101. The bridge has a 4-foot-wide walkway on each side with metal railing and was constructed around 1949. Based on as-built plans provided by Caltrans dated September 1949, the existing bridge is a 12-span structure supported on two abutments and 11 bents. The overall length of the structure is approximately 760 feet. The superstructure was constructed with a concrete slab supported on steel I-beams. According to the as-built drawings, the abutments are supported on driven steel H-piles (12BP53), vertical and batter, and bents are supported on three rows of vertical untreated timber piles. Steel piles at the abutments are estimated to be approximately 50 to 55 feet long with a specified capacity of 24 tons, and the timber piles at bents are estimated to be approximately 40 feet long with a specified capacity of 20 tons. Based on our review of the available as-built and soil boring information, it appears that the existing pile foundations at the Broadway Overcrossing derive support through a combination of skin friction in the upper 40 to 50 feet of the alluvial soil profile, and potentially through end-bearing resistance in the dense sands and gravels encountered below approximately Elevation -40 feet. Bottom of pile cap at the abutments of the original structure ranges from Elevation 9.5 to 11.5 feet at Abutment 1 and from Elevation 13.7 to 14.5 feet at Abutment 13; the bottom of pile cap at all bents is Elevation 1 foot.

The interchange was modified in 1970 with the addition of an on-ramp from Broadway to southbound US101. The on-ramp is a four span cast-in-place slab bridge on pile extensions consisting of corrosion resistant Class XI concrete piles (45-ton capacity). The specified tip elevation for these concrete piles was Elevation -40 feet.

The General Plan, Sheet 1 of 10, for the 1970 improvements lists the datum as USC & GC. We were not provided with the General Plan, Sheet 1 of 18, for the 1949 original construction and therefore, do not have information regarding that project datum.

Copies of these as-built structure plans are presented in Appendix E.

10.1 DISCUSSION

The proposed bridge and approach areas are blanketed by about 4 to 12 feet of fill, underlain by up to 10 feet of very soft to medium stiff and highly compressible Bay Mud and occasional discontinuous layers of moderately compressible lean to fat clays. In addition, potentially liquefiable sands were encountered near the surface at the proposed abutment and bent locations.

The principal geotechnical issues at the site are:

- Excessive total and differential settlements due to consolidation of foundation soils under the weight of new approach fills,
- Risk of embankment slope instability if fill placement occurs rapidly due to weak underlying Bay Mud,
- Post-liquefaction settlement of potentially liquefiable soils and the potential for liquefaction induced lateral spreading at and near the bridge,
- Selection of the type and depth of foundation that will be compatible with the underlying soils, and
- Construction issues associated with the proximity of proposed new fills to existing structures.

We understand that 16-inch square precast, prestressed (PCPS) concrete piles, vertical and batter, are planned at the abutments. Piles at the abutments will be Class 90.

As discussed in the "Consolidation Settlement" section of this report, we estimate that elastic and long-term consolidation settlement of the Bay Mud and other clays under the weight of the proposed fills could be as much as 17 inches beneath the thickest approach fills, and on the order of about 7 to 8 inches at the abutments. Settlement of this magnitude will induce downdrag loads on the piles and potentially cause distress of approach fills and the overlying structural pavement sections. Due to the very low permeability of the Bay Mud and other native clays, we estimate that the settlement period to reach 90 to 95% consolidation would be approximately 3 to 4 years.

We considered three alternatives for approach fill construction to mitigate consolidation settlement and soil shear strength concerns at the site, including:

- Surcharge proposed structure backfill and embankment fill areas using wick drains to facilitate drainage and to accelerate settlement and strength gain of the underlying Bay Mud and other native clays.
- Use of very lightweight expanded polystyrene (EPS) blocks as an alternative to Caltrans standard embankment fill and structure backfill so that new loads imposed on the underlying highly compressible clays are reduced significantly, resulting in tolerable post-construction total and differential settlements at foundations.
- Cement Deep Soil Mixing (CDSM) ground treatment of the underlying Bay Mud, potentially liquefiable granular deposits and fat clays at the abutment locations to reduce post liquefaction and long-term consolidation settlements to tolerable levels.

CDSM is currently proposed to a depth of about 50 feet at the abutments to mitigate consolidation and post-liquefaction settlement. CDSM ground improvement typically consists of a regular grid of in-place columns that are placed in rows (treatment zones) aligned parallel to the longitudinal axis of an embankment. The horizontal extent and pattern of the CDSM columns near the bridge abutments are shown on the CDSM Plans, Figures 9A to 9D. A more detailed discussion of CDSM is presented in Section 11.

Provided that one or more of the above options is implemented, we believe downdrag loads on the abutment piles can be mitigated. Potentially liquefiable soils were encountered in Boring R-11-015 advanced near Abutment 1 to a depth of about 26 feet bgs.

In our opinion, use of CDSM in areas of new construction and extending ground improvement to the bottom of the potentially liquefiable soils (around 30 feet bgs) should mitigate the risk of downdrag loads due to post-liquefaction settlement acting on the piles at the abutments.

10.2 PILE DESIGN CAPACITY AND TIP ELEVATION

10.2.1 Axial Pile Capacity Analysis

Based on our review of the subsurface conditions encountered in the current explorations, in our opinion, the proposed bridge can be supported on Class 90, 16-inch square PCPS piles at the abutments as planned.

Current Caltrans practice is to design abutments in accordance with Working Stress Design (WSD) methodology and bents in accordance with LRFD. The following table presents a summary of the foundation design data provided by the Structural Engineer.

Table 10-1: Foundation Design Data for Broadway On-Ramp

Location	Design Method	Pile Type	Finished Grade Elevation (ft)	Cut-off Elevation (ft)	Pile Cap Size (ft) W x L	Permissible Settlement Under Service Load	No. of Piles per Support
Abut 1	WSD	Class 90	10.0	4.75	15 x 67.25	1-inch	48
Abut 2	WSD	Class 90	10.0	4.75	12.5 x 47.15	1-inch	35
Abut 1 Rt RW	LRFD	Class 90	10.0	4.75	15.0 x 22.3	1-inch	16
Abut 2 Lt RW	LRFD	Class 90	10.0	4.75	9.0 x 25.0	1-inch	12
Abut 2 Rt RW	LRFD	Class 90	10.0	4.75	9.0 x 25.0	1-inch	12

Lt: Left Rt: Right

The design loading conditions and nominal resistance are developed in accordance with the LRFD approach. Loads from LRFD Serice-1 Limit State are used as design loads for WSD of abutments. The table below presents the design loads.

Table 10-2: Foundation Design Loads for Broadway On-Ramp

Location	Service Limit State (kips)			Strength Limit State (Controlling Group, kips)				Extreme Limit State (Controlling Group, kips)			
	Total Load			Compression		Tension		Compression		Tension	
	Per Support	Max per Pile	Permanent Loads	Per Support	Max per Pile	Per Support	Max per Pile	Per Support	Max per Pile	Per Support	Max per Pile
Abut 1	3,565	84	3,054	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Abut 2	2,229	86	1,761	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Abut 1 Rt RW	762	76	733	1,003	111	n/a	n/a	864	111	117	20
Abut 2 Lt RW	472	75	444	654	109	27	5	636	106	167	28
Abut 2 Rt RW	457	69	430	608	101	n/a	n/a	598	100	144	24

Tables 10-3 and 10-4 present the foundation design for abutments and return walls, respectively.

Table 10-3: Foundation Recommendations for Abutments

Location	Pile Type	Cut-off Elevation (ft)	LRFD Service-I Limit State Load (kips) per Support		LRFD Service-I Limit State Total Load (kips) per pile (Compression)	Nominal Resistance (kips)	Design Tip Elevation (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance (kips)
			Total	Permanent					
Abut 1	Class 90 Alt "X",T=16 in	4.75	3,565	3,054	84	170	-35 (a) -24 (c) -16 (d)	-35	170
Abut 2	Class 90 Alt "X", T=16 in	4.75	2,229	1,761	86	180	-35 (a) -24 (c) -16 (d)	-35	180

Design tip elevation is controlled by the following demands: (a) Compression, (c) Settlement, (d) Lateral

Table 10-4: Foundation Recommendations for Return Walls

Location	Pile Type	Cut-off Elevation (ft)	Service-I Limit State Load (kips) per support	Total Permissible Support Settlement (inches)	Required Factored Nominal Resistance (kips)				Design Tip Elevation (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance (kips)*
					Strength Limit		Extreme Event				
					Comp. (ø=0.7)	Tension (ø=0.7)	Comp. (ø=1)	Tension (ø=1)			
Abut 1 RW	Class 90 Alt "X", T=16 in	4.75	762	1	111	n/a	111	20	-35 (a-I) n/a (b-I) -28 (a-II) -11 (b-II) -24 (c) -16 (d)	-35	160
Abut 2 Lt RW	Class 90 Alt "X", T=16 in	4.75	472	1	109	5	106	28	-35 (a-I) -1 (b-I) -22 (a-II) -20 (b-II) -24(c) -16 (d)	-35	160
Abut 2 Rt RW	Class 90 Alt "X", T=16 in	4.75	457	1	101	n/a	100	24	-35 (a-I) n/a (b-I) -20 (a-II) -20 (b-II) -24(c) -16 (d)	-35	150

* Nominal driving resistance is the sum of nominal resistance and downdrag
Design tip elevation is controlled by the following demands: (a-I) Compression (Strength Limit, (b-I) Tension (Strength Limits, (a-II) Compression (Extreme Event), (b-II) Tension (Extreme Event), (c) Settlement, (d) Lateral Load

The specified tip elevations presented in Table 10-5 are based on skin friction and end bearing in the native clays and sands.

Table 10-5: Pile Data Table for Broadway On-Ramp

Location	Pile Type	Nominal Resistance (kips)		Design Tip Elevation (ft)	Specified Tip Elevation (ft)	Nominal Driving Resistance (kips)
		Compression	Tension			
Abut 1	Class 90 Alt "X",T=16 in	170	0	-35 (a) -24 (c) -16 (d)	-35	170
Abut 2	Class 90 Alt "X",T=16 in	180	0	-35 (a) -24 (c) -16 (d)	-35	180
Abut 1 Rt RW	Class 90 Alt "X",T=16 in	160	20	-35 (a) -11 (b) -24 (c) -16 (d)	-35	160
Abut 2 Lt RW	Class 90 Alt "X",T=16 in	160	30	-35 (a) -20 (b) -24 (c) -16 (d)	-35	160
Abut 2 Rt RW	Class 90 Alt "X",T=16 in	150	30	-35 (a) -20 (b) -24 (c) -16 (d)	-35	150

Design tip elevation is controlled by the following demands: (a) Compression, (b) Tension, (c) Settlement, (d) Lateral Load

The results of our axial pile capacity analysis, which form the basis of our selection of the design tip elevations, are presented in Appendix I.

No group reduction factor needs to be applied to the single pile compression load capacities presented above provided a center-to-center spacing of at least three pile diameters is used.

10.2.2 Lateral Load Capacity

Pile foundations are capable of resisting lateral loads through bending of the pile and by pile-soil interaction. The magnitude of the lateral load resistance that can develop depends upon several factors such as the pile size, the physical properties of the surrounding soils, and the structural design of the pile. We used LPILE 5.0 (Reese et al., July 2004) and GROUP 7.0 (Reese et al., July 2006) to assist in estimating the lateral load resistance of PCPS piles and the corresponding lateral pile group effects. Both programs model the soil response in the form of load-deflection (p-y) curves. Charts showing load versus deflection based on LPILE output for free and fixed head conditions at top of pile are included in Appendix J.

California Amendment to AASHTO LRFD Bridge Design Specifications recommends that a P-multplier (P_m) be applied to the lateral capacity of individual piles to account for pile group efficiency. Table 10-6 presents the Caltrans recommended P_m for the corresponding rows of

piles within a group based on Caltrans Amendments of AASHTO LRFD, Section 10.7.2.4. Row 1 refers to the leading row of piles in the direction of loading.

Table 10-6: Pile P-Multiplier, P_m for Multiple Row Shading

Pile Center-to-Center Spacing (in the direction of loading)	Group Efficiency Factor (P-Multiplier, P_m)		
	Row 1	Row 2	Row 3 and higher
2 x Pile Width/Diameter (B)	0.60	0.35	0.25
3 B	0.75	0.55	0.4
5 B	1.0	0.85	0.7
7 B	1.0	1.0	0.9

If additional lateral capacity is needed beyond the lateral load capacity of the PCPS piles at abutments, passive resistance against the abutment walls or pile cap can be utilized, provided that abutment backfill meets the requirements for Caltrans structure backfill. For abutments, Caltrans limits the soil resistance at the back wall to a 5.5 foot wall height and a maximum uniform soil pressure of 5,000 pounds per square foot (psf). For wall heights less than 5.5 feet, the average unit pressure should be reduced linearly in proportion to the height. The uniform soil pressure of 5,000 psf is an ultimate value, and should be used with an appropriate load resistance factor for the service limit-state consistent with the LRFD approach.

10.2.3 Axial Pile Load-Deflection

Axial pile load-deflection curves are used by the Structural Engineer to develop vertical foundation stress-strain coefficients for use in the superstructure analyses. The computer program TZPILE 2.0 (Ensoft, Inc. 2005) was used to model the axial pile load behavior. Axial load deflection curves were developed for 14-inch square PCPS piles. The results of TZPILE analyses are presented in Appendix I.

10.3 PILE INSTALLATION

All piles should be installed under the direct observation of the Geotechnical Engineer and in accordance with Section 49 of the Caltrans Standard Specifications, “Piling”. Specific additions and modifications to these requirements are discussed below.

The Contractor should submit evidence of compatibility of the proposed pile hammer with the pile type (16-inch square Class 90 PCPS) and soil conditions at the site. The Contractor’s hammer submittal should include, as a minimum, a dynamic analysis of the pile driving system that is based on wave equation analysis using computer programs such as WEAP. Acceptance criteria for driven piles should follow Caltrans Standard Specifications Section 49-1.08, Pile Driving Acceptance Criteria as well as Special Provisions 49-228, Redriving. As discussed in the Special Provisions 29-228, piles, piles which do not attain the required bearing value when the pile tip has reached the specified pile tip elevation should be allowed to stand for a “set period” without driving. The “set period” should be at least 24 to 48 hours unless the bearing has been obtained sooner. After the required “set period” has elapsed piles that do not meet criteria should be redriven. Driven piles reaching refusal within 10 feet of the specified tip elevation and meeting the acceptance criteria may be cut-off above the tip elevation required by

the compression loads. This assumes that the design lateral load and tension load tip elevations have been reached (see Pile Data Table 10-5). Preliminarily, we recommend that the refusal criteria be two times the minimum required blowcount. However, refusal criteria will be defined later based on the pile driving system proposed by the Contractor.

When required, and as approved by the Geotechnical Engineer, predrilling should be used to assist in the installation of piles to the required tip elevations. Predrilled holes should be no larger than the least dimension of the new pile, in conformance with the provisions of Section 49-1.05 of the Standard Specifications, Driving Equipment. The use of water in the predrilling process or jetting should not be allowed, unless approved in advance by the Geotechnical Engineer.

10.4 APPROACH EMBANKMENT SETTLEMENT

Approach fills as high as 22 feet are currently planned. As discussed in the "Subsurface Conditions" section of this report, the native soils below the fill consist of as much as 10 feet of soft to very soft and highly compressible Bay Mud which is underlain in some areas by moderately compressible fat clay. We estimated the settlement of the approach embankment due to placement of new fill to the grades shown on the 'B3' Line profile. Based on these assumptions, we estimate that total settlement on the order of 17 inches could occur along the approach centerline and up to 7 inches at the abutments.

Because of the very low permeability of the native fat clays, the settlement period to reach 90 to 95% of the total estimated consolidation settlement under the weight of new fills is expected to be 3 to 4 years, which is not practical from a construction standpoint. To reduce the potential for downdrag loads to act on the driven pile foundations, we evaluated the following construction options to limit post-construction settlements at the bridge abutments to less than about ½-inch:

1. Accelerate settlement under normal weight fill using surcharging and wick drains. With this alternative, consideration must be given to the potential adverse effects on fill loads on existing underground utilities and adjacent structures to remain. Construction of the embankment fill will have to be in multiple stages in order to avoid risk of slope instability due to weak underlying Bay Mud.
2. Decrease settlement to negligible amounts using very light weight EPS blocks in the approach fills.
3. Improve the strength and compressibility characteristics of the native clays using CDSM ground improvement to a depth of approximately 50 feet at the abutments.

At present, the CDSM ground improvement option has been identified as the most cost-effective option for mitigating potential settlements. A discussion of methodology and construction of CDSM ground improvement is presented in the "Construction Considerations" section of this report.

10.5 SLOPE STABILITY

The approach fills on both sides of the bridge are to be retained by MSE retaining walls. We analyzed the global stability of the MSE walls underlain by CDSM treated soil and computed a minimum factor of safety of more than 2.0, which exceeds the minimum value of 1.3 for the end of construction condition and 1.5 for the long-term drained condition.

10.6 APPROACH FILL EARTHWORK

All earthwork should be completed in accordance with the applicable sections of the Caltrans Standard Specifications and as described in the companion Geotechnical Design and Materials Report for the US101/Broadway Interchange Project, prepared by URS.

10.7 APPROACH FILLS AND ABUTMENT EXCAVATION

All earthwork should be completed in accordance with applicable section of the Caltrans Standard Specifications and as described in URS' companion Geotechnical Design and Materials Report for US101/Broadway Interchange project. The requirements of structural backfill and pervious backfill are set forth under Section 19-3.06 and 19-3.065, respectively, in the Standard Specifications (Caltrans 2006).

Expansive soil materials including Bay Mud and other native fat clays, should not be placed as part of the proposed embankment within the limits of the abutment for the full width of the embankment. Expansive soil materials for this requirement are defined as having either an Expansion Index (EI) greater than 50 (EI to be determined in accordance with ASTM D 4829), or a Sand Equivalent (SE) less than 20 (SE to be determined in accordance with California Test 217). This requirement is exclusive of the structure backfill and pervious backfill requirements as shown on the plans and set forth under Sections 19-3.06 and 19-3.065, respectively, in the Standard Specifications (Caltrans, 1999).

The fills that blanket the site can be used as general fill for the project provided that they meet Caltrans material requirements. The native fat clays and Bay Mud should not be used as engineered fill due to their high moisture and organic contents, and expansive nature, i.e. potential to shrink and swell with moisture changes. We therefore, recommend that the native clays be hauled offsite and not be used in constructing the approach fill and abutment backfill.

Footing/pile cap areas should be excavated as required to bring those areas to their finish subgrade elevations. All loose soil should be removed from the exposed subgrade prior to pile cap construction. Because shallow groundwater could be encountered, we recommend the type of excavation at the abutments and bents be classified as "Structure Excavation Type D" in accordance with Section 11 of Bridge Design Aids, March 2005.

11.1 CEMENT DEEP SOIL MIXING

Cement deep soil mixing (CDSM) is a process whereby soil is improved by injecting cement grout through one or more augers that simultaneously mix the soil, forming in-place soil-cement columns. CDSM is performed in a regular grid of in-place columns to effectively improve the target soils with the layout typically consisting of blocks of CDSM columns that are placed in rows (treatment zones) aligned parallel to the longitudinal axis of an embankment. The blocks consist of exterior and interior walls formed by adjacent CDSM columns. Analysis of settlement and stability of CDSM improved soil ignores the strength of the soils within and between the blocks.

The CDSM mix is designed by a specialty contractor with the improved properties of the stabilized soil governed by a number of factors including soil type, slurry properties, mixing procedures and curing conditions. High strengths can be attained in the final soil-cement product, typically greater than 100 pounds per square inch (psi).

The challenges associated with CDSM construction include limitations on space for construction staging and rig operations, coordination during excavation and embankment reconstruction, assessing the effectiveness of the soil improvement, and evaluating the depth of penetration. Close coordination between the design team and the specialty CDSM contractor is important to avoid cost overruns and/or schedule impacts to the project. Locations of CDSM columns should be carefully reviewed and coordinated between the Design Team and Specialty Contractor in order to avoid conflict with the pile layouts; this may require more than one iteration during design.

To assess the effectiveness of the CDSM improvements, a detailed monitoring and testing program should be established. The program should include test sections utilizing several different mix designs with varied cement contents and water-cement ratios, monitoring of various parameters during CDSM construction, full depth coring of the completed CDSM columns, unconfined compressive strength testing on selected CDSM core samples, test borings prior to CDSM construction or adjacent to completed CDSM columns, and test redrilling of cured CDSM.

Special provisions for CDSM construction will be included as part of the final Geotechnical Design and Materials report for the US101/Broadway Interchange project.

11.2 TEMPORARY CONSTRUCTION EXCAVATIONS

We anticipate that pile cap excavations to about Elevation 4.5 feet will require cuts on the order of 6 to 7 feet in height. Based on the recent explorations, it appears likely that these excavations will be through the existing roadway embankment fills and could encounter Bay Mud. Based on the depth of footings supporting the adjacent PG&E towers as shown on the as-built plans (1947), we do not anticipate that the existing tower footings will be undermined during excavation for the new pile caps.

Safety standards set by OSHA limit the height of the unshored vertical excavations to 5 feet if construction personnel will be working in the excavations. The set of guidelines published by OSHA (Department of Labor, Occupational Safety and Health Administration, 1999), classifies

soils in detail as Type A, B, or C. In general, Type A soils are stronger, Type B soils are intermediate, and Type C soils are weaker. Based on the soil type, depth, and duration the excavation is open, and sequence of soils exposed in the excavation, OSHA recommends maximum allowable slopes. Based on the strengths of the soils encountered in our recent borings, the existing roadway embankment fills are generally considered to be OSHA Type B and Type C. On this basis, we recommend that temporary slopes in these soils be cut no steeper than 1½:1 (horizontal:vertical).

We expect that OSHA guidelines for Type A soils would be applicable for excavations in soil stabilized with CDSM ground improvement. However, if excavations are made into untreated Bay Mud (i.e., no CDSM), then the Contractor's Engineer should determine the maximum slope inclination for cuts in Bay Mud overlain by existing fill. The Contractor's Engineer should submit his calculations to Caltrans for review prior to excavation.

We recommend that the Geotechnical Engineer be retained to review the conditions in temporary cut slopes as they are exposed during construction. Additional recommendations could be provided at that time regarding the advisability of different temporary slope inclinations in particular areas.

For locations where excavation with sloping sides is not viable because of space limitations or in areas where temporary slopes steeper than 1:1 are planned, shoring will be required. The Contractor should retain an experienced Registered Civil Engineer to design the shoring system.

11.3 CONSTRUCTION DEWATERING

Free groundwater was encountered in each of the borings drilled in the vicinity of the proposed Broadway on-ramp bridge at depths ranging from about 4 to 14½ feet bgs (Elevation 8 to -3.5 feet); these are the depths where free groundwater was first encountered during drilling and therefore do not necessarily represent a stabilized groundwater level at the boring locations.

A pore pressure dissipation test at the CPT location suggests groundwater at a depth of about ½ foot bgs (Elevation 10.5 feet).

With bottom of pile cap at Elevation 4.5 feet for the abutments and return walls, it is likely that groundwater will be encountered in the pile cap excavations. Therefore, we recommend that the Contractor be prepared to dewater the excavations as necessary during construction.

It should be noted that the recent explorations were completed during the dry 2011 summer and fall seasons and higher groundwater levels might occur during the winter months. As discussed previously, groundwater encountered in the explorations does not represent a stabilized groundwater elevation and/or could represent perched conditions. In addition, fluctuations in the groundwater level could occur due to tidal action in the nearby San Francisco Bay, water level fluctuations in nearby Easton Creek or Sanchez Creek, and variations in rainfall or other factors not in evidence at the time of the investigation.

11.4 PILE CUTOFF

When driven piles develop the required compressive capacities before reaching the specified tip elevation, the Contractor may be given the option, with the Geotechnical Engineer's approval, to

stop driving and cut off the piles. Pile cut-off should be approved only if the piles also have satisfied the tension and lateral demand requirements, and the structural capacity has not been compromised. For maximum pile cut-off length, refer to the Standard Plans Sheet B2-5 (Caltrans, 2010).

11.5 EFFECTS OF CONSTRUCTION WORK ON ADJACENT STRUCTURES

Efforts should be made to minimize effects of construction work on adjacent structures. A monitoring program should be required for pile driving at, or adjacent to, existing structures that are susceptible to damage or sensitive to noise and/or vibration.

In addition, a settlement monitoring program, including video taping, should be implemented for adjacent existing structures and underground utilities, particularly before and during CDSM soil mixing and embankment fill placement.

The opinions, conclusions and recommendations presented in this Foundation Report are based on information obtained from new and previous explorations made at widely separated locations, site reconnaissance, review of available topographic information and historic data, and upon experience and engineering judgment.

The recommendations presented in this report are based on the assumption that the soil and geologic conditions do not deviate substantially from those encountered in the exploratory borings and CPT. If any variations are encountered during construction, URS should be contacted so that supplementary recommendations can be made.

If the planned construction is changed from that presently conceived, URS should be retained to review the changes and make modifications to the original recommendations presented in this report in order to meet the project needs.

The Geotechnical Engineer should review the final specifications and drawings to verify that these documents are consistent with the intent of the geotechnical recommendations. Geotechnical issues may arise during construction which are not apparent at this time. URS should be retained during construction to review the soil conditions encountered and the construction procedures. All earthwork and testing, as well as pile installation, should be done under the direct observation of a representative of our firm.

The elevations shown on the new LOTBs are based on interpolation from spot and contour elevations shown on available topographic maps.

As-built drawings pertinent only to the geotechnical investigation are included.

Specific review and investigation for environmental issues and subsurface environmental contamination were beyond the scope of our services.

The opinions and recommendations presented in this Foundation Report were developed with the standard of care commonly used as state of the practice in the profession. No other warranties are included, either express or implied, as to the professional advice provided in this report.

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INDEX OF PLANS

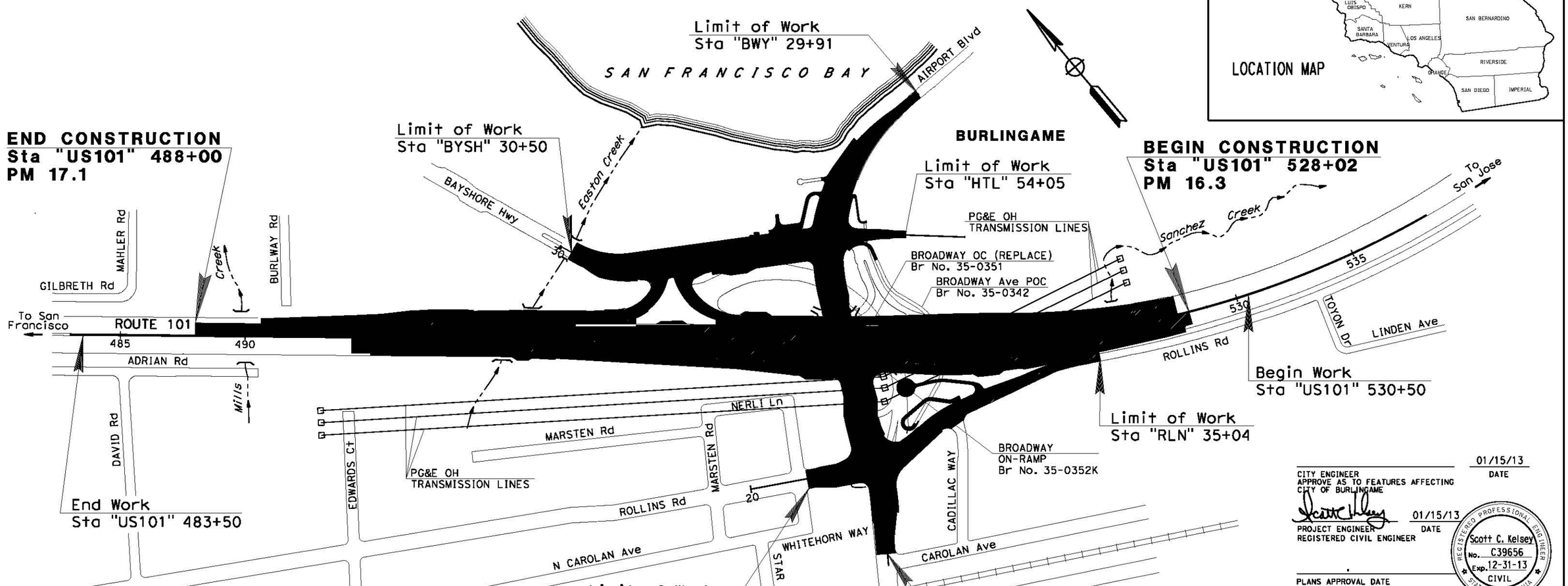
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ON
STATE HIGHWAY

IN SAN MATEO COUNTY
IN BURLINGAME
FROM 0.3 MILE NORTH OF ANZA BOULEVARD
TO 0.9 MILE SOUTH OF MILLBRAE AVENUE OVERCROSSING

TO BE SUPPLEMENTED BY STANDARD PLANS DATED 2010

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.



PROJECT VICINITY MAP
FIGURE 1

NO SCALE

100% PS&E SUBMITTAL
JANUARY 17, 2013

CITY ENGINEER
APPROVE AS TO FEATURES AFFECTING
CITY OF BURLINGAME — DATE 01/15/13

PROJECT ENGINEER
REGISTERED CIVIL ENGINEER — DATE 01/15/13

REGISTERED PROFESSIONAL ENGINEER
Scott C. Kelsey
No. C39656
Exp. 12-31-13
CIVIL
STATE OF CALIFORNIA

PLANS APPROVAL DATE .

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SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

CONTRACT No.	04-235844
PROJECT ID	0400000684

THE CONTRACTOR SHALL POSSESS THE CLASS (OR CLASSES) OF LICENSE AS SPECIFIED IN THE "NOTICE TO BIDDERS."

APPROVED AS TO IMPACT ON STATE FACILITIES AND CONFORMANCE WITH APPLICABLE STATE STANDARDS AND PRACTICES AND THAT TECHNICAL OVERSIGHT WAS PERFORMED.

CONSULTANT DESIGN ENGINEER: SCOTT C. KELSEY
CALTRANS DESIGN OVERSIGHT APPROVAL: AMIR SANATKAR
REGISTRATION No. . LICENSE Exp DATE . DATE SIGNED .

LAST REVISION 12-27-12 DATE PLOTTED => 4/3/2013 TIME PLOTTED => 4:44:41 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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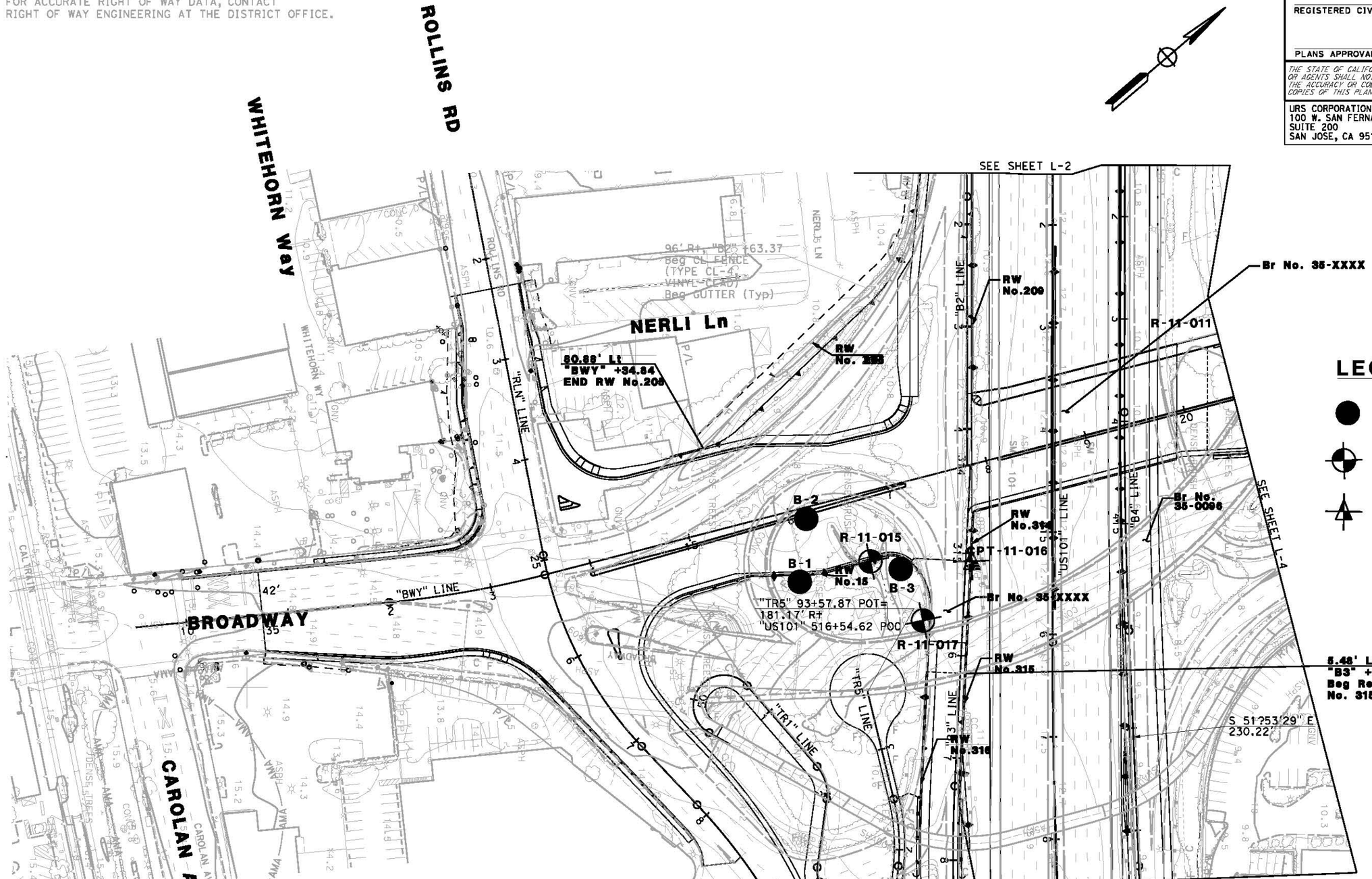
NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



SITE and BORING LOCATION PLAN
FIGURE 2

LAYOUT
SCALE 1" = 50'

L-3

REVISED BY	DATE REVISED
.	.

CALCULATED-DESIGNED BY . CHECKED BY .

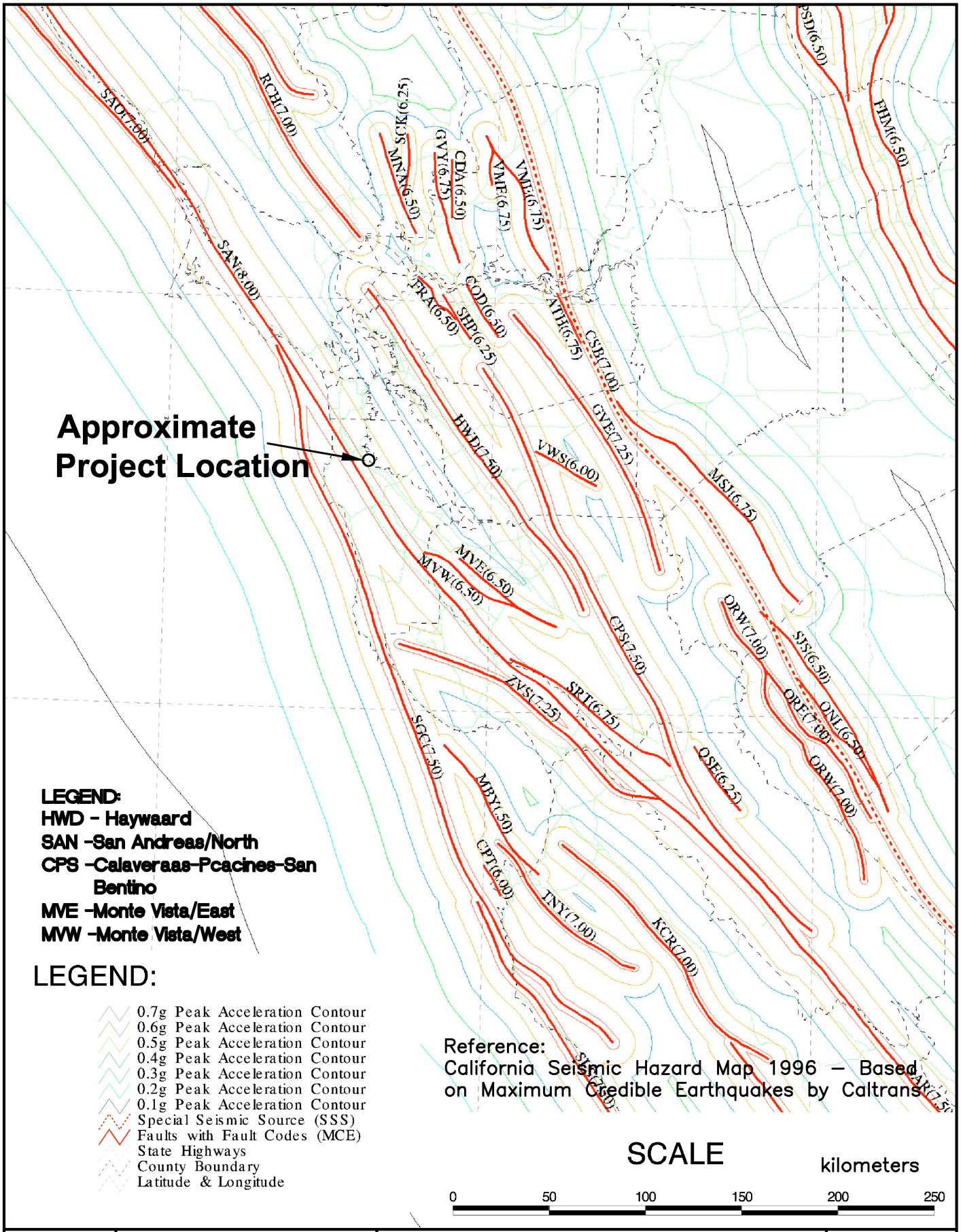
CONSULTANT FUNCTIONAL SUPERVISOR

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

LAST REVISION 12-23-11 DATE PLOTTED => 2/16/2012 TIME PLOTTED => 11:26:35 AM

URS	US 101/Broadway Interchange Reconstruction Project	GEOLOGY MAP	Not to Scale Figure 3 April 2009



URS	US 101/Broadway Interchange Reconstruction Project	REGIONAL FAULT MAP SAN MATEO COUNTY	Not to Scale Figure 4 April 2009

Susceptibility Level

- Very High
- High
- Moderate
- Low
- Very Low

Major Roads

Local Roads

Scale: 1 inch equals 0.33 miles

This map is intended for planning use only and is not intended to be site-specific. Rather, it depicts the general risk within neighborhoods and the relative risk from community to community. More detailed maps are needed for site development decisions.

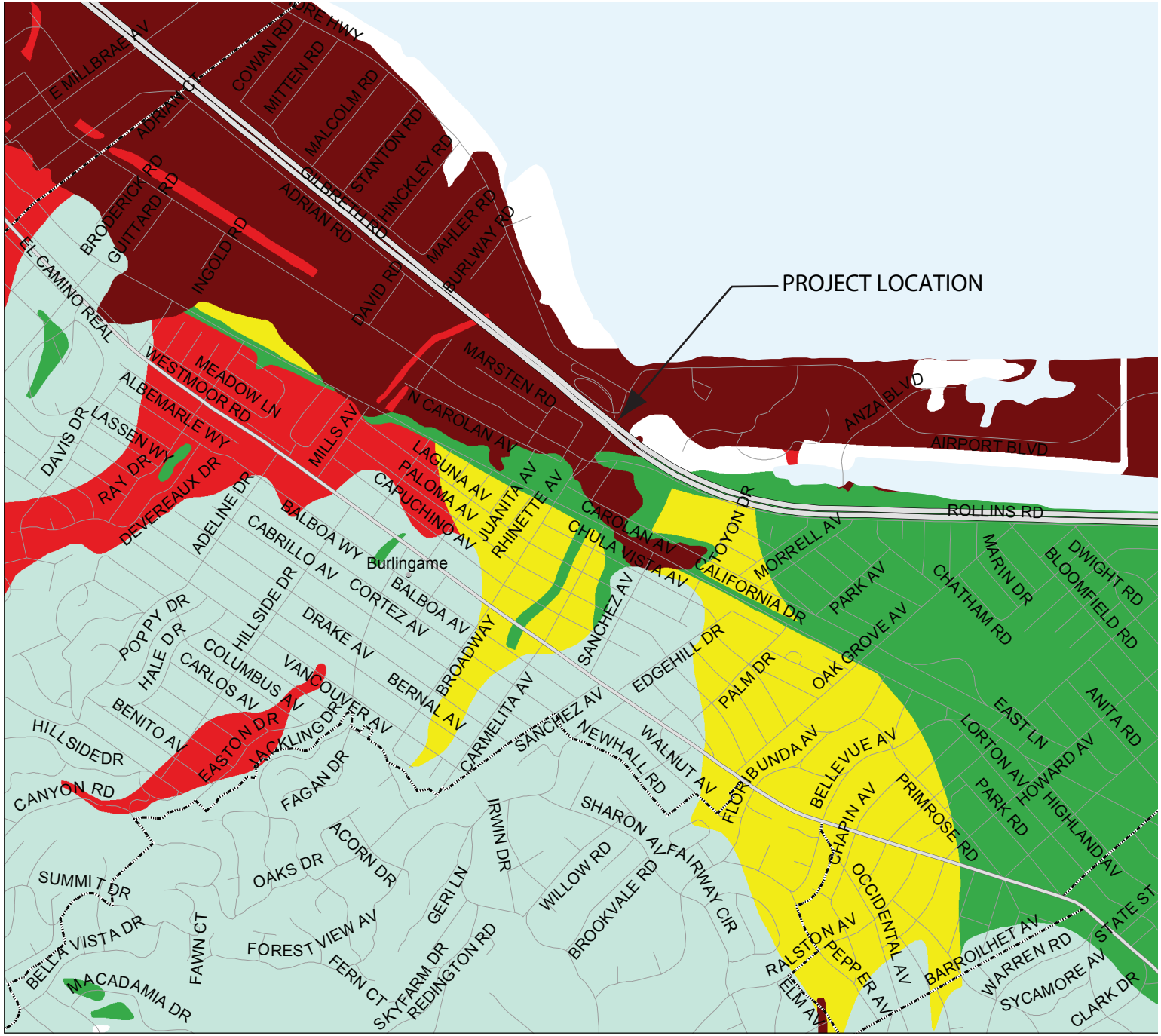
This map is available at http://quake.abag.ca.gov

Source:
This map is based on work by William Lettis & Associates, Inc. and USGS. USGS Open-File Report 00-444, Knudsen & others, 2000

For more information visit: http://geopubs.wr.usgs.gov/open-file/of00-444/

Map Prepared by the ABAG Earthquake Program. April 2004.

ABAG Geographic Information Systems



Project No. 28645286	Broadway Interchange Reconstruction U. S. 101 Burlingame, California	LIQUEFACTION SUSCEPTIBILITY MAP	Figure 5
URS			February 2012

W:\101BdwyPSE_28645286\450_Geotech\Report\FR\RetainingWalls\PDF\Figure\lig_fig.pdf

Flood Hazard Areas

- Zone V- (100 yr. Flood Zone)
- Zone A- (100 yr. Flood Zone)
- Zone X500- (500 yr. Flood Zone or other concerns)
- Urbanized Area

Shaded to show topographical relief

Detailed FEMA Explanation

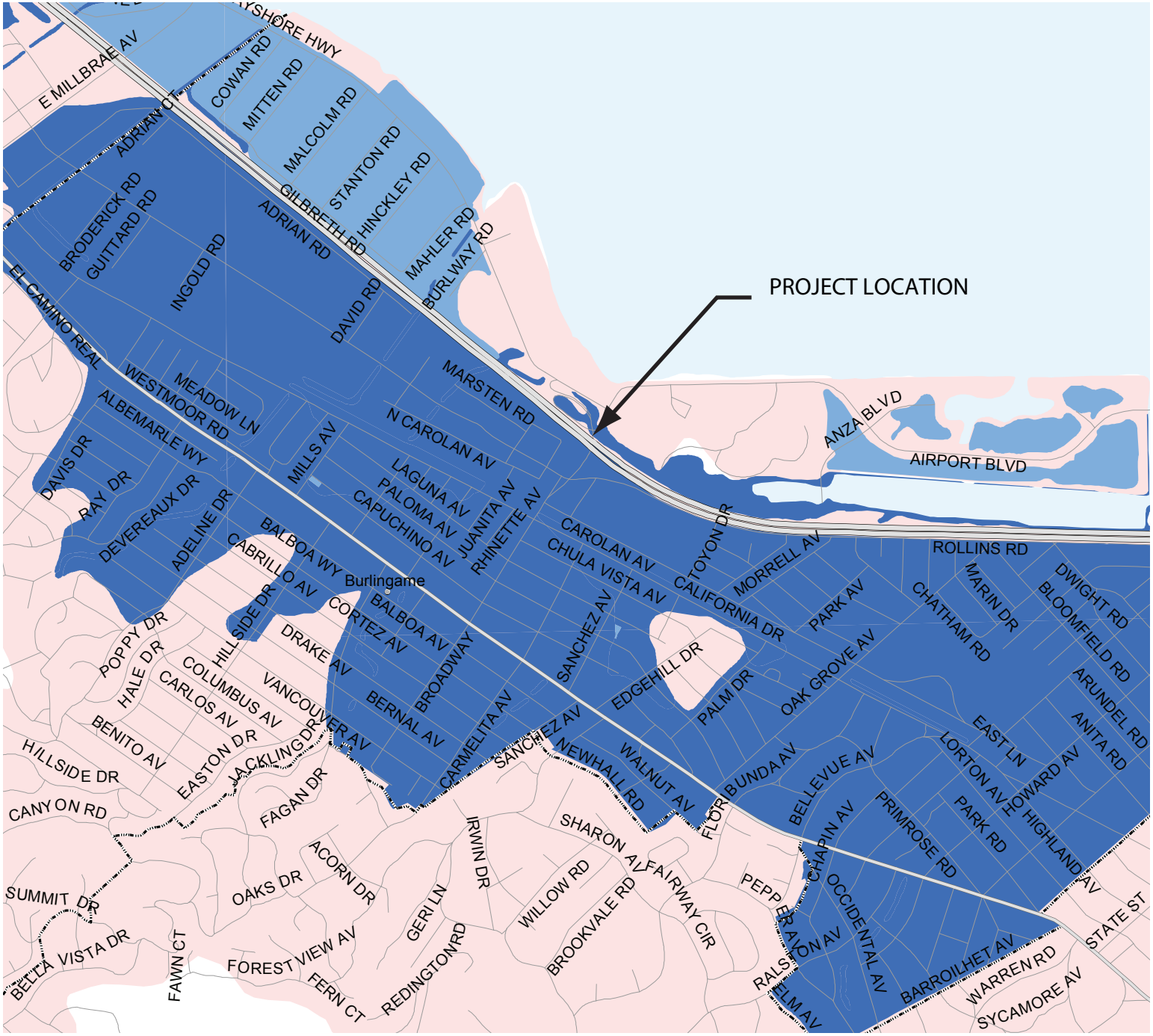
Flood Zone	Description
Zone V	This code identifies an area inundated by 1% annual chance flooding with velocity hazard (wave action).
Zone A	This code identifies an area inundated by 1% annual chance flooding.
Zone X500	This code identifies an area inundated by 0.2% annual chance flooding; an area inundated by 1% annual chance flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from 1% annual chance flooding.

N

Scale: 1 inch equals 0.32 miles

Source: FEMA Q3 Flood Data and ABAG.
The Q3 Flood Data do not replace the existing hardcopy FIRM, or, if one exists, Digital FIRM product. The product has been designed to support planning activities.
A more detailed version of this map is available at http://quake.abag.ca.gov

ABAG Geographic Information Systems



Project No. 28645286	Broadway Interchange Reconstruction U. S. 101 Burlingame, California	FEMA FLOOD HAZARD AREAS MAP	Figure 6
URS			February 2012

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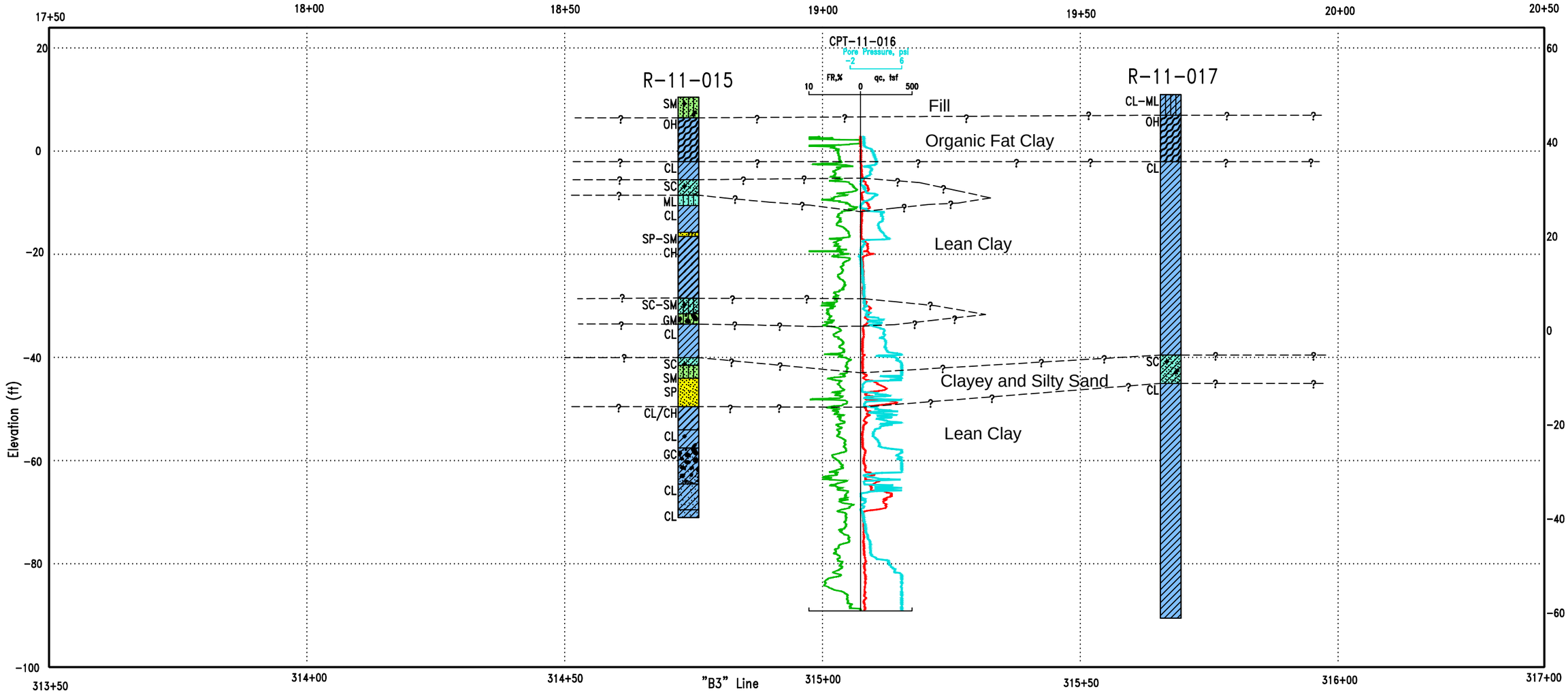

NOTES:

1. The generalized soil profile was developed based on extrapolation of the borings drilled for this investigation and, therefore, may differ from actual conditions. The dashed lines connecting the various layers at each exploration location are done for schematic illustration purposes only. They are not in any way to be construed as the actual conditions in the field.
2. Engineering soil parameters presented on the profile were selected from laboratory test restsuls as well as engineering judgement and local experience.
3. For detailed descriptions of materials encountered, refer to Log of Test Borings (Appendix B).

Soil Layer	Dry Unit Weight (pcf)	Moisture Content (%)	Undrained Shear Strength (psf))	Internal Friction Angle (Degrees)
Fill	NA	NA	NA	NA
Organic Fat Clay	46–59	68–97	400–1,110	NA
Lean Clay	93–112	18–30	1,630–3,881	NA
Clayey and Silty Sand	107–124	11–21	NA	36–40
Lean Clay	86–118	15–32	1,910–13,270	NA

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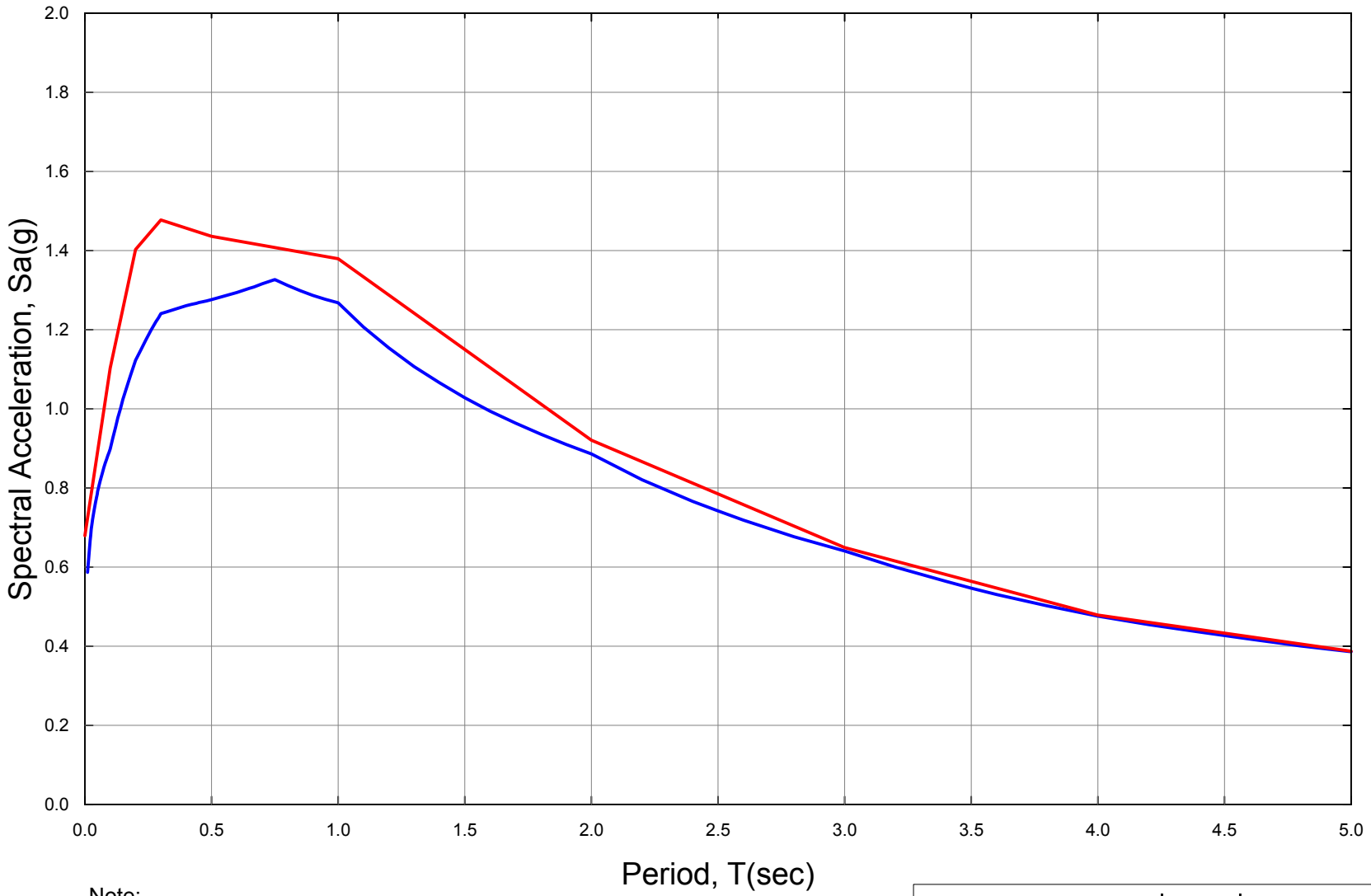
LITHOLOGY GRAPHICS

- USCS Silty Gravel (poorly graded)
- USCS Poorly Graded Gravel
- USCS Lean Clay
- USCS Clayey Gravel
- USCS Clayey Sand
- USCS Sandy Lean Clay with gravel
- USCS Clayey Sand with gravel
- USCS Sandy Lean Clay
- USCS Silty Sand
- USCS Poorly Graded Sand
- USCS Poorly Graded Sand with silt
- USCS Silty, Clayey Sand
- USCS Organic Fat Clay
- USCS Fat Clay with sand
- USCS Fat Clay

GENERALIZED SOIL PROFILE
Broadway On-Ramp

BURLINGAME, CALIFORNIA

FIGURE 7



Note:
1. Site Location: LAT = 37.590061 LONG = -122.361241
2. V_{s30} = 820 feet per second

Legend
Caltrans ARS Online
USGS Deaggregation/Design Curve

Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	Acceleration Response Spectra Comparisons	Figure 8A
URS			

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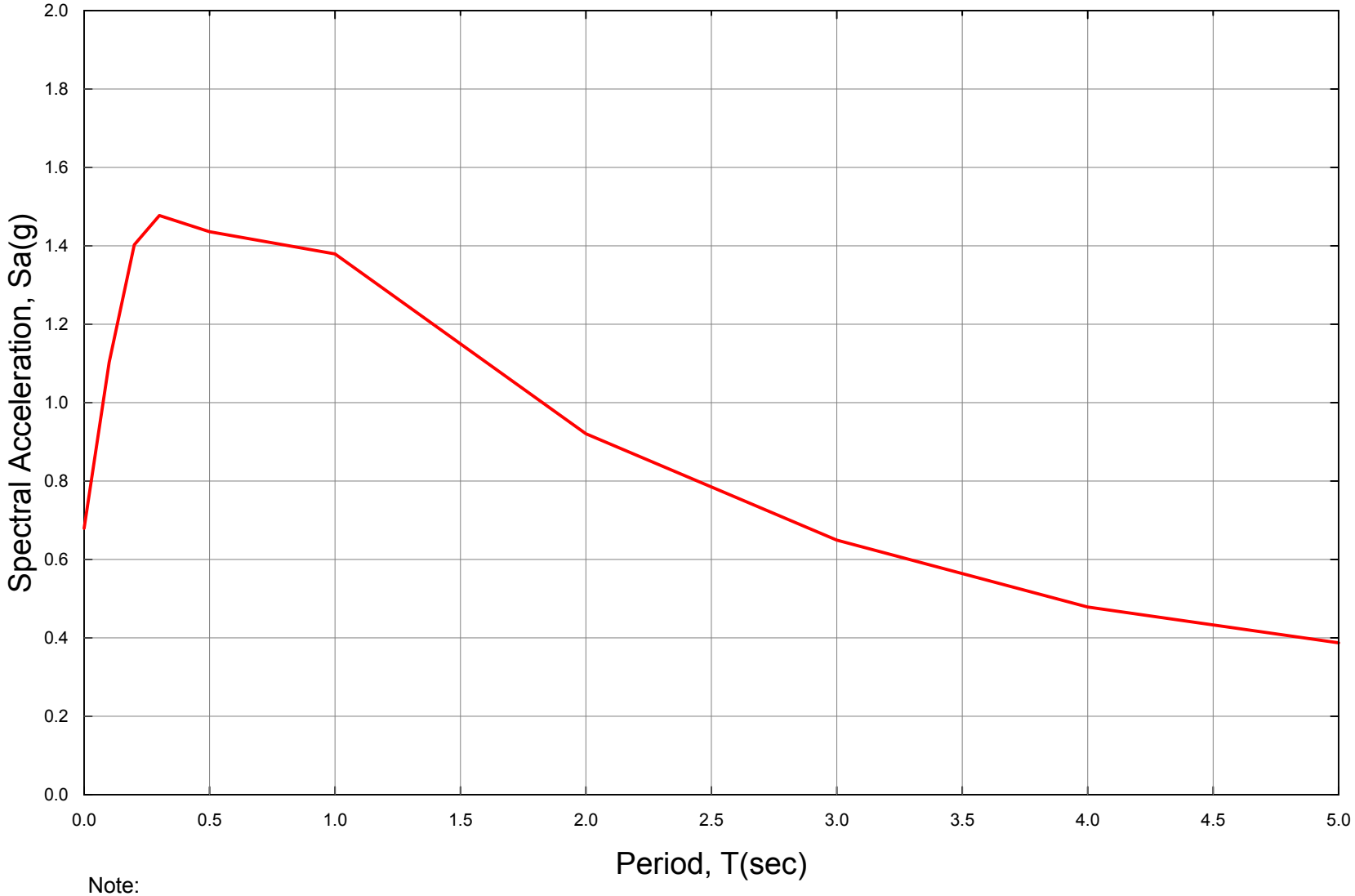

Note:
1. Site Location: LAT = 37.590061 LONG = -122.361241
2. V_{s30} = 820 feet per second

Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**Recommended Acceleration Response Spectra**	Figure 8B
URS			

W:\101BdwyPSE_28645286\450_Geotech\Analysis\ARS Online\Broadway OC (Replace)_ARS Design.grf

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

ARBhoi
REGISTERED CIVIL ENGINEER — 01/15/13 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Abhijeet R. Bhoi — No. C68606 — Exp. 09-30-13 — CIVIL — STATE OF CALIFORNIA

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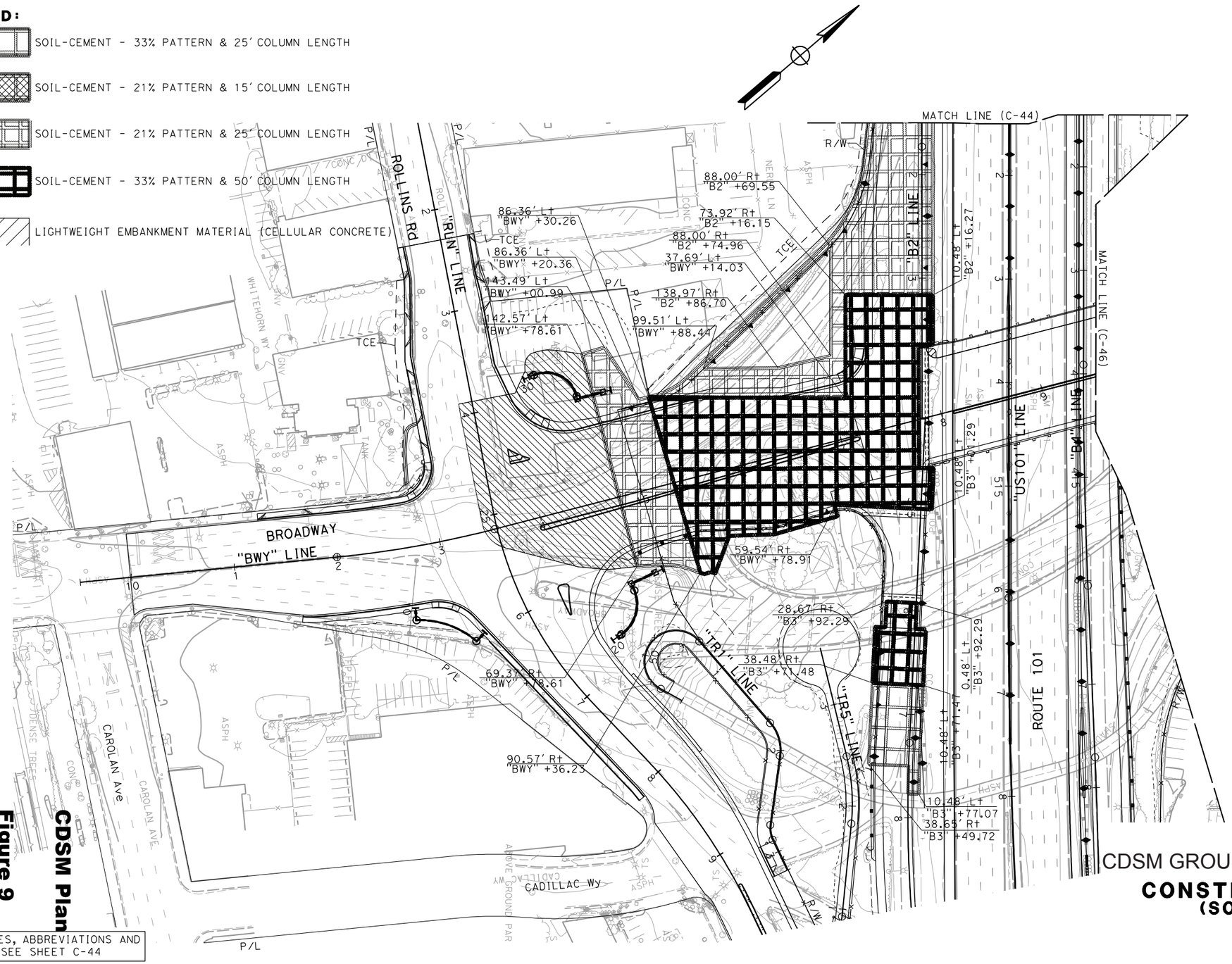
NOTES:

1. FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.
2. SEE C-47 FOR CEMENT DEEP SOIL MIXING DETAILS AND SECTION VIEWS.
3. SEE C-48 TO C-50 FOR LIGHTWEIGHT EMBANKMENT MATERIAL (CELLULAR CONCRETE) DETAILS AND PROFILES.

LEGEND:

- SOIL-CEMENT - 33% PATTERN & 25' COLUMN LENGTH
- SOIL-CEMENT - 21% PATTERN & 15' COLUMN LENGTH
- SOIL-CEMENT - 21% PATTERN & 25' COLUMN LENGTH
- SOIL-CEMENT - 33% PATTERN & 50' COLUMN LENGTH
- LIGHTWEIGHT EMBANKMENT MATERIAL (CELLULAR CONCRETE)



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET C-44

CDSM Plan

Figure 9

FIGURE 9A -
CDSM GROUND IMPROVEMENT PLAN

CONSTRUCTION DETAILS
(SOIL TREATMENT)

SCALE 1" = 50'

C-45

REVISED BY	AB		
DATE REVISED	01/15/13		
CALCULATED-DESIGNED BY	ABHIJEET BHOI		
CHECKED BY	ELIE ABI-JAOUDE		
CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN		
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION	Caltrans		

LAST REVISION 01-15-13 | DATE PLOTTED => 4/2/2013 | TIME PLOTTED => 5:24:02 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

ARBhoi 01/15/13
REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Abhijeet R. Bhoi No. C68606 Exp. 09-30-13 CIVIL STATE OF CALIFORNIA

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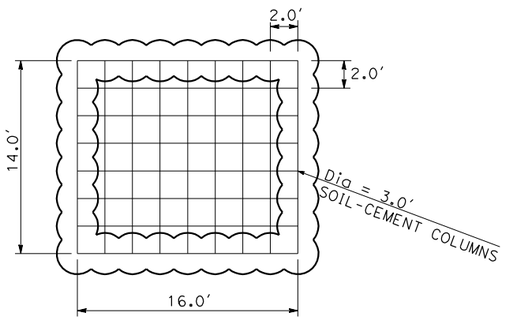
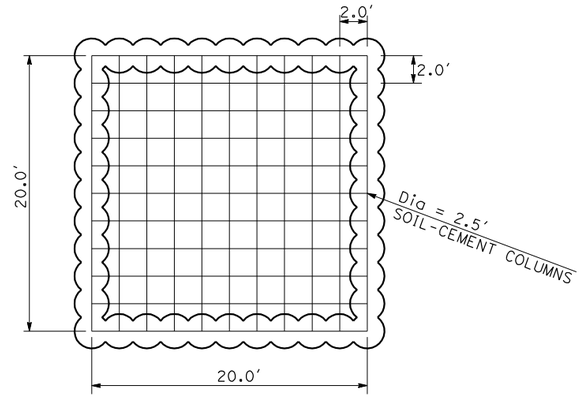
URS CORPORATION
100 W. SAN FERNANDO St
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306



SOIL-CEMENT TREATMENT 33% PATTERN LAYOUT

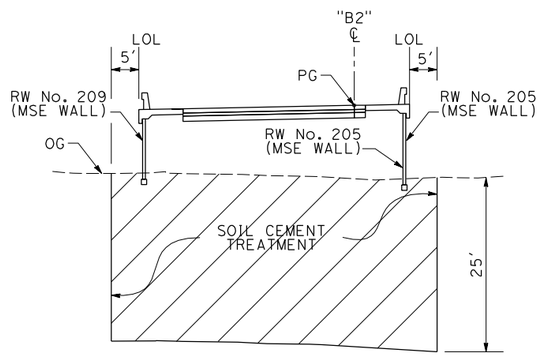


SOIL-CEMENT TREATMENT 21% PATTERN LAYOUT

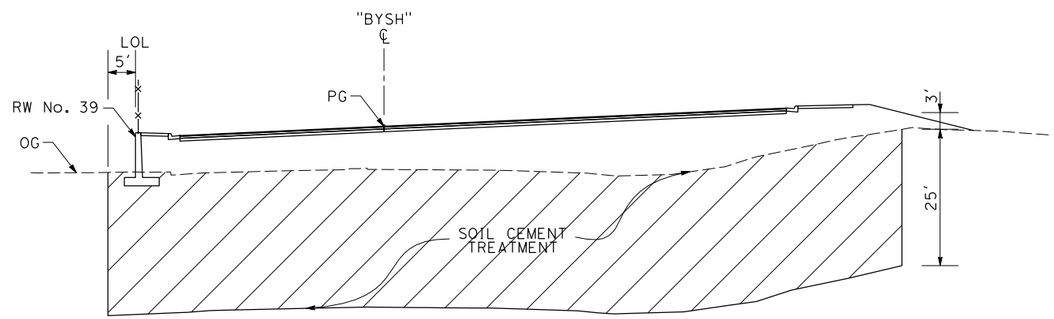
TABLE A

STATION LIMITS	PATTERN	SOIL CEMENT-COLUMN LENGTH
"B2" 208+16.00 TO "B2" 210+14.11	0.21	25
"B2" 210+14.11 TO "B2" 213+16.25	0.33	25
"B2" 213+16.25 TO "BWY" 15+33.17	0.33	50
"BWY" 14+78.61 TO "BWY" 15+33.17	0.33	25
"B3" 315+92.29 TO "B3" 316+71.47	0.33	50
"B3" 316+71.47 TO "B3" 317+77.07	0.21	25
"BWY" 19+98.84 TO "BWY" 20+50.65	0.33	50
"BWY" 20+50.65 TO "BWY" 23+03.53	0.33	25
"BWY" 23+03.53 TO "BWY" 24+57.02	0.21	25
"BYSH" 39+52.61 TO "BYSH" 39+87.36	0.21	15

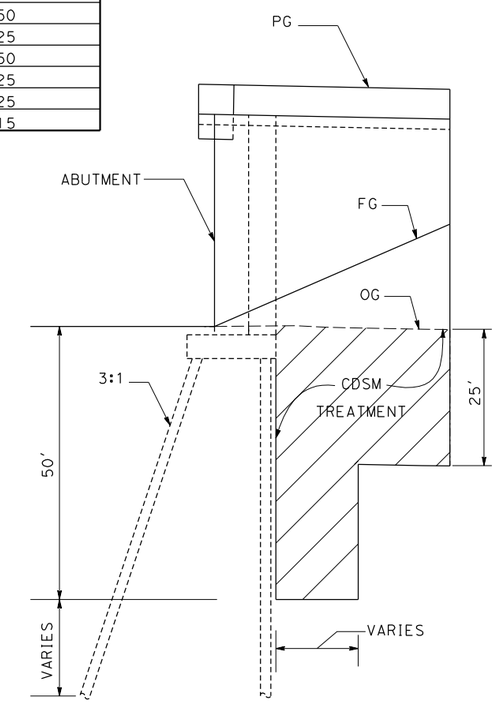
* COLUMN LENGTH INCREASES TO 50.0' NEAR BRIDGE ABUTMENTS AND PG&E TOWER LOCATIONS, SEE TABLE A.



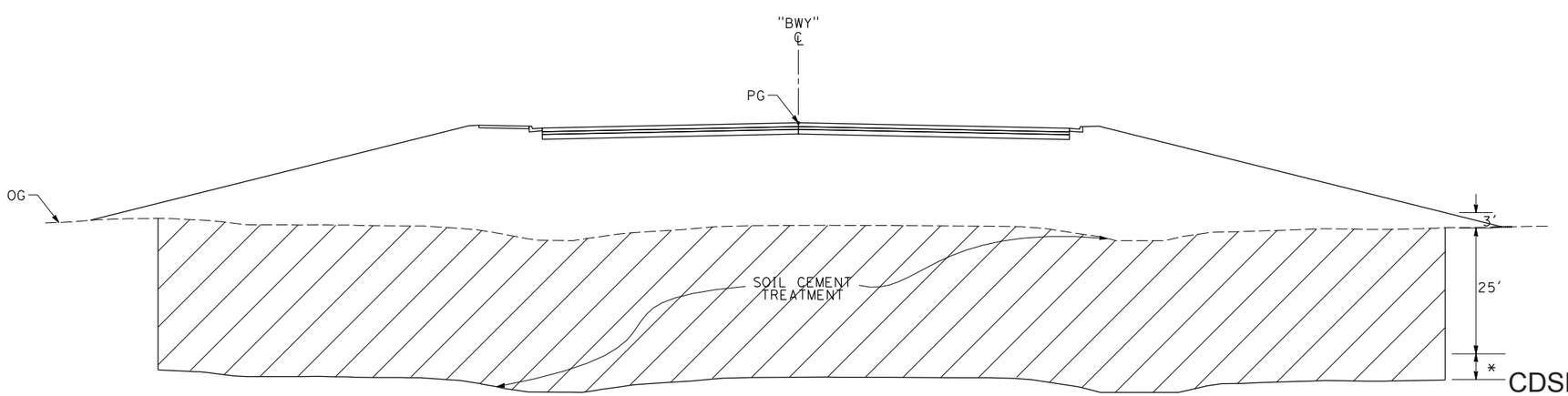
TYPICAL SECTION A-A



TYPICAL SECTION B-B



TYPICAL SECTION D-D



TYPICAL SECTION C-C

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET C-44

FIGURE 9B -
CDSM GROUND IMPROVEMENT PLAN

CONSTRUCTION DETAILS
(SOIL TREATMENT)

NO SCALE

C-47

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN
CALCULATED-DESIGNED BY: ABHIJEET BHOI
CHECKED BY: ELIE ABI-JAOUDE
REVISED BY: AB
DATE REVISED: 01/15/13

LAST REVISION 01-15-13
DATE PLOTTED => 4/2/2013
TIME PLOTTED => 5:24:20 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER — DATE 2-12-13

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Austin Prince — No. C80659 — Exp. 3/31/13 — CIVIL — STATE OF CALIFORNIA

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SMCTA
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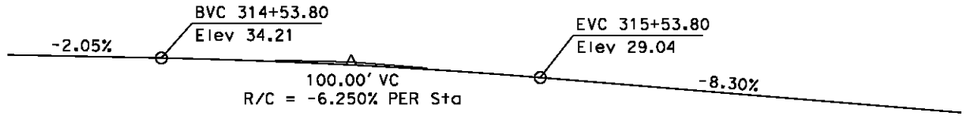
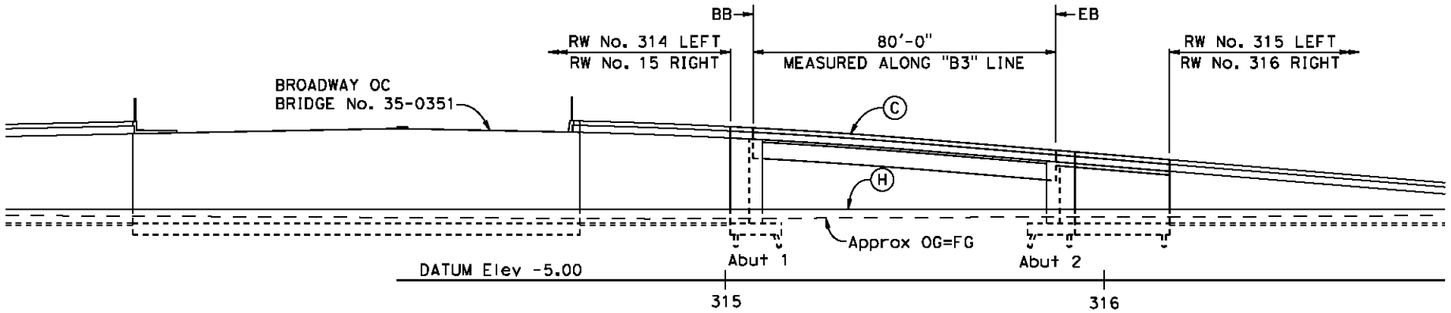
SAN CARLOS, CA 94070-1306

URS CORPORATION
2870 GATEWAY OAKS DRIVE, SUITE 150
SACRAMENTO, CA 95833-4308



PROFILE GRADE
NO SCALE



MIRRORED ELEVATION
1"=20'-0"

NOTES:

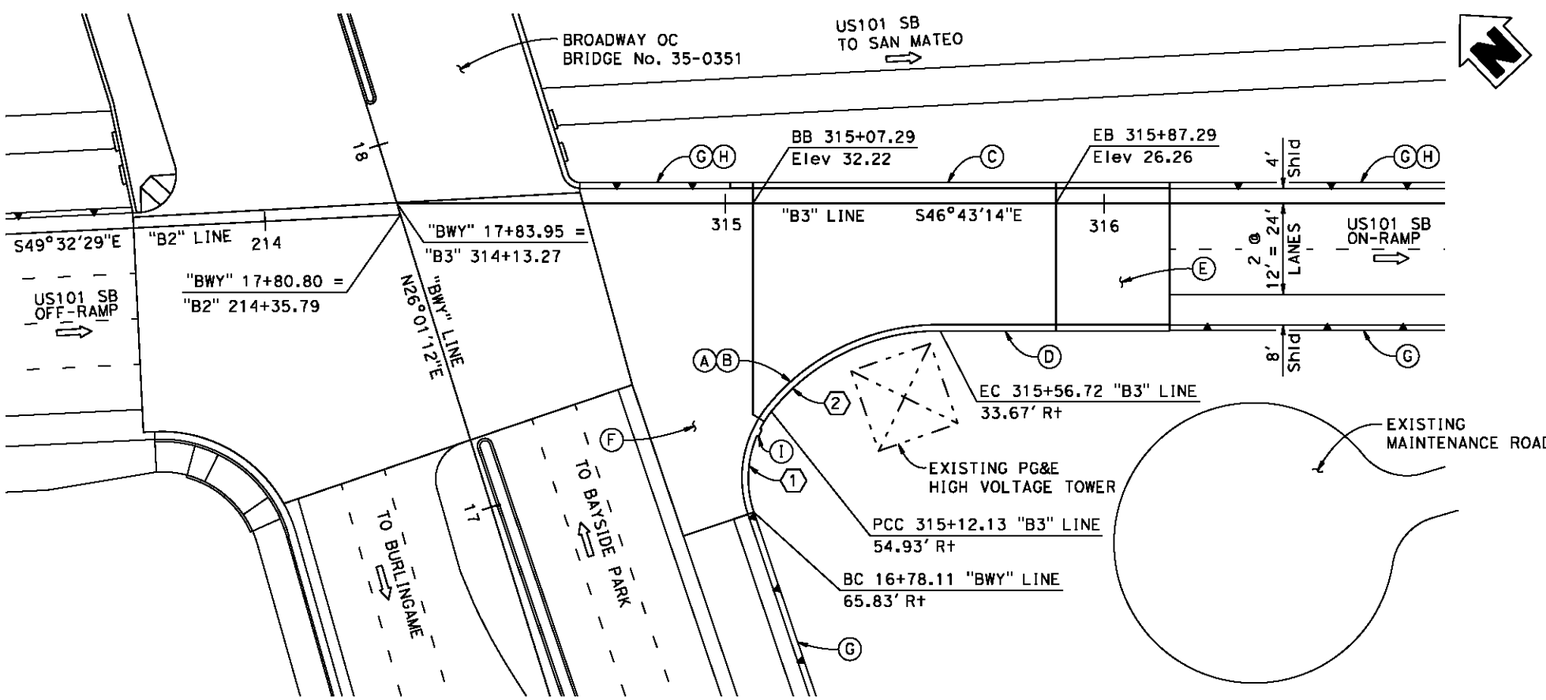
- (A) Paint "Bridge No. 35-0352K" and Year Constructed
- (B) Paint Bridge Name
- (C) Concrete Barrier (Type 736)
- (D) California ST-10 Bridge Rail
- (E) Structure Approach Type N(30S)
- (F) Structure Approach Type N(30S) Modified
- (G) MSE Wall, see "RETAINING WALL" sheets
- (H) Concrete Barrier, see "ROAD PLANS"
- (I) Light with pedestal, see "PEDESTAL DETAILS" sheet

LEGEND:

- - — Indicates existing structure
- ⇨ Indicates direction of traffic

CURVE DATA

CURVE	R	Δ	T	L
1	28.33'	56°54'25"	15.35'	28.14'
2	56.62'	51°44'49"	27.46'	51.13'



PLAN
1"=20'-0"

Note: For "GENERAL NOTES", "STANDARD PLANS" and "INDEX TO PLANS" see "INDEX TO PLANS" sheet.

DESIGN OVERSIGHT	DESIGN	BY A. Prince	CHECKED J. Hueser	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 W/"LOW-BOY"; PERMIT DESIGN VEHICLE
	DETAILS	BY R. Lim	CHECKED J. Hueser	LAYOUT	BY A. Prince — CHECKED J. Hueser
SIGN OFF DATE	QUANTITIES	BY A. Prince	CHECKED S. Landis	SPECIFICATIONS	BY D. Harnagel — PLANS AND SPECS COMPARED

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Syed Kazmi
PROJECT ENGINEER

BRIDGE NO. 35-0352K
POST MILES 16.58

BROADWAY ON-RAMP
GENERAL PLAN No. 1

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES: 2-12-13 2-24-12 9-5-12 11-16-12

SHEET 1 OF 25

FILE => 35-0352K-a-gp01.dgn

USERNAME => raymond_lim DATE PLOTTED => 2/12/2013 TIME PLOTTED => 10:12:11 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER — DATE 2-12-13

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Austin Prince — No. C80659 — Exp. 3/31/13 — CIVIL — STATE OF CALIFORNIA

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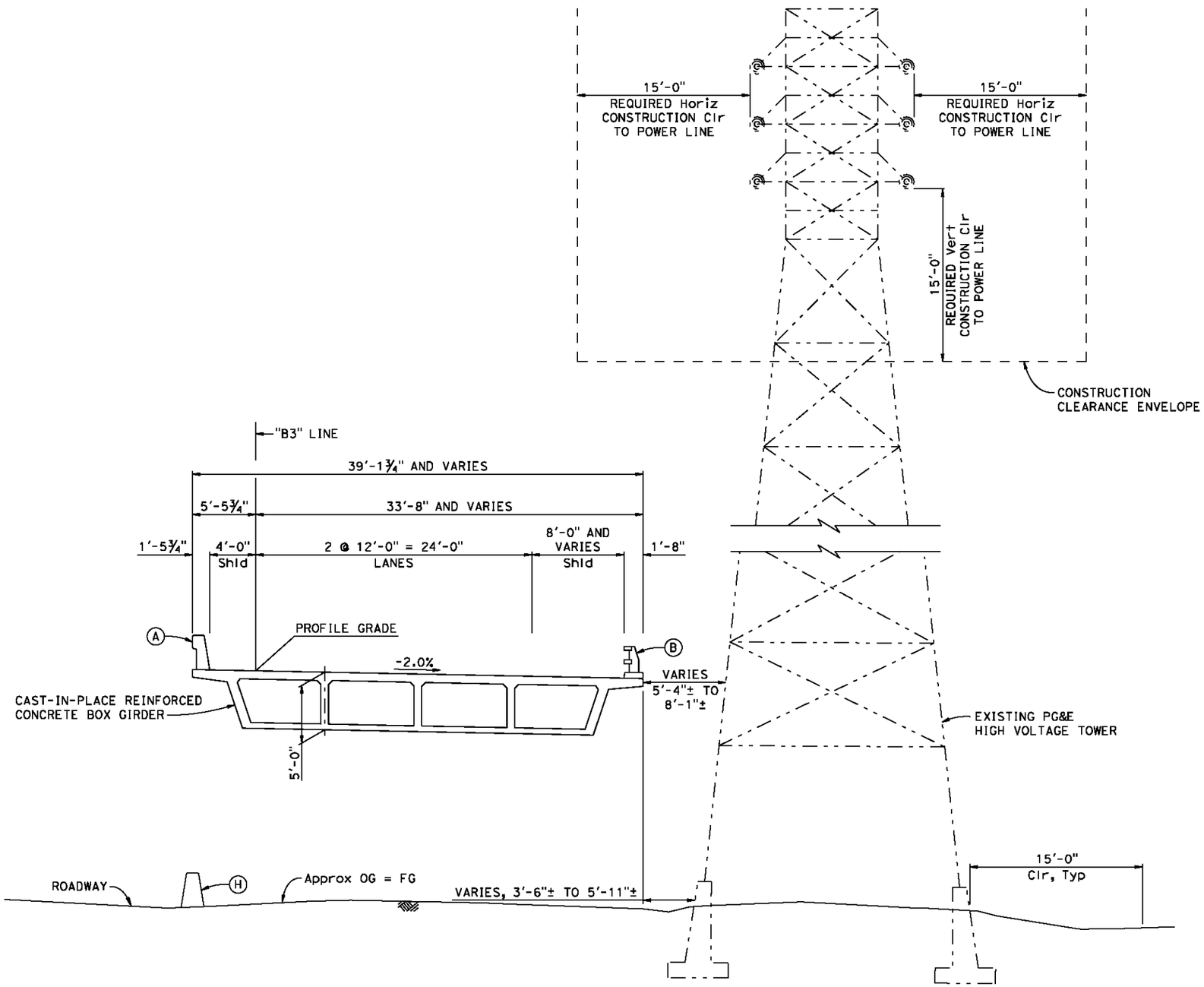
2870 GATEWAY OAKS DRIVE, SUITE 150
SACRAMENTO, CA 95833-4308



TYPICAL SECTION

1" = 5'-0"

NOTES:

(A) Concrete Barrier (Type 736)
(B) California ST-10 Bridge Rail
(H) Concrete Barrier, see "ROAD PLANS"

LEGEND:

- - — Indicates existing structure

DESIGN OVERSIGHT	DESIGN	BY A. Prince	CHECKED J. Hueser	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 W/"LOW-BOY"; PERMIT DESIGN VEHICLE
	DETAILS	BY R. Lim	CHECKED J. Hueser	LAYOUT	BY A. Prince — CHECKED J. Hueser
SIGN OFF DATE	QUANTITIES	BY A. Prince	CHECKED S. Landis	SPECIFICATIONS	BY D. Harnagel — PLANS AND SPECS COMPARED

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

Syed Kazmi
PROJECT ENGINEER

BRIDGE NO. 35-0352K
POST MILES 16.58

BROADWAY ON-RAMP
GENERAL PLAN No. 2

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES: 2-12-13 2-21-13 3-5-13 11-14-13

SHEET 2 OF 25

FILE => 35-0352K-a-gp02.dgn

USERNAME => raymond_lim DATE PLOTTED => 2/12/2013 TIME PLOTTED => 10:12:11 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER 2-12-13 DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER Austin Prince No. C80659 Exp. 3/31/13 CIVIL STATE OF CALIFORNIA

SMCTA
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

URS CORPORATION
2870 GATEWAY OAKS DRIVE, SUITE 150
SACRAMENTO, CA 95833-4308

PILE DATA TABLE

LOCATION	PILE TYPE	NOMINAL RESISTANCE (kips)		DESIGN TIP ELEVATION (ft)	SPECIFIED TIP ELEVATION (ft)	NOMINAL DRIVING RESISTANCE (kips)*
		COMPRESSION	TENSION			
Abut 1	CLASS 90 Alt "X", T=16"	180	0	-35(A), -24(C), -16(D)	-35	180
Abut 1 Rt RW	CLASS 90 Alt "X", T=16"	160	20	-35(A), -11(B), -24(C), -16(D)	-35	160
Abut 2	CLASS 90 Alt "X", T=16"	180	0	-35(A), -24(C), -16(D)	-35	180
Abut 2 Lt RW	CLASS 90 Alt "X", T=16"	160	28	-35(A), -20(B), -24(C), -16(D)	-35	160
Abut 2 Rt RW	CLASS 90 Alt "X", T=16"	150	24	-35(A), -20(B), -24(C), -16(D)	-35	150

DESIGN TIP ELEVATION IS CONTROLLED BY THE FOLLOWING DEMANDS:
(A) COMPRESSION, (B) TENSION, (C) SETTLEMENT, (D) LATERAL LOAD.
* NOMINAL DRIVING RESISTANCE IS THE SUM OF NOMINAL RESISTANCE AND DOWNDRAG.

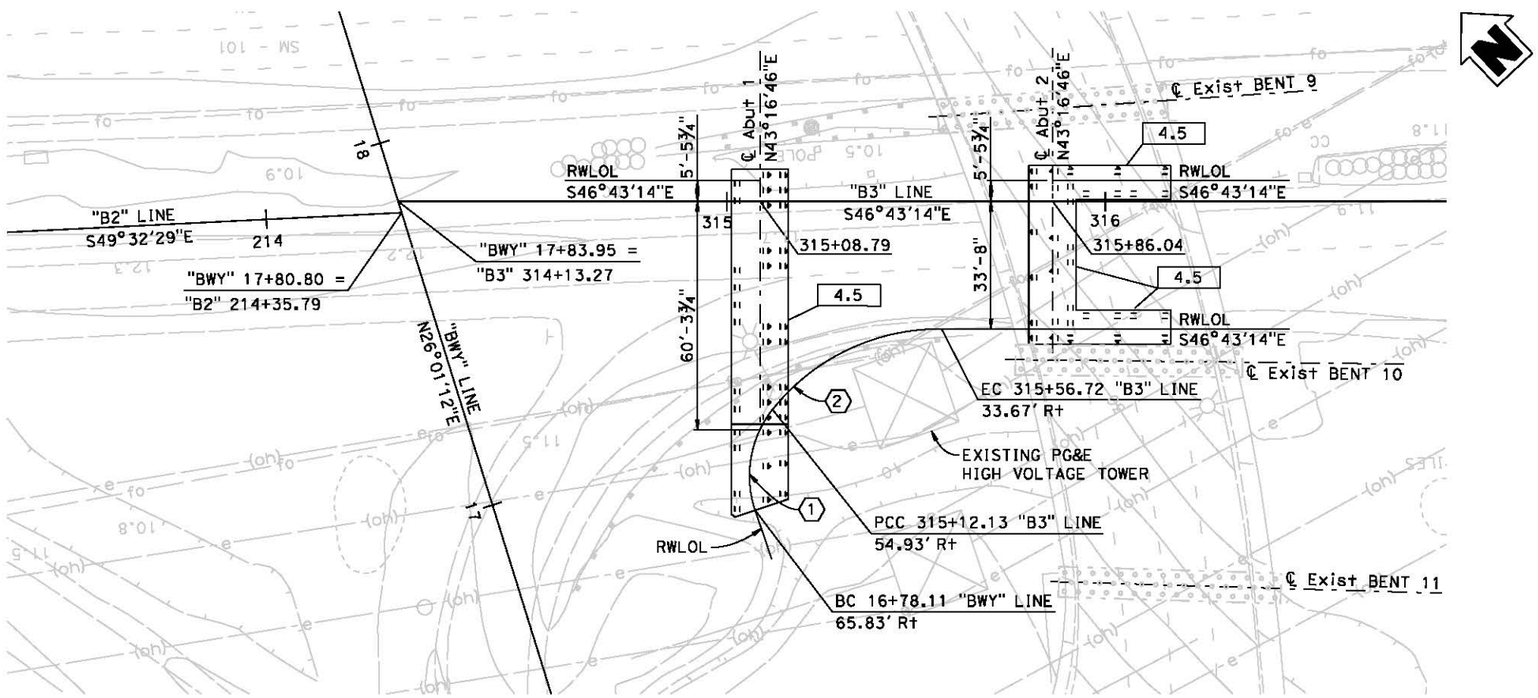
BENCH MARK

BENCH MARK	N	E	ELEV	DESCRIPTION
1003	2043769.910	6021712.494	10.93	STANDARD CITY WELL MONUMENT AT THE CENTERLINE OF BAYSHORE HWY IN A CURB MEDIAN OVER A BOX CULVERT AT EASTON CREEK
510	2042355.119	6022633.562	12.66	SURVEY SPIKE & URS WASHER ON THE BROADWAY ON-RAMP TO SB US 101, IN THE AC SHOULDER, ± 3.2' SOUTHWEST OF ETW & ± 3' NORTHWEST OF EP

SURVEY CONTROL
HORIZONTAL CONTROL FOR THIS SURVEY IS BASED ON THE CALIFORNIA COORDINATE SYSTEM, ZONE 3, US SURVEY FEET, NORTH AMERICAN DATUM OF 1983 (NAD83 2007),
VERTICAL CONTROL IS THE NORTH AMERICAN VERTICAL DATUM (NAVD88 RCFCD).

NOTES:

1. For location of utilities, see "UTILITY PLANS".
2. Foundation for Broadway OC (Replace), Bridge No. 35-0351 not shown.



LEGEND:

- Indicates battered piles
- Indicates vertical piles
- Indicates bottom of footing elevation

CURVE DATA

CURVE	R	Δ	T	L
1	28.33'	56°54'25"	15.35'	28.14'
2	56.62'	51°44'49"	27.46'	51.13'

PLAN

GEOTECHNICAL PROFESSIONAL 2-12-13 APPROVAL DATE

DESIGN OVERSIGHT	SCALE: 1"=20'-0"	VERT.DATUM NAVD88	HORZ.DATUM NAD83	DESIGN	BY A. Prince	CHECKED J. Hueser	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
	PHOTOGRAMMETRY AS OF: 6-23-2010	ALIGNMENT TIES		DETAILS	BY R. Lim	CHECKED J. Hueser	
	SURVEYED BY C. Radman	DRAFTED BY K. Iangari		QUANTITIES	BY A. Prince	CHECKED S. Landis	
SIGN OFF DATE	FIELD CHECKED BY S. Christensen	CHECKED BY A. Bhoi					

Syed Kazmi
PROJECT ENGINEER

BRIDGE NO. 35-0352K
POST MILES 16.58

BROADWAY ON-RAMP
FOUNDATION PLAN

FOUNDATION PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 2-12-13 2-24-12 8-1-12 11-16-12 SHEET 5 OF 25

FILE => 35-0352K-e-fdpl.dgn

USERNAME => raymond_lim DATE PLOTTED => 2/12/2013 TIME PLOTTED => 10:12:13 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

GEOTECHNICAL PROFESSIONAL — DATE 2-12-13

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER — Stephen Huang — No. C 42289 — Exp. 06/30/14 — GEOTECHNICAL — STATE OF CALIFORNIA

SMCTA
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

URS CORPORATION
2870 GATEWAY OAKS DRIVE, SUITE 150
SACRAMENTO, CA 95833-4308

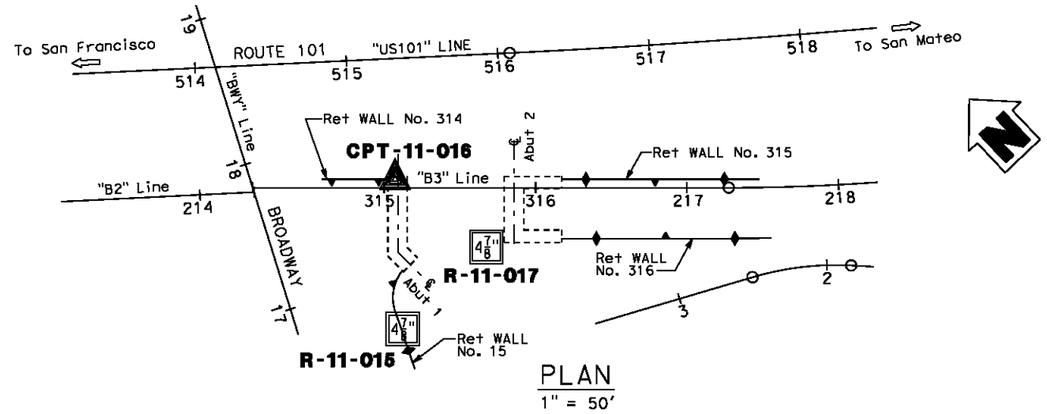
BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

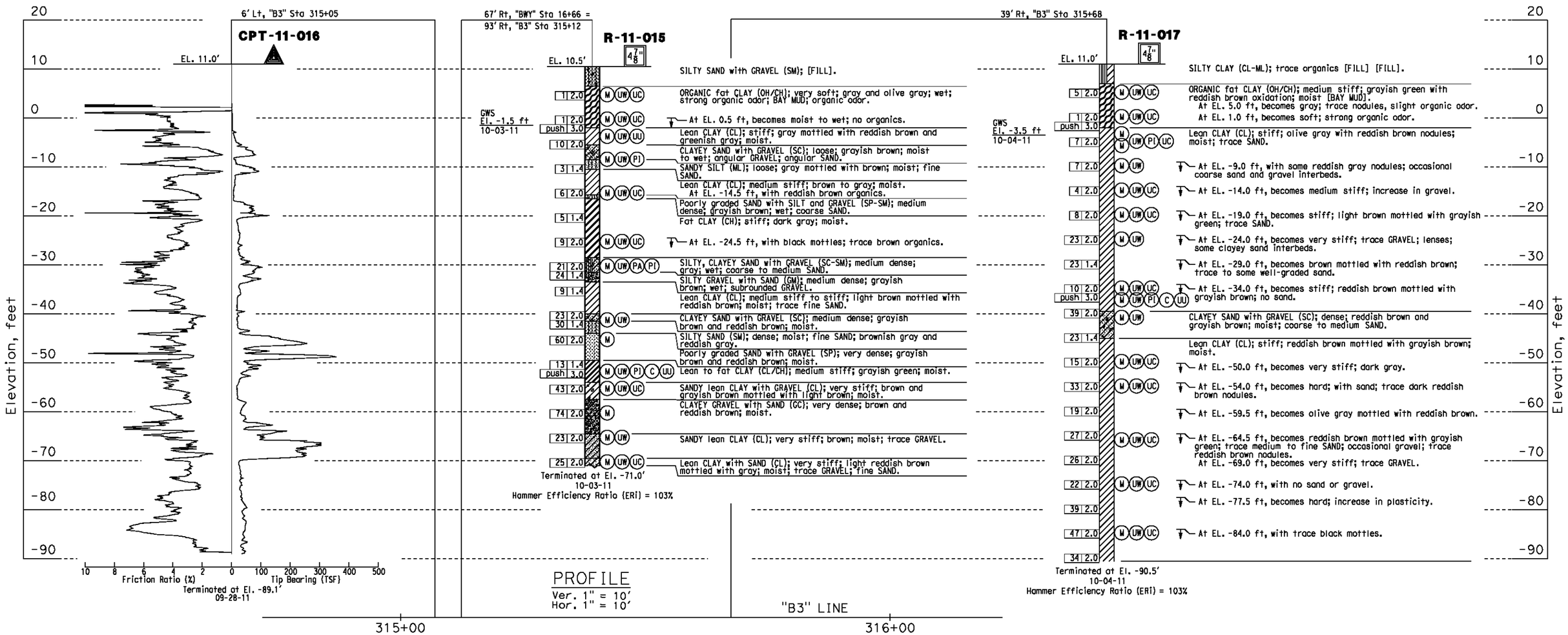
BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

1. This LOTB Sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).
2. Standard Penetration test sampler I.D. = 1.44 inch (1.4)
   Modified California sampler I.D. = 1.96 inch (2.0)
   Thin-walled Shelby tube sampler I.D. = 2.97 inch (3.0)



PLAN
1" = 50'



PROFILE
Ver. 1" = 10'
Hor. 1" = 10'

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG	S. HUANG	BRIDGE NO. 35-0352K
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:	PROJECT ENGINEER	POST MILES 16.58

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

BROADWAY ON-RAMP
LOG OF TEST BORINGS

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES 8-8-12 11-16-12 2-12-13

SHEET 25 OF 25

FILE => 35-0352K-z-ltb01.dgn

USERNAME => raymond_lim DATE PLOTTED => 2/12/2013 TIME PLOTTED => 10:12:23 AM

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	MILE POST-TOTAL PROJECT	Sheet No.	Total Sheets
04	SM	101	16.3/17.1		

REGISTERED GEOTECHNICAL ENGINEER — DATE

DATE PLOTTED => 4/4/2013

BROADWAY ON-RAMP

LOG OF TEST BORINGS (2 OF 2)

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE AND INVESTIGATIONS, SACRAMENTO, CALIFORNIA

CU: 04
EA: 235844

BRIDGE No. 35-0352K

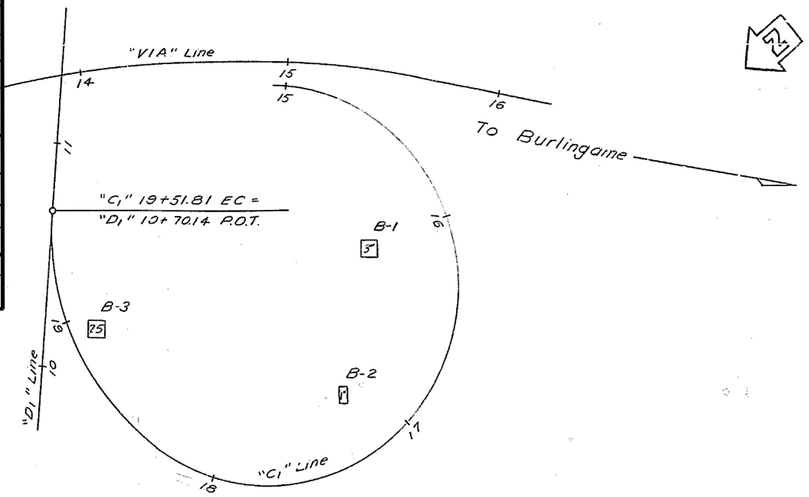
Sheet ___ of ___

Boring	Station	Offset from "B3" Line
B-1	315+35	161.3Rt
B-2	314+74	157.9Rt
B-3	315+18	63.2 Rt

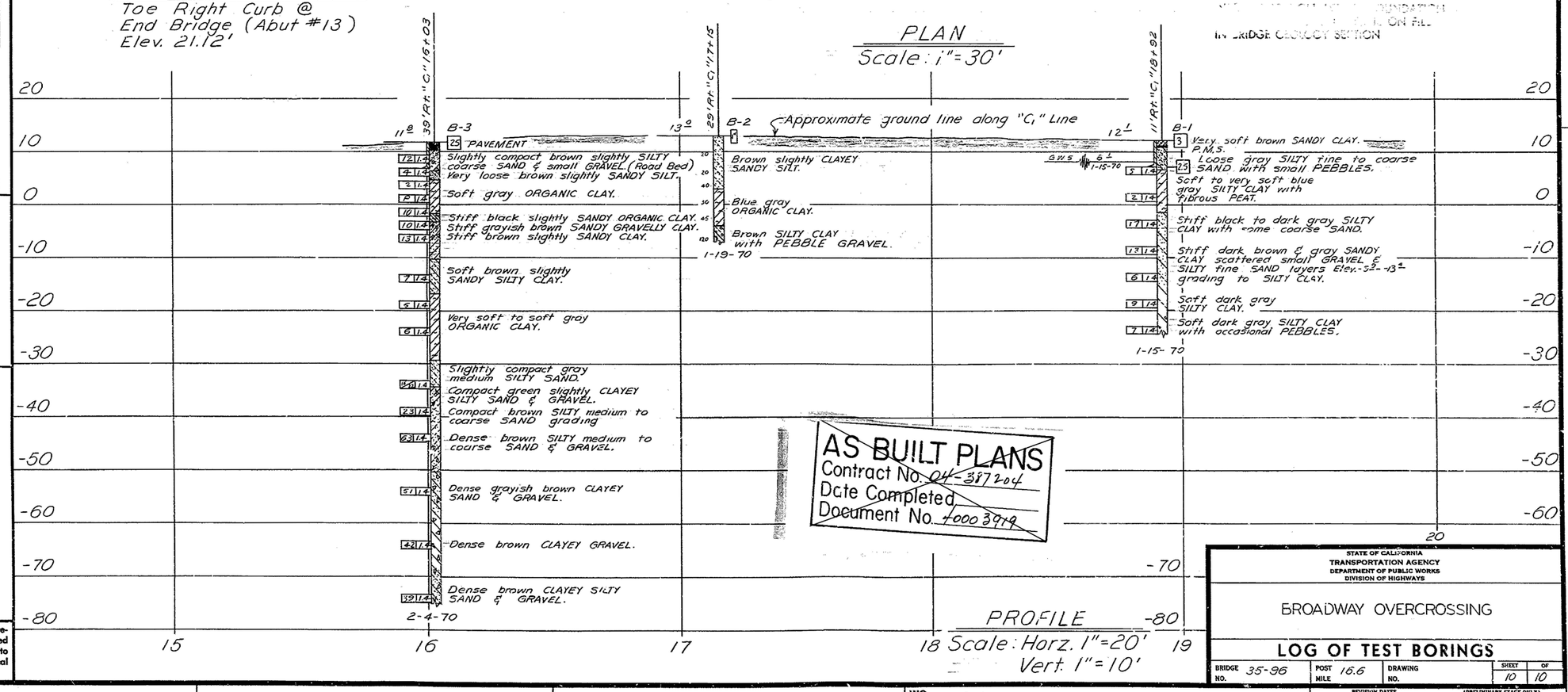
DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.6	62	62

BRIDGE ENGINEER — REGISTERED CIVIL ENGINEER NO. 9966
DATE APPROVED September 14, 1976

REGISTERED PROFESSIONAL ENGINEER
Stephen Huang
No. C 42289
Exp. 03/31/14
CIVIL
STATE OF CALIFORNIA



PLAN
Scale: 1" = 30'



PROFILE
Scale: Horz. 1" = 20'
Vert. 1" = 10'

AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 4000 3919

LEGEND OF BORING OPERATIONS

PENETROMETER — 2½" CONE PENETROMETER — SAMPLER BORING (DRY) — ROTARY BORING (WET) — AUGER BORING (DRY) — JET BORING — CORE BORING — TEST PIT

LEGEND OF EARTH MATERIALS

GRAVEL — SAND — SILT — CLAY — SILTY CLAY OR CLAYEY SILT — SANDY CLAY OR CLAYEY SAND — SANDY SILT OR SILTY SAND — ROCK WITH ORGANIC MATTER — FILL MATERIAL — IGNEOUS ROCK — SEDIMENTARY ROCK — METAMORPHIC ROCK

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

FIELD STUDY — BY: G. Miller 2-70
DRAWN — BY: J. Schuler 6-70
CHECKED — BY: G. Miller 6-70
Approval Recommended by: T. L. Sommers, Engineering Geologist 11/76

BRIDGE DEPARTMENT
ENGINEERING GEOLOGY SECTION

62

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING

LOG OF TEST BORINGS

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
35-96	16.6		10	10

REVISION DATES (PRELIMINARY STAGE ONLY) 2/8/70

WO 387201
CU 04205

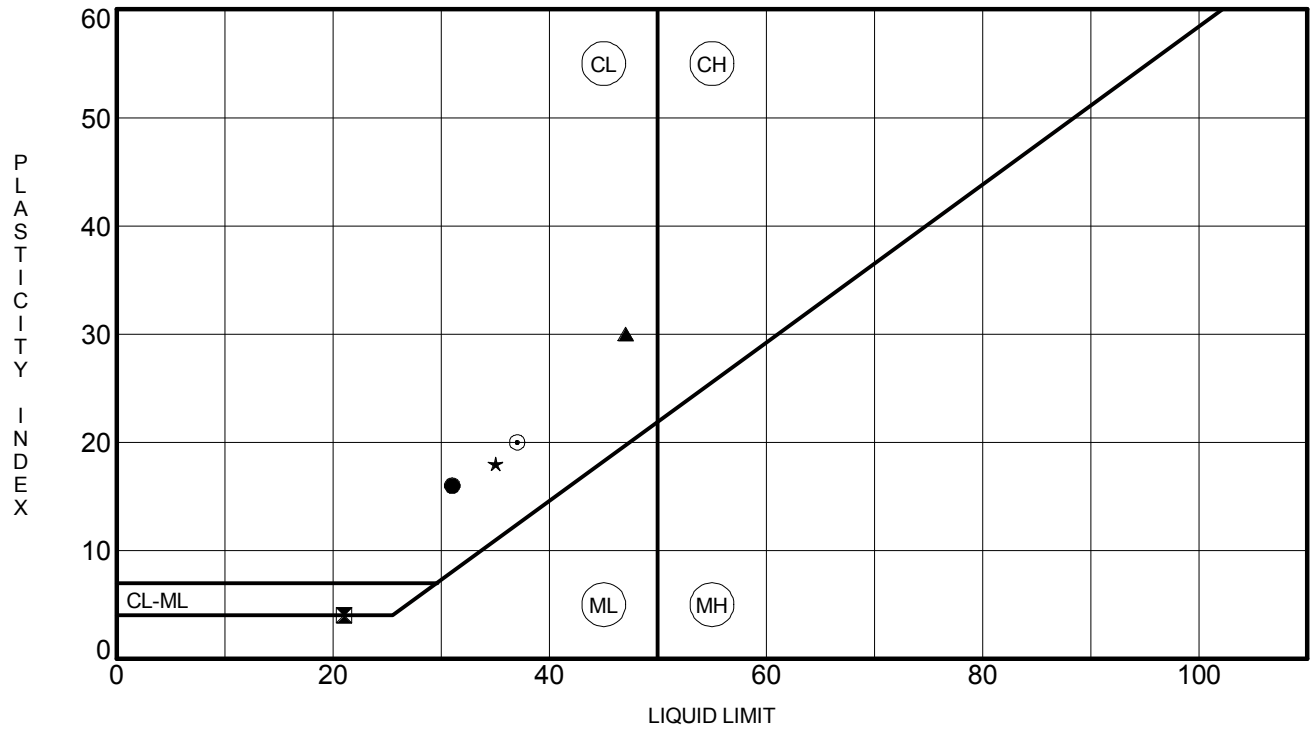
Disregard prints bearing earlier revision dates

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF PUBLIC WORKS.

DATE 6-13-72 SIGNATURE ___ TITLE SR. RME

TABLE C-1
SUMMARY OF LABORATORY TEST RESULTS

						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	5																	490	87.0	49
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	10																	400	95.8	47
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	13.5																	3421	18.8	110
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	15														31	15	16			
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	16.2																		13.5	122
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	25																	1910	28.0	96
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	35																	2750	30.4	93
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	40			100	99	98	87	69	59	51	42	38	21		21	17	4		13.1	124
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	51																		20.9	107
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	55																		10.2	
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	61.5														47	17	30	2648	32.4	86
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	65																	5820	16.3	116
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	70																		11.2	
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	75																		16.4	116
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	80																	7550	17.5	114
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	5																	1110	67.6	59
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	10																	580	97.2	46
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	13.5																		24.0	
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	15														35	17	18	2080	22.5	105
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	20																		18.5	112
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	25																	1630	21.3	106
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	30																	3400	20.9	106
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	35																		18.2	112
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	45																	3250	28.4	96
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	46.5														37	17	20	3881	25.4	100
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	51																		11.1	124
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	60																	5110	21.2	106
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	65																	10320	15.8	116
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	76																	8280	16.0	116
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	85																	7310	19.8	111
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	95																	13270	14.7	118



Sample Identification/Depth (ft)			LL	PL	PI	Fines	Classification
●	**R-11-015**	**15.0**	**31**	**15**	**16**		**CLAYEY SAND with GRAVEL (SC)**
⧗	**R-11-015**	**40.0**	**21**	**17**	**4**	**21**	**SILTY, CLAYEY SAND (SC-SM)**
▲	**R-11-015**	**61.5**	**47**	**17**	**30**		**Lean to fat CLAY (CL/CH)**
★	**R-11-017**	**15.0**	**35**	**17**	**18**		**Lean CLAY (CL)**
⊙	**R-11-017**	**46.5**	**37**	**17**	**20**		**Lean CLAY (CL)**

URS

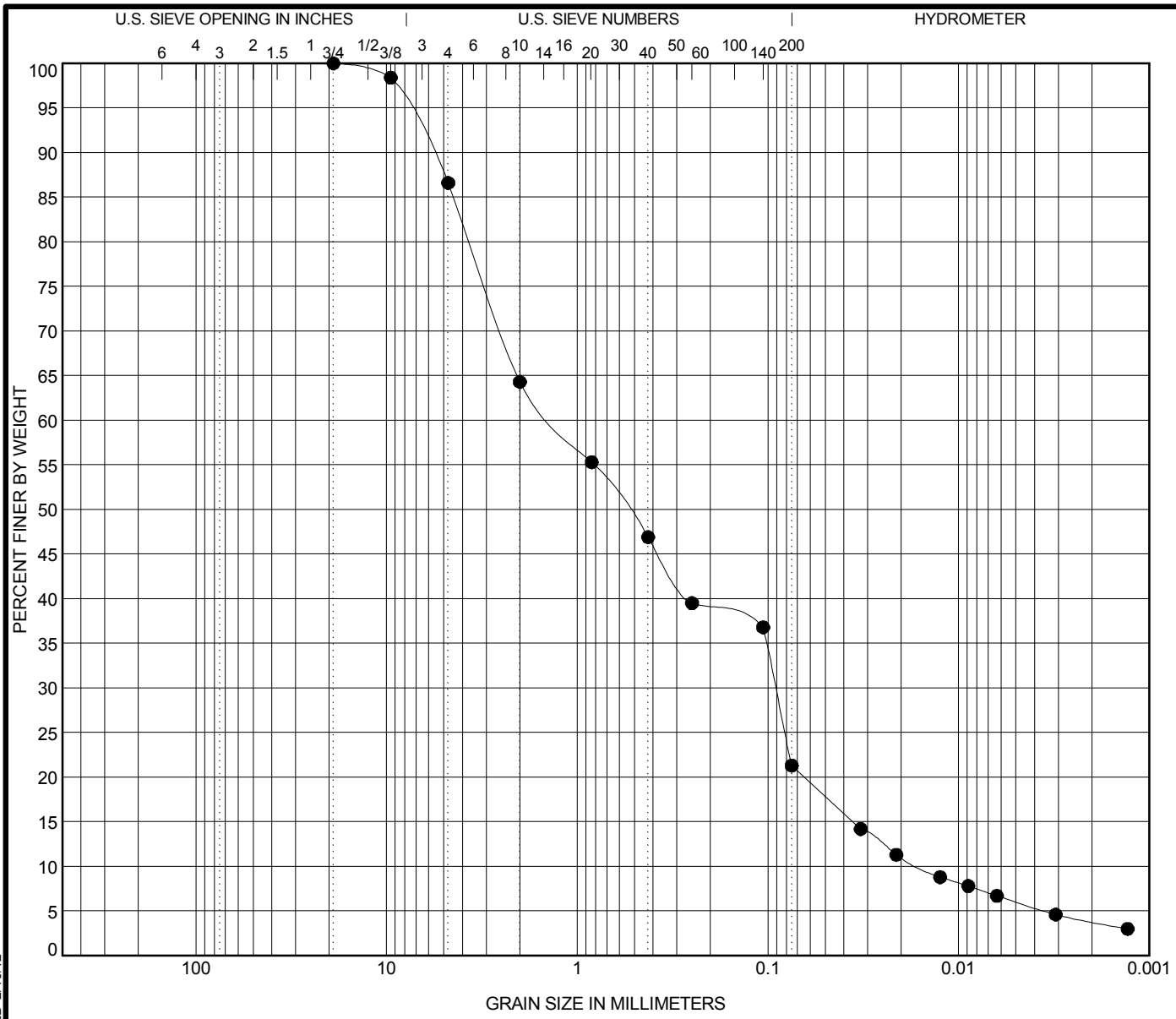
San Jose office

100 W. San Fernando St, Suite 200
San Jose, CA 95113

ATTERBERG LIMITS RESULTS

Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS ATTERBERG LIMITS 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ CT.GLB 2/16/12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Identification/Depth (ft)		Classification	LL	PL	PI	Cc	Cu
●	**R-11-015**	**40.0**	**SILTY, CLAYEY SAND**	**21**	**17**	**4**	**0.39**	**82.03**

	Sample Identification/Depth (ft)		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**R-11-015**	**40.0**	**19**	**1.321**	**0.091**	**0.016**	**13.4**	**65.3**	**15.3**	**6.0**

URS

San Jose Office

100 W. San Fernando, Ste 200
San Jose, CA 95113

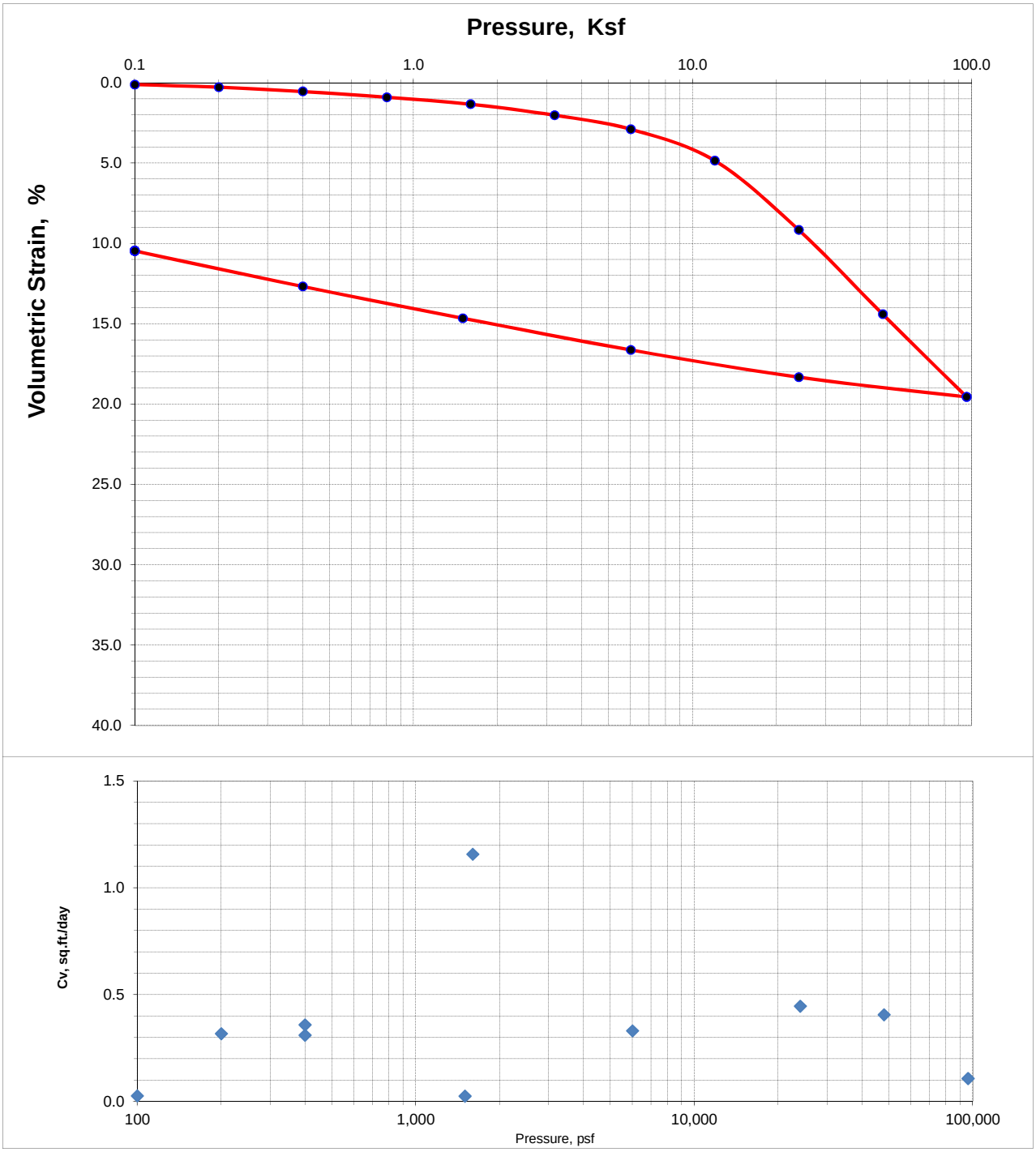
GRAIN SIZE DISTRIBUTION

Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS GRAIN SIZE 28645286-BROADWAY INTERCHANGE RECONSTRUCTION SM.GPJ SNJ_CT.GLB 2/16/12

CONSOLIDATION TEST

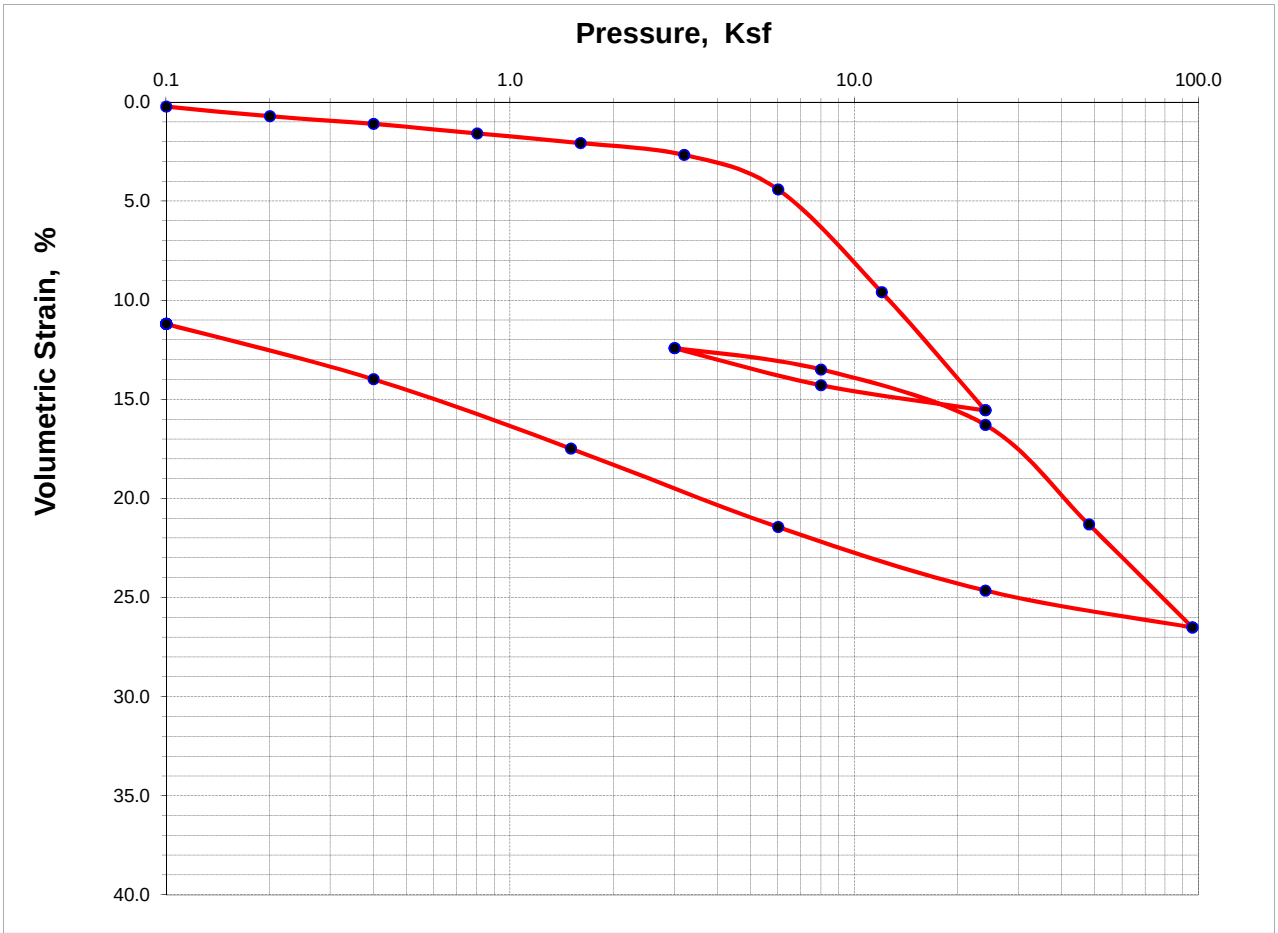
Boring Number	R-11-017	Sample Number	11	Depth (ft)	46.5-49			
Soil Description	Grayish brown lean clay							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	26.1	122.7	0.734	96.1	1.00	2.420	(assumed) 2.70	37	20
Final	19.8	132.6	0.523	102.1	0.878				

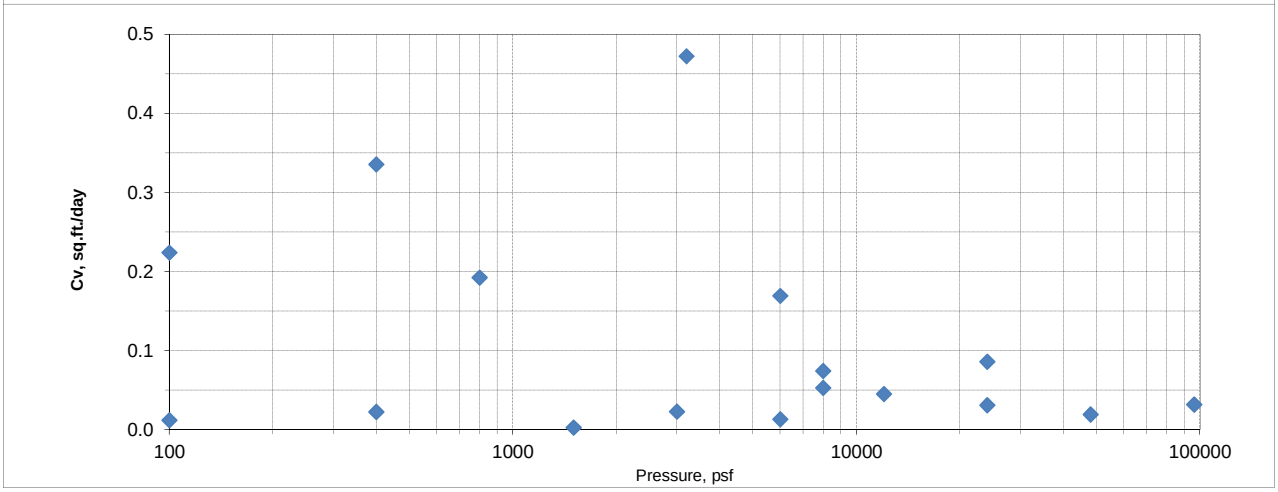


28645286.02

CONSOLIDATION TEST

Boring Number	R-11-015	Sample Number	16	Depth (ft)	61.5-64			
Soil Description	Olive gray lean clay							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	31.6	119.1	0.863	98.9	1.00	2.420	(assumed) 2.70	47	30
Final	23.4	128.9	0.615	102.9	0.867				





28645286.02

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-017
Sample # : 11
Depth (ft) : 46.5-49
Date tested : 11/30/11
Soil : Grayish brown lean clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

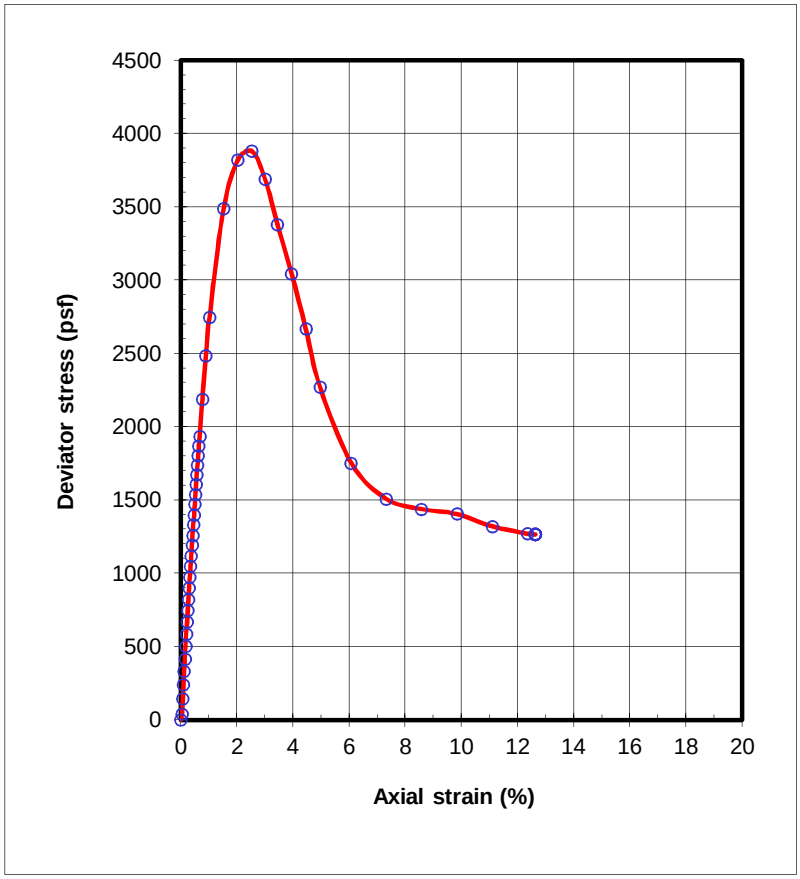
Specimen:

Total wt. =	1249.5	gms
Ht. =	5.970	in
Ave dia. =	2.843	in
Area =	6.352	sq.in
Volume =	621.4	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.682	
Ht/Dia ratio =	2.10	
Moisture =	25.3	%
Total density =	125.5	pcf
Dry density =	100.1	pcf
Saturation =	100.0	%
Chamber pressure =	3000	psf
Max. deviator stress =	3881	psf
Strain @ failure =	2.54	%

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	1.7	0.05	38.4
0.003	6.4	0.07	145.4
0.005	10.6	0.10	240.9
0.006	14.6	0.12	330.7
0.007	18.4	0.15	416.5
0.009	22.2	0.17	502.4
0.010	25.9	0.20	585.3
0.012	29.5	0.22	666.4
0.013	33.0	0.25	745.3
0.015	36.3	0.27	821.4
0.016	39.7	0.30	897.9
0.018	43.0	0.32	971.5
0.019	46.4	0.35	1047.3
0.021	49.5	0.37	1118.1
0.022	52.7	0.40	1190.6
0.024	55.8	0.42	1258.9
0.025	59.0	0.45	1330.6
0.027	62.0	0.47	1398.7
0.028	65.2	0.50	1469.9
0.030	68.2	0.52	1537.6
0.031	71.2	0.55	1606.3
0.033	74.1	0.57	1671.0
0.034	77.2	0.60	1739.4
0.036	80.0	0.62	1801.8
0.037	83.0	0.65	1869.2
0.039	85.9	0.67	1933.7
0.045	97.3	0.77	2188.0
0.052	110.5	0.90	2482.8
0.060	122.5	1.02	2747.6
0.090	156.4	1.53	3490.3
0.120	172.1	2.03	3821.5
0.150	175.6	2.54	3880.6
0.178	167.9	3.00	3691.8
0.204	154.5	3.45	3380.8
0.234	139.8	3.95	3044.1
0.264	123.2	4.45	2668.6
0.295	105.4	4.96	2270.1
0.361	82.3	6.07	1752.9
0.436	71.8	7.32	1508.0
0.510	69.4	8.57	1438.1
0.586	68.7	9.83	1404.2
0.661	65.5	11.09	1319.9
0.736	64.0	12.34	1270.8
0.752	63.9	12.62	1265.1



UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-015
Sample # : 16
Depth (ft) : 61.5-64
Date tested : 11/30/11
Soil : Olive gray lean clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

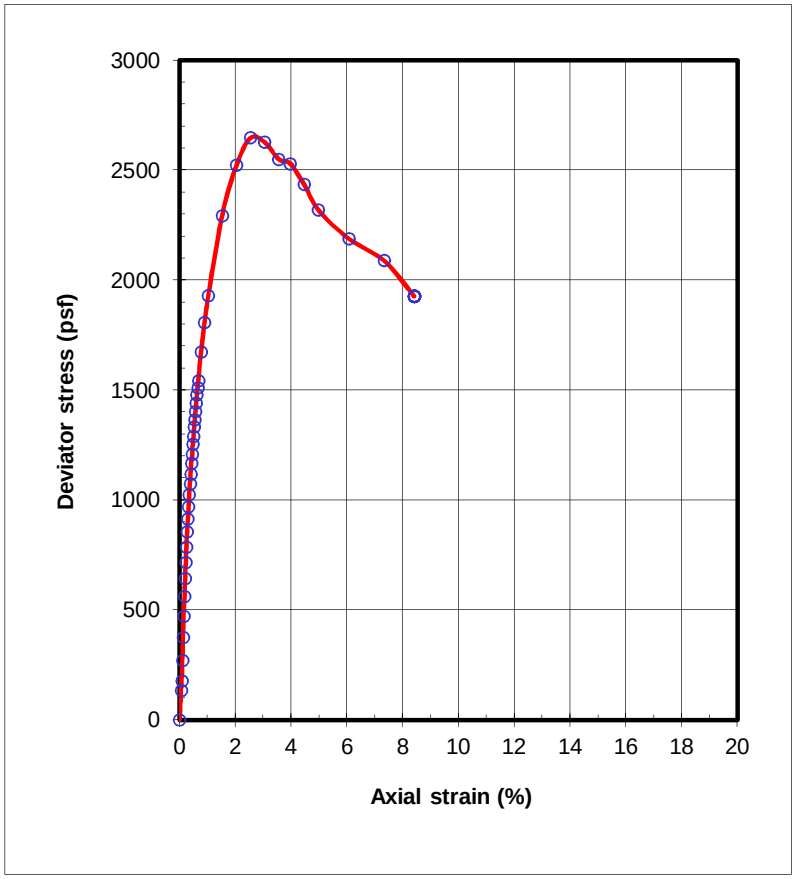
Specimen:

Total wt. =	1124.1	gms
Ht. =	5.970	in
Ave dia. =	2.833	in
Area =	6.308	sq.in
Volume =	617.1	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.962	
Ht/Dia ratio =	2.11	
Moisture =	32.4	%
Total density =	113.7	pcf
Dry density =	85.9	pcf
Saturation =	90.9	%
Chamber pressure =	3950	psf
Max. deviator stress =	2648	psf
Strain @ failure =	2.55	%

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	5.8	0.05	132.6
0.003	7.8	0.07	177.7
0.005	11.9	0.10	271.1
0.006	16.4	0.12	374.6
0.007	20.7	0.15	472.0
0.009	24.7	0.17	562.8
0.011	28.2	0.20	643.0
0.012	31.5	0.22	717.1
0.013	34.6	0.25	787.3
0.015	37.5	0.27	854.5
0.016	40.1	0.30	912.8
0.018	42.7	0.32	970.6
0.019	45.0	0.35	1023.3
0.021	47.2	0.37	1073.2
0.022	49.2	0.40	1119.3
0.024	51.3	0.42	1166.2
0.025	53.1	0.45	1207.6
0.027	55.2	0.47	1253.2
0.028	56.8	0.50	1290.7
0.030	58.7	0.52	1332.1
0.031	60.2	0.55	1366.6
0.033	61.9	0.57	1404.4
0.034	63.5	0.60	1441.6
0.036	65.1	0.62	1477.6
0.037	66.7	0.65	1512.2
0.039	68.1	0.67	1544.0
0.045	73.9	0.77	1673.9
0.052	79.9	0.90	1808.4
0.060	85.4	1.02	1928.8
0.090	102.1	1.53	2295.4
0.121	112.8	2.04	2523.5
0.151	119.0	2.55	2648.3
0.181	118.7	3.05	2627.7
0.211	115.8	3.56	2550.2
0.236	115.4	3.97	2530.3
0.265	111.8	4.46	2438.1
0.295	107.0	4.96	2321.5
0.361	102.1	6.07	2188.5
0.436	98.7	7.33	2089.1
0.501	92.1	8.41	1926.5



UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-015
Sample # : 3
Depth (ft) : 11.5-14
Date tested : 11/29/11
Soil : Dark olive brown lean clay with gravel

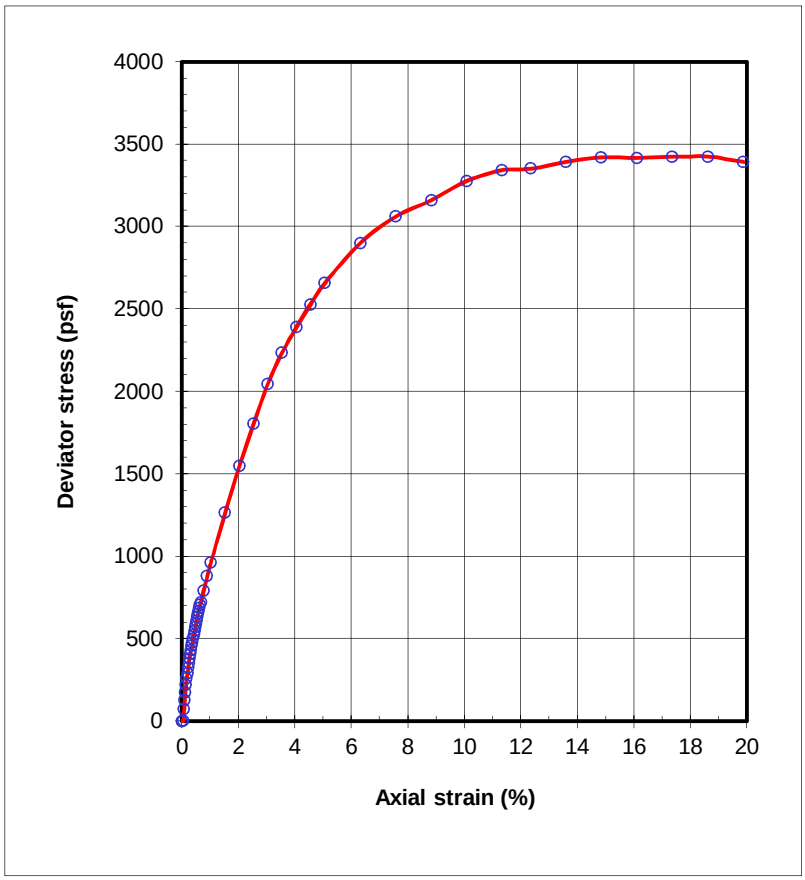
Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt. =	1288.2	gms
Ht. =	5.930	in
Ave dia. =	2.837	in
Area =	6.322	sq.in
Volume =	614.4	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.530	
Ht/Dia ratio =	2.09	
Moisture =	18.8	%
Total density =	130.8	pcf
Dry density =	110.2	pcf
Saturation =	95.8	%
Chamber pressure =	850	psf
Max. deviator stress =	3421	psf
Strain @ failure =	14.84	%



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	0.2	0.05	3.9
0.003	3.2	0.07	72.2
0.005	5.6	0.10	127.1
0.006	7.7	0.12	174.7
0.007	9.7	0.15	219.7
0.009	11.4	0.17	258.1
0.010	12.8	0.20	290.7
0.012	14.3	0.22	324.4
0.013	15.6	0.25	354.3
0.015	16.7	0.27	380.1
0.016	17.9	0.30	405.4
0.018	18.9	0.32	430.2
0.019	20.1	0.35	455.7
0.021	21.1	0.37	478.8
0.022	22.1	0.40	500.7
0.024	23.1	0.42	524.0
0.025	24.1	0.45	546.1
0.027	25.1	0.47	569.3
0.028	26.0	0.50	588.2
0.030	26.9	0.52	609.5
0.031	27.9	0.55	631.0
0.033	28.7	0.57	650.4
0.034	29.5	0.60	667.6
0.036	30.3	0.62	686.1
0.037	31.2	0.65	704.9
0.039	32.0	0.67	723.1
0.045	35.1	0.77	793.1
0.052	39.0	0.90	879.2
0.059	42.6	1.02	960.8
0.089	56.4	1.53	1264.8
0.119	69.4	2.04	1547.4
0.149	81.3	2.54	1804.0
0.179	92.7	3.04	2046.4
0.209	101.7	3.54	2234.7
0.239	109.4	4.05	2389.8
0.268	116.3	4.55	2528.0
0.298	122.9	5.05	2657.2
0.373	136.0	6.31	2901.0
0.448	145.5	7.57	3062.3
0.522	152.2	8.83	3160.2
0.596	160.0	10.08	3277.8
0.671	165.5	11.33	3342.8
0.730	167.9	12.33	3351.9
0.805	172.4	13.59	3392.9
0.879	176.4	14.84	3421.1
0.954	178.8	16.10	3417.5
1.028	181.9	17.36	3423.5
1.103	184.8	18.61	3425.1

LANKELMA

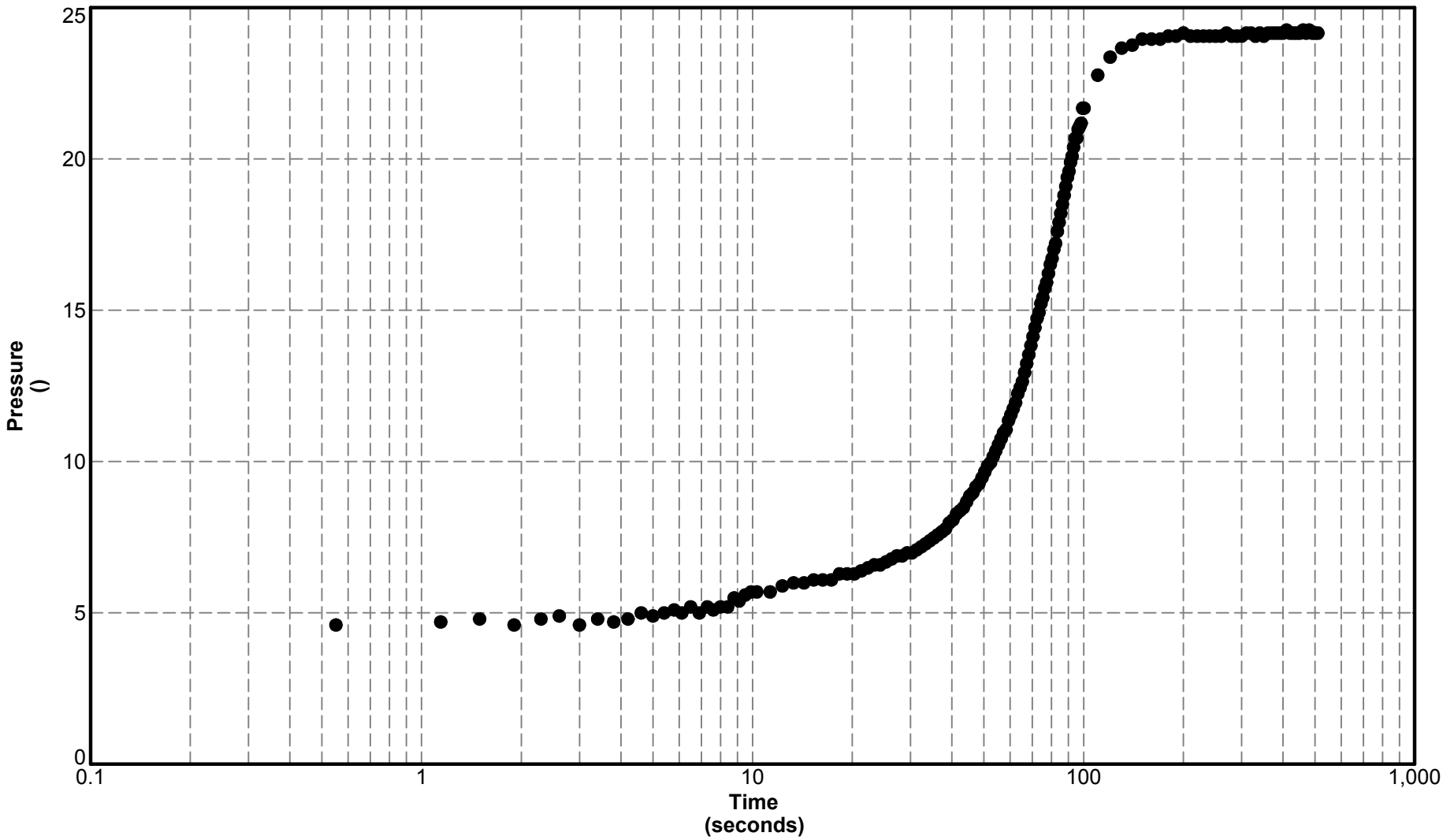
BIRP
(Burlingame,California)
Project Number :17326636

Pore Pressure Dissipation:

Date: Sep. 28, 2011
Estimated Water Depth: 0.5
Rig/Operator: JT | VB

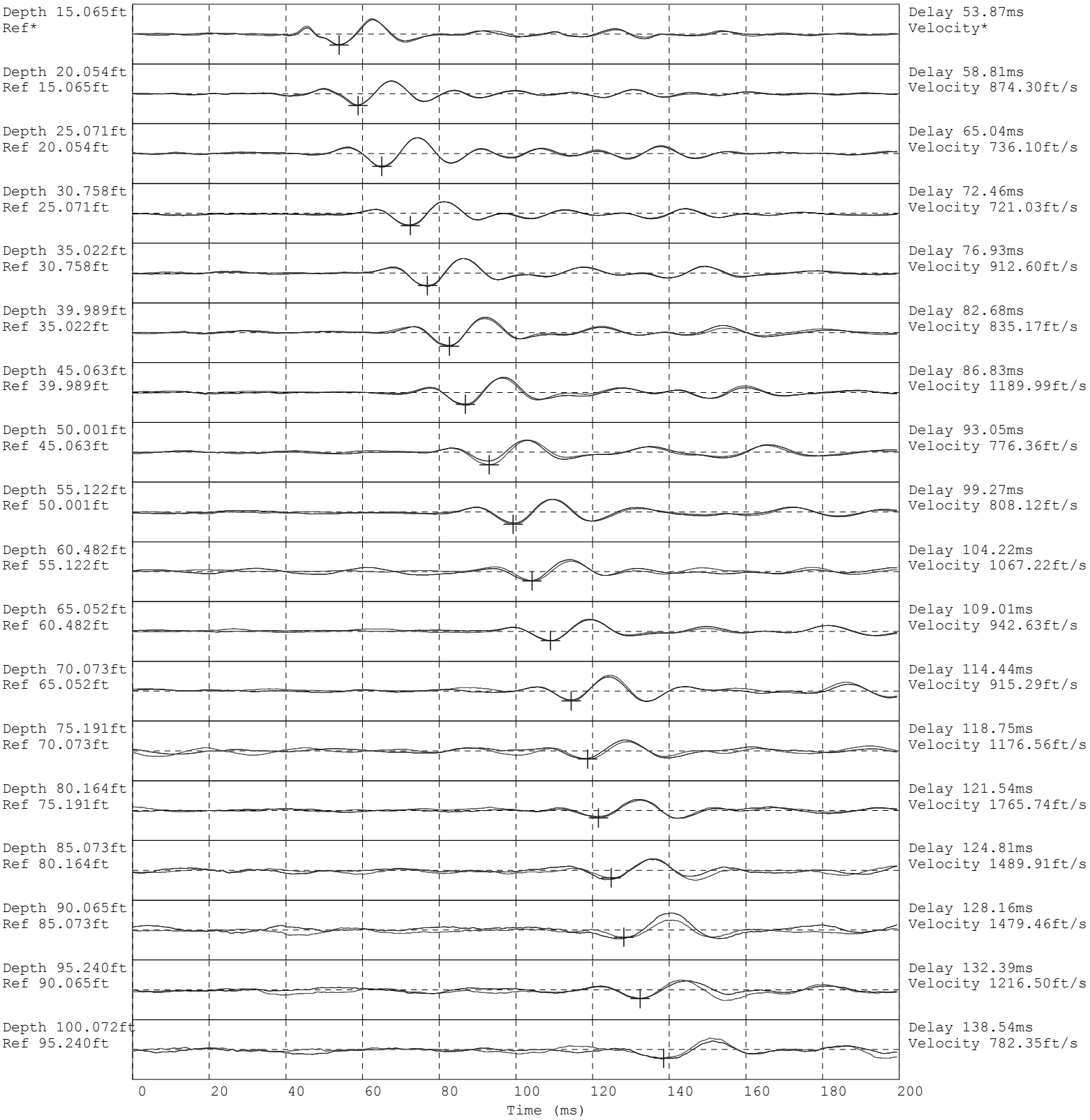
Northing: N/A
Easting: N/A
Elevation: N/A

Total Depth: 100.1 ft
Termination Criteria: Target Depth
Test Depth: 55.8 ft



CPT-11-016

S-Wave CPT-11-016
BIRP SCPT



Hammer to Rod String Distance 3.05 (m)
* = Not Determined

DIST.	COUNTY	ROUTE	POST MILE—TOTAL PROJECT	SHEET	TOTAL SHEETS
04	SM	101	16.6	68	68

September 14, 1970

As-Built Log of Test Borings

As-Built Log of Test Borings sheet is considered an information document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date will not be required. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

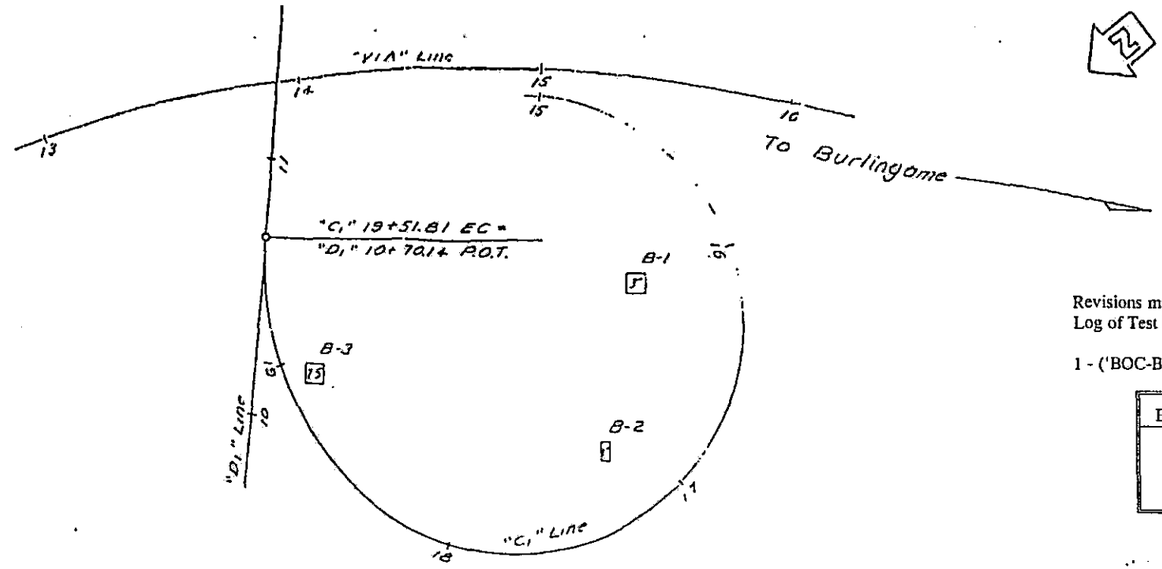
DIST.	COUNTY	ROUTE	KILOMETER POST - TOTAL PROJECT	Sheet No.	Total Sheets
04	SM	101	21.7/28.8		

BROADWAY POC

LOG OF TEST BORINGS 3 OF 3

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.	CU 245 EA 26420K	BRIDGE No. 35-0342
THIS STRUCTURE	SHEET NO.	OF

To accompany plans dated_____



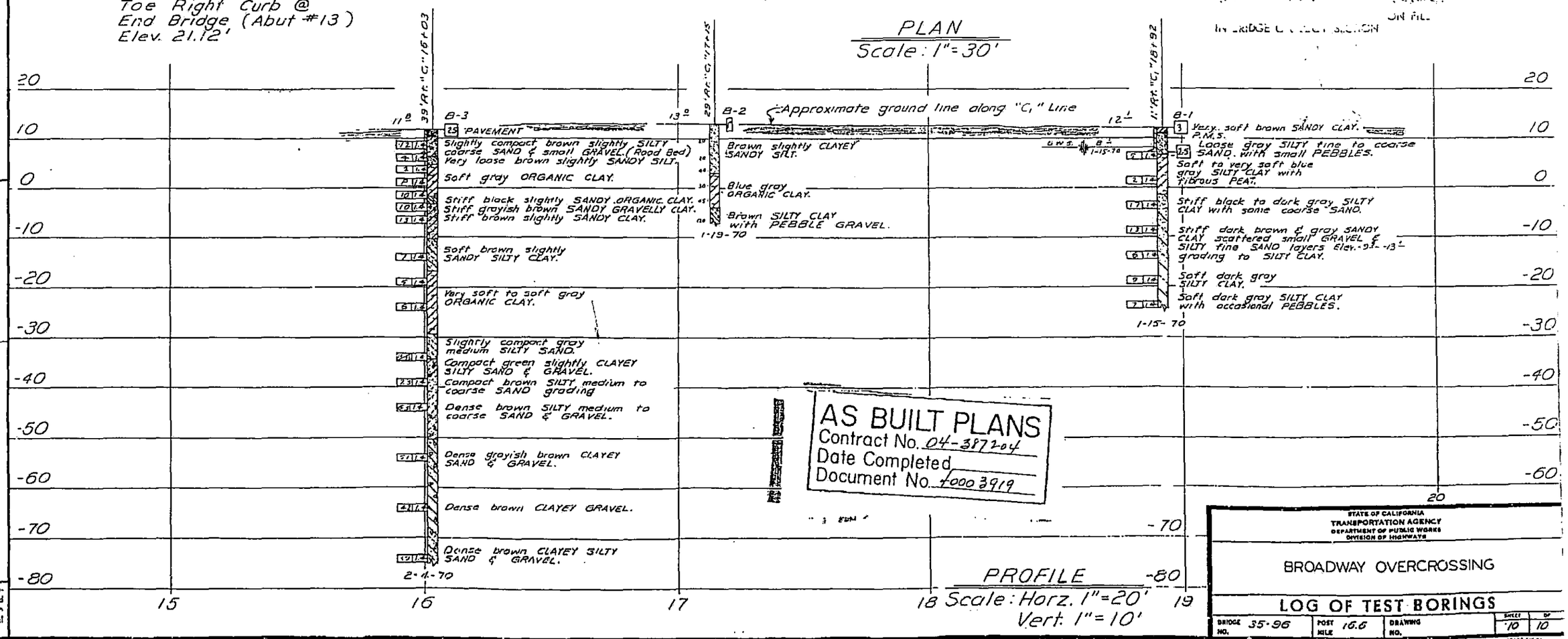
Revisions made to this Log of Test Borings from the original 1970 Log of Test Borings are:

1 - ('BOC-BDWY' Line)-metric stations and offsets:

Boring	Station	Offset (from 'BOC-BDWY')
B-1	9+76	39.2 m Lt.
B-2	9+77	60.6 m Lt.
B-3	10+57	105.0 m Lt.

B.M.
Toe Right Curb @ End Bridge (Abut #13) Elev. 21.12'

PLAN
Scale: 1"=30'



AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 4000 3919

PROFILE
Scale: Horz. 1"=20'
Vert. 1"=10'

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING

LOG OF TEST BORINGS

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
35-96	16.6		10	10

NOTE: Classification of earth materials shown on this sheet is based on field inspection and is not to be construed to imply mechanical analysis.

WO 387201
CU 04205

Disregard prints bearing earlier revision dates

REVISION DATES (PRELIMINARY STAGE ONLY)
2/8/10

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.8		

GEOTECHNICAL PROFESSIONAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/05 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
356 SOUTH MILPITAS BLVD.,
MILPITAS CA 95035

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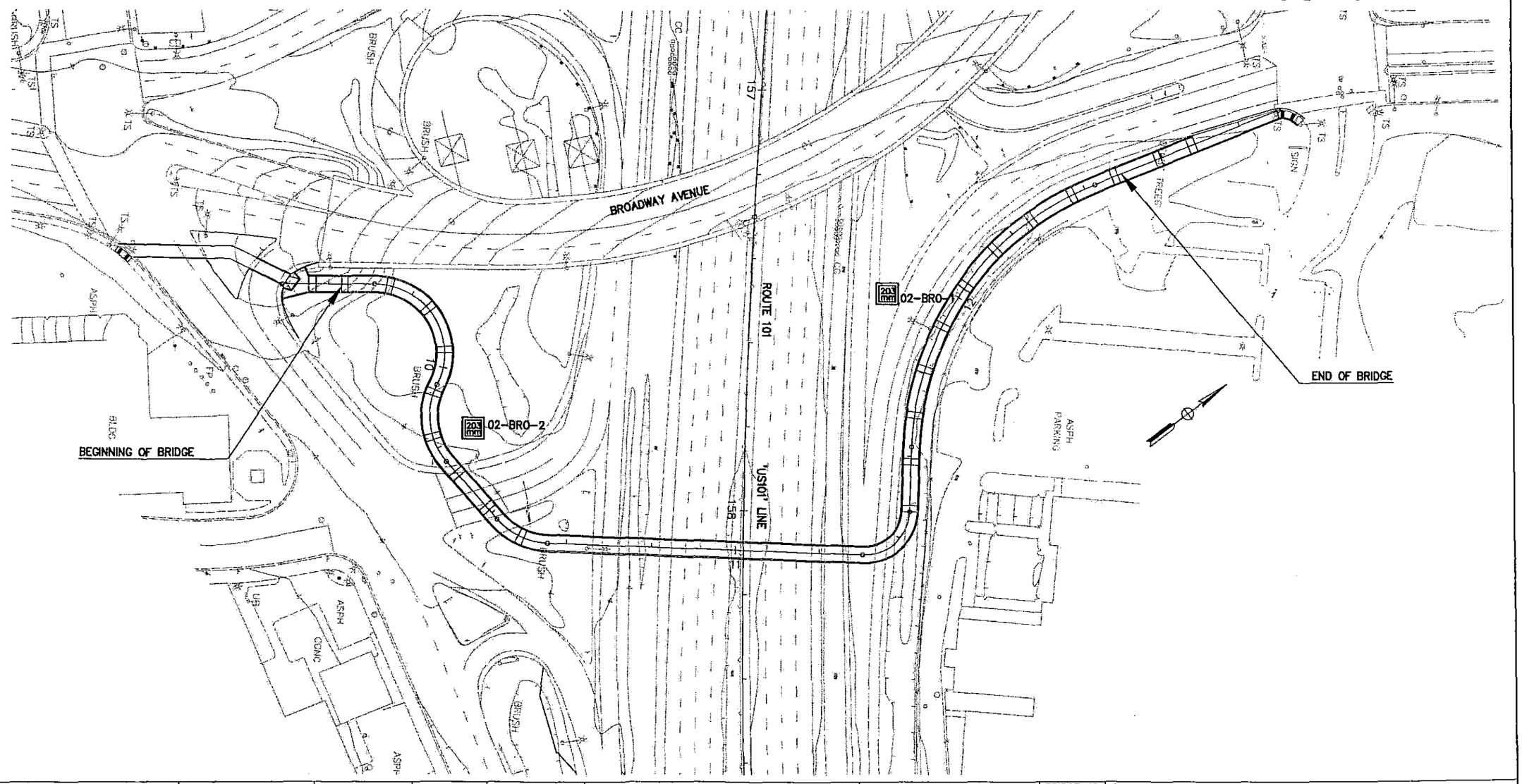
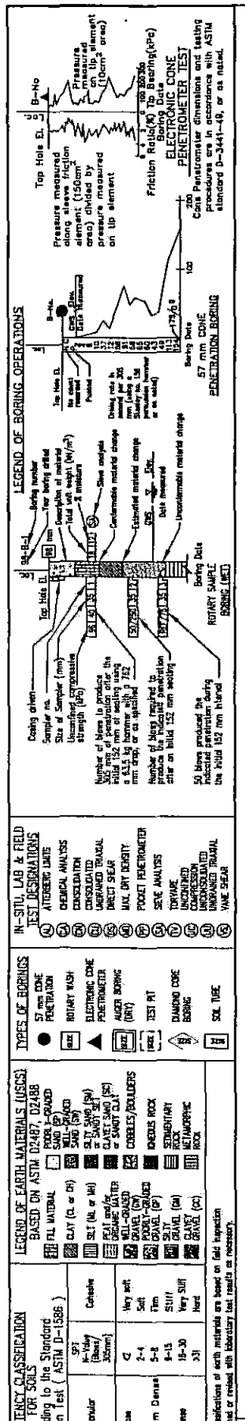
DRAFT

PLAN
1:500





DESIGN OVERSIGHT	FIELD INVESTIGATOR	L. Bhangoo / R. Au	DATE	JAN 2002
	DRAWN BY	R. Au	DATE	FEB 2002
SIGN OFF DATE	CHECKED BY	A. Kozompolis	DATE	FEB 2002

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Y. DAVID WANG
PROJECT ENGINEER

CU 245
EA 26420K

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

BRIDGE NO 35-0342
KP/PM 26.7/16.6

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 2-18-02 | SHEET | OF

BROADWAY POC

LOG OF TEST BORINGS 1 OF 3

C:\ACAD\201191\LOTB\STRUCTURES.DWG

PLATE NO: A-1

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.8		

GEOTECHNICAL PROFESSIONAL

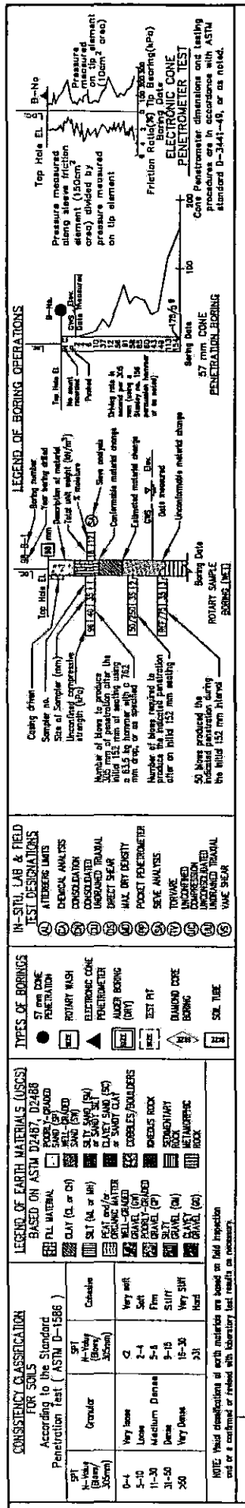
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/05 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
356 SOUTH MILPITAS BLVD.,
MILPITAS CA 95035

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

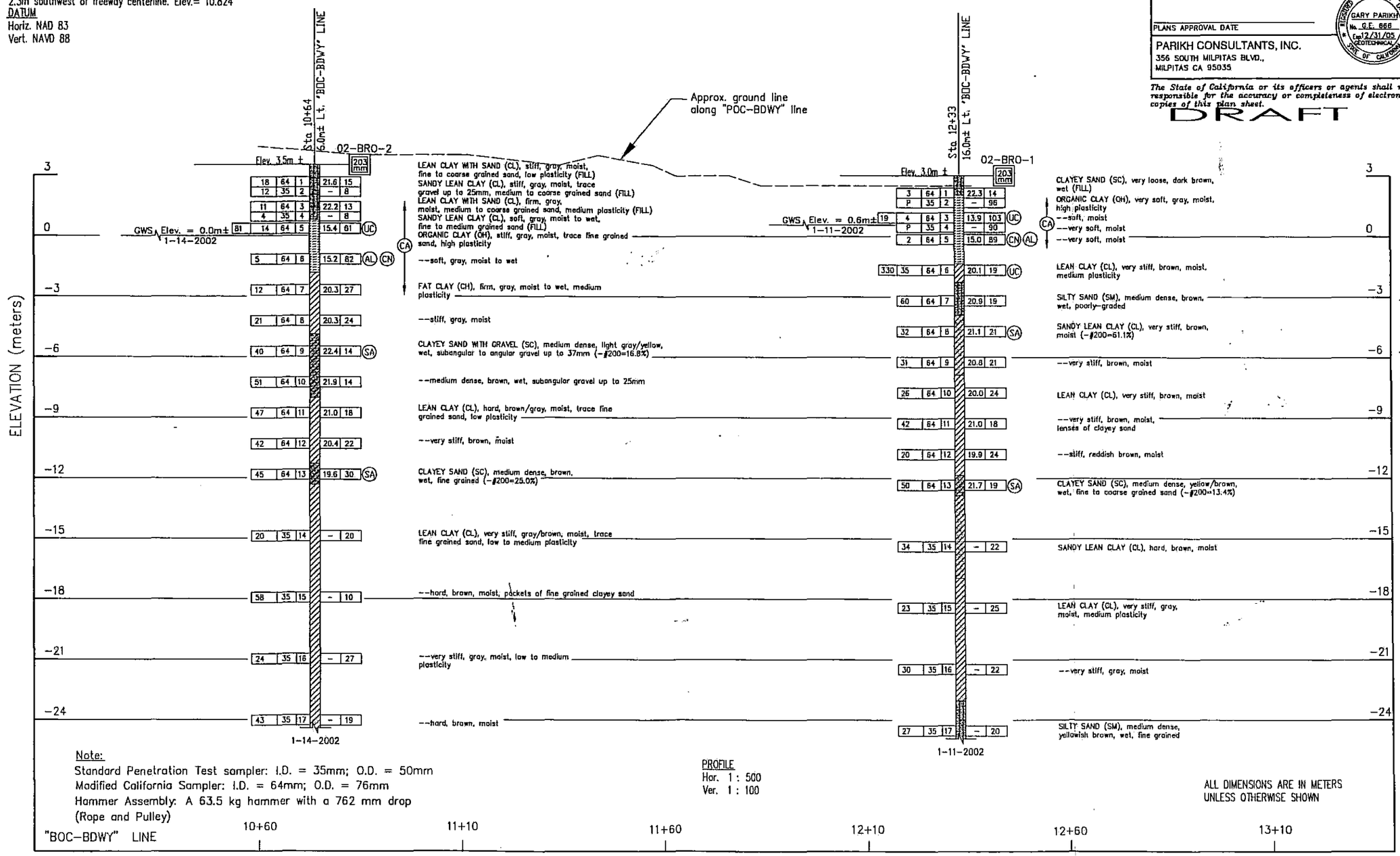
DRAFT



BENCHMARK
BENCHMARK KW-74
Scribbed cross in concrete sidewalk 0.4m southeast of face of curb, on southeast side of Broadway O.C. Bridge (No.35-0096), 2.3m southwest of freeway centerline. Elev.= 10.824
DATUM
Horiz. NAD 83
Vert. NAVD 88

FOR PLAN SHEET SEE SHEET 1 OF 3

Caltrans Metric



Note:
Standard Penetration Test sampler: I.D. = 35mm; O.D. = 50mm
Modified California Sampler: I.D. = 64mm; O.D. = 76mm
Hammer Assembly: A 63.5 kg hammer with a 762 mm drop (Rope and Pulley)

PROFILE
Hor. 1 : 500
Ver. 1 : 100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	FIELD INVESTIGATOR	L. Bhangoo / R. Au	DATE	JAN 2002
	DRAWN BY	R. Au	DATE	FEB 2002
SIGN OFF DATE	CHECKED BY	A. Kozompolis	DATE	FEB 2002

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Y. DAVID WANG
PROJECT ENGINEER

BRIDGE NO. 35-0342
KP/PM 26.7/16.6

BROADWAY POC
LOG OF TEST BORINGS 2 OF 3

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU 245
EA 26420K

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 2-18-02 | SHEET | OF

C:\ACAD\201191\LOTB\STRUCTURES.DWG

PLATE NO: A-2

FED. ROAD DIST. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
2	CAL.		48 49	54	

DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
IV	S M	82	Burl	2	18

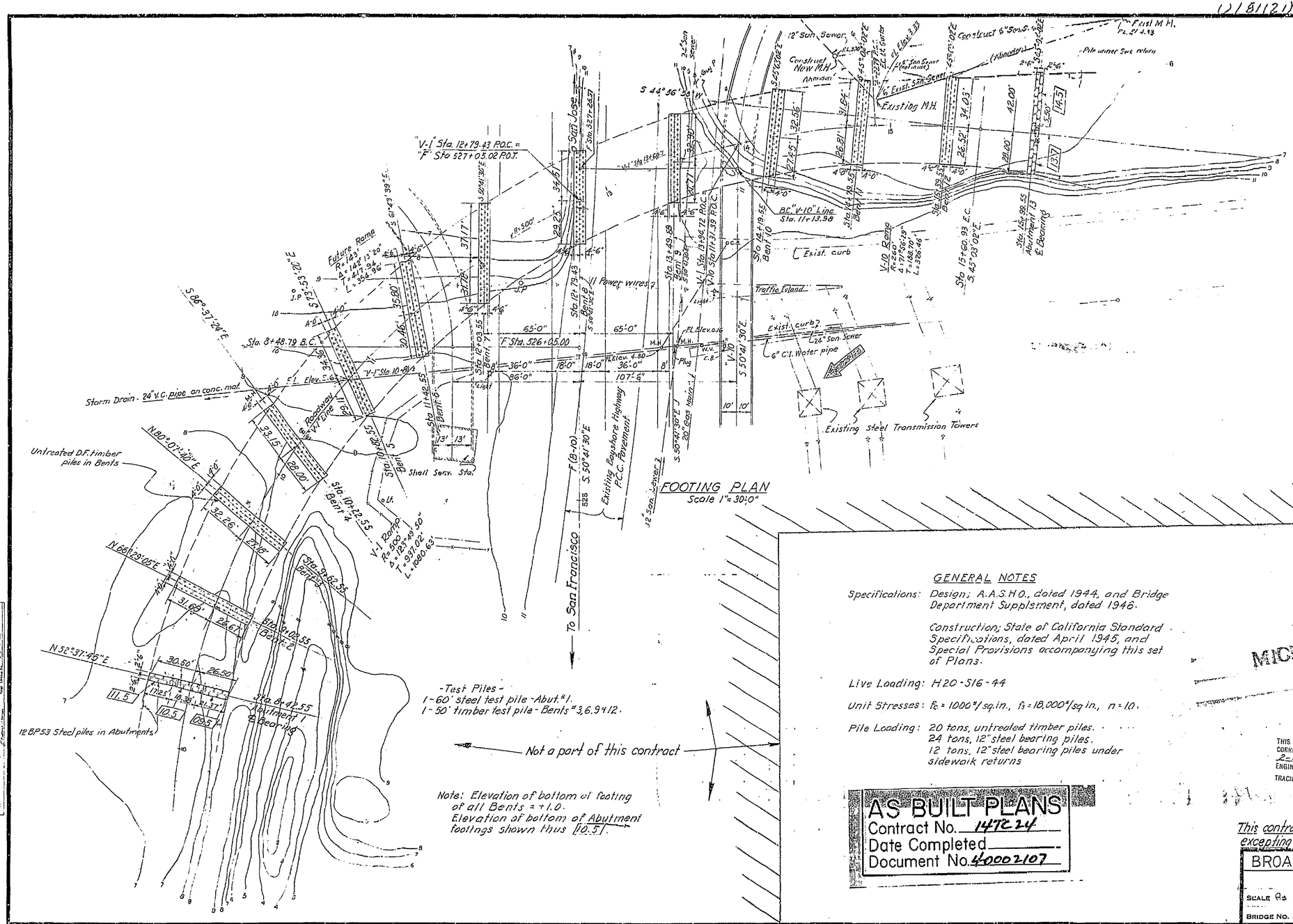
Bridge Engineer

Date approved March 11, 1941

121 B1(21)

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
STATE OF CALIFORNIA

BRIDGE DEPARTMENT



FOOTING PLAN
Scale 1" = 30'-0"

-Test Piles-
1-60' steel test pile - Abut. #1.
1-50' timber test pile - Bents #3, 6, 9 & 12.

Note: Elevation of bottom of footing of all Bents = +1.0.
Elevation of bottom of Abutment footings shown thus [10.5].

GENERAL NOTES

Specifications: Design; A.A.S.H.O., dated 1944, and Bridge Department Supplement, dated 1948.

Construction; State of California Standard Specifications, dated April 1945, and Special Provisions accompanying this set of Plans.

Live Loading: H20-S16-44

Unit Stresses: $f_c = 1000^{\#}/sq.in.$, $f_s = 18{,}000^{\#}/sq.in.$, $n = 10$.

Pile Loading: 20 tons, untreated timber piles.
24 tons, 12" steel bearing piles.
12 tons, 12" steel bearing piles under sidewalk returns

MICROFILMED

THIS SET OF PLANS HAS BEEN CORRECTED TO CORRESPOND TO THE "AS BUILT" PRINTS, DATED 2-4-49, AS SUBMITTED BY RESIDENT ENGINEER W.N.S.
TRACINGS CORRECTED BY SDM DATE 9-2-49.

AS BUILT PLANS
Contract No. 147224
Date Completed
Document No. 40002107

This contract is for superstructure only, excepting anchor bolts.

Submitted by: Edward R. Bergman
DESIGN — Chief Bridge Engineer
DETAILS — Bridge Engineer
QUANTITIES — Bridge Engineer
SPECIFICATIONS — Bridge Engineer
Approval Recommended by: W. H. Wheeler, Chief Engineer

DESIGN	R. J.	R. E.	11-46
DETAILS	W. C.	R. E.	11-46
QUANTITIES		R. E.	11-46
SPECIFICATIONS		R. E.	11-46

Scale: 1" = 30'-0"
Checked by: J. T. Hoffman
Approved by: W. H. Wheeler, Chief Engineer

BROADWAY OVERCROSSING
FOOTING PLAN

SCALE As shown	FILE NO.
BRIDGE NO. 35-96	DRAWING NO. C-1908-75

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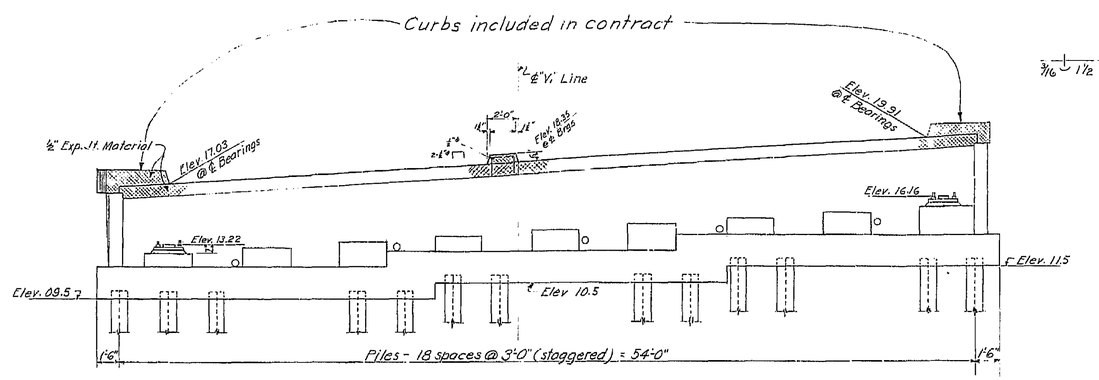
FED. AID PROJ. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
2	CAL.		48	114	54

(1181(21))

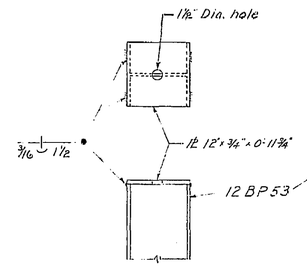
DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
11	M	60	Bur	9	13

March 12, 1947



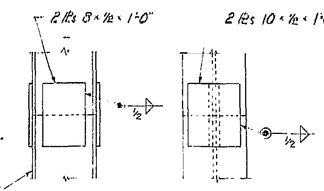
Note:- Top of Bearings are on straight grade between end bearings.

ELEVATION
Scale: ¼" = 1'-0"

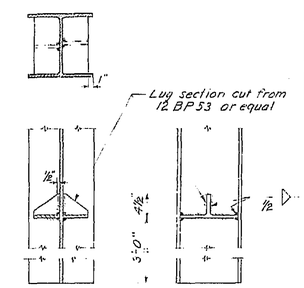


PILE CAP
Scale: 1" = 1'-0"

Pile caps to be placed on all piles after cutoff.



PILE FIELD SPLICE
Scale: 1" = 1'-0"

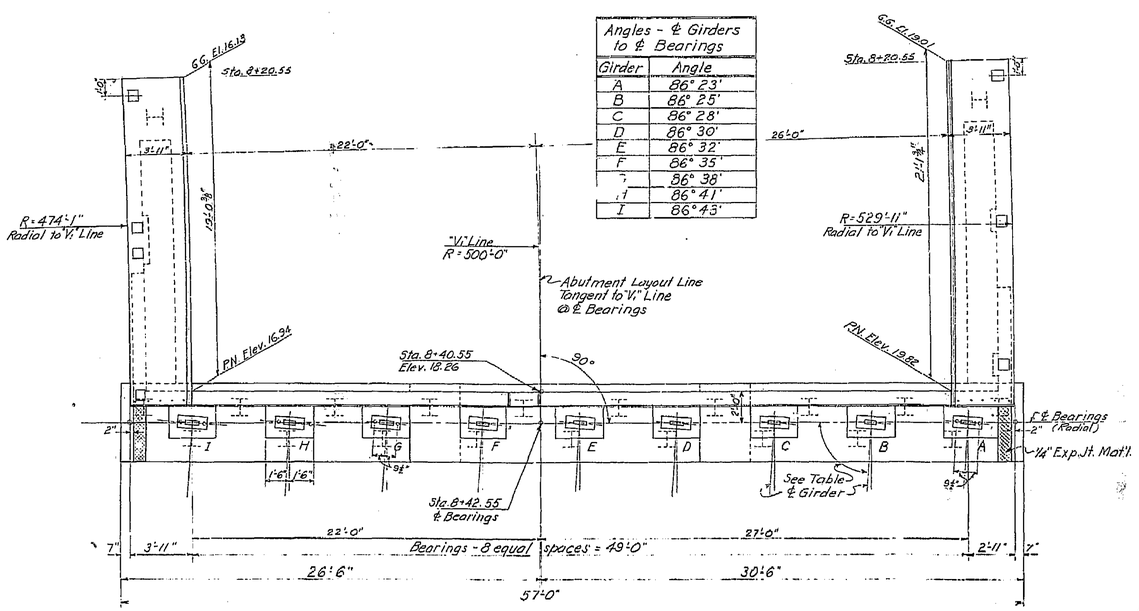


PILE LUG
Scale: 1" = 1'-0"

Notes:
1. Weld splice plates to top pile before placing top pile in position.
2. Place top pile in position and hammer sufficiently to secure good bearing on bottom pile.
3. Weld splice plate to bottom pile and butt weld any opening remaining between piles.
4. All piles to be flame cut, using steel yoke to secure square and even cut.
5. Lug to be used when ordered by the Engineer.

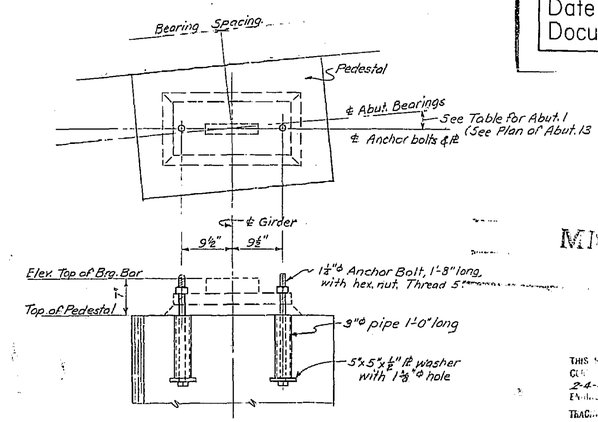
AS BUILT PLANS
Contract No. 14TC24
Date Completed
Document No. 40002107

Angles - ℄ Girders to ℄ Bearings	
Girder	Angle
A	86° 23'
B	86° 25'
C	86° 28'
D	86° 30'
E	86° 32'
F	86° 35'
G	86° 38'
H	86° 41'
I	86° 43'



Note: For details not shown see Sheet 4.
Railing not shown. For details & rail post spacing see Sh. 11.

PLAN
Scale: ¼" = 1'-0"



ANCHOR BOLT DETAILS
Scale: 1" = 1'-0"
Anchor bolts to be placed by others.

Abutments, excepting curb and railing, not a part of this contract.

MICROFILMED

THIS SET OF PLANS [illegible] FROM ORIGINAL TO 1-0 [illegible] PLANS, DATED 2-4-49 [illegible] SUBMITTED BY RESIDENT ENGINEER [illegible] H.N.S. TRACED BY: S.O.M. DATE: 9-2-49

This contract is for superstructure only, excepting anchor bolts.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING

ABUTMENT NO. 1

SCALE	BRIDGE	FILE	DRAWING
As Shown	35-96		C-1909-176

BRIDGE DEPARTMENT

Submitted by: Charles R. Hansen

DESIGN	By R.C.F.	10-46	Checked	R.S.B. 11-46
DETAILS	By R.W.K.	10-46	Checked	R.S.B. 11-46
QUANTITIES	By [illegible]	11-46	Checked	R.S.B. 11-46
SPECIFICATIONS	By [illegible]		Date Last Mod.	
Approx. Recommended by: C.F. Hansen			Bridge Engr.	R.S.B. 11-46
			Bridge Engr.	

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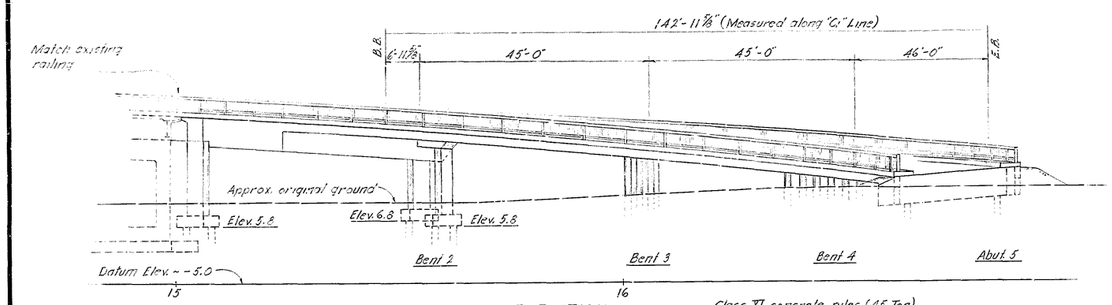
DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.6	53	62

BRIDGE ENGINEER — REGISTERED CIVIL ENGINEER NUMBER 5515

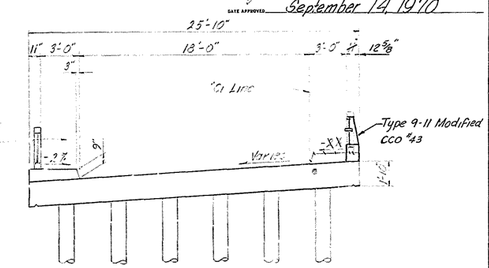
ASSISTANT STATE HIGHWAY ENGINEER — REGISTERED CIVIL ENGINEER NUMBER 5515

DATE APPROVED September 14 1970

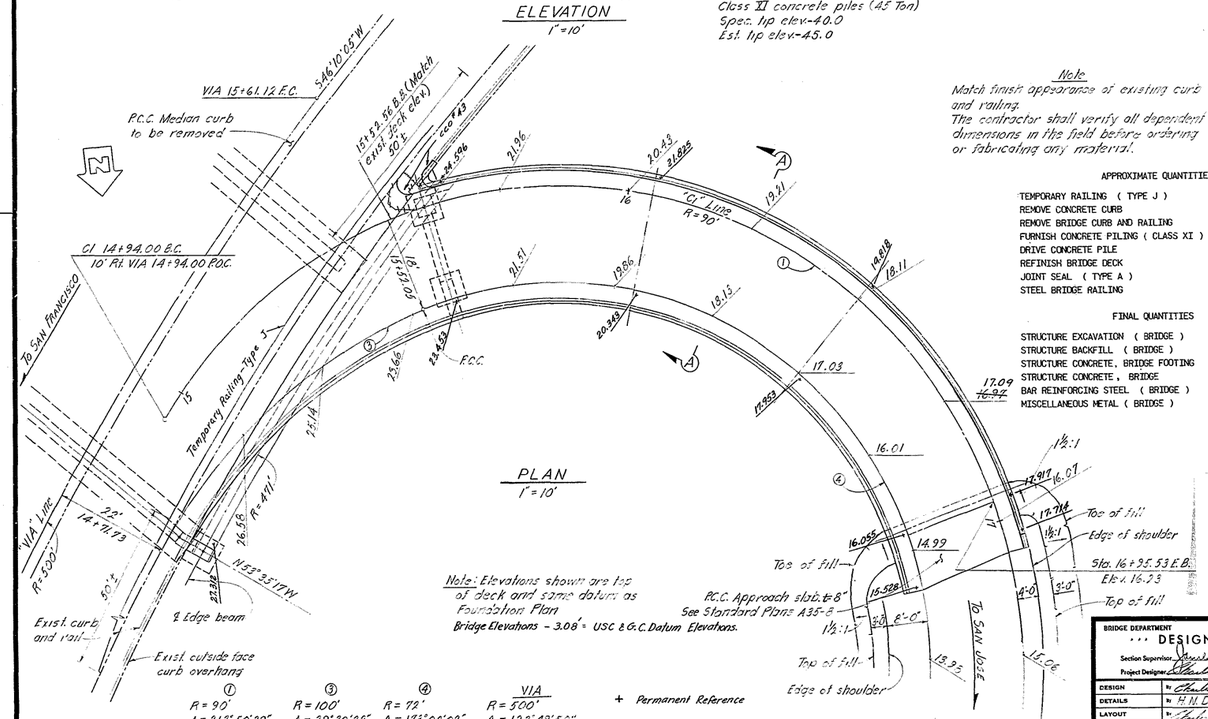


ELEVATION
1" = 10'

Class XI concrete piles (45 Ton)
Spec. tip elev.-40.0
Est. tip elev.-45.0



SECTION A-A
1/4" = 1'-0"



PLAN
1" = 10'

Note: Elevations shown are top of deck and same datum as Foundation Plan
Bridge Elevations - 3.08' = USC & G.C. Datum Elevations.

①	③	④	VIA
R = 90'	R = 100'	R = 72'	R = 500'
Δ = 213°50'29"	Δ = 39°30'32"	Δ = 173°02'07"	Δ = 123°42'50"
L = 335.901'	L = 68.956'	L = 217.441'	T = 937.015'
			L = 1,080.625'

FOR GENERAL NOTES SEE "Foundation Plan"

LIVE LOADING HS20-44 AND ALTERNATIVE

Note
Match finish appearance of existing curb and railing.
The contractor shall verify all dependent dimensions in the field before ordering or fabricating any material.

APPROXIMATE QUANTITIES

TEMPORARY RAILING (TYPE J)	181 LF
REMOVE CONCRETE CURB	761 LF
REMOVE BRIDGE CURB AND RAILING	81 LF
FURNISH CONCRETE PILING (CLASS XI)	1,585 LF
DRIVE CONCRETE PILE	28 EA
REFINISH BRIDGE DECK	1,790 SQ FT
JOINT SEAL (TYPE A)	98 LF
STEEL BRIDGE RAILING	338 LF

FINAL QUANTITIES

STRUCTURE EXCAVATION (BRIDGE)	50 CY
STRUCTURE BACKFILL (BRIDGE)	30 CY
STRUCTURE CONCRETE, BRIDGE FOOTING	10 CY
STRUCTURE CONCRETE, BRIDGE	375 CY
BAR REINFORCING STEEL (BRIDGE)	83,600 LB
MISCELLANEOUS METAL (BRIDGE)	400 LB

17.09 / 16.97

INDEX TO PLANS

SHEET No.	TITLE
1.	General Plan
2.	Foundation Plan
3.	Abutment & Bent Details
4.	Slab Details - Multi Span
5.	Miscellaneous Details
6.	Slab Details
7.	Steel Railing Details
8.	Corrosion Resistant Concrete Pile Details - 45 Ton
9.	Drainage Details
10.	Log of Test Borings

STANDARD PLANS dated July 1969

A35-B	P.C.C. Paving Details and Bridge Approaches
A62-B.2	Excavation and Backfill Bridges and Walls
B0-1 & 13	Bridge Details
B6-21	Joint Seal Details
B7-6	Drain Details, Types D-1 & D-4
B11-30	Temporary Railings

AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 4003719

CORRECTED AS BUILT — K.C.B. 6-22-72 — J. SACHDEV B.D.R. 9/24/71
CONTRACT NO. 04-387204

BRIDGE DEPARTMENT
··· DESIGN SECTION ··· 2
Section Supervisor: Charles E. Gilchrist
Project Designer: Charles E. Yakel

DESIGN	By Charles E. Yakel	Checked Ahmad Tadjid	
DETAILS	By H.H. Dahl 3/73	Checked Ahmad Tadjid	
LAYOUT	By Charles E. Yakel 4/73	Checked Ahmad Tadjid	
QUANTITIES	By Ahmad Tadjid	Checked M. Camacho 8/70	
SPECIFICATIONS	By W. White 4/70	Checked W. White 8/70	

Approved Recommended by R.C. Crocker — Bridge Engineer — Registered Civil Eng. License No. 9013

STATE OF CALIFORNIA
HIGHWAY TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING (WIDEN)
LOCATED WITHIN THE CITY OF BURLINGAME

GENERAL PLAN

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
35-96	16.6		1	10

REVISION DATES (PRELIMINARY STAGE ONLY)

WO 387201 04205 Disregard prints bearing earlier revision dates

53

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF PUBLIC WORKS.

DATE 6-13-72 SIGNATURE [illegible] TITLE SR. [illegible]

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF PUBLIC WORKS - MICROFILM

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.6	54	62

DIVISION SECTION REPRESENTATIVE — REGISTERED CIVIL ENGINEER No. 31621

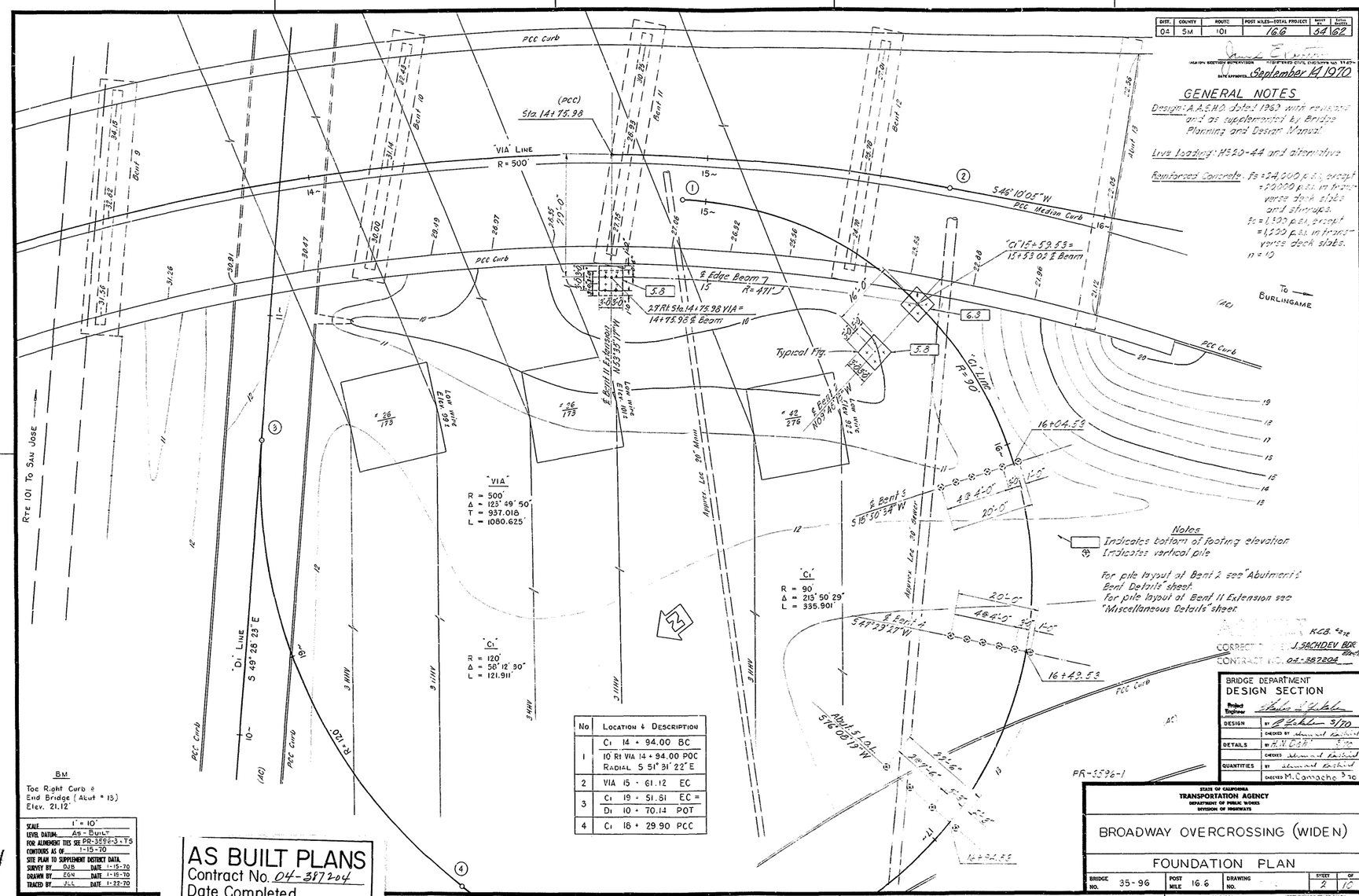
DATE COMPLETED September 14, 1970

GENERAL NOTES

Design: A.A.S.H.O. Issue 1969 with revisions and as supplemented by Bridge Planning and Design Manual.

Live loading: HS20-44 and alternative

Reinforced Concrete - fs = 24,000 p.s.i. except = 20,000 p.s.i. in transverse deck slabs and stirrups. fc = 1,500 p.s.i. except = 1,200 p.s.i. in transverse deck slabs. n = 10



Notes

Indicates bottom of footing elevation

Indicates vertical pile

For pile layout at Bent 2 see "Abutments & Bent Details" sheet.
For pile layout at Bent 11 Extension see "Miscellaneous Details" sheet.

No	Location & Description
1	C1 14 + 94.00 BC 10 Rt VIA 14 + 94.00 POC Radial S 51° 31' 22" E
2	VIA 15 + 61.12 EC
3	C1 19 + 51.51 EC = D1 10 + 70.14 POT
4	C1 16 + 29.90 PCC

SCALE	1" = 10'
LEVEL DATUM	As-Built
FOR ALINEMENT TIES SEE	PR-3596-3, TS
CONTOURS AS OF	1-15-70
SITE PLAN TO SUPPLEMENT DISTRICT DATA.	
SURVEY BY	DJB DATE 1-15-70
DRAWN BY	EGN DATE 1-15-70
TRACED BY	JLL DATE 1-22-70

54

AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 40003919

CORRECT FOR CONSTRUCTION J. SACHDEV BDE
CONTRACT NO. 04-387204

BRIDGE DEPARTMENT
DESIGN SECTION

Project Engineer		
DESIGN	BY R. Lichtenberg	3/70
	CHECKED BY Edward Kirkland	
DETAILS	BY H. N. Cobb	3/70
	CHECKED Edward Kirkland	
QUANTITIES	BY Edward Kirkland	
	CHECKED M. Camacho	3/70

PR-3596-1

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING (WIDEN)

FOUNDATION PLAN

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
35-96	16.6		2	16

WO 387201
CU 04205

Disregard prints bearing earlier revision dates

REVISION DATES (PRELIMINARY STAGE ONLY)

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF PUBLIC WORKS.

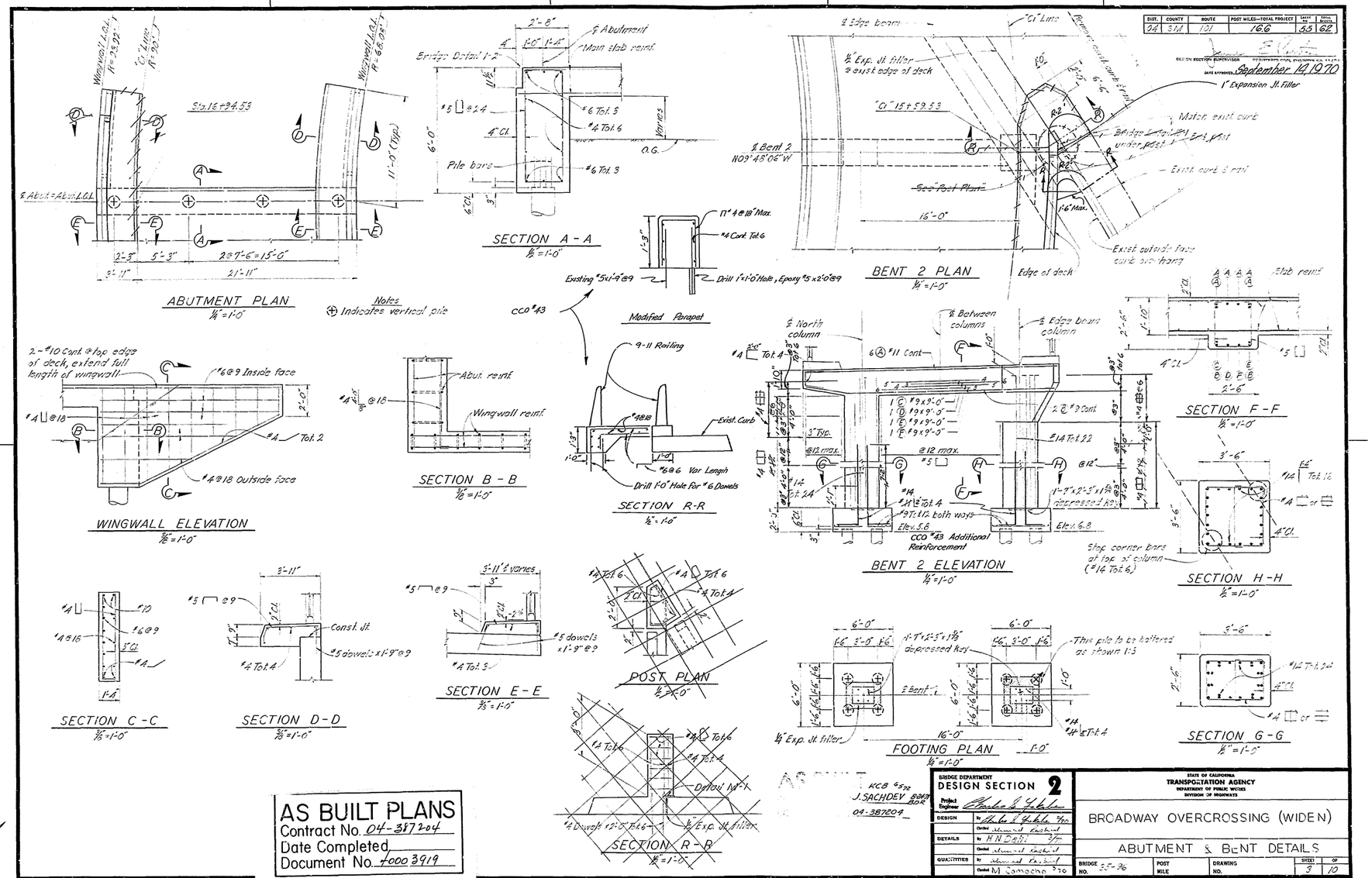
DATE 2-11-72 SIGNATURE _____ TITLE SR. W.M.

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF PUBLIC WORKS - MICROFILM
SCALE 1" = 50' · SCALE 1" = 20' · SCALE 1" = 10' or 1" = 100' · SCALE 1" = 40' · SCALE 1" = 60' or 1" = 120'

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.6	55	62

DESIGN SECTION SUPERVISOR — RESPONSIBLE CIVIL ENGINEER IN CHARGE

DATE APPROVED September 14, 1970



AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 4000 3919

55

RCB 4572
J. SACHDEV 8/27/70 BDR
04-387204

BRIDGE DEPARTMENT
DESIGN SECTION 2
Project Engineer
DESIGN — By — Checked
DETAILS — By H N Dalli — Checked
QUANTITIES — By — Checked M Somacho

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING (WIDEN)

ABUTMENT & BENT DETAILS

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
55-26			3	10

WO
CU

Disregard prints bearing earlier revision dates

REVISION DATES (PRELIMINARY STAGE ONLY)

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF PUBLIC WORKS.

DATE 4-13-72 SIGNATURE TITLE

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF PUBLIC WORKS - MICROFILM

Revised Chart 3-61 PTK

Added Camber Diagram & notes relating thereto FAS 5-11-62

Removed notes about "Cantil or transverse Slab Const Jt" Added 5-7-63 FJS

Revised - "Notes" Revised steel spacing bars and longitudinal tees; Table: Title Block; Added New "Notes". 7 Jan 66 EJS

L=Length of Span				A	B	D
Type of Span					#9	#10
REINFORCEMENT	Top of Slab	ⓐ bars	Size	See A-Span note	Varies	Varies
			Length		22'-0"	22'-6"
		ⓑ bars	Size		11'-0"	10'-6"
			Length		#11	#11
		ⓒ bars	Size		16'-0"	15'-6"
			Length		8'-0"	6'-6"
			Xc		#9	#11
	Bottom of Slab	ⓓ bars	Size		Varies	Varies
			Length		#9	#9
		ⓔ bars	Size		32'-0"	36'-0"
			Length		5'-6"	9'-0"
			Xe		#9	#11
		ⓕ bars	Size		24'-0"	24'-0"
			Length		9'-6"	14'-0"
			Xf			
Dist. Steel Spacing					11"	8"
T=Thickness of Slab				22"		
S=Bar Spacing				5"		
Clearance to main reinforcing				2"		

NOTES :

Splices in top main bars to be 35 dia. and located near center of span.

Splices in bottom main bars to be 20 dia. and located near bent.

Spacing of #5 bars in bottom of slab is measured along ℄ roadway. For spacing in center half of span see Table.

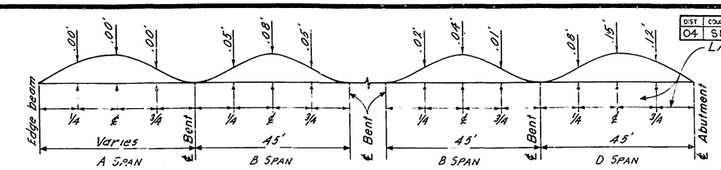
Top reinforcement for "B" Span" to be modified when adjacent to a hinge. See "Slab Details - Hinge" sheet.

Place all transverse bars in B and D Spans radial to and space along ℄ roadway.

❶ Distance measured along ℄ Line.

DIST	COUNTY	ROUTE	POST MILES - TOTAL PROJECT	SHEET	TOTAL SHEETS
04	SM	101	16.6	56	62

DATE APPROVED September 14, 1970



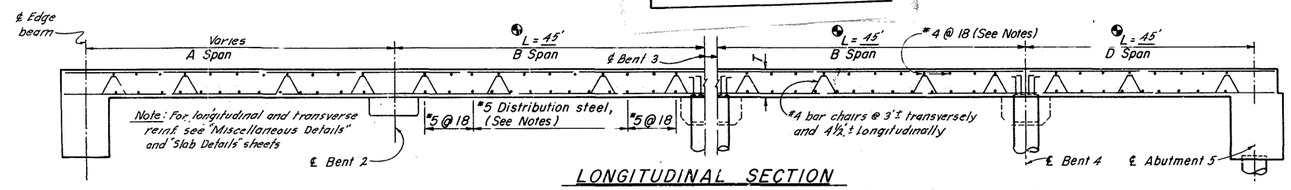
CAMBER DIAGRAM

TOTAL SLAB DEFLECTION DUE TO DEAD LOADS

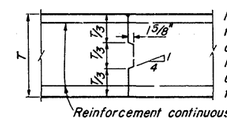
The total deflection will be reached about 4 years after falsework removal. For values at time of falsework removal divide those shown by 4.

The amount of camber for construction will be determined by the Engineer.

AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 4000 3919



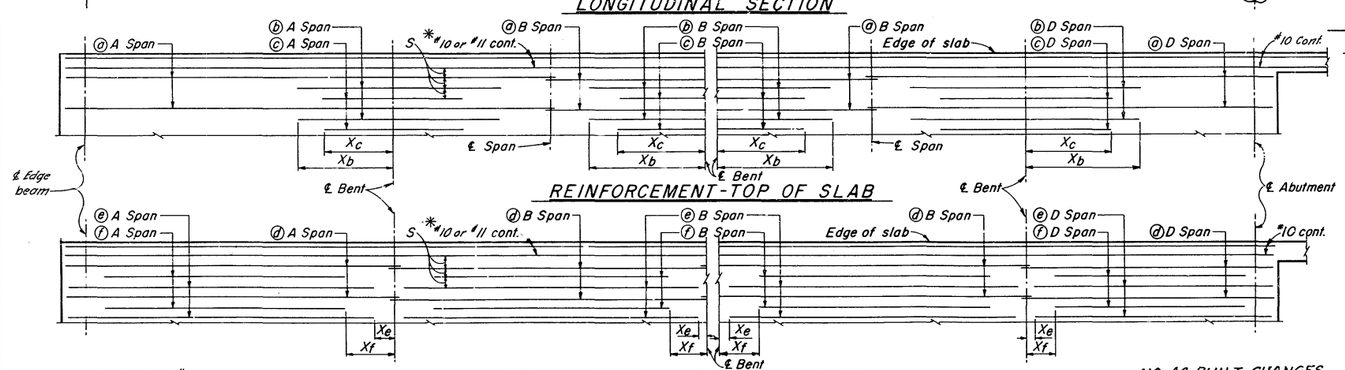
LONGITUDINAL SECTION



Note: Transverse joints, if used, to be located at ¼ point of span and longitudinal joint to be located at edge of traffic lanes unless otherwise permitted by the Engineer.

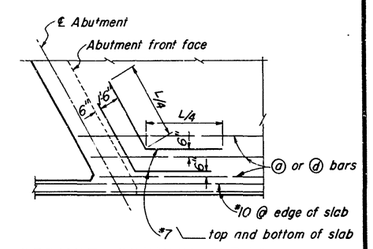
Reinforcement continuous through joint.

LONGITUDINAL OR TRANSVERSE SLAB CONSTRUCTION JOINT

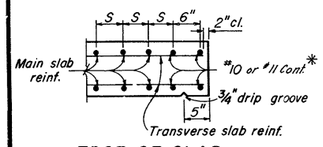


REINFORCEMENT-TOP OF SLAB

REINFORCEMENT -BOTTOM OF SLAB

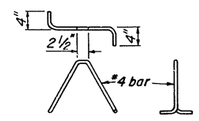


OBTUSE CORNER DETAIL



EDGE OF SLAB DETAIL

Curb and railing not shown



BAR CHAIR DETAIL

* #10 Cont. B and D Spans.
#11 Cont. Right side A Span. Lap with #10 Cont. near ℄ B Span for top slab reinf. and near ℄ Bent 2 for bottom slab reinf.

LIVE LOADING: HS 20-44 and ALTERNATIVE

NO AS-BUILT CHANGES
AS BUILT KCB 8-24-71
CORRECTIONS BY J SACHDEV BDR 8-24-71
CONTRACT NO. 04-387204

STANDARD DRAWING
DESIGN
DETAILS
APPROVED FOR USE

1/66 — STATE OF CALIFORNIA TRANSPORTATION AGENCY DEPARTMENT OF PUBLIC WORKS DIVISION OF HIGHWAYS — XS-12-40

BROADWAY OVERCROSSING (WIDEN)

SLAB DETAILS-MULTI SPAN

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
35-96	16.6		4	10

W.O.

Disregard prints bearing earlier revision dates

REVISION DATES (PRELIMINARY STAGE ONLY)

56

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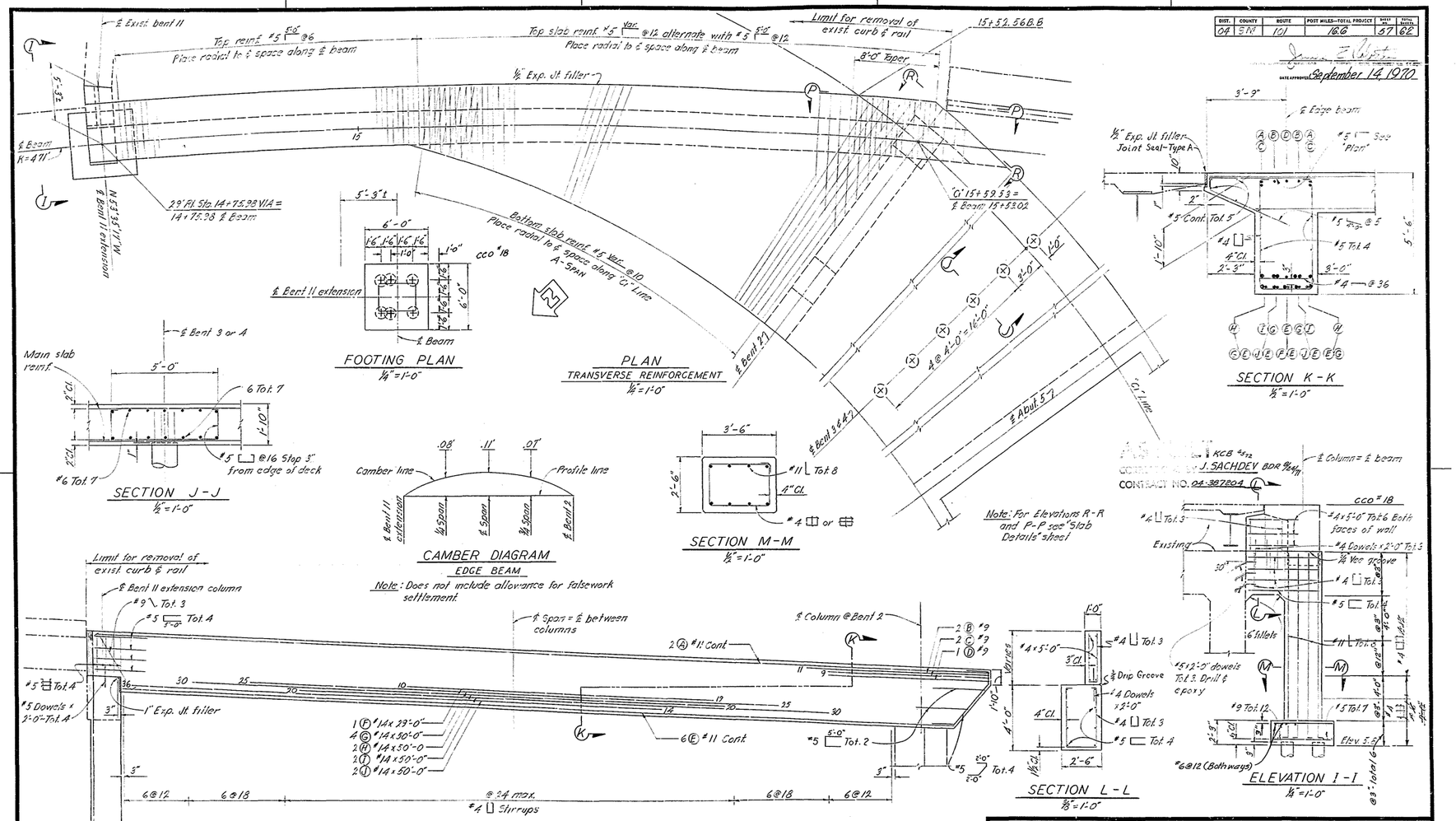
DATE 6-13-72 SIGNATURE TITLE SR RME

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF PUBLIC WORKS - MICROFILM

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.6	57	62

DATE APPROVED September 14 1970



Note

Numbers at ends of bars indicate distance in feet from ℄ column @ bent 2 for top reinf. or from ℄ span for bottom reinf. No splicing of bars permitted near ℄ column bent 2 for top reinf. or near ℄ span for bottom reinf.

AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 40003919

57

BRIDGE DEPARTMENT
DESIGN SECTION 2

Project Engineer	Charles E. Gabelein	
DESIGN	by Charles E. Gabelein	3/70
	Checked Edward Rachford	
DETAILS	by H. N. Dahl	3/70
	Checked Edward Rachford	
QUANTITIES	by Edward Rachford	
	Checked M. Comacho	3/70

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING (WIDEN)

MISCELLANEOUS DETAILS

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
35-96	16.6		5	10

REVISION DATES (PRELIMINARY STAGE ONLY)

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DATE 6-13-72 SIGNATURE [illegible] TITLE SR. RMA

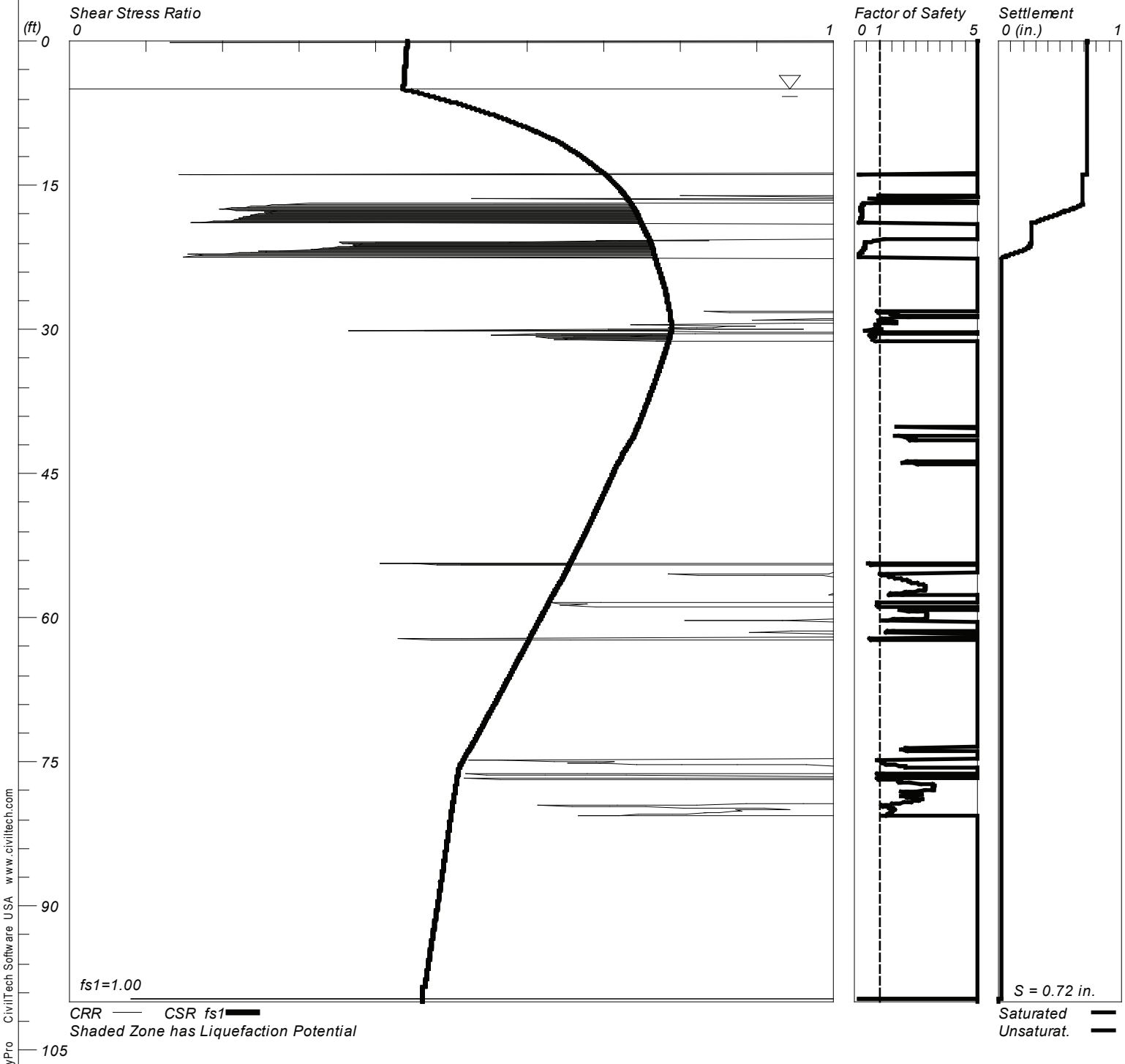
MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF PUBLIC WORKS - MICROFILM
SCALE 1" = 50' SCALE 1" = 20' SCALE 1" = 10' or 1" = 100' SCALE 1" = 10 or 1" = 100' SCALE 1" = 40'

LIQUEFACTION ANALYSIS

Broadway Interchange Reconstruction

Hole No.=CPT-11-016 Water Depth=5 ft Surface Elev.=11 ft

Magnitude=7.9
Acceleration=0.68g



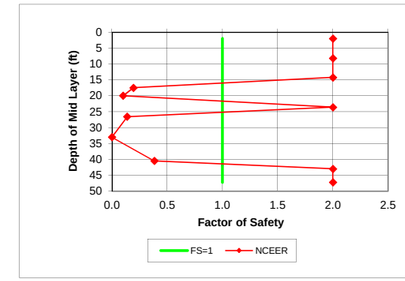
LIQUEFACTION ANALYSIS

Project	Broadway Interchange Reconstruction
Project No.	28645286
Boring No.	R-11-015

PGA =	0.68	
M_w =	7.9	
GWT during EQ	4.5	ft
Sampler:	Symbol	Corr. Factor
SPT	S	1
Mod.Cal	M	0.8
California	C	0.7
Mag. Weighting Factor($CSR_M/CSR_{M=7.5}$)		1.16

Note: Cells in Red must be input

Hammer type :	Type		C_E	Code	C_E
	Donut		0.75	1	3
	Safety		1	2	
	Auto		1.72	3	
Borehole Diameter:	(inch)	(mm)	C_B		C_B
	2.5-4.5	65-115	1	1	1
	6	150	1.05	2	
	8	200	1.15	3	
Rod Length:	(feet)	(m)	C_R		
	Default			999	
Sampling Method:	Type		Cs		
	Stand		1		
	No liners		1.2		



Note: F.S. greater than 2 is set to be equal to 2

Layer Number	Soil Type	γ_m	At Bottom of Layer Depth		At Center of Layer Depth		σ_o	EQ u	EQ σ'_o	r_d	EQ CSR
	(USCS)	pcf	ft	m	ft	m	psf	psf	psf		
1	SM	125	4.0	1.22	2	0.61	250	0	250	0.997	0.441
2	OH/CH	90	12.5	3.81	8.3	2.51	883	234	649	0.983	0.591
3	CL	130	16.0	4.88	14.3	4.34	1,493	608	884	0.970	0.724
4	SC	135	19.0	5.79	17.5	5.33	1,923	811	1,111	0.963	0.736
5	ML	125	21.0	6.40	20.0	6.10	2,250	967	1,283	0.957	0.742
6	CL	120	26.2	7.99	23.6	7.19	2,687	1,192	1,495	0.947	0.752
7	SP-SM	120	27.0	8.23	26.6	8.11	3,047	1,379	1,668	0.936	0.756
8	CH	120	39.0	11.89	33.0	10.06	3,815	1,778	2,037	0.904	0.748
9	SC-SM	140	42.0	12.80	40.5	12.34	4,745	2,246	2,499	0.847	0.711
10	GM	140	44.0	13.41	43.0	13.11	5,095	2,402	2,693	0.823	0.689
11	CL	120	50.5	15.39	47.3	14.40	5,625	2,668	2,957	0.781	0.656

Layer Number	Depth to Bot. Layer	Thickness ft	σ_o psf	u psf	σ'_o psf	r_d	$(N_1)_{60-cs}$	Liquefy ? NCEER	τ_{cyc} psf	$CSR_{M=7.5}$ τ_{cyc}/σ'_o	CSR_M τ_{cyc}/σ'_o	Volumetric Strain** %	Settl. in	
1	4.0	4.0	250	0	250	0.997		N	110.2	0.441	0.51			
2	12.5	8.5	883	234	649	0.983		N	383.4	0.591	0.69			
3	16.0	3.5	1,493	608	884	0.970		N	640.0	0.724	0.84			
4	19.0	3.0	1,923	811	1,111	0.963	15.5	Liquef	818.3	0.736	0.86	0.0	0.00	LL=31, PI=16 falls in Zone B, WC(14%)<0.85LL, Non-liquefiable
5	21.0	2.0	2,250	967	1,283	0.957	7.8	Liquef	951.6	0.742	0.86	3.0	0.72	
6	26.2	5.2	2,687	1,192	1,495	0.947		N	1124.2	0.752	0.88			
7	27.0	0.8	3,047	1,379	1,668	0.936	11.2	Liquef	1260.4	0.756	0.88	2.3	0.22	
8	39.0	12.0	3,815	1,778	2,037	0.904		N	1523.9	0.748	0.87			
9	42.0	3.0	4,745	2,246	2,499	0.847	27.3	Liquef	1775.5	0.711	0.83	0.00	0.00	LL=21, PI=4, -#200=21%, Clay=5.1%, WC (13%)<0.85LL, Non-liquefiable
10	44.0	2.0	5,095	2,402	2,693	0.823	37.2	N	1854.1	0.689	0.80			
11	50.5	6.5	5,625	2,668	2,957	0.781		N	1941.4	0.656	0.76			
												Total Settlement (inch) =	**0.94**	

Layer Number	N raw	Sampler	N SPT	Fines Content %	C_{fines}	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60-cs}$ during EQ	$CRR^*_{7.5,1tsf}$ Critical	Magnitude Scaling Factor NCEER K_m Lower	Upper	Middle	Overburden Correction K_σ	Above GWT?	F.S. NCEER	Liquefy ? NCEER	F.S=1.0
1													0.88	0.84	0.86	1.000	Y	2.00	N	1
2													0.88	0.84	0.86	1.000	N	2.00	N	1
3													0.88	0.84	0.86	1.000	N	2.00	N	1
4	10	M	8	20	1.15	1.15	1.72	1.00	0.85	1.00	15	0.167	0.88	0.84	0.86	1.000	N	0.19	Liquef	1
5	3	S	3	55	1.47	1.09	1.72	1.00	0.95	1.00	8	0.087	0.88	0.84	0.86	1.000	N	0.10	Liquef	1
6													0.88	0.84	0.86	1.000	N	2.00	N	1
7	8	M	6	10	1.09	0.99	1.72	1.00	0.95	1.00	11	0.122	0.88	0.84	0.86	1.000	N	0.14	Liquef	1
8													0.88	0.84	0.86	1.000	N	0.00	N	1
9	21	M	17	21	1.13	0.84	1.72	1.00	1.00	1.00	27	0.326	0.88	0.84	0.86	0.975	N	0.38	Liquef	1
10	24	S	24	20	1.11	0.81	1.72	1.00	1.00	1.00	37	0.459	0.88	0.84	0.86	0.963	N	2.00	N	1
11													0.88	0.84	0.86	0.948	N	2.00	N	1

* Note: The equation used to obtain $CRR_{7.5}$ is not valid for corrected $(N_1)_{60}$ higher than 30. According to NCEER 1997, the soil layer with corrected $(N_1)_{60}$ higher than 30 blows per foot is unlikely to be susceptible to liquefaction.

** Note: These values were obtained from a chart for estimation of volumetric strain in saturated sands based on a cyclic stress ratio and standard penetration resistance (Tokimatsu and Seed, 1987).
See figure 9.53 from "Geotechnical Earthquake Engineering" by S. Kramer.

US 101/BROADWAY
INTERCHANGE RECONSTRUCTION PROJECT

PROPOSED EASTON CREEK BOX CULVERT, DRAINAGE CULVERTS, AND BOX GIRDER

MATERIALS REPORT

Prepared for

URS

Prepared by

V&A

January 2012

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APPENDICES

Appendix A: Soil Sample Laboratory Chemical Analysis Results
Appendix B: Caltrans AltPipe Version 6.08 Alternative Pipes for Culverts

EXECUTIVE SUMMARY

V&A was retained by URS Corporation to perform a soil corrosivity investigation for the proposed US 101/Broadway Interchange Replacement Project in the City of Burlingame, San Mateo County. This project extends from Toyon Drive at the south to Mills Creek at the north, along US 101 from Post Mile 16.30 to Post Mile 17.06. The project objectives include reconstruction improvements to US 101 on-ramps and off-ramps at Rollins Road, the Bayshore Highway, Airport Boulevard, and the Crowne Plaza Hotel access road. Retaining walls, concrete barriers, a new Broadway overcrossing bridge, a single-span box girder structure over PG&E high-voltage tower foundations, and modifications to the existing US 101 pedestrian overcrossing approach structures will be constructed to accommodate the proposed US 101 mainline and Broadway interchange improvements.

This report provides recommendations for corrosion control of materials under consideration for the Easton Creek box culvert extension, drainage culverts to be replaced or installed as part of the project, and the reinforced concrete box girder over the PG&E high-voltage tower foundations. The structures being considered as part of this investigation are buried reinforced concrete and various standard culvert pipe alternatives. The investigation was conducted in accordance with California Department of Transportation's Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch *Corrosion Guidelines*, Version 1.0, dated September 2003. These Guidelines consider representative soil or water samples to be corrosive to metallic or reinforced concrete structural elements if one or more of the following conditions exist:

- **The chloride concentration is 500 ppm or greater**
- **The sulfate concentration is 2,000 ppm or greater**
- **The pH is 5.5 or less**

Evaluation of the soil environment was made in terms of potential corrosion damage to the proposed box culvert, drainage culvert, and reinforced concrete box girder materials to a depth of 15 feet below grade. Soil resistivity measurements were conducted by V&A in the field during the initial stages of the work. Soil resistivity was determined to a depth of 15 feet at the location of the proposed retaining walls and three PG&E high-voltage towers, as well as to a depth of 100 feet at the proposed Broadway overcrossing bridge abutment sites. In addition, 14 soil samples taken during a geotechnical investigation by URS were sent to Cooper Testing Laboratory in Palo Alto, California, for chemical analysis. The soil samples were analyzed for as-received and minimum (saturated) resistivity, for pH, and for water-soluble chloride and sulfate ion concentrations. All of these chemical properties affect the corrosion rate of buried reinforced concrete structures. A previously reported soil sample from Rajappan & Meyers for Job No. 201191.GDR, December 22, 2005, page 72, is included with the current analyses to provide information along a portion of the northbound US 101 on-ramp. A water sample from Easton Creek was sent to XENCO Laboratories in Houston, Texas, to be analyzed for specific conductance (conductivity), pH, and chloride, sulfate, and bicarbonate ion concentration. The water sample analysis is pertinent to the proposed box culvert widening where the reconstructed northbound US 101 on-ramp will cross Easton Creek.

Fourteen soil samples from selected points throughout the Broadway interchange site, and the previous sample B-31, had minimum (saturated) resistivities that ranged from 61 to 3,566 ohm-cm. The soil pH values varied from 7.6 to 8.8. Water-soluble chlorides ranged from less than 2 to 8,325 mg/kg (ppm), and the water-soluble sulfate concentrations were from 6 to 5,391 mg/kg (ppm). Six borehole soil samples (A-11-004, A-11-023, A-11-030-2-4, A-11-031-2-3, R-11-018-2-2, and B-31) are considered *corrosive* based on their chloride contents. Two borehole sites (A-11-030-2-4 and R-11-010-1-3) are *corrosive* based on their sulfate ion concentrations as defined by the Caltrans *Corrosion Guidelines*. The other soil samples are *non-corrosive* based on the Caltrans *Corrosion Guidelines*.

The water sample taken from Easton Creek has a chloride content of 11,600 mg/kg (ppm) and a sulfate content of 2,030 mg/kg (ppm). The water is *corrosive* to reinforced concrete structures based on the Caltrans *Corrosion Guidelines* criteria.

Alternative pipe materials were selected using Caltrans AltPipe software, version 6.08, which calculates maintenance-free service design estimates for various service life expectancies. Values are entered into the program for pipe diameter in inches, soil pH, minimum soil resistivity (ohm-cm), sulfate concentration (ppm), chloride concentration (ppm), abrasion level, 2- to 5-year-storm maximum flow velocity (feet per second), height of cover over the culvert (feet), and the service design life in years. The software calculates the permissible culvert material alternatives from a list that includes corrugated steel pipe, corrugated aluminum pipe, plastic pipe, and reinforced concrete pipe. The pipe diameters that were selected for the AltPipe calculations were 12, 18, 24, and 30 inches. Other parameters selected for the analyses were abrasion level 1, a 2-to 5-year maximum flow velocity of 5 feet per second, 5 feet of cover over the culverts, and a 50-year design service life.

For each proposed drainage system, the minimum resistivity and chemical values of the closest URS core boring sample were used in AltPipe to represent the harshest soil conditions in the drainage system. Where more than one URS soil sample was taken near the drainage system, the values of the most corrosive sample were used.

Conclusions

- Six soil boring samples (A-11-004, A-11-023, A-11-030-2-4, A-11-031-2-3, R-11-018-2-2, and B-31) had soluble chloride concentrations greater than 500 mg/kg. Two soil boring samples (A-11-030-2-4 and R-11-010-1-3) had soluble sulfate concentrations greater than 2,000 mg/kg. According to the Caltrans *Corrosion Guidelines*, these soils are *corrosive* to buried reinforced concrete structures.
- The Easton Creek water has a chloride content of 11,600 mg/kg (ppm) and a sulfate concentration of 2,030 mg/kg (ppm). This water is considered to be *corrosive* to buried reinforced concrete structures according to the Caltrans *Corrosion Guidelines*.
- Three soil samples were taken within about 75 feet of the proposed box girder structure over the PG&E high-voltage tower foundations at the US 101 southbound on-ramp. Of these three, one (R-11-018-2-2) had a water-soluble chloride content of 4,965 mg/kg (ppm), which

is considered *corrosive* to buried reinforced concrete structures per the Caltrans *Corrosion Guidelines*.

- The project site is within 1,000 feet of salt water or brackish water.

Recommendations

General

- Corrosion protection against a marine atmosphere is required by the *Corrosion Guidelines* for above-ground reinforced concrete structures at the proposed box culvert and box girder locations.
- Design of structures installed in these locations should include corrosion mitigation measures as detailed below.

Buried Reinforced Concrete Structures and Driven Concrete Piles

Buried concrete structures and driven reinforced concrete piles should be constructed of durable concrete as described in ACI Standards 201.2R and 222R and Chapter 850.3, "Corrosion," of the Caltrans *Highway Design Manual* (last updated September 28, 2011). Criteria for protecting reinforced concrete structures under corrosive conditions discussed in Caltrans Standard Special Provision (SSP) S8-C04, "Corrosion Control for Portland Cement Concrete" (a modification of Bridge Design Specifications, Section 8, "Reinforced Concrete"), should be followed for the Easton Creek box culvert and the box girder structure at the proposed US 101 southbound on-ramp. These recommendations include, but are not limited to, the following for reinforced concrete in corrosive soil or exposed to corrosive water:

- The following concrete compositional requirements are recommended per the Caltrans Standard Specifications updated July 28, 2011, Section 90-1.02H, "Concrete in Corrosive Environments":
  - The cementitious material used in the concrete must be a combination of Type II or Type V Portland cement and SCM (supplementary cementitious materials).
  - The concrete must contain at least 675 pounds of cementitious material per cubic yard.
  - The reduction of cementitious material content specified in Section 90-1.02E(2) is not allowed.
  - The specifications for SCM content in Section 90-1.02B(3) do not apply.
  - The cementitious material must be composed of one of the following by weight:
    - 25% natural pozzolan or fly ash with a CaO content of up to 10%, and 75% Portland cement.
    - 20% natural pozzolan or fly ash with a CaO content of up to 10%, 5% silica fume, and 75% Portland cement.
    - 12% silica fume, metakaolin, or UFFA (ultra-fine fly ash) and 88% Portland cement.
    - 50% GGBFS (ground granular blast furnace slag) and 50% Portland cement.

- A maximum water-to-cementitious material ratio of 0.40 shall be used in the concrete.

- Concrete sealant (silane) shall not be allowed as an option for concrete in a corrosive environment.
- A minimum concrete cover of 3 inches for a 50-year design life, and 4 inches for a 75-year design life, shall be applied over all steel reinforcement. This is based on a soil water-soluble chloride concentration of 5,000 to 10,000 mg/kg (ppm) for buried reinforced concrete above the groundwater table.

  This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete Cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.
- Sand and water used in concrete mixtures should contain a maximum of 100 mg/kg (ppm) of water-soluble chloride ions and water-soluble sulfate ions. Sand and water pH shall be between 6.5 and 8.0. Potable water should be used in all concrete mixtures.

Reinforced Concrete Exposed to Marine Atmosphere

- Above-ground reinforced concrete structures within 1,000 feet of brackish or salt water are exposed to a corrosive marine atmosphere. The following minimum concrete cover over unprotected reinforcing steel is recommended for the concrete structures listed below:
  - 3 inches concrete cover for the following:
    - Footings and pile caps
    - Walls, columns, and cast-in-place piles
    - Cast-in-place "I" and "T" girders, box-girder webs, bent caps, diaphragms, and hinged joints
  - 2.5 inches concrete cover for the top surface of deck slabs
  - 2 inches concrete cover for precast piles and pile extensions
  - 1.5 inches concrete cover for the following:
    - Bottom surface of deck slab
    - Box-girder bottom slabs
- This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete Cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.

Culvert, Mechanically Stabilized Embankment, and Metallic Soil Reinforcement Backfill

Non-corrosive backfill for mechanically stabilized embankments with metallic soil reinforcement, such as tieback and tiedown anchors or soil nails, and reinforced concrete structures, shall meet the following requirements, in accordance with the *Corrosion Guidelines*:

- Minimum resistivity greater than 2,000 ohm-cm as determined by California Test Method (CTM) 643.

- Chloride concentration less than 250 ppm as determined by CTM 422.
- Sulfate concentration less than 500 ppm as determined by CTM 417.
- A pH value between 5.5 and 10.0 as determined by CTM 643.
- Slag aggregate should not be used as a backfill due to high water-soluble sulfate concentrations.

Fast-setting concrete backfill may need to be used when placing culverts in existing roadways. When using an admixture to decrease concrete curing times, only non-chloride admixtures should be considered.

If soil nails, tieback anchors, or tiedown anchors are used for any of the reinforced concrete structures proposed for the project, the following shall apply:

- Corrosion mitigation is required for soil nails, tieback anchors, and tiedown anchors due to the critical nature of their application.
  - Soil nails
    - Soil nails shall be either a reinforcing bar encapsulated for its full length in a grouted corrugated plastic sheathing or an epoxy-coated reinforcing bar partially encapsulated in a grouted corrugated plastic sheathing.
    - Soil nails shall be constructed in conformance with Structure Reference Specification 19-660, section 10-1.
    - The bar shall be centered in the sheathing and the space between the sheathing and the bar shall be filled with grout
    - The epoxy coating shall have a minimum thickness of 12 mils.
  - Tieback anchors
    - Tieback anchors shall be constructed in conformance with Structure Reference Specification 50-560, section 10-1.
    - Grouting procedures shall follow guidelines discussed in Section 50, “Prestressing Concrete,” in the Caltrans Standard Specifications.
    - The tieback anchorage assembly and anchor steel shall be protected against rust, corrosion, and physical damage prior to completing enclosure grouting or concrete encasement per Section 50 of the Caltrans Standard Specifications.
    - Strand-type tendons shall be encapsulated in corrosion-inhibiting grease per Structure Reference Specification 50-560.
  - Tiedown anchors
    - Tiedown anchors shall be constructed in conformance with Structure Reference Specification 50-570, Section 10-1.
    - Grouting procedures shall follow guidelines discussed in Section 50, “Prestressing Concrete,” in the Caltrans Standard Specifications.
    - Tieback anchor steel shall be protected prior to completion of all grouting against rust, corrosion, and physical damage per Section 50 of the Caltrans Standard Specifications.

- ◊ Strand-type tendons shall be encapsulated in corrosion-inhibiting grease per Structure Reference Specification 50-560.

Alternative Pipe Material Selection

Culvert materials were selected for the 22 selected drainage systems using Caltrans AltPipe web-based software, version 6.08. Alternative pipe material recommendations for each of the 22 drainage systems under consideration are presented in Appendix B and summarized as follows:

- Refer to the table in Appendix B for permissible steel pipe types, coatings, and minimum thicknesses for each drainage system.
- Use of aluminum pipe (corrugated and spiral-rib) and Type 2 aluminized steel pipe is highly restricted at the project site. Aluminum pipe and aluminum-coated steel pipe can only be used where the soil pH range is 5.5 to 8.5, the minimum soil resistivity is greater than 1,500 ohm-cm, and the abrasion level is 1 to 3 (non-abrasive).
- Corrugated PVC pipe can be used in all of the drainage systems at the specified pipe diameters. Other PVC and HDPE (high-density polyethylene) pipes are permissible with size restrictions.
- Reinforced concrete pipes can be used in all of the drainage systems with the specified minimum concrete cover over the reinforcing steel.

TESTING OVERVIEW

Figures 1 and 2 show the overall project location.

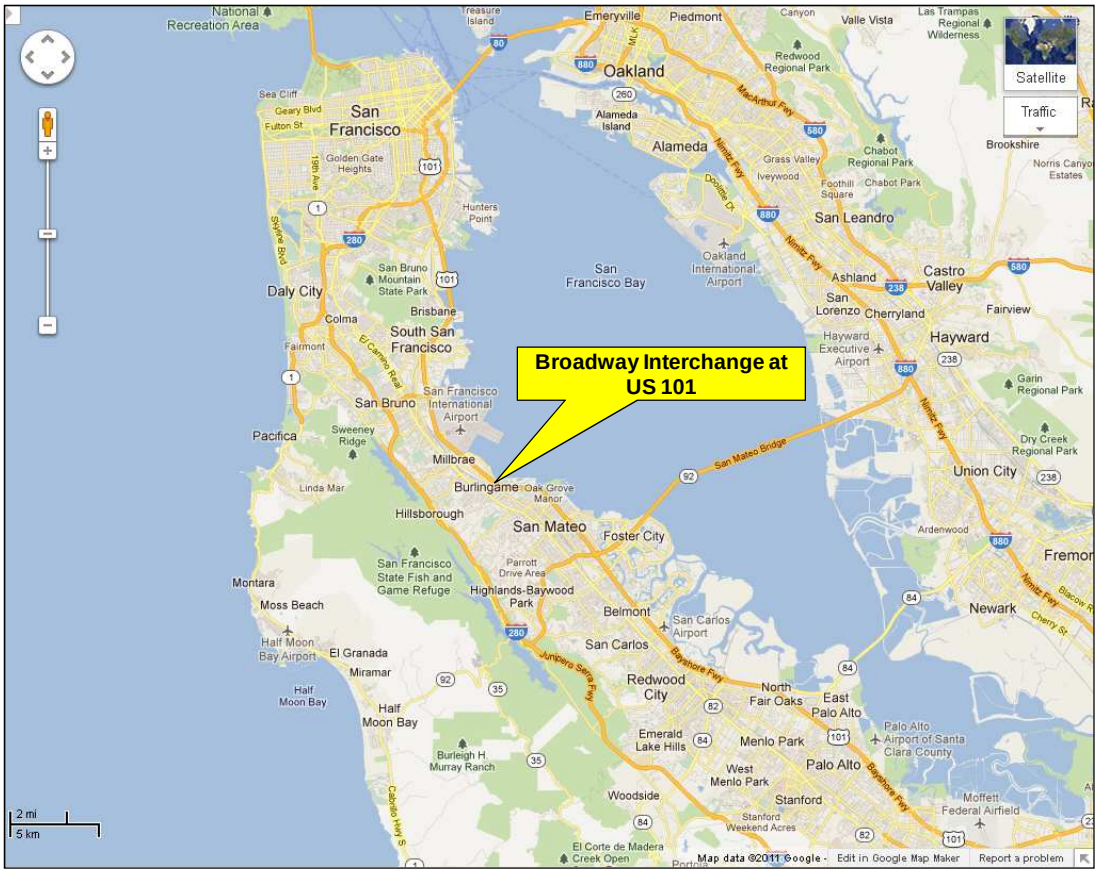


Figure 1. Vicinity and Project Site Map

Figure 2. Aerial View of Project Site (Red Box)

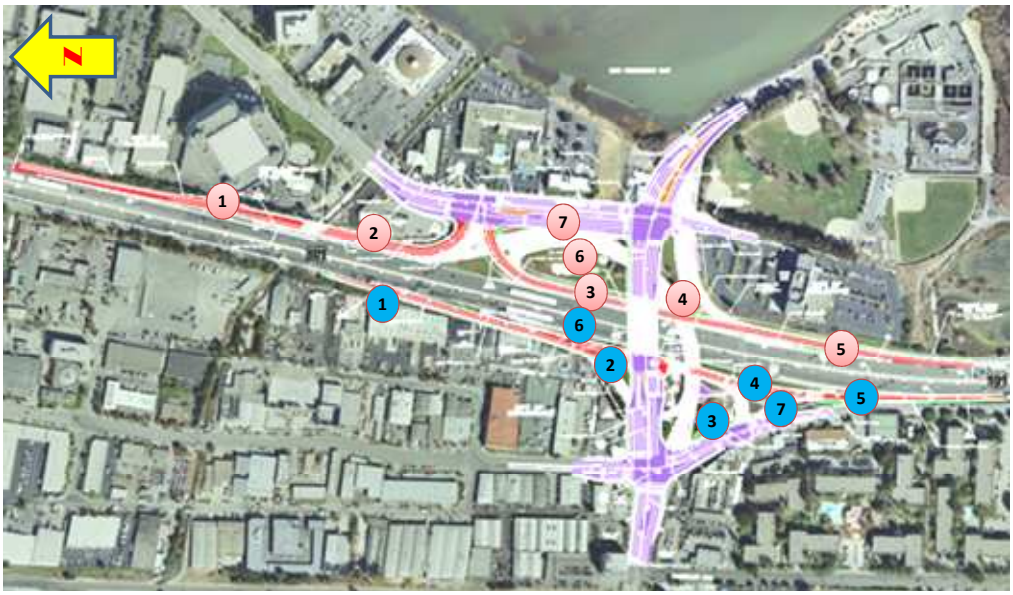
Proposed box girder and box culvert locations are shown in Figure 3.

Figure 3. Proposed Box Girder and Easton Creek Box Culvert Locations

To predict corrosion problems associated with a particular type of structure prior to installation, it is necessary to investigate the soil conditions the structure will encounter. Since corrosion is an electrochemical process accompanied by current flow, the electrochemical characteristics of a soil are of primary importance when evaluating corrosivity. Test methods utilized during this investigation reflect the most practical methods of determining soil corrosivity. This investigation was based on field measurements of soil resistivity and laboratory analysis of soil samples from the project site. The field resistivity tests have been conducted for comparison with laboratory soil boring sample analyses.

Resistivity is a measure of the ability of a soil to conduct an electric current. Soil resistivity is primarily dependent on the chemical and moisture content of the soil. As the concentrations of soluble chemical constituents increases, the soil resistivity will decrease. Lower soil resistivity is associated with higher corrosivity to buried metal and reinforced concrete structures.

At 14 sites the soil resistivity was measured to a depth of 15 feet below grade. Soil resistivities at four sites located near the abutments for the proposed Broadway overcrossing bridge (NB-6, NB-7, SB-6, and SB-7) were also measured to depths of 25, 50, 75 and 100 feet below grade. Figure 4 shows the soil resistivity test sites at the US 101/Broadway interchange project site.



Legend

1 Northbound (NB) soil resistivity test location

1 Southbound (SB) soil resistivity test location

Figure 4. Soil Resistivity Test Sites

A wide variety of water-soluble salts is typically found in soils. Two soils having the same resistivity may have significantly different corrosion characteristics, depending on the specific ions available. The major constituents that accelerate corrosion are chlorides, sulfates, and the acidity (pH) of the soil. Also, concentrations of bicarbonates tend to decrease soil resistivities. Bicarbonates are not

directly aggressive to buried metallic or concrete structures, but the lower soil resistivity can promote corrosion activity.

Chloride ions break down otherwise protective surface deposits and can facilitate corrosion of buried metallic structures. Sulfates in soil can be highly aggressive to Portland cement by combining chemically with certain constituents of the concrete, principally tricalcium aluminate. This reaction is accompanied by expansion and eventual disruption of the concrete matrix. Sulfate ions reduce the soil resistivity, which also promotes corrosion activity on buried metallic structures.

Acidity, as indicated by the pH value, is another important factor of soil with respect to corrosivity. Lower pH (more acidic) will result in a greater degree of corrosivity with respect to buried metallic structures. When pH increases above 7.0 (the neutral value) the conditions become increasingly more alkaline. In alkaline environments, iron forms a protective layer on its surface. This is referred to as passivation. When the soil pH drops below about 9.0, the passive layer may break down.

Figure 5 shows the URS soil boring sites that provided soil samples for laboratory analysis.

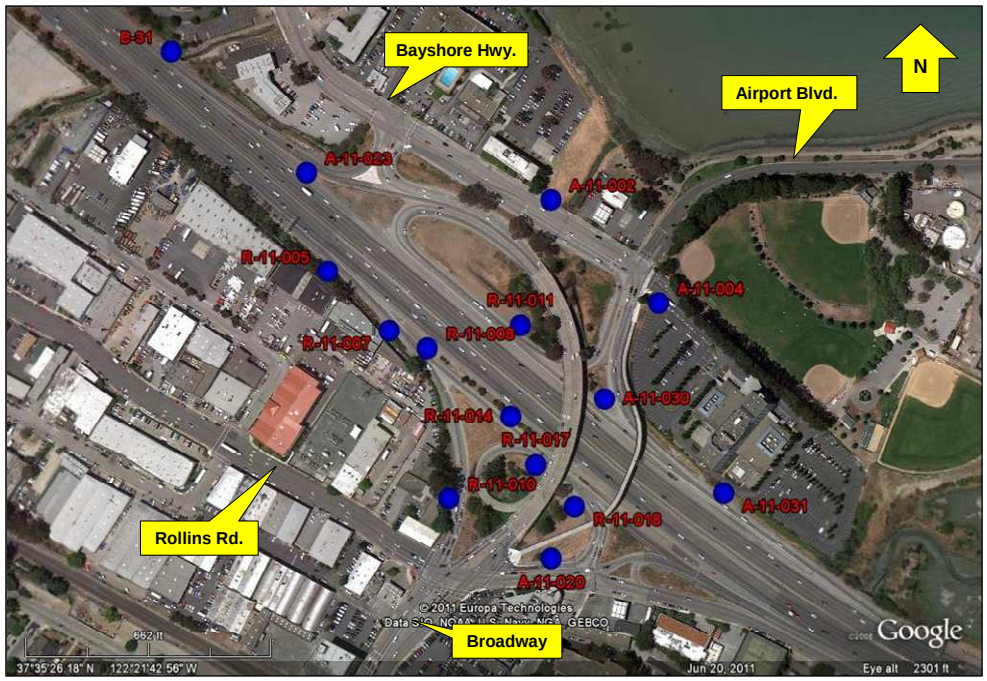


Figure 5. Soil Borehole Locations

TESTING METHODS

Field Soil Resistivity

Field soil resistivity measurements were taken using the Wenner four-electrode method (ASTM G57), utilizing an AEMC Instruments Model 4500 soil resistance meter. The Wenner method uses four

metal pins or electrodes, driven into the ground along a straight line, equidistant from each other, as shown in Figure 6. Soil resistivity measurements were conducted at electrode spacings of 2.5, 5, 7.5, 10, and 15 feet; and where applicable 25, 50, 75, and 100 feet.

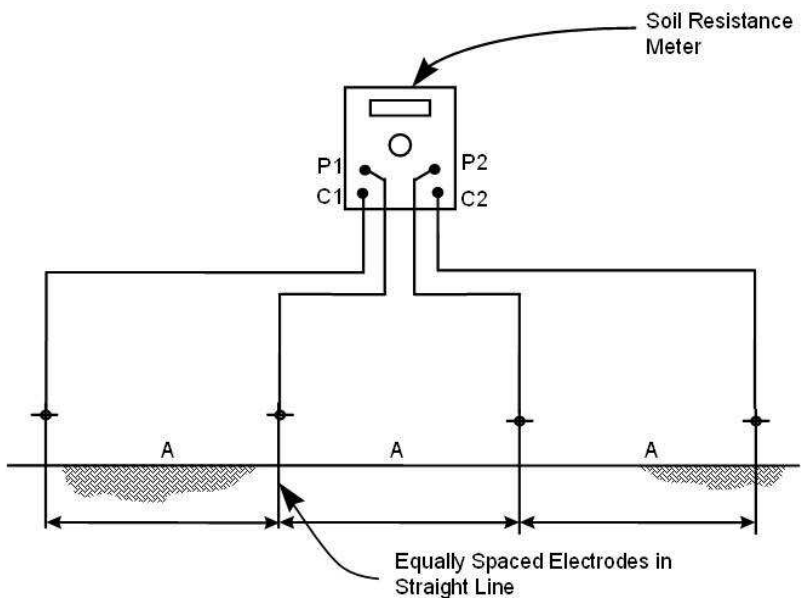


Figure 6. Soil Resistivity Measurement

An alternating current from the soil resistance meter causes a current to flow through the soil between the outer electrodes, C1 and C2. The current creates a voltage gradient in the soil, which is proportional to the average resistance of the soil mass to a depth equal to the electrode spacing. The voltage drop is then measured across pins P1 and P2. Resistivity of the soil is then computed from the instrument reading according to the formula

$$\rho = 2\pi AR$$

where ρ = soil resistivity (ohm-cm)
A = distance between electrodes (cm)
R = soil resistance, instrument reading (ohms)
π = 3.14 (approximate).

To calculate the resistivity of a soil layer, the Barnes layer method is used based on the results of the Wenner four-electrode tests. The Wenner method measures soil resistivity from the surface to various depths below grade. The Barnes layer method is used to calculate the resistivity of a soil layer between two depths below grade from the surface-to-depth resistivity measurements. The Barnes layer method assumes the soil layers are a uniform thickness and that the upper and lower boundaries are parallel to the surface.

The Barnes layer resistivity of each layer of soil was calculated using the equations

$$\rho_{b-a} = KR_{(b-a)}$$

and

$$\frac{1}{R_{b-a}} = \frac{1}{R_a} - \frac{1}{R_b}$$

where

ρ_{b-a}	=	resistivity of soil layer from depth *a* to *b* (ohm-cm)
a	=	soil depth to top of layer (cm)
b	=	soil depth to bottom of layer (cm)
R_a	=	soil resistance read at depth *a* (ohms)
R_b	=	soil resistance read at depth *b* (ohms)
R_{b-a}	=	resistance of soil layer from depth *a* to *b* (ohms)
K	=	layer constant (cm)
	=	$2\pi(b–a)$.

Laboratory Soil Analysis

For the purposes of this analysis, 14 soil samples were obtained from 14 URS soil boreholes (Figure 5) for laboratory soil resistivity analysis. A soil box was used in accordance with California Test Method 643. The test apparatus is shown in Figure 7. It consists of a small plastic box with metal end plates for passing current through a tightly packed soil sample. Electric current flowing through the sample causes a voltage drop between pins P1 and P2. The soil resistivity is measured with a soil resistance meter. The soil box is designed so that the meter resistance reading is also the sample resistivity in ohm-cm. The soil resistivity is first measured in the "as-received" state. Distilled water is then added in increments to the soil sample. The soil resistivity is measured after each water addition. As the soil sample becomes more saturated, the resistivity decreases until the minimum soil resistivity is reached. Adding more water increases the resistivity as the soil electrolyte solution is diluted. The minimum observed resistivity is recorded.

The soil samples from the URS boreholes were forwarded to Cooper Testing Laboratory in Palo Alto, California, for minimum resistivity measurement, pH analysis, and analysis of water-soluble chloride and sulfate ion concentrations. The analytical procedures followed California Test Methods 417, 422, 643, and 644.

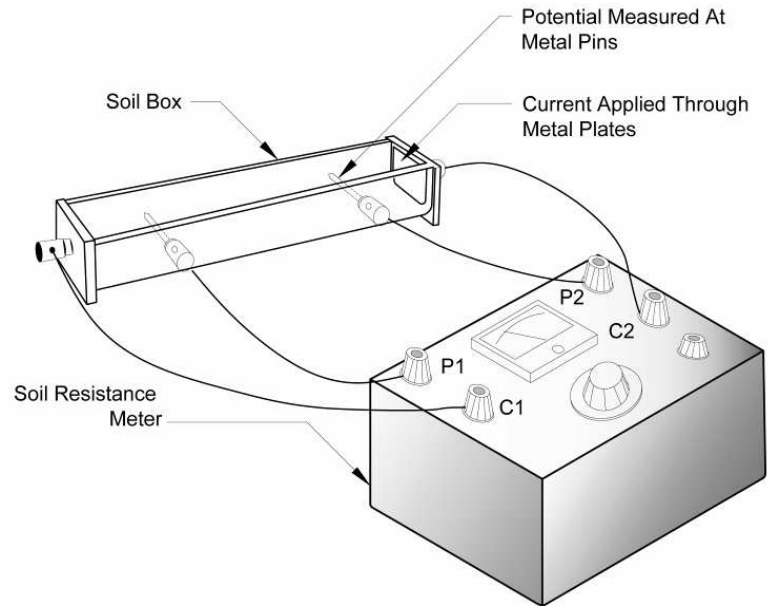


Figure 7. Soil Resistivity Measurement Using the Soil Box Method

TEST RESULTS

Field Soil Resistivity Results

Data obtained during this investigation has been tabulated for analysis and presentation. Table 1 lists the results of the Wenner soil resistivity measurements and Barnes layer calculations conducted at the US 101/Broadway interchange project site.

Table 1. Field Soil Resistivity Measurements

Site	Depth (feet)	Resistivity (Ohm-cm)	Layer Depth (feet)	Layer Resistivity (ohm-cm)	Site	Depth (feet)	Resistivity (Ohm-cm)	Layer Depth (feet)	Layer Resistivity (ohm-cm)
NB-1	2.5	2,298	0 - 2.5	2,298	SB-1	2.5	2,557	0 - 2.5	2,557
	5	852	2.5 - 5	523		5	1,274	2.5 - 5	848
	7.5	417	5 - 7.5	206		7.5	603	5 - 7.5	294
	10	402	7.5 - 10	364		10	306	7.5 - 10	124
	15	259	10 - 15	151		15	259	10 - 15	197
NB-2	2.5	1,197	0 - 2.5	1,197	SB-2	2.5	2,427	0 - 2.5	2,427
	5	259	2.5 - 5	145		5	1,455	2.5 - 5	1,039
	7.5	172	5 - 7.5	103		7.5	1,508	5 - 7.5	1,626
	10	96	7.5 - 10	41		10	1,111	7.5 - 10	620
	15	29	10 - 15	12		15	1,207	10 - 15	1,458
NB-3	2.5	1,647	0 - 2.5	1,647	SB-3	2.5	5,042	0 - 2.5	5,042
	5	929	2.5 - 5	647		5	3,074	2.5 - 5	2,211
	7.5	632	5 - 7.5	386		7.5	1,566	5 - 7.5	790
	10	249	7.5 - 10	88		10	900	7.5 - 10	396
	15	172	10 - 15	107		15	373	10 - 15	172
NB-4	2.5	1,666	0 - 2.5	1,666	SB-4	2.5	1,628	0 - 2.5	1,628
	5	1,676	2.5 - 5	1,685		5	1,302	2.5 - 5	1,085
	7.5	632	5 - 7.5	281		7.5	747	5 - 7.5	403
	10	345	7.5 - 10	146		10	594	7.5 - 10	368
	15	201	10 - 15	110		15	402	10 - 15	244
NB-5	2.5	6,334	0 - 2.5	6,334	SB-5	2.5	6,195	0 - 2.5	6,195
	5	3,447	2.5 - 5	2,368		5	3,371	2.5 - 5	2,315
	7.5	4,252	5 - 7.5	7,972		7.5	1,566	5 - 7.5	756
	10	1,666	7.5 - 10	590		10	900	7.5 - 10	396
	15	431	10 - 15	174		15	718	10 - 15	511
NB-6	2.5	12,448	0 - 2.5	12,448	SB-6	2.5	3,332	0 - 2.5	3,332
	5	1,609	2.5 - 5	860		5	3,074	2.5 - 5	2,852
	7.5	862	5 - 7.5	447		7.5	1,566	5 - 7.5	790
	10	218	7.5 - 10	67		10	1,072	7.5 - 10	551
	15	204	10 - 15	180		15	172	10 - 15	64
	25	321	15 - 25	2,278		25	48	15 - 25	23
	50	278	25 - 50	245		50	**ND**	25 - 50	**ND**
	75	373	50 - 75	1,203		75	**ND**	50 - 75	**ND**
	100	315,036	75 - 100	11,031		100	**ND**	75 - 100	**ND**
NB-7	2.5	1,254	0 - 2.5	1,254	SB-7	2.5	6,464	0 - 2.5	6,464
	5	1,072	2.5 - 5	937		5	4,376	2.5 - 5	3,308
	7.5	282	5 - 7.5	114		7.5	975	5 - 7.5	382
	10	170	7.5 - 10	78		10	515	7.5 - 10	213
	15	359	10 - 15	296		15	290	10 - 15	155
	25	737	15 - 25	1,271		25	326	15 - 25	399
	50	517	25 - 50	398		50	354	25 - 50	389
	75	876	50 - 75	2,253		75	733	50 - 75	645
	100	102,267	75 - 100	1,093		100	**ND**	75 - 100	**ND**

ND: not determined. Insufficient space to set up the Wenner four-electrode test array for the indicated soil depth.

Laboratory Soil Analysis Results

Table 2 lists the minimum soil resistivity and chemical analyses of the 14 soil samples retrieved from URS soil borings taken at the project site and analyzed at the Cooper Testing Laboratory.

An additional sample from a previous soil boring (B-31) was included to provide additional information along the proposed northbound US 101 on-ramp concrete barrier alignment. The results for B-31 were reported in Rajappan & Meyer Job No. 201191.GDR (GDMR for US 101 Auxiliary Lane Project), December 22, 2005, Table 8B, page 72.

Table 2. Laboratory Soil Resistivity and Chemical Data

Sample No.	Depth (feet)	Minimum Resistivity (ohm-cm)	Chemical Data		
			pH	Chloride (mg/kg)	Sulfate (mg/kg)
A-11-002	2.5 - 5	1,236	8.8	92	434
A-11-004	2.5 - 5	622	8.3	528	900
A-11-020-2-3	5 - 6.5	3,566	8.3	<2	6
A-11-023	2 - 5	198	8.2	2,034	447
A-11-030-2-4	3 - 6.5	114	7.8	6,739	2,606
A-11-031-2-3	3 - 6.5	90	7.7	3,284	425
R-11-005	3.5 - 5	1,151	7.9	90	542
R-11-007-1-3	5 - 7	1,952	7.9	13	6
R-11-008-1-3	5 - 7	2,517	8.0	<2	132
R-11-010-1-3	5 - 7	1,768	7.7	24	5,391
R-11-011	0 - 6	1,252	8.0	246	9
R-11-014-1	5 - 6.5	1,328	7.6	181	8
R-11-017-1-2	5 - 7	561	7.7	451	272
R-11-018-2-2	10 - 11.5	131	8.0	4,965	786
B-31*	9.5 - 19.5	61	8.1	8,325	1,094
Easton Creek Water		26	7.3	11,600	2,030

* Soil sample B-31 was previously reported in Rajappan & Meyer Job No. 201191.GDR, 12/22/05, page 72
mg/kg – milligrams per kilogram (ppm)
Minimum resistivity by Caltrans Method 643
pH by Caltrans Method 644
Chloride by Caltrans Method 422-modified
Sulfate by Caltrans Method 417-modified

Based on the *Corrosion Guidelines*, six of the analyzed soil samples and Rajappan & Meyer soil sample B-31 are considered corrosive to buried metallic objects and reinforced concrete structures with regards to chloride or sulfate contents. These samples are color-highlighted in Table 2 above.

APPENDIX A: SOIL SAMPLE LABORATORY CHEMICAL ANALYSIS RESULTS

COOPER TESTING LABORATORY

Corrosivity Test Summary

CTL #	632-011		**Date:**	12/19/2011		**Tested By:**	PJ		**Checked:**	PJ	
Client:	V&A Consulting Engineers		**Project:**	URS Hwy 101 Broadway Interchange					**Proj. No:**	11-0149	
Remarks:											

Sample Location or ID			**Resistivity @ 15.5 °C (Ohm-cm)**			**Chloride**	**Sulfate**		**pH**	**ORP**	**Moisture**	
Boring	**Sample, No.**	**Depth, ft.**	**As Rec.**	**Minimum**	**Saturated**	**mg/kg**	**mg/kg**	**%**		(Redox)	At Test	**Soil Visual Description**
						Dry Wt.	Dry Wt.	Dry Wt.		mV	%	
			ASTM G57	Cal 643	ASTM G57	Cal 422-mod.	Cal 417-mod.	Cal 417-mod.	Cal 643	SM 2580B	ASTM D2216	
A-11-002	-	2.5-5	29,118	1,236	-	92	434	0.0434	8.8	-	8.3	Olive Silty SAND (Slightly Plastic)
A-11-004	-	2.5-5	1,308	622	-	528	900	0.0900	8.3	-	16.8	Dark Olive Gray Clayey SAND w/ Gravel
A-11-020-2-3	-	5-6.5	3,566	3,566	-	<2	6	0.0006	8.3	-	20.4	Olive Brown Silty SAND
A-11-023	-	2-5	5,591	198	-	2,034	447	0.0447	8.2	-	7.8	Olive Gray Clayey SAND w/ Gravel
A-11-030-2-4	-	3-6.5	129	114	-	6,739	2,606	0.2606	7.8	-	95.7	Olive Gray CLAY w/ Organics
A-11-031-2-3	-	3-6.5	104	90	-	3,284	425	0.0425	7.7	-	77.0	Dark Greenish Gray CLAY
R-11-005	-	3.5-5	149,040	1,151	-	90	542	0.0542	7.9	-	4.8	Olive Brown Clayey SAND w/ Gravel
R-11-007-1-3	-	5-7	6,381	1,952	-	13	6	0.0006	7.9	-	12.5	Gray Clayey SAND changing to Sandy CLAY
R-11-008-1-3	-	5-7	2,904	2,517	-	<2	132	0.0132	8.0	-	7.4	Gray Clayey SAND w/ Gravel
R-11-010-1-3	-	5-7	5,515	1,768	-	24	5,391	0.5391	7.7	-	20.8	Olive Brown Clayey SAND
R-11-011	-	0-6	600,080	1,252	-	246	9	0.0009	8.0	-	3.9	Olive Brown Clayey SAND w/ Gravel
R-11-011-13-3	-	55-60	821	719	-	341	9	0.0009	7.7	-	23.6	Olive Brown Clayey SAND
R-11-014-1	-	5-6.5	1,605	1,328	-	181	8	0.0008	7.6	-	24.9	Brown Clayey SAND w/ Gravel
R-11-014-13-4	-	57-58	3,214	2,829	-	43	<5	<0.0005	8.0	-	16.1	Olive Brown Clayey SAND
R-11-017-1-2	-	5-7	561	561	-	451	272	0.0272	7.7	-	15.4	Olive Brown Sandy CLAY w/ Gravel
R-11-018-2-2	-	10-11.5	146	131	-	4965	786	0.0786	8.0	-	80.3	Gray CLAY

APPENDIX B: CALTRANS ALTPIPE VERSION 6.08
ALTERNATIVE PIPES FOR CULVERTS

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	1	1	1	1	2	2	2	2	3	3	3	3
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PA (Polymerized Asphalt)	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
	PS (Polymeric Sheet)	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	`	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	1	1	1	1	2	2	2	2	3	3	3	3
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Plastic Pipes

	Drainage System	1	1	1	1	2	2	2	2	3	3	3	3
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Availability				Availability				Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	1	1	1	1	2	2	2	2	3	3	3	3
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Steel Cover (in)		1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	1	1	1	1	2	2	2	2	3	3	3	3
	Soil Bore Sample I.D.	B-31				B-31				B-31			
Soil pH		8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
Minimum Soil Resistivity (ohm-cm)		61	61	61	61	61	61	61	61	61	61	61	61
Sulfate Concentration (ppm)		1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,094
Chloride Concentration (ppm)		8,325	8,325	8,325	8,325	8,325	8,325	8,325	8,325	8,325	8,325	8,325	8,325
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	4	4	4	4	5	5	5	5	6	6	6	6
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Pipe Type	**Coating**	**Minimum Thickness (in)**				**Minimum Thickness (in)**				**Minimum Thickness (in)**			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	0.109	NA	NA	NA	0.109
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	0.064	0.064	0.064	0.064	NA	NA	0.079	0.079
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.064	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	NA	0.079	0.079
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.109	0.109	NA	NA	0.109	0.109
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.079	0.079
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.109	0.109	NA	NA	0.109	0.109
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.079	0.079
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.109	0.109	NA	NA	0.109	0.109
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.079	0.079
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	4	4	4	4	5	5	5	5	6	6	6	6
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Pipe Type		**Minimum Thickness (in)**				**Minimum Thickness (in)**				**Minimum Thickness (in)**			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Plastic Pipes

	Drainage System	4	4	4	4	5	5	5	5	6	6	6	6
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Pipe Type		**Availability**				**Availability**				**Availability**			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	4	4	4	4	5	5	5	5	6	6	6	6
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Steel Cover (in)		0.75	0.75	1	1	0.75	0.75	1	1	0.75	0.75	1	1
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	4	4	4	4	5	5	5	5	6	6	6	6
	Soil Bore Sample I.D.	**A-11-023**				**A-11-002**				**R-11-005**			
Soil pH		8.2	8.2	8.2	8.2	8.8	8.8	8.8	8.8	7.9	7.9	7.9	7.9
Minimum Soil Resistivity (ohm-cm)		198	198	198	198	1,236	1,236	1,236	1,236	1,151	1,151	1,151	1,151
Sulfate Concentration (ppm)		447	447	447	447	434	434	434	434	542	542	542	542
Chloride Concentration (ppm)		2,034	2,034	2,034	2,034	92	92	92	92	90	90	90	90
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	7	7	7	7	8	8	8	8	9	9	9	9
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	0.109	NA	NA	NA	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.079	0.079	0.064	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.079	0.079	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.079	0.079	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.079	0.079	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.079	0.079	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	7	7	7	7	8	8	8	8	9	9	9	9
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Plastic Pipes

	Drainage System	7	7	7	7	8	8	8	8	9	9	9	9
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Availability				Availability				Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	7	7	7	7	8	8	8	8	9	9	9	9
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Steel Cover (in)		0.75	0.75	1	1	0.75	0.75	1	1	1.25	1.25	1.25	1.25
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	7	7	7	7	8	8	8	8	9	9	9	9
	Soil Bore Sample I.D.	R-11-005				R-11-011				A-11-030-2-4			
Soil pH		7.9	7.9	7.9	7.9	8.0	8.0	8.0	8.0	7.8	7.8	7.8	7.8
Minimum Soil Resistivity (ohm-cm)		1,151	1,151	1,151	1,151	1,252	1,252	1,252	1,252	114	114	114	114
Sulfate Concentration (ppm)		542	542	542	542	9	9	9	9	2,606	2,606	2,606	2,606
Chloride Concentration (ppm)		90	90	90	90	246	246	246	246	6,739	6,739	6,739	6,739
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	10	10	10	10	11	11	11	11	12	12	12	12
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079			0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	10	10	10	10	11	11	11	11	12	12	12	12
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA				0.060				0.060
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	0.060	0.060	0.060	0.075	0.060	0.060	0.060	0.075
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA				0.060				0.060
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA			0.060	0.060			0.060	0.060
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA			0.060	0.060			0.060	0.060

Plastic Pipes

	Drainage System	10	10	10	10	11	11	11	11	12	12	12	12
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Availability				Availability				Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	10	10	10	10	11	11	11	11	12	12	12	12
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Steel Cover (in)		1.25	1.25	1.25	1.25	0.75	0.75	1	1	0.75	0.75	1	1
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	10	10	10	10	11	11	11	11	12	12	12	12
	Soil Bore Sample I.D.	A-11-030-2-4				R-11-010-1-3				R-11-010-1-3			
Soil pH		7.8	7.8	7.8	7.8	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Minimum Soil Resistivity (ohm-cm)		114	114	114	114	1,768	1,768	1,768	1,768	1,768	1,768	1,768	1,768
Sulfate Concentration (ppm)		2,606	2,606	2,606	2,606	5,391	5,391	5,391	5,391	5,391	5,391	5,391	5,391
Chloride Concentration (ppm)		6,739	6,739	6,739	6,739	24	24	24	24	24	24	24	24
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	**13**	**13**	**13**	**13**	**14**	**14**	**14**	**14**	**15**	**15**	**15**	**15**
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**18**	**18**
Pipe Type	**Coating**	**Minimum Thickness (in)**				**Minimum Thickness (in)**				**Minimum Thickness (in)**			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	BC (Bituminous Coating)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	BCI (BC+paved invert)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	**13**	**13**	**13**	**13**	**14**	**14**	**14**	**14**	**15**	**15**	**15**	**15**
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Pipe Type		**Minimum Thickness (in)**				**Minimum Thickness (in)**				**Minimum Thickness (in)**			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		0.060	0.060	0.060	0.075	0.060	0.060	0.060	0.075	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations					0.060				0.060	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		0.060	0.060	0.060	0.075	0.060	0.060	0.060	0.075	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations					0.060				0.060	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch				0.060	0.060			0.060	0.060	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch				0.060	0.060			0.060	0.060	NA	NA	NA	NA

Plastic Pipes

	Drainage System	**13**	**13**	**13**	**13**	**14**	**14**	**14**	**14**	**15**	**15**	**15**	**15**
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Pipe Type		**Availability**				**Availability**				**Availability**			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	**13**	**13**	**13**	**13**	**14**	**14**	**14**	**14**	**15**	**15**	**15**	**15**
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Steel Cover (in)		0.75	0.75	1	1	0.75	0.75	1	1	0.75	0.75	1	1
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	**13**	**13**	**13**	**13**	**14**	**14**	**14**	**14**	**15**	**15**	**15**	**15**
	Soil Bore Sample I.D.	**A-11-020-2-3**				**A-11-020-2-3**				**A-11-023**			
Soil pH		8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.2	8.2	8.2	8.2
Minimum Soil Resistivity (ohm-cm)		3,566	3,566	3,566	3,566	3,566	3,566	3,566	3,566	198	198	198	198
Sulfate Concentration (ppm)		6	6	6	6	6	6	6	6	447	447	447	447
Chloride Concentration (ppm)		2	2	2	2	2	2	2	2	2,034	2,034	2,034	2,034
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	16	16	16	16	17	17	17	17	18	18	18	18
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	0.109	NA	NA	NA	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	0.109
	BCI (BC+paved invert)	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	NA	NA	NA	0.109
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	16	16	16	16	17	17	17	17	18	18	18	18
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Plastic Pipes

	Drainage System	16	16	16	16	17	17	17	17	18	18	18	18
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Availability				Availability				Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	16	16	16	16	17	17	17	17	18	18	18	18
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Steel Cover (in)		0.75	0.75	1	1	0.75	0.75	1	1	0.75	0.75	1	1
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	16	16	16	16	17	17	17	17	18	18	18	18
	Soil Bore Sample I.D.	A-11-002				A-11-002				A-11-004			
Soil pH		8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.3	8.3	8.3	8.3
Minimum Soil Resistivity (ohm-cm)		1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236	622	622	622	622
Sulfate Concentration (ppm)		434	434	434	434	434	434	434	434	900	900	900	900
Chloride Concentration (ppm)		92	92	92	92	92	92	92	92	528	528	528	528
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	19	19	19	19	20	20	20	20	21	21	21	21
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	0.064	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	0.109	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	0.109	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	19	19	19	19	20	20	20	20	21	21	21	21
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	0.060	0.060	0.060	0.075	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA				0.060	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	0.060	0.060	0.060	0.075	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA				0.060	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA			0.060	0.060	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA			0.060	0.060	NA	NA	NA	NA

Plastic Pipes

	Drainage System	19	19	19	19	20	20	20	20	21	21	21	21
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Availability				Availability				Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	19	19	19	19	20	20	20	20	21	21	21	21
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Steel Cover (in)		0.75	0.75	1	1	0.75	0.75	1	1	1.25	1.25	1.25	1.25
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	19	19	19	19	20	20	20	20	21	21	21	21
	Soil Bore Sample I.D.	A-11-004				A-11-020-2-3				R-11-018-2-2			
Soil pH		8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.0	8.0	8.0	8.0
Minimum Soil Resistivity (ohm-cm)		622	622	622	622	3,566	3,566	3,566	3,566	131	131	131	131
Sulfate Concentration (ppm)		900	900	900	900	6	6	6	6	786	786	786	786
Chloride Concentration (ppm)		528	528	528	528	2	2	2	2	4,965	4,965	4,965	4,965
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	22	22	22	22
	Pipe Diameter (in)	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	22	22	22	22
	Pipe Diameter (in)	12	18	24	30
Pipe Type		Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA

Plastic Pipes

	Drainage System	22	22	22	22
	Pipe Diameter (in)	12	18	24	30
Pipe Type		Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	22	22	22	22
	Pipe Diameter (in)	12	18	24	30
Steel Cover (in)		0.75	0.75	1	1
Sacks of Cement		5	5	5	5
Percentage Water		10	10	10	10

Other Information

	Drainage System	22	22	22	22
	Soil Bore Sample I.D.	A-11-004			
Soil pH		8.3	8.3	8.3	8.3
Minimum Soil Resistivity (ohm-cm)		622	622	622	622
Sulfate Concentration (ppm)		900	900	900	900
Chloride Concentration (ppm)		528	528	528	528
Abrasion Level		1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5
Design Service Life (years)		50	50	50	50
Height of Cover (ft)		5	5	5	5

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This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in *Appendix B of Caltrans Seismic Design Criteria*. More...

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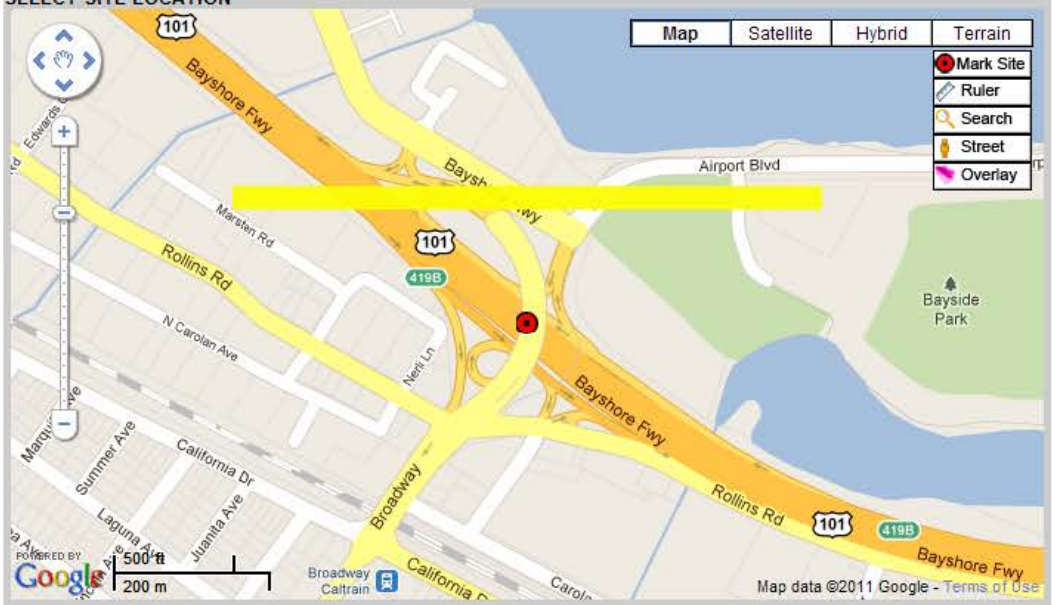

Latitude: 37.59006138 Longitude: -122.36124068 V_{S30}: 250 m/s Calculate

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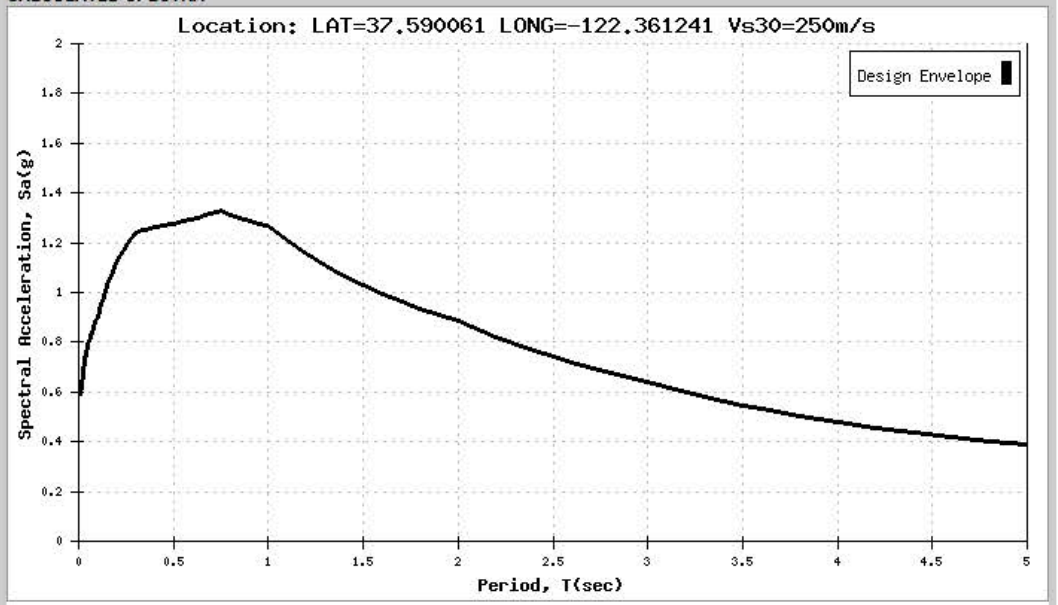

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Printer Friendly View | Show Basin Factor

Apply Near Fault Adjustment To:

NOTE: Caltrans SDC requires application of a Near Fault Adjustment factor for sites less than 25 km (Rrup) from the causative fault.

☑ Deterministic Spectrum Using

4.37 Km San Andreas fault zone (Peninsula section)

☑ Probabilistic Spectrum Using

3.6 Km (Recommend Performing Deaggregation To Verify)

◉ Show Spectrum with Adjustment Only

○ Show Spectrum with and without near fault Adjustment

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ARS Online - Windows Internet Explorer

http://dap3.dot.ca.gov/shake_stable/index.php

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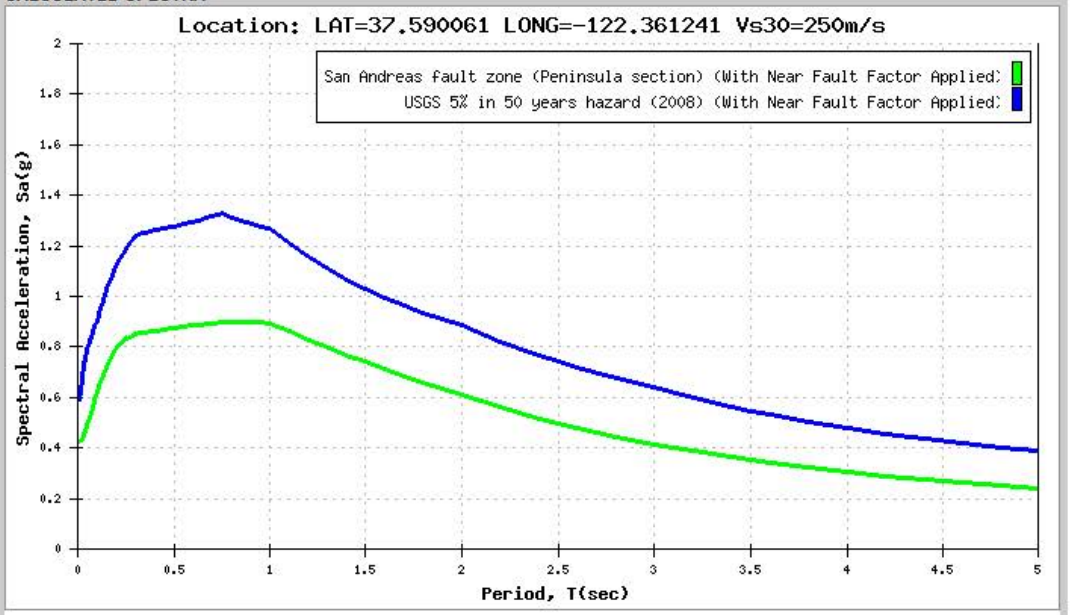
CALCULATED SPECTRA



View Tabular Data | Show Envelope Only | Hide Near Fault Adjustment | Axis Scale

Printer Friendly View | Show Basin Factor

Apply Near Fault Adjustment To:

NOTE: Caltrans SDC requires application of a Near Fault Adjustment factor for sites less than 25 km (Rrup) from the causative fault.

☑ Deterministic Spectrum Using

4.37 Km San Andreas fault zone (Peninsula section)

☑ Probabilistic Spectrum Using

3.6 Km (Recommenc Performing Deaggregation To Verify)

◉ Show Spectrum with Adjustment Only

○ Show Spectrum with and without near fault Adjustment

OK

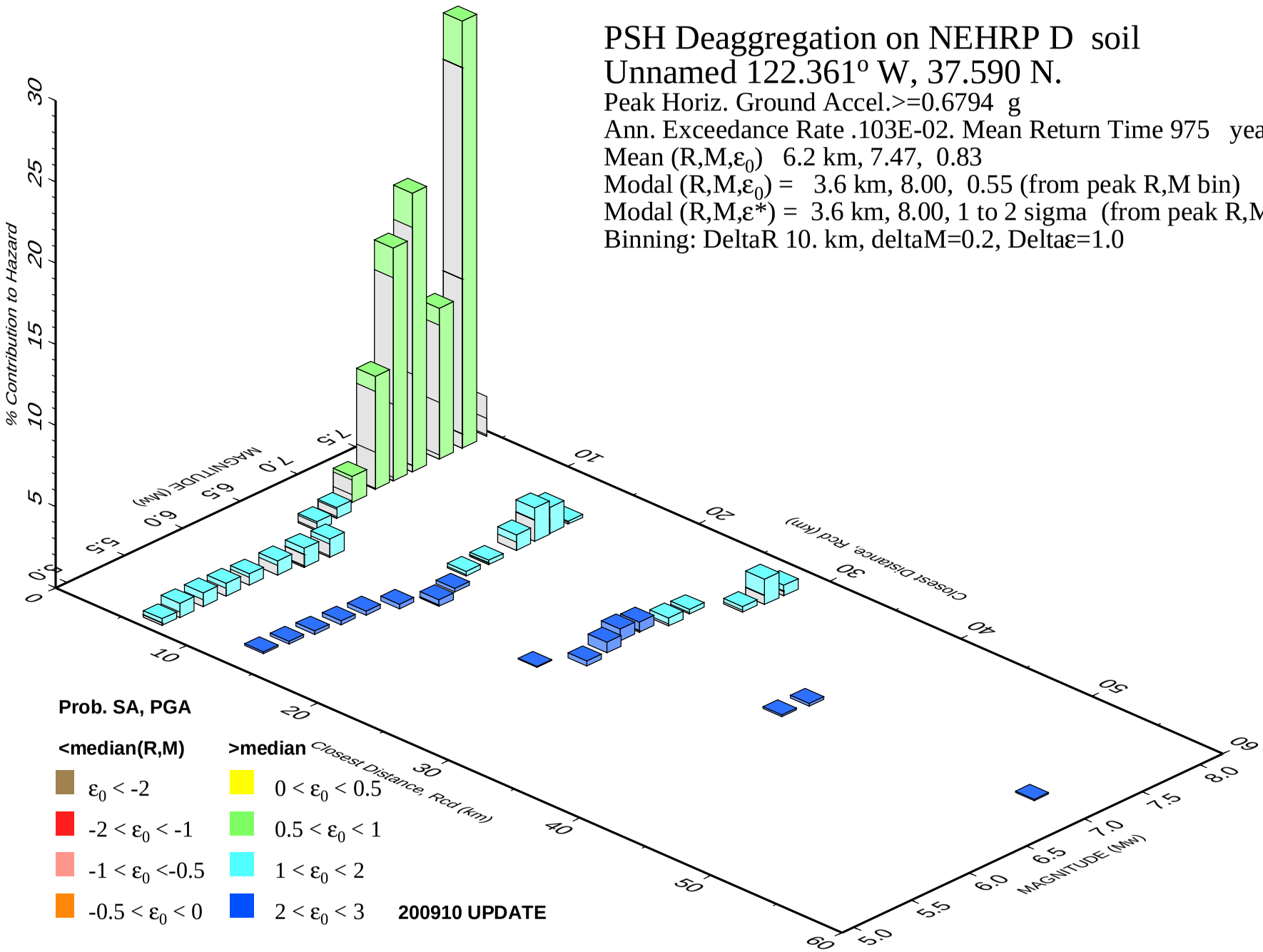
Done | Internet | 100%

Estimate of Shear Wave Velocity
Vs30
U.S. 101 Broadway Interchange Reconstruction

PointID	Depth	BottomDepth	Velocity	Layer Thickness (ft)	D/V			
CPT-11-012	5	19	712.42	14	0.019651			
CPT-11-012	19	24	560.99	5	0.008913			
CPT-11-012	24	29	690.71	5	0.007239			
CPT-11-012	29	34	780.73	5	0.006404			
CPT-11-012	34	39	661.5	5	0.007559			
CPT-11-012	39	44	976.38	5	0.005121			
CPT-11-012	44	49	810.03	5	0.006173			
CPT-11-012	49	54	1125.74	5	0.004442	Vs30=	807	ft/sec
CPT-11-012	54	64	829.14	10	0.012061		246	m/sec
CPT-11-012	64	69	1027.24	5	0.004867			
CPT-11-012	69	74	745.56	5	0.006706			
CPT-11-012	74	79	709.29	5	0.007049			
CPT-11-012	79	84	1061.63	5	0.00471			
CPT-11-012	84	99	962.13	15	0.01559			
CPT-11-016	8	19	874.3	11	0.012581			
CPT-11-016	19	24	736.1	5	0.006793			
CPT-11-016	24	29	721.03	5	0.006935			
CPT-11-016	29	34	912.6	5	0.005479			
CPT-11-016	34	39	835.17	5	0.005987			
CPT-11-016	39	44	1189.99	5	0.004202			
CPT-11-016	44	49	776.36	5	0.00644			
CPT-11-016	49	54	808.12	5	0.006187			
CPT-11-016	54	59	1067.12	5	0.004686	Vs30=	964	ft/sec
CPT-11-016	59	64	942.63	5	0.005304		294	m/sec
CPT-11-016	64	69	915.29	5	0.005463			
CPT-11-016	69	74	1176.56	5	0.00425			
CPT-11-016	74	79	1765.74	5	0.002832			
CPT-11-016	79	84	1489.91	5	0.003356			
CPT-11-016	84	89	1479.46	5	0.00338			
CPT-11-016	89	94	1216.5	5	0.00411			
CPT-11-016	94	99	782.35	5	0.006391			

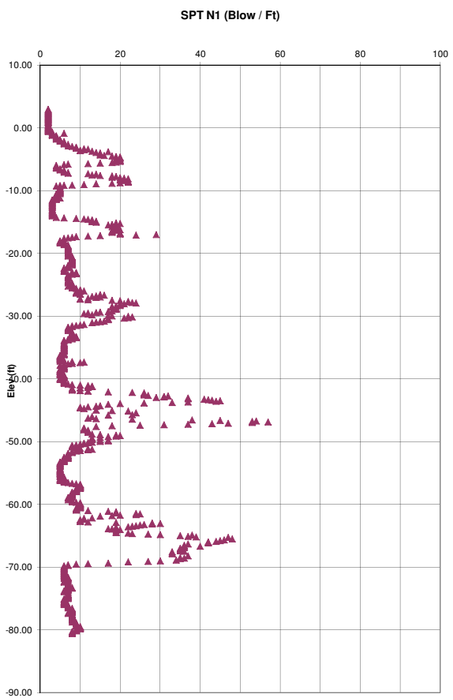
PSH Deaggregation on NEHRP D soil
Unnamed 122.361° W, 37.590 N.

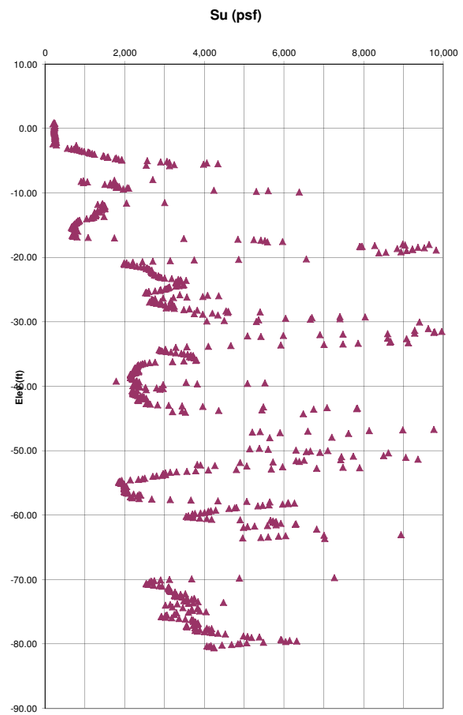
Peak Horiz. Ground Accel.>=0.6794 g
Ann. Exceedance Rate .103E-02. Mean Return Time 975 years
Mean (R,M,ε_0) 6.2 km, 7.47, 0.83
Modal (R,M,ε_0) = 3.6 km, 8.00, 0.55 (from peak R,M bin)
Modal (R,M,ε*) = 3.6 km, 8.00, 1 to 2 sigma (from peak R,M,ε bin)
Binning: DeltaR 10. km, deltaM=0.2, Deltaε=1.0

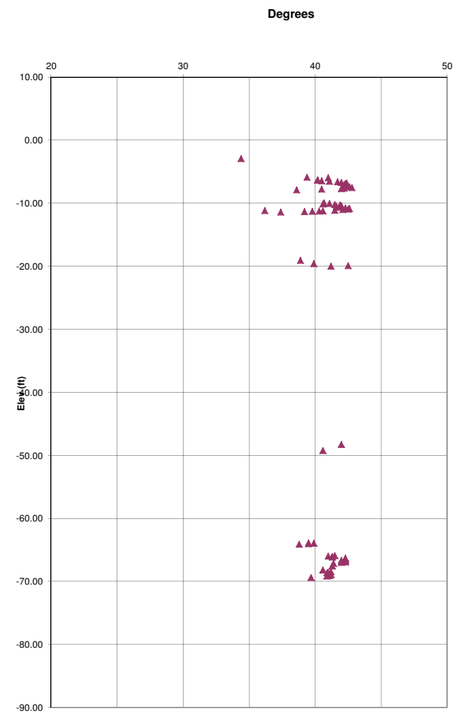


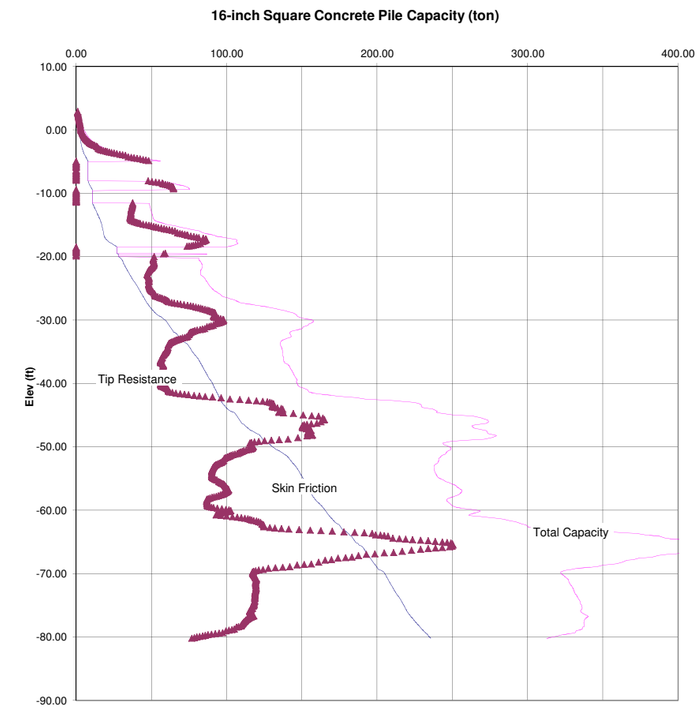
GMT 2012 Jan 22 17:16:24 Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on soil with average vs= 250. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted

CPT-11-016
Southbound US101 On-Ramp at Broadway Overcrossing
Abutment 1





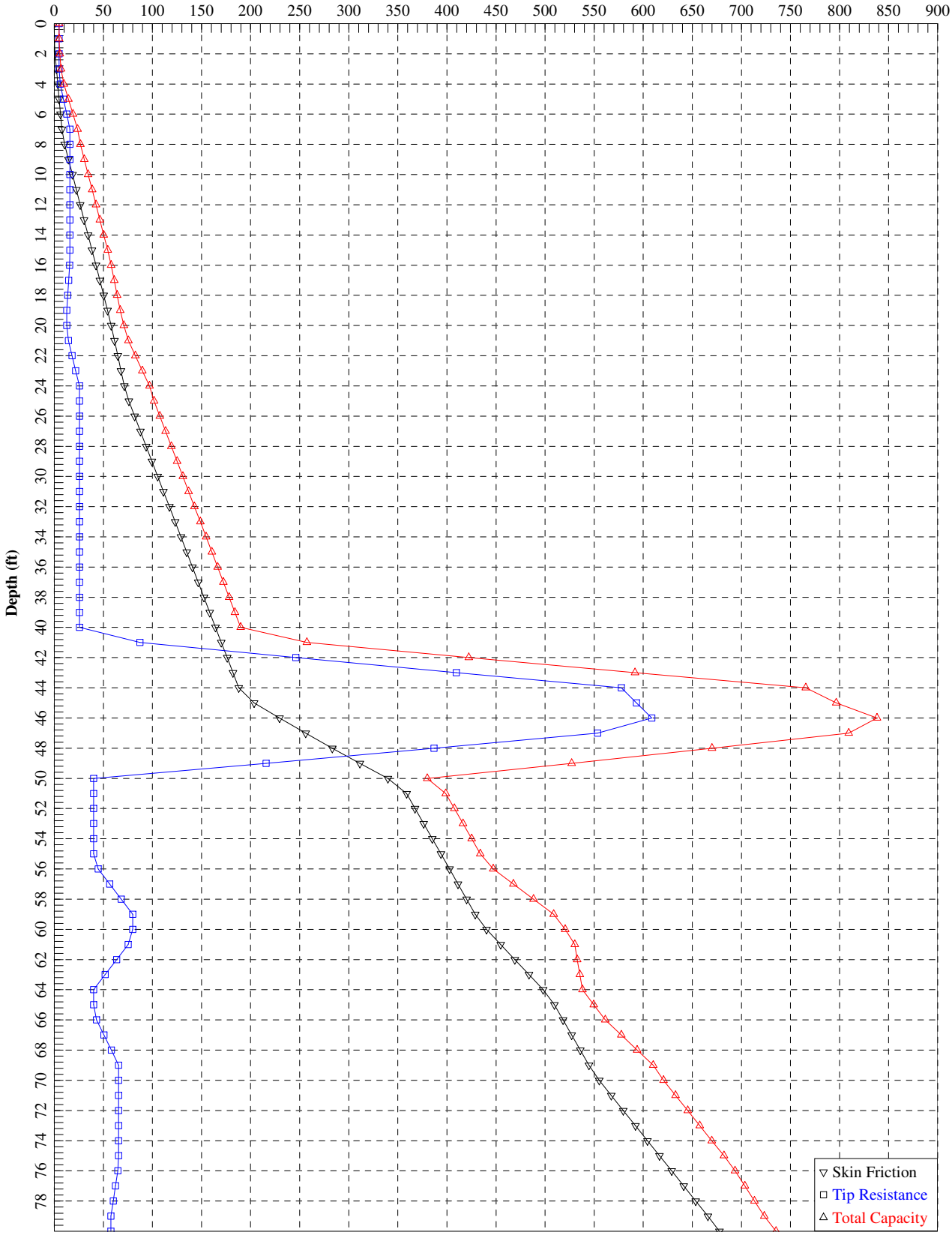




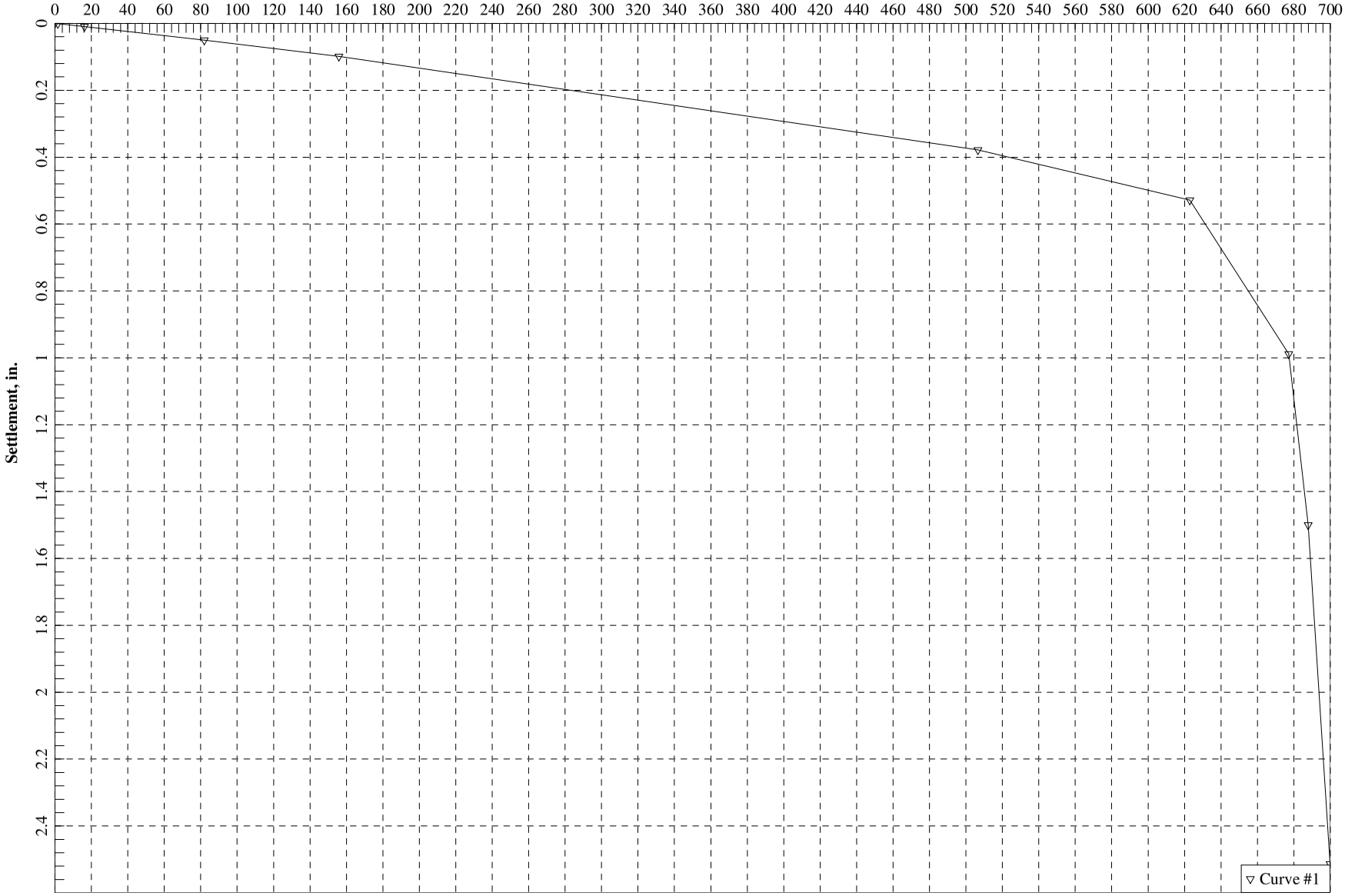
Pile Analysis for Abutment 1 (CPT-11-016)

1. Pile Design procedure based on FHWA-TS-78-209 "Guidelines for Cone Pentration Test, Performance and Design," July 1978.

Southbound US 101 On-Ramp_Abutment 2_16 in PCPS_Class 140 (Modiified)
Axial Capacity (kips)



Southbound US 101 On-Ramp_16 in PCPS Class 140 (Modified) Pile
Axial Load (kips)



W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Axial\PGEBridge_Abut 2.cpt

AXIALLY LOADING PILE ANALYSIS PROGRAM - APILEplus
VERSION 5.0 - (C) COPYRIGHT ENSOFT,INC.,1987-2008.

PG&E Tower Bridge_Abutment 2

DESIGNER : Madhu Thummaluru

DATE : 01/30/2012

PILE PROPERTIES :

PERIMETER OF PILE WITH NONCIRCULAR SECTION= 64.00 IN.
TIP AREA OF PILE WITH NONCIRCULAR SECTION = 1.78 SQF
OUTSIDE DIAMETER OF CIRCULAR PILE = 16.00 IN.
INTERNAL DIAMETER OF CIRCULAR PILE = 0.00 IN.
PILE LENGTH = 80.00 FT.
MODULUS OF ELASTICITY = 0.337E+07 PSI

LENGTH OF SURFACE SECTION WITH ZERO SKIN FRICTION = 0.00 FT.
INCREMENT OF PILE LENGTH USED IN COMPUTATION = 1.00 FT.

SOIL INFORMATIONS :

DEPTH FT.	SOIL TYPE	LATERAL EARTH PRESSURE	EFFECTIVE UNIT WEIGHT LB/CF	FRICTION ANGLE DEGREES	BEARING CAPACITY FACTOR
0.00	CLAY	0.00	27.60	0.00	0.00
6.50	CLAY	0.00	27.60	0.00	0.00
6.50	CLAY	0.00	67.60	0.00	0.00
18.50	CLAY	0.00	67.60	0.00	0.00
18.50	CLAY	0.00	65.60	0.00	0.00
23.50	CLAY	0.00	65.60	0.00	0.00
23.50	CLAY	0.00	62.60	0.00	0.00
44.00	CLAY	0.00	62.60	0.00	0.00
44.00	SAND	0.00	72.60	40.00	0.00
49.50	SAND	0.00	72.60	40.00	0.00
49.50	CLAY	0.00	62.60	0.00	0.00
58.50	CLAY	0.00	62.60	0.00	0.00
58.50	CLAY	0.00	72.60	0.00	0.00
63.50	CLAY	0.00	72.60	0.00	0.00
63.50	CLAY	0.00	62.60	0.00	0.00
68.50	CLAY	0.00	62.60	0.00	0.00
68.50	CLAY	0.00	72.60	0.00	0.00
78.50	CLAY	0.00	72.60	0.00	0.00
78.50	CLAY	0.00	67.60	0.00	0.00
83.50	CLAY	0.00	67.60	0.00	0.00
83.50	CLAY	0.00	72.60	0.00	0.00
95.00	CLAY	0.00	72.60	0.00	0.00

MAXIMUM UNIT FRICTION KSF	MAXIMUM UNIT BEARING KSF	UNDISTURB SHEAR STRENGTH KSF	REMOLDED SHEAR STRENGTH KSF	BLOW COUNT	UNIT SKIN FRICTION KSF	UNIT END BEARING KSF
0.10E+08	0.10E+08	0.30	0.30	0.00	0.00	0.00
0.10E+08	0.10E+08	0.30	0.30	0.00	0.00	0.00

0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	1.00	1.00	0.00	0.00	0.00
0.10E+08	0.10E+08	0.80	0.80	0.00	0.00	0.00
0.10E+08	0.10E+08	0.80	0.80	0.00	0.00	0.00
0.10E+08	0.10E+08	1.60	1.60	0.00	0.00	0.00
0.10E+08	0.10E+08	1.60	1.60	0.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	39.00	0.00	0.00
0.10E+08	0.10E+08	0.00	0.00	39.00	0.00	0.00
0.10E+08	0.10E+08	2.50	2.50	0.00	0.00	0.00
0.10E+08	0.10E+08	2.50	2.50	0.00	0.00	0.00
0.10E+08	0.10E+08	5.00	5.00	0.00	0.00	0.00
0.10E+08	0.10E+08	5.00	5.00	0.00	0.00	0.00
0.10E+08	0.10E+08	2.50	2.50	0.00	0.00	0.00
0.10E+08	0.10E+08	2.50	2.50	0.00	0.00	0.00
0.10E+08	0.10E+08	4.10	4.10	0.00	0.00	0.00
0.10E+08	0.10E+08	4.10	4.10	0.00	0.00	0.00
0.10E+08	0.10E+08	3.60	3.60	0.00	0.00	0.00
0.10E+08	0.10E+08	3.60	3.60	0.00	0.00	0.00
0.10E+08	0.10E+08	6.60	6.60	0.00	0.00	0.00
0.10E+08	0.10E+08	6.60	6.60	0.00	0.00	0.00

SET MAXIMUM UNIT FRICTION AND MAXIMUM UNIT BEARING
TO BE 0.10E+08 BECAUSE THE USER DOES NOT PLAN TO
LIMIT THE COMPUTED DATA.

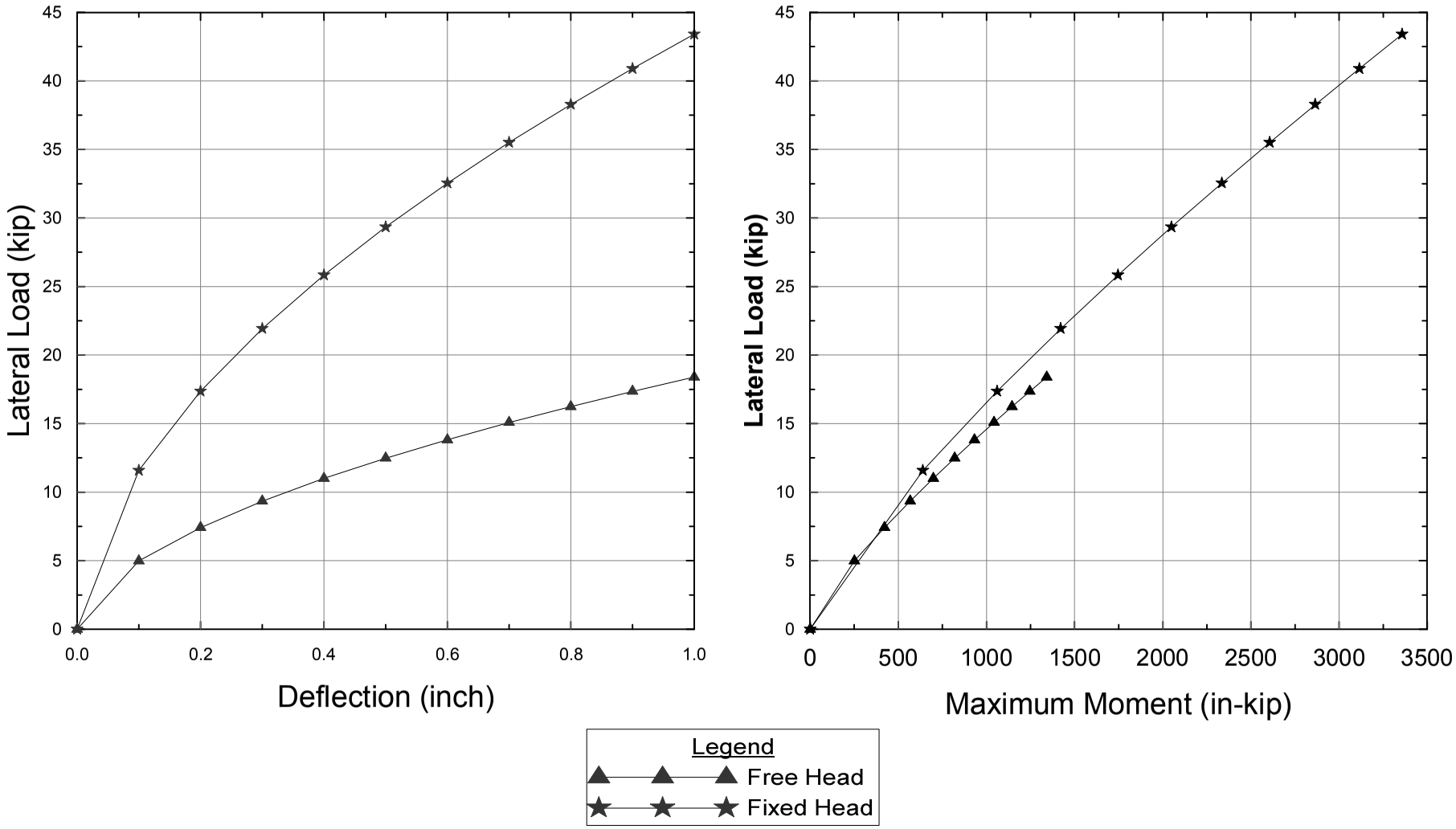
****
* COMPUTATION RESULT *
****

PILE PENETR- ATION FT.	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC- ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC- ITY KIP	TOTAL SKIN FRIC KIP	END BEARING KIP	ULTIM CAPAC- ITY KIP
	********** FED. HWY. METHOD *			********** ARMY CORPS METHOD *			********** LAMBDA 2 METHOD		
0.0	0.0	4.8	4.8	0.0	4.8	4.8	0.0	4.8	4.8
1.0	0.0	4.8	4.8	1.6	4.8	6.4	1.1	4.8	5.9
2.0	0.7	4.8	5.5	3.2	4.8	8.0	2.0	4.8	6.8
3.0	2.1	4.8	6.9	4.8	4.8	9.6	2.8	4.8	7.6
4.0	3.6	6.1	9.7	6.4	6.1	12.5	3.5	6.1	9.6
5.0	5.0	9.4	14.4	8.0	9.4	17.4	4.3	9.4	13.7
6.0	6.4	12.7	19.1	9.6	12.7	22.3	5.0	12.7	17.7
7.0	7.8	16.0	23.8	11.2	16.0	27.2	5.7	16.0	21.7
8.0	10.6	16.0	26.6	14.0	16.0	30.0	7.6	16.0	23.6
9.0	14.5	16.0	30.5	18.0	16.0	34.0	9.4	16.0	25.4
10.0	18.5	16.0	34.5	22.0	16.0	38.0	11.1	16.0	27.1
11.0	22.5	16.0	38.5	26.0	16.0	42.0	12.8	16.0	28.8
12.0	26.5	16.0	42.5	30.0	16.0	46.0	14.4	16.0	30.4
13.0	30.4	16.0	46.4	34.0	16.0	50.0	15.9	16.0	31.9
14.0	34.4	16.0	50.4	38.0	16.0	54.0	17.3	16.0	33.3
15.0	38.4	16.0	54.4	42.0	16.0	58.0	18.7	16.0	34.7
16.0	42.4	15.6	58.0	46.0	15.6	61.6	20.4	15.6	36.1
17.0	46.4	14.7	61.0	50.0	14.7	64.7	22.5	14.7	37.2
18.0	50.3	13.7	64.1	54.0	13.7	67.7	24.7	13.7	38.5
19.0	54.3	12.8	67.1	58.0	12.8	70.8	26.9	12.8	39.7
20.0	58.0	12.8	70.8	61.8	12.8	74.6	28.9	12.8	41.7
21.0	61.3	14.3	75.6	65.4	14.3	79.7	30.9	14.3	45.2
22.0	64.7	18.1	82.7	69.1	18.1	87.1	33.0	18.1	51.0
23.0	68.0	21.8	89.8	72.7	21.8	94.5	35.1	21.8	56.9
24.0	71.4	25.6	97.0	76.3	25.6	101.9	37.3	25.6	62.9
25.0	76.0	25.6	101.6	80.3	25.6	105.9	40.7	25.6	66.3
26.0	81.9	25.6	107.5	84.5	25.6	110.1	44.1	25.6	69.7

27.0	87.7	25.6	113.3	88.8	25.6	114.4	47.6	25.6	73.2
28.0	93.6	25.6	119.2	93.1	25.6	118.7	51.2	25.6	76.8
29.0	99.5	25.6	125.1	97.3	25.6	122.9	54.8	25.6	80.4
30.0	105.4	25.6	131.0	101.6	25.6	127.2	58.4	25.6	84.0
31.0	111.3	25.6	136.9	105.9	25.6	131.5	62.1	25.6	87.7
32.0	117.2	25.6	142.8	110.1	25.6	135.7	65.8	25.6	91.4
33.0	123.1	25.6	148.7	114.4	25.6	140.0	69.6	25.6	95.2
34.0	129.0	25.6	154.6	118.7	25.6	144.3	73.4	25.6	99.0
35.0	134.9	25.6	160.5	122.9	25.6	148.5	77.3	25.6	102.9
36.0	140.8	25.6	166.4	127.2	25.6	152.8	81.2	25.6	106.8
37.0	146.6	25.6	172.2	131.5	25.6	157.1	85.2	25.6	110.8
38.0	152.5	25.6	178.1	135.7	25.6	161.3	89.2	25.6	114.8
39.0	158.4	25.6	184.0	140.0	25.6	165.6	93.3	25.6	118.9
40.0	164.3	25.6	189.9	144.3	25.6	169.9	97.4	25.6	123.0
41.0	170.2	87.2	257.4	148.5	58.2	206.8	101.5	22.6	124.2
42.0	176.1	246.1	422.2	152.8	140.8	293.6	105.7	15.1	120.8
43.0	182.0	409.6	591.6	157.1	223.4	380.4	110.0	7.5	117.5
44.0	187.9	577.6	765.5	161.3	305.9	467.3	114.3	0.0	114.3
45.0	203.6	593.1	796.7	163.5	305.9	469.4	116.3	0.0	116.3
46.0	229.5	608.6	838.1	163.5	305.9	469.4	118.3	0.0	118.3
47.0	256.1	553.4	809.4	163.5	275.0	438.4	120.3	4.7	125.0
48.0	283.3	386.8	670.1	163.5	196.6	360.1	122.4	16.4	138.9
49.0	311.3	215.7	527.0	163.5	118.3	281.8	124.6	28.2	152.8
50.0	340.0	40.0	380.0	163.5	40.0	203.5	126.8	40.0	166.8
51.0	358.9	40.0	398.9	166.8	40.0	206.8	132.9	40.0	172.9
52.0	367.6	40.0	407.6	173.5	40.0	213.5	138.9	40.0	178.9
53.0	376.4	40.0	416.4	180.1	40.0	220.1	145.0	40.0	185.0
54.0	385.1	40.0	425.1	186.8	40.0	226.8	151.2	40.0	191.2
55.0	393.9	40.0	433.9	193.5	40.0	233.5	157.4	40.0	197.4
56.0	402.6	44.7	447.3	200.1	44.7	244.8	163.6	44.7	208.3
57.0	411.3	56.4	467.8	206.8	56.4	263.2	169.9	56.4	226.3
58.0	420.1	68.2	488.3	213.5	68.2	281.7	176.2	68.2	244.5
59.0	428.8	80.0	508.8	220.1	80.0	300.1	182.6	80.0	262.6
60.0	440.4	80.0	520.4	230.1	80.0	310.1	192.8	80.0	272.8
61.0	454.8	75.3	530.2	243.5	75.3	318.8	203.0	75.3	278.4
62.0	469.2	63.6	532.8	256.8	63.6	320.4	213.3	63.6	276.9
63.0	483.6	51.8	535.4	270.1	51.8	321.9	223.6	51.8	275.4
64.0	498.0	40.0	538.0	283.5	40.0	323.5	234.0	40.0	274.0
65.0	509.6	40.0	549.6	293.5	40.0	333.5	240.7	40.0	280.7
66.0	518.3	43.0	561.3	300.1	43.0	343.1	247.5	43.0	290.5
67.0	527.1	50.5	577.6	306.8	50.5	357.3	254.3	50.5	304.8
68.0	535.8	58.1	593.9	313.5	58.1	371.5	261.1	58.1	319.2
69.0	544.6	65.6	610.2	320.1	65.6	385.7	268.0	65.6	333.6
70.0	555.1	65.6	620.7	328.9	65.6	394.5	277.3	65.6	342.9
71.0	567.4	65.6	633.0	339.9	65.6	405.5	286.7	65.6	352.3
72.0	579.7	65.6	645.3	350.8	65.6	416.4	296.2	65.6	361.8
73.0	592.0	65.6	657.6	361.7	65.6	427.3	305.7	65.6	371.3
74.0	604.3	65.6	669.9	372.7	65.6	438.3	315.2	65.6	380.8
75.0	616.6	65.6	682.2	383.6	65.6	449.2	324.8	65.6	390.4
76.0	628.9	64.7	693.6	394.5	64.7	459.2	334.5	64.7	399.1
77.0	641.2	62.3	703.5	405.5	62.3	467.8	344.2	62.3	406.5
78.0	653.5	60.0	713.4	416.4	60.0	476.4	353.9	60.0	413.9
79.0	665.8	57.6	723.4	427.3	57.6	484.9	363.7	57.6	421.3
80.0	677.6	57.6	735.2	437.6	57.6	495.2	372.9	57.6	430.5

LOAD VERSUS SETTLEMENT CURVE
****

TOP LOAD KIP	TOP MOVEMENT IN.	TIP LOAD KIP	TIP MOVEMENT IN.
0.1623E+01	0.9879E-03	0.3534E-01	0.1000E-03
0.1625E+02	0.9881E-02	0.3534E+00	0.1000E-02
0.8196E+02	0.4997E-01	0.1767E+01	0.5000E-02
0.1558E+03	0.9838E-01	0.3534E+01	0.1000E-01
0.5066E+03	0.3781E+00	0.1499E+02	0.5000E-01
0.6229E+03	0.5286E+00	0.1821E+02	0.1000E+00
0.6772E+03	0.9882E+00	0.3453E+02	0.5000E+00
0.6879E+03	0.1500E+01	0.4518E+02	0.1000E+01
0.6999E+03	0.2513E+01	0.5721E+02	0.2000E+01



Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**PG&E Tower Bridge** **Abutments 1, 2 & RW Pile Lateral Resistance** **Class 90 PCPS Pile**	Figure I-1
	URS		

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LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

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This program is licensed to:

Madhu Thummaluru
URS Corporation

Files Used for Analysis

Path to file locations:
W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\
Name of input data file: PG&E Tower Bridge_Abutment_16 in PCPS_Fixed.lpd
Name of output file: PG&E Tower Bridge_Abutment_16 in PCPS_Fixed.lpo
Name of plot output file: PG&E Tower Bridge_Abutment_16 in PCPS_Fixed.lpp
Name of runtime file: PG&E Tower Bridge_Abutment_16 in PCPS_Fixed.lpr

---

Time and Date of Analysis

Date: June 22, 2012 Time: 16:05:37

Problem Title

PG&E Tower_Abutment 1,2 & RW_16 inch PCPS Class 140 (Mod)

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile

- Additional p-y curves computed at specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 594.00 in

Depth of ground surface below top of pile = -78.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	16.00000000	5461.3000	256.0000	3600000.
2	594.0000	16.00000000	5461.3000	256.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 11 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = -78.000 in
Distance from top of pile to bottom of layer = 78.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 78.000 in
Distance from top of pile to bottom of layer = 222.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 222.000 in
Distance from top of pile to bottom of layer = 282.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 282.000 in
Distance from top of pile to bottom of layer = 528.000 in

Layer 5 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 528.000 in
Distance from top of pile to bottom of layer = 594.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

Layer 6 is stiff clay without free water

```
Distance from top of pile to top of layer    =      594.000 in
Distance from top of pile to bottom of layer =      702.000 in

Layer  7 is stiff clay without free water
Distance from top of pile to top of layer    =      702.000 in
Distance from top of pile to bottom of layer =      762.000 in

Layer  8 is stiff clay without free water
Distance from top of pile to top of layer    =      762.000 in
Distance from top of pile to bottom of layer =      822.000 in

Layer  9 is stiff clay without free water
Distance from top of pile to top of layer    =      822.000 in
Distance from top of pile to bottom of layer =      942.000 in

Layer 10 is stiff clay without free water
Distance from top of pile to top of layer    =      942.000 in
Distance from top of pile to bottom of layer =     1002.000 in

Layer 11 is stiff clay without free water
Distance from top of pile to top of layer    =     1002.000 in
Distance from top of pile to bottom of layer =     1140.000 in


(Depth of lowest layer extends  546.00 in below pile tip)


--------------------------------------------------------------------------------
                    Effective Unit Weight of Soil vs. Depth
--------------------------------------------------------------------------------

Effective unit weight of soil with depth defined using 22 points
```

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-78.00	0.01600
2	78.00	0.01600
3	78.00	0.03912
4	222.00	0.03912
5	222.00	0.03800
6	282.00	0.03800
7	282.00	0.03620
8	528.00	0.03620
9	528.00	0.04200
10	594.00	0.04200
11	594.00	0.03620
12	702.00	0.03620
13	702.00	0.04200
14	762.00	0.04200
15	762.00	0.03620
16	822.00	0.03620
17	822.00	0.04200
18	942.00	0.04200
19	942.00	0.03910
20	1002.00	0.03910
21	1002.00	0.04200
22	1140.00	0.04200

Shear Strength of Soils

Shear strength parameters with depth defined using 22 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-78.000	2.08000	0.00	0.02000	0.0
2	78.000	2.08000	0.00	0.02000	0.0
3	78.000	6.94000	0.00	0.00700	0.0
4	222.000	6.94000	0.00	0.00700	0.0
5	222.000	5.56000	0.00	0.01000	0.0
6	282.000	5.56000	0.00	0.01000	0.0
7	282.000	11.11000	0.00	0.00700	0.0
8	528.000	11.11000	0.00	0.00700	0.0
9	528.000	0.00000	40.00	------	------
10	594.000	0.00000	40.00	------	------
11	594.000	17.36000	0.00	0.00500	0.0
12	702.000	17.36000	0.00	0.00500	0.0
13	702.000	35.42000	0.00	0.00400	0.0
14	762.000	35.42000	0.00	0.00400	0.0
15	762.000	17.36000	0.00	0.00500	0.0
16	822.000	17.36000	0.00	0.00500	0.0
17	822.000	28.47000	0.00	0.00400	0.0
18	942.000	28.47000	0.00	0.00400	0.0
19	942.000	25.00000	0.00	0.00400	0.0
20	1002.000	25.00000	0.00	0.00400	0.0
21	1002.000	45.83000	0.00	0.00200	0.0
22	1140.000	45.83000	0.00	0.00200	0.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 10

Load Case Number 1

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.100 in
Slope at pile head = 0.000 in/in
Axial load at pile head = 120000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head = 0.200 in
Slope at pile head = 0.000 in/in

```
Axial load at pile head     =      120000.000 lbs

Load Case Number  3

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.300 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  4

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.400 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  5

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.500 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  6

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.600 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  7

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.700 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  8

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.800 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number  9

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           0.900 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs

Load Case Number 10

Pile-head boundary conditions are Displacement and Slope (BC Type 5)
Deflection at pile head     =           1.000 in
Slope at pile head          =           0.000 in/in
Axial load at pile head     =      120000.000 lbs
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
5	y= 0.100000	S= 0.000	120000.	0.1000000	-639724.	11588.1558
5	y= 0.200000	S= 0.000	120000.	0.2000000	-1060139.	17354.9392
5	y= 0.300000	S= 0.000	120000.	0.3000000	-1421468.	21926.6367
5	y= 0.400000	S= 0.000	120000.	0.4000000	-1746911.	25838.3826
5	y= 0.500000	S= 0.000	120000.	0.5000000	-2049468.	29337.1746
5	y= 0.600000	S= 0.000	120000.	0.6000000	-2335058.	32539.0391
5	y= 0.700000	S= 0.000	120000.	0.7000000	-2607019.	35510.3728
5	y= 0.800000	S= 0.000	120000.	0.8000000	-2865323.	38274.6285
5	y= 0.900000	S= 0.000	120000.	0.9000000	-3115014.	40895.1975
5	y= 1.000000	S= 0.000	120000.	1.0000000	-3358385.	43402.2980

Pile-head Deflection vs. Pile Length

Boundary Condition Type 5, Deflection and Slope

Deflection = 0.10000 in
Slope = 0.00000
Axial Load = 120000. lbs

Pile Length in	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
594.000	0.10000000	-639724.09633	11588.15579
564.300	0.10000000	-650559.49496	11849.83652
534.600	0.10000000	-647365.13790	11767.62733
504.900	0.10000000	-645476.60101	11720.54616
475.200	0.10000000	-645209.29427	11712.57142
445.500	0.10000000	-646578.58203	11743.64661
415.800	0.10000000	-649342.61942	11810.82644
386.100	0.10000000	-643437.93128	11665.98689
356.400	0.10000000	-650408.04621	11833.87130
326.700	0.10000000	-650070.98809	11824.76116

The analysis ended normally.

==========

LPILE Plus for Windows, Version 5.0 (5.0.47)

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method

(c) 1985-2010 by Ensoft, Inc.
All Rights Reserved

==========

This program is licensed to:

Madhu Thummaluru
URS Corporation

Files Used for Analysis

Path to file locations:
W:\101BdwyPSE_28645286\450_Geotech\Analysis\Pile\Lateral\
Name of input data file: PG&E Tower Bridge_Abutment_16 in PCPS_Free.lpd
Name of output file: PG&E Tower Bridge_Abutment_16 in PCPS_Free.lpo
Name of plot output file: PG&E Tower Bridge_Abutment_16 in PCPS_Free.lpp
Name of runtime file: PG&E Tower Bridge_Abutment_16 in PCPS_Free.lpr

---

Time and Date of Analysis

Date: June 22, 2012 Time: 16:10:17

Problem Title

PG&E Tower_Abutment 1 & RW_16 inch PCPS Class 140 (Mod)

Program Options

Units Used in Computations - US Customary Units: Inches, Pounds

Basic Program Options:

Analysis Type 1:
- Computation of Lateral Pile Response Using User-specified Constant EI

Computation Options:
- Only internally-generated p-y curves used in analysis
- Analysis does not use p-y multipliers (individual pile or shaft action only)
- Analysis assumes no shear resistance at pile tip
- Analysis includes automatic computation of pile-top deflection vs. pile embedment length
- No computation of foundation stiffness matrix elements
- Output pile response for full length of pile
- Analysis assumes no soil movements acting on pile

- Additional p-y curves computed at specified depths

Solution Control Parameters:
- Number of pile increments = 100
- Maximum number of iterations allowed = 100
- Deflection tolerance for convergence = 1.0000E-05 in
- Maximum allowable deflection = 1.0000E+02 in

Printing Options:
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (spacing of output points) = 1

Pile Structural Properties and Geometry

Pile Length = 594.00 in

Depth of ground surface below top of pile = -78.00 in

Slope angle of ground surface = 0.00 deg.

Structural properties of pile defined using 2 points

Point No.	Point Depth in	Pile Diameter in	Moment of Inertia in**4	Pile Area Sq.in	Modulus of Elasticity lbs/Sq.in
1	0.0000	16.00000000	5461.3000	256.0000	3600000.
2	594.0000	16.00000000	5461.3000	256.0000	3600000.

Soil and Rock Layering Information

The soil profile is modelled using 11 layers

Layer 1 is soft clay, p-y criteria by Matlock, 1970
Distance from top of pile to top of layer = -78.000 in
Distance from top of pile to bottom of layer = 78.000 in

Layer 2 is stiff clay without free water
Distance from top of pile to top of layer = 78.000 in
Distance from top of pile to bottom of layer = 222.000 in

Layer 3 is stiff clay without free water
Distance from top of pile to top of layer = 222.000 in
Distance from top of pile to bottom of layer = 282.000 in

Layer 4 is stiff clay without free water
Distance from top of pile to top of layer = 282.000 in
Distance from top of pile to bottom of layer = 528.000 in

Layer 5 is sand, p-y criteria by Reese et al., 1974
Distance from top of pile to top of layer = 528.000 in
Distance from top of pile to bottom of layer = 594.000 in
p-y subgrade modulus k for top of soil layer = 125.000 lbs/in**3
p-y subgrade modulus k for bottom of layer = 125.000 lbs/in**3

Layer 6 is stiff clay without free water

```
Distance from top of pile to top of layer    =      594.000 in
Distance from top of pile to bottom of layer =      702.000 in

Layer  7 is stiff clay without free water
Distance from top of pile to top of layer    =      702.000 in
Distance from top of pile to bottom of layer =      762.000 in

Layer  8 is stiff clay without free water
Distance from top of pile to top of layer    =      762.000 in
Distance from top of pile to bottom of layer =      822.000 in

Layer  9 is stiff clay without free water
Distance from top of pile to top of layer    =      822.000 in
Distance from top of pile to bottom of layer =      942.000 in

Layer 10 is stiff clay without free water
Distance from top of pile to top of layer    =      942.000 in
Distance from top of pile to bottom of layer =     1002.000 in

Layer 11 is stiff clay without free water
Distance from top of pile to top of layer    =     1002.000 in
Distance from top of pile to bottom of layer =     1140.000 in


(Depth of lowest layer extends  546.00 in below pile tip)


--------------------------------------------------------------------------------
                    Effective Unit Weight of Soil vs. Depth
--------------------------------------------------------------------------------

Effective unit weight of soil with depth defined using 22 points
```

Point No.	Depth X in	Eff. Unit Weight lbs/in**3
1	-78.00	0.01600
2	78.00	0.01600
3	78.00	0.03912
4	222.00	0.03912
5	222.00	0.03800
6	282.00	0.03800
7	282.00	0.03620
8	528.00	0.03620
9	528.00	0.04200
10	594.00	0.04200
11	594.00	0.03620
12	702.00	0.03620
13	702.00	0.04200
14	762.00	0.04200
15	762.00	0.03620
16	822.00	0.03620
17	822.00	0.04200
18	942.00	0.04200
19	942.00	0.03910
20	1002.00	0.03910
21	1002.00	0.04200
22	1140.00	0.04200

Shear Strength of Soils

Shear strength parameters with depth defined using 22 points

Point No.	Depth X in	Cohesion c lbs/in**2	Angle of Friction Deg.	E50 or k_rm	RQD %
1	-78.000	2.08000	0.00	0.02000	0.0
2	78.000	2.08000	0.00	0.02000	0.0
3	78.000	6.94000	0.00	0.00700	0.0
4	222.000	6.94000	0.00	0.00700	0.0
5	222.000	5.56000	0.00	0.01000	0.0
6	282.000	5.56000	0.00	0.01000	0.0
7	282.000	11.11000	0.00	0.00700	0.0
8	528.000	11.11000	0.00	0.00700	0.0
9	528.000	0.00000	40.00	------	------
10	594.000	0.00000	40.00	------	------
11	594.000	17.36000	0.00	0.00500	0.0
12	702.000	17.36000	0.00	0.00500	0.0
13	702.000	35.42000	0.00	0.00400	0.0
14	762.000	35.42000	0.00	0.00400	0.0
15	762.000	17.36000	0.00	0.00500	0.0
16	822.000	17.36000	0.00	0.00500	0.0
17	822.000	28.47000	0.00	0.00400	0.0
18	942.000	28.47000	0.00	0.00400	0.0
19	942.000	25.00000	0.00	0.00400	0.0
20	1002.000	25.00000	0.00	0.00400	0.0
21	1002.000	45.83000	0.00	0.00200	0.0
22	1140.000	45.83000	0.00	0.00200	0.0

Notes:

(1) Cohesion = uniaxial compressive strength for rock materials.
(2) Values of E50 are reported for clay strata.
(3) Default values will be generated for E50 when input values are 0.
(4) RQD and k_rm are reported only for weak rock strata.

Loading Type

Static loading criteria was used for computation of p-y curves.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 10

Load Case Number 1

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.100 in
Bending moment at pile head = 0.000 in-lbs
Axial load at pile head = 120000.000 lbs

Load Case Number 2

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head = 0.200 in
Bending moment at pile head = 0.000 in-lbs

```
Axial load at pile head     =      120000.000 lbs

Load Case Number  3

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.300 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  4

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.400 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  5

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.500 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  6

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.600 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  7

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.700 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  8

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.800 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number  9

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           0.900 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs

Load Case Number 10

Pile-head boundary conditions are Displacement and Moment (BC Type 4)
Deflection at pile head     =           1.000 in
Bending moment at pile head =           0.000 in-lbs
Axial load at pile head     =      120000.000 lbs
```

Summary of Pile Response(s)

Definition of Symbols for Pile-Head Loading Conditions:

Type 1 = Shear and Moment, y = pile-head displacment in
Type 2 = Shear and Slope, M = Pile-head Moment lbs-in
Type 3 = Shear and Rot. Stiffness, V = Pile-head Shear Force lbs
Type 4 = Deflection and Moment, S = Pile-head Slope, radians
Type 5 = Deflection and Slope, R = Rot. Stiffness of Pile-head in-lbs/rad

Load Type	Pile-Head Condition 1	Pile-Head Condition 2	Axial Load lbs	Pile-Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
4	y= 0.100000	M= 0.000	120000.	0.1000000	251205.	4983.0252
4	y= 0.200000	M= 0.000	120000.	0.2000000	421357.	7414.2009
4	y= 0.300000	M= 0.000	120000.	0.3000000	567237.	9347.1338
4	y= 0.400000	M= 0.000	120000.	0.4000000	699044.	11004.4749
4	y= 0.500000	M= 0.000	120000.	0.5000000	819997.	12479.3242
4	y= 0.600000	M= 0.000	120000.	0.6000000	932870.	13820.0190
4	y= 0.700000	M= 0.000	120000.	0.7000000	1043165.	15077.8270
4	y= 0.800000	M= 0.000	120000.	0.8000000	1145088.	16234.4067
4	y= 0.900000	M= 0.000	120000.	0.9000000	1245658.	17351.2280
4	y= 1.000000	M= 0.000	120000.	1.0000000	1341610.	18390.1995

Pile-head Deflection vs. Pile Length

Boundary Condition Type 4, Deflection and Moment

Deflection = 0.10000 in
Moment = 0. in-lbs
Axial Load = 120000. lbs

Pile Length in	Pile Head Deflection in	Maximum Moment in-lbs	Maximum Shear lbs
594.000	0.10000000	251205.13311	4983.02518
564.300	0.10000000	257078.63875	5085.66173
534.600	0.10000000	255193.07653	5051.15277
504.900	0.10000000	254272.03616	5034.23307
475.200	0.10000000	253865.60936	5029.50351
445.500	0.10000000	254359.98282	5041.33004
415.800	0.10000000	255980.28397	5068.50609
386.100	0.10000000	252670.75847	5011.58519
356.400	0.10000000	256519.90377	5077.02982
326.700	0.10000000	256214.49054	5073.10225

The analysis ended normally.

Office of Special Funded Projects
Comment & Response Form

General Project Information	Review Phase		Reviewer Information
Dist: 04 EA: 2358411 **Project Name: US101/Broadway IC** **OSFP Liaison: Paul Cotter** **Phone: 916-227-5671** **e-mail: Paul Cotter/HQ/Caltrans/CAGov@DOT**	☐ PSR/PDS (Review No. _) ☐ APS/PSR (Review No. _) ☐ APS/PR (Review No. _) ☐ Type Selection	☐ 65% PS&E Unchecked Details ☐ PS&E (Review No. _) ☐ Construction Support ☒ Other: 100% PS&E	**Reviewer Name: Eduardo Ortega (Geotech)** **Caroline Chen (Geotech)** **Hossain Salimi (Seismic)** **Ron Karpowicz (Geology)** **Functional Unit: Geotechnical** **Cost Center: 327** **Phone Number: 510-286-4821** **e-mail: Eduardo_Ortega@dot.ca.gov** **Date of Review: 2/12/13**
	Structure Information (Use when necessary to document comments by individual structure) **Structure Name: FR Broadway OC (Replace)** **Br No: 35-0351** **FR SB US 101 On-Ramp Br No: 35-0352K** **FR Retaining Wall Nos. 15, 38, 39, 205, 209, 314, 315 and 316**		

Consultant Information (to be filled in by Consultant)

Consultant Structure Lead (First and Last Name)	Structure Consultant Firm	Phone Number	e-mail	Response Date

#	Doc. (See Note 1)	Page, Section, or SSP	Review Comments	Consultant Responses	✓
1	FR Ret. Walls		Prior to construction, the MSE retaining wall designer shall submit his calculations in order to review and approve that the design meets all requirements for internal retaining wall stability.	Will incorporate the language in the project Special Standard Provisions.	
2	Broadway OC (35-0351)		Broadway OC (35-0351): 1. Nominal resistance (compression) shown on Table 10-5 is not consistent with those presented on Tables 10-3 and 10-4 for Abutments and Abutment 3 RWs. 2. Table 10-5: For Abut 1, piles at specified tip elevation is very likely not to have nominal resistance (compression)	1. Have revised the nominal resistance (compression) values on Table 10-5 to be consistent with Tables 10-3 and 10-4. 2. Have updated nominal driving resistance to be consistent with nominal resistance (compression) of 240 kips.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓ = Comment Resolved (for Reviewer's use)

			of 280 kips. 3. Tables 10-3 and 10-4: Please remove the column showing Nominal Driving Resistance. 4. For CDSM zone: what are the recommendations about the limit of the recommended improving zone, spacing of grid, and depth of CDSM?	3. The format of Table 10-3 and 10-4 are consistent with Memo to Designers (MTD) 3-1 (July 2008). Will keep the column showing Nominal Driving Resistance per MTD 3-1. 4. Have included Figure 9C to present the limit of the recommended CDSM zone, spacing of grid and depth of CDSM.	
3	SB US 101 On-Ramp (35-0352K)		SB US 101 On-Ramp (35-0352K) 1. Nominal resistance (compression) shown on Table 10-5 is not consistent with those presented on Table 10-3 for Abutment 1. 2. Tables 10-3 and 10-4: Please remove the column showing Nominal Driving Resistance. 3. Table 10-5: Please round the nominal resistance (tension) up to the nearest 10 kips. 4. For CDSM zone: what are the recommendations about the limit of the recommended improving zone, spacing of grid, and depth of CDSM?	1. Have revised the nominal resistance (compression) values on Table 10-5 to be consistent with Tables 10-3 and 10-4. 2. Have updated nominal driving resistance to be consistent with nominal resistance (compression) of 240 kips. 3. The format of Table 10-3 and 10-4 are consistent with Memo to Designers (MTD) 3-1 (July 2008). Will keep the column showing Nominal Driving Resistance per MTD 3-1. 4. Have included Figure 9B to present the limit of the recommended CDSM zone, spacing of grid and depth of CDSM.	
4	FR Broadway OC Replace FR US 101 On Ramp FR Retaining Walls-Dated Nov 2012.		Our previous comments on the June 2012 submittal have been addressed satisfactorily.	Noted.	

Note 1: Abbreviations for Typical Documents (if Abbr. is not below, type in the document type)					
P=Structure Plans	SP=Special Provisions	FR=Foundation Rpt	DC=Design Calcs	TS=Type Sel. Report	QCC=Quant. Check Calcs
RP=Road Plans	E=Estimate	H=Hydraulics Rpt	CC=Check Calcs	QC=Quant. Calcs	

✓= Comment Resolved (for Reviewer's use)

Review Discipline:	Caltrans Geotechnical	By:	
Comments Due By:		**Date:**	September 6, 2012
Date Reviewed By:		**Next Meeting Date:**	

TECHNICAL COMMENT REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: Foundation Reports Structure Name: SB US 101 On-Ramp, Bridge No. 35-0352K Reports Updated: June 2012

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

AGCY	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
Caltrans Comment and Response Form									
General									
Caltrans -osfp geotech	Eduardo ortega	1		We have reviewed URS: Foundation Report Broadway Overcrossing (Bridge No. 35-0351) dated June 22, 2012. Foundation Report Southbound US 101 on-ramp (Bridge No. 35-0352K) dated June 25, 2012. Foundation Report Retaining Walls Nos. 15, 38, 39, 205, 209, 314, 315 and 316.	No comment.				
SB US 101 On-Ramp									
		2		Section 4.2 states rotary wash drilling was used to advance the borings. But LOTBs shows auger drilling.	LOTBs have been revised.				
		3		Section 5.2.1: Borings by Caltrans conducted in 1970 were referenced in this section. Please include these as-built borings in the LOTB sheets.	As-built LOTB sheet from 1970 investigation of the existing southbound loop ramp has been included. However, boring logs from the 2002 investigations are not included because the borings are approximately 200 feet east of the SB US 101 On-Ramp bridge.				

Review Discipline:	Caltrans Geotechnical	By:	
Comments Due By:		**Date:**	September 6, 2012
Date Reviewed By:		**Next Meeting Date:**	

TECHNICAL COMMENT REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: Foundation Reports Structure Name: SB US 101 On-Ramp, Bridge No. 35-0352K Reports Updated: June 2012

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

AGCY	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
		4		Section 10.2.1: • Table 10-2 has two columns both read Total Load Per Support under Service Limit State. Please correct the mistake. Please remove minus sign associated with the tension loads. • Please present foundation recommendations showing Required Factored Nominal Resistance and resistance factors used for each applicable limit state, and the design tips and specified tip elevations for each controlling case. Please refer to Memo To Designer 3-1 for details. • What is the estimated settlement under service load? • Piles may not be able to achieve the required capacity when driven to the specified tip elevation. If this happens during pile installation, piles should be allowed to set up for certain time and then re-struck.Please include appropriate statement accordingly.	Table revised. Table of foundation recommendations has been added. Estimated settlement at both abutments under service load is 0.1 inch. The discussion about pile set up and restrikes has been included in Section 10.3.				
		5		Section 10.4, CDSM: Please specify horizontal extent of CDSM. Plans should show the extent of CDSM.	Figure 9 presents the aerial extent of CDSM.				
		6		Please include soil profiles showing soil parameters used in the analyses.	Figure 7 has been added to show the soil profile and soil parameters used in the analyses.				

US101/BROADWAY INTERCHANGE RECONSTRUCTION PROJECT

PS&E Phase

Foundation Report

Retaining Wall Nos. 15, 38, 39, 205, 209, 314, 315 and 316

November 16, 2012

THE CITY OF BURLINGAME

TA SAN MATEO COUNTY Transportation Authority

Caltrans

URS

November 16, 2012
URS Project 28645286

File No 04-SM-101-PM 16.3/17.1
EA 04-235844

Mr. Jim McKim
Project Manager
San Mateo County Transportation Authority
1250 San Carlos Avenue
San Carlos, CA 94070-1306

Subject: **Foundation Report**
Retaining Wall Nos. 15, 38, 39, 205, 209, 314, 315 and 316
US101/Broadway Interchange Project
Burlingame, California

Dear Mr. McKim:

URS has completed a geotechnical investigation for retaining walls as part of the US101/Broadway Interchange Project in Burlingame, California. The accompanying report presents our engineering opinions and recommendations regarding the geotechnical factors influencing the design and construction of the proposed retaining walls. The opinions and recommendations have been based upon the results of our field investigation, laboratory testing, engineering judgment and local experience. Mr. Madhu Thummaluru, Senior Staff Engineer, Mr. Allen Moore, Project Geotechnical Engineer, and Ms. Anne-Marie Moore, Geotechnical Engineer, assisted in the preparation of this report. Mr. Michael Larson, Senior Geotechnical Project Manager, provided peer review.

If any questions should arise, or if we can be of any further service, please contact the undersigned at (408) 297-9585.

Sincerely,

REGISTERED PROFESSIONAL ENGINEER
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The US101/Broadway Interchange Project will require construction of two bridge structures, eight retaining walls, and extension of one double barrel box culvert. New overhead sign structures are also planned.

Retaining walls are the subject of this Foundation Report. The planned retaining wall locations are shown in Table 1-1 below:

Table 1-1: Retaining Wall Stationing and Lengths

Retaining Wall No.	Approximate Beginning Station	Approximate Length* (feet)
15	'BWY' Line Sta. 15+46.28	134
38	'BYSH' Line Sta. 38+24.49	97
39	'BYSH' Line Sta. 39+20.98	92
205	'B2' Line Sta. 208+16.00	727
209	'B2' Line Sta. 208+85 .00	480
314	'B3' Line Sta. 314+61.60	46
315	'B3' Line Sta. 316+17 .29	130
316	'B3' Line Sta. 316+17.29	138

*Length measured along retaining wall layout line

Figure 1 shows the US101/Broadway Interchange Project location, and Figures 2a and 2b show the locations of subsurface explorations for the current and previous studies, as well as locations of the eight retaining walls.

The scope of this study was to characterize the subsurface conditions using exploratory borings and cone penetration tests (CPTs), perform laboratory testing and engineering analyses, and provide conclusions and recommendations for the geotechnical design of retaining walls. The recommendations and opinions presented in this report are based on the results of the site specific subsurface investigation, review of available information, as well as engineering judgment and experience.

We developed opinions, recommendations, and other design criteria for the following geotechnical aspects of the project:

- MSE wall geotechnical design parameters, stability, bearing capacity and drainage;
- Modified Standard Plan Type 5 wall geotechnical design parameters, stability, and bearing capacity;
- Site geology, seismicity and geologic hazards;
- Seismic design criteria;
- Potential for post-liquefaction and consolidation settlements of subsurface materials; and
- Construction considerations.

This report includes our observations of the site conditions, a summary of the subsurface conditions at the field exploration locations, and geotechnical laboratory test results. As part of the project, a soil corrosion study was made by our subconsultant, V&A Consulting Engineers (V&A).

2.1 GENERAL

The proposed project will replace the existing Broadway Overcrossing with a wider structure, and reconfigure all northbound and southbound ramp connections to US101. The total length of the project is 0.75 mile. The purpose of the project is to reduce congestion, enhance safety, and improve performance of the interchange. It is also intended to relieve the weaving problems at the interchange by eliminating the collector-distributor roads and thus improving the traffic safety and operations. In addition to the new overcrossing bridge, a new pile supported bridge will be constructed along a portion of the on-ramp to southbound US101 adjacent to the existing PG&E transmission towers to reduce the potential for settlement of the towers due to new fill loads.

The pedestrian overcrossing located approximately 50 feet south of the existing Broadway Overcrossing will remain. A total of eight retaining walls are planned at different locations to minimize the right-of-way impacts to existing business properties and to support the ramp approaches and roadway embankments. The existing 6 foot by 6 foot double barrel box culvert at Easton Creek on the east side of northbound US101 will be extended by approximately 50 feet to accommodate the construction of the new northbound US101 on-ramps. The new interchange will be constructed in several stages in order to keep traffic flowing.

Because the potential for excessive settlement of the underlying mapped Bay Mud was identified as a major geotechnical and construction concern during the preliminary planning stages of the project, the decision was made to use MSE construction for the tallest retaining walls, all located west of US101. Cement Deep Soil Mixing (CDSM) ground improvement to depths of 25 and 50 feet is currently proposed to reduce the magnitude of long-term settlement to tolerable levels. For shorter walls RW 38 and 39, a modified Standard Plan Type 5 wall is proposed; the modification is primarily based on seismic coefficient for earth pressure greater than the Standard Plan seismic coefficient of 0.2.

This report pertains to retaining walls associated with the US101/Broadway Interchange Project in Burlingame, California. The project alignment, including the locations of the proposed retaining walls, are shown on the Retaining Wall Plan (RWP) Sheets 1 through 10, included in Appendix A. Recommendations for the proposed two bridges, the box culvert extension, and several overhead sign structures are presented in accompanying reports.

All project elevations reference NAVD88; exploration stationing is based on NAD83.

2.2 RETAINING WALL NO. 15

Retaining Wall No. 15 (RW15) will retain approach fill on the south side of the western abutment for the Broadway Overcrossing (replace) structure (see RWP Sheet 2). This MSE wall will also be located in close proximity to existing PG&E transmission towers. The wall is to be located between ‘BWY’ Line Stations 15+46 and 16+78 for a total length about 134 feet. The design height of this wall ranges from about 19 to 24 feet. Bottom of leveling pad for this MSE wall is at Elevation 6.97 feet. This wall will have level backfill and level ground surface at the toe.

2.3 RETAINING WALL NOS. 205 AND 209

Retaining Wall Nos. 205 and 209 (RW205 and RW209) are to be located along the west and east sides of the southbound US101 off-ramp at the proposed Broadway Overcrossing (replace), respectively (see RWP Sheets 5 to 7). These walls will retain new fills and pavement associated with the off-ramp as it ties into new bridge approach fills.

RW205 will be located along the western side of the off-ramp embankment between 'B2' Line Station 208+16 and 'BWY' Line Station 15+01 for a total length about 727 feet. The design height of this wall ranges from about 9 to 27 feet. Bottom of leveling pad for this MSE wall varies from Elevation 4.41 feet to 6.91 feet. This wall will have level backfill for the portion of the wall parallel to southbound US101; the remainder of the wall will retain sloping backfill no steeper than 2:1 (horizontal:vertical). The ground surface at the toe of the wall is expected to be relatively flat.

Three existing buildings are located within about 30 feet laterally of the RW205 layout line, with the nearest building, having concrete masonry unit construction, located approximately 8 feet from the layout line.

RW209 will be located along the eastern side of the off-ramp embankment between 'B2' Line Station 208+85 and 'B2' Line Station 213+65 for a total length about 480 feet. The design height of this wall ranges from about 12 to 27 feet. Bottom of leveling pad for this MSE wall is at Elevation 8.06 feet. This wall will have level backfill and level ground surface at the toe.

2.4 RETAINING WALL NO. 314

Retaining Wall No. 314 (RW314) will retain new fills for the on-ramp to southbound US101 between the proposed Broadway Overcrossing and proposed new bridge structure adjacent to the PG&E transmission towers (see RWP Sheet 8). This wall will be located between 'B3' Line Stations 314+62 to 315+07 for a total length about 46 feet. The design height of this wall is about 27 feet. Bottom of leveling pad is expected to be at Elevation 8.55 feet. This wall will have level backfill and level ground surface at the toe.

2.5 RETAINING WALL NOS. 315 AND 316

Retaining Wall Nos. 315 and 316 (RW315 and RW316) are to be located along the east and west sides of the southbound US101 on-ramp at the proposed Broadway Overcrossing, respectively (see RWP Sheets 9 and 10). These walls will retain new fills and pavement associated with the on-ramp as it ties into the Broadway Overcrossing approach fills.

RW315 will be located along the eastern side of the on-ramp embankment between 'B3' Line Station 316+17 and 'B3' Line Station 317+48 for a total length about 130 feet. The design height of this wall ranges from about 7 to 17 feet. Bottom of leveling pad for this MSE wall is at Elevation 8.81 feet. This wall will have level backfill and level ground surface at the toe.

RW316 will be located along the western side of the on-ramp embankment between 'B3' Line Station 316+17 and 'B3' Line Station 317+55 for a total length about 138 feet. The design height of this wall ranges from 7 to 17 feet. Bottom of leveling pad for this MSE wall is at Elevation 8.38 feet. This wall will have level backfill and level ground surface at the toe.

2.6 RETAINING WALL NOS. 38 AND 39

Retaining Wall Nos. 38 and 39 (RW 38 and RW 39) are to be located along the northeast edge of Bayshore Highway (see RWP Sheets 3 and 4). These walls will retain new fills and pavement associated with the embankment along Bayshore Highway as it ties into the Broadway Overcrossing approach fills.

RW 38 is to be located between 'BYSH' Line Station 38+24 and 'BYSH' Line Station 39+21 for a total length about 97 feet. The design height of this wall ranges from about 6 to 8 feet. Bottom of the proposed modified Type 5 wall is at Elevation 7.57 feet. This wall will have level backfill and relatively level ground surface at the toe.

RW 39 is to be located between 'BYSH' Line Station 39+21 and 'BYSH' Line Station 40+13 for a total length about 92 feet. The design height of this wall ranges from 10 to 12 feet. Bottom of the proposed modified Type 5 wall is at Elevation 6.4 feet. This wall will have level backfill and relatively level ground surface at the toe.

Pertinent project information provided by Caltrans includes the following:

- As-built structural plans for the existing Broadway Overcrossing (Bridge No. 35-0096) dated 1949 and as-built plans for the Broadway Overcrossing Widen dated 1970/1971. The latter project included a Log of Test Boring Sheet for Borings B-1, B-2 and B-3.
- As-built Log of Test Boring Sheets and layout plan for the Broadway Pedestrian Overcrossing and overhead sign structures dated 2002; this plan set included the log of Boring 02-OS-79.

As-built LOTBs from these studies are included in Appendix B

4.1 GENERAL

Prior to the start of drilling, boring and CPT locations were checked for conflict with underground utilities by contacting Underground Service Alert (USA) Network and a private utility locator. URS obtained drilling permits from the San Mateo County Department of Environmental Health. All explorations were backfilled with cement grout as required.

The locations of the borings and CPTs advanced during this study are shown on Figures 2a and 2b.

4.2 EXPLORATORY BORINGS

Truck-mounted rotary wash drilling equipment was used to advance the borings. Borings for this study were advanced between September 27 and October 18, 2011; boring depths ranged from 51.5 to 101.5 feet. Samples of the soil encountered in the exploratory borings were collected with a modified California sampler (1.96-inch inside diameter), a standard split spoon sampler (1.38-inch inside diameter) or thin walled Shelby tube (2.97-inch inside diameter). The split spoon and modified California samplers were driven 18 inches into the soil with a 140-pound hammer free falling 30 inches, with blow counts being recorded for the last 12 inches of driving. When very dense or hard materials were encountered and the blow count exceeded 50 blows per 6 inches, refusal criteria were met. The amount of penetration was recorded along with the blow count. Shelby tubes were hydraulically pushed into the soil; the pressure required to push the sampler 30 inches was recorded on the boring log.

After the sampler was advanced to the desired depth, it was withdrawn from the borehole. The exposed soil was examined, classified, and the brass liners containing the samples were sealed to preserve the natural moisture. The samples were taken to our geotechnical laboratory for further examination and testing.

A representative of URS observed the drilling operations and soil sampling. Visual classifications of the soils encountered were made from cuttings and soil samples. The soil samples collected from the borings were sealed and labeled immediately to preserve their natural moisture content.

The subsurface conditions encountered in the exploratory borings are shown on the Log of Test Borings (LOTBs) in Appendix B. The logging method adopted is consistent with Caltrans Soil & Rock Logging, Classification, and Presentation Manual (Field Guide), 2010.

4.3 LABORATORY TESTING

Soil classifications made in the field were verified in the laboratory after further examination and testing. Laboratory tests were performed on selected soil samples. These tests include grain size distribution and unconfined compressive strength. The results of these tests are presented at the corresponding sample locations on the LOTBs included in Appendix B and are summarized in Appendix C.

Plasticity index (PI), water content, and dry unit weight were determined for selected samples from the borings; the results of these tests are presented in Appendix C. One-dimensional consolidation and unconsolidated undrained triaxial compression tests were performed on

relatively undisturbed samples retrieved in our exploratory borings. The results of these tests are also presented graphically in Appendix C.

4.4 CONE PENETRATION TEST (CPT) EXPLORATION

CPT exploration consists of pushing a cone-tipped probe into the soil while simultaneously recording the cone tip resistance and side friction resistance to penetration. The CPTs completed for this report were conducted on September 28 and October 18, 2011, in general accordance with ASTM specifications (ASTM D3441-98) using an electric cone penetrometer. CPT depths ranged from 80 to 100 feet.

The CPT equipment consists of a cone assembly mounted at the end of a series of hollow rods. A set of hydraulic rams is used to push the cone and rods into the soil while a continuous record of cone and friction resistance versus depth is obtained in both analog and digital form at the ground surface. A specially designed all-wheel drive truck is used to transport and house the test equipment and to provide a 20-ton reaction to the thrust of the hydraulic rams.

The cone penetrometer assembly consists of a conical tip and a cylindrical friction sleeve. The conical tip has a 60-degree apex angle and a projected cross-sectional area of 2.3 in^2. The cylindrical friction sleeve has a surface area of 35 in^2. Both the conical tip and cylindrical friction sleeve have outer diameters of 1.75 inches. The interior of the cone penetrometer is instrumented with strain gauges that allow simultaneous measurement of cone tip and friction sleeve resistance during penetration. Continuous electric signals from the strain gauges are transmitted by a cable in the rods to analog and digital data recorders in the CPT truck.

Data obtained during a CPT consists of continuous stratigraphic information with close vertical resolution. Stratigraphic interpretation is based on relationships between cone tip resistance and friction resistance. The calculated friction ratio (CPT friction sleeve resistance divided by cone tip resistance) is used as an indicator of soil type. Granular soils typically have low friction ratios and high cone resistance, while cohesive or organic soils have high friction ratios and low cone resistance. These stratigraphic material categories form the basis for all subsequent calculations that utilize the CPT data. Soil interpretations presented on the CPT logs from this investigation were based on correlations developed by Robertson, 1990. CPT logs are presented on the LOTBs in Appendix B.

4.5 PORE PRESSURE DISSIPATION AND SHEAR WAVE VELOCITY TEST RESULTS FROM CPTS

Pore pressure dissipation tests were performed at each CPT location to provide an estimate of the groundwater depth. Shear wave velocity tests were also performed at selected depths at two of the CPT locations. The results of the pore pressure dissipation tests are presented on the LOTBs included in Appendix B and are summarized on figures included in Appendix D. The results of shear wave velocity tests are shown graphically at the corresponding average test depths in Appendix D.

5.1 SITE CONDITIONS

RW15 will support approach fills for the proposed Broadway Overcrossing replace on the west side of US101. Based on topographic information provided, the existing ground surface in the vicinity of RW15 ranges from approximately Elevation 9 to 11 feet. Three PG&E transmission towers are located just south of the proposed retaining wall within the loop connecting the existing Broadway Overcrossing to the southbound US101 on-ramp.

5.2 SUBSURFACE CONDITIONS

5.2.1 Field Exploration

Subsurface data collected for design of the Broadway Overcrossing Widen circa 1970 included three borings, B-1, B-2, and B-3, which extended to depths ranging from approximately 20 to 90 feet below ground surface (bgs). The as-built LOTB sheet prepared for the 1970 subsurface investigation is included in Appendix B.

Recent subsurface investigation along the proposed RW15 layout line included one rotary wash boring, Boring R-11-015, drilled on October 3, 2011; this boring extended to a depth of 81.5 feet. Borings R-11-010 and R-11-017, and CPT-11-016 were also advanced in the vicinity of RW15; these explorations were made for design of the overcrossing structure and other nearby project retaining walls between September 28 and October 4, 2011, and extended to depths ranging from 51.5 to 101.5 feet bgs.

5.2.2 Soil Conditions

5.2.2.1 Fill

Borings B-1, B-2, and B-3 from the 1970 investigation reportedly encountered 5 to 7 feet of fill consisting of very loose to slightly compact silty sand and sandy silt, and very soft sandy clay.

Boring R-11-015 encountered silty sand with gravel fill to a depth of 4 feet (Elevation 6.5 feet). Boring R-11-017 encountered silty clay fill to a depth of about 4 feet (Elevation 7 feet). Boring R-11-010, advanced approximately 100 feet from the proposed layout line, encountered an approximately 3½-foot-thick pavement section underlain by medium dense silty sand/sandy silt with gravel fill to a depth of about 8 feet bgs (Elevation 3.5 feet)

The consistency and make up of the fill were not evaluated at CPT-11-016 since the upper 8 feet of the exploration was hand augered to minimize the potential of damaging existing utilities.

5.2.2.2 Native Soils

Very soft and highly compressible organic fat clay, known locally as Bay Mud, was encountered below the fill in Boring R-11-015 to a depth of about 12 feet bgs (Elevation -1.5 feet). The Bay Mud is immediately underlain by stiff lean clay to a depth of about 16 feet and loose clayey sand and sandy silt to a depth of about 21 feet. Below the loose granular soils, the boring encountered medium stiff lean clay to a depth of about 26 feet, underlain by medium dense poorly graded

sand to a depth of 27 feet. Stiff fat clay was encountered below the sand to a depth of about 39 feet, underlain by medium dense silty and clayey sand with gravel and silty gravel to a depth of about 44 feet bgs. Below a depth of about 44 feet, the soil profile remains interbedded, consisting of alternating layers of medium dense to dense silty, clayey and poorly graded sand, very dense clayey gravel and medium stiff to very stiff lean and fat clay to the bottom of the boring at 81.5 feet bgs (Elevation -71 feet).

The record for CPT-11-016 suggests a predominantly fine-grained soil profile with Bay Mud likely extending to a depth of about 14 feet (Elevation -3 feet) and soft highly compressible fat clay between depths of about 23 to 28 feet (Elevation -12 to -17 feet). The CPT record also suggests the presence of sand and silty sand interbeds between depths of about 15 and 23 feet and between depths of about 75 and 81 feet.

Bay Mud was encountered in Boring R-11-017 at depths of about 4 to 13 feet (Elevation 7 to -2 feet) and in Boring R-11-010 at depths of about 8 to 16.5 feet (Elevation 3.5 to -5 feet). Below the Bay Mud, both of these borings encountered predominantly medium stiff to very stiff lean clays with occasional interbeds of clayey sand and silty gravel to the maximum depths explored at each location.

The borings drilled in 1970 indicate that the thickness of the Bay Mud is about 9 to 10 feet and consists of soft to very soft, dark gray to black organic clay with peat layers and occasional shells and thin sand interbeds. Alluvium underlying the Bay Mud consisted of complexly interbedded medium dense to dense silty to clayey sand and silt and soft to very stiff lean clay. Fine to medium gravel interbeds were also common throughout the alluvium.

5.2.3 Groundwater

Free groundwater was first encountered at a depth of 12.5 feet (Elevation -2 feet) in Boring R-11-015 and at depths of 14.5 feet (Elevation -3.5 feet) in Boring R-11-017 and 12.5 feet (Elevation -1 foot) in Boring R-11-010; a final or stabilized groundwater level reading was not taken in any of these borings.

A pore pressure dissipation test performed at CPT-11-016 suggests groundwater at a depth of about 0.5 feet (Elevation 10.5 feet). Test results are included in Appendix D.

Free groundwater was reportedly encountered in Boring B-1 from the 1970 study at a depth of about 4 feet.

In cohesive soils, as generally encountered at the site, a fairly long time would be required for the groundwater to seep into the borehole and attain an equilibrium position with the long-term hydrostatic groundwater table. Thus, the immediate readings obtained may or may not be representative of the actual groundwater table level.

Groundwater levels at the site are likely influenced by tidal fluctuations in the nearby San Francisco Bay, and by water levels in nearby Sanchez Creek and Easton Creek. In addition, seasonal fluctuations in the groundwater level should be anticipated throughout the year with variations in precipitation, evaporation, and surface runoff.

6.1 SITE CONDITIONS

RW38 and RW39 will retain fills for the raised embankment along Bay Shore Highway. Based on topographic information provided, the existing ground surface in the vicinity of these walls ranges from approximately Elevation 11.0 to 11.2 feet.

6.2 SUBSURFACE CONDITONS

6.2.1 Field Exploration

The subsurface conditions were investigated on November 8, 2011, by advancing Boring R-11-002 to a depth of 40 feet. In addition, Boring R-11-003, advanced as part of our investigations for the Broadway Overcrossing, was completed nearby to a depth of 80 feet.

6.2.2 Soil Conditions

6.2.2.1 Fill

Boring R-11-002 encountered a pavement section consisting of 12 inches of asphalt concrete over 18 inches of aggregate base. The pavement section was underlain by stiff silt to sandy silt fill to a depth of 6 feet (Elevation 4.5 feet).

Boring R-11-003 encountered sandy lean clay with gravel fill to a depth of about 3 feet (Elevation 6 feet).

6.2.2.2 Native Soils

Below the fill, soft Bay Mud extends to depths of 13 to 16 feet bgs that are underlain by loose to medium dense gravelly sand and silty sand deposits extending to depths of 29 to 34 feet. Stiff to very stiff lean to fat clays with interbedded layers of dense clayey sand and gravel extend to terminal depths of the borings. Soft to medium stiff, highly compressible organic fat clay (Bay Mud) was encountered in each of the borings below the fill to a depth of about 13 feet (Elevation -2 feet).

6.2.3 Groundwater

Free groundwater was first encountered at a depth of 6 feet (Elevation 4.5 feet) in Boring R-11-002 and at a depth of 5 feet (Elevation 4 feet) in Boring R-11-003; a final or stabilized groundwater level reading was not taken in either of these borings.

In cohesive soils, as generally encountered at the site, a fairly long time would be required for the groundwater to seep into the borehole and attain an equilibrium position with the long-term hydrostatic groundwater table. Thus, the immediate readings obtained may or may not be representative of the actual groundwater table level.

Groundwater levels at the site are likely influenced by tidal fluctuations in the nearby San Francisco Bay, and by water levels in nearby Sanchez Creek and Easton Creek. In addition,

seasonal fluctuations in the groundwater level should be anticipated throughout the year with variations in precipitation, evaporation, and surface runoff.

7.1 SITE CONDITIONS

RW205 and RW209 will support new fills for the off-ramp from southbound US101 to Broadway. Based on topographic information provided, the existing ground surface in the vicinity of RW205 is at generally between approximately Elevation 7 to 11 feet. The existing ground surface in the vicinity of RW209 is relatively flat, ranging from approximately Elevation 10.5 to 12 feet.

7.2 SUBSURFACE CONDITIONS

7.2.1 Field Exploration

Subsurface data collected for design of overhead sign structures along US101 included Boring 02-OS-79 (near RW 205 and 209), which extended to a depth of approximately 30 feet. The as-built LOTB obtained from the 2002 subsurface investigation by others is provided in Appendix B.

Recent subsurface exploration along the proposed retaining wall layout lines between September 27 and October 18, 2011, included drilling six rotary wash borings and advancing one CPT to depths ranging from 51.5 to 80 feet. The explorations included Borings R-11-005, R-11-006, R-11-007, R-11-008, R-11-010 and R-11-014, and CPT-11-009.

7.2.2 Soil Conditions

7.2.2.1 Fill

Boring 02-OS-79 reportedly encountered approximately 13 feet of loose to medium dense silty sand and medium dense clayey sand with gravel fill.

Boring R-11-005 encountered a pavement section consisting of 16 inches of asphalt concrete over 26 inches of aggregate base. The pavement section was underlain by medium dense clayey sand to a depth of 8 feet (Elevation 3 feet).

Boring R-11-006 encountered a pavement section consisting of 9 inches of asphalt concrete over 2 inches of aggregate base. The pavement section was underlain by stiff lean clay and medium dense clayey sand and gravel to a depth of about 8 feet (Elevation 2.5 feet).

Boring R-11-007 encountered fill starting at the ground surface and consisting of stiff sandy lean clay with gravel to a depth of about 6.5 feet (Elevation 3 feet).

Boring R-11-008 encountered fill starting at the ground surface and consisting of loose to medium dense silty sand, sandy silt and clayey gravel to a depth of about 9 feet (Elevation 1.5 feet).

Boring R-11-010 encountered a pavement section consisting of 6 inches of asphalt concrete over 18 inches of aggregate base and 18 inches of aggregate subbase. The pavement section was underlain by medium dense sandy silt and silty sand with gravel to a depth of about 8 feet (Elevation 3.5 feet).

The consistency and make up of the fill were not evaluated at CPT-11-009 since the upper 6 feet of the exploration was hand augered to minimize the potential of damaging existing utilities.

Boring R-11-014 encountered fill consisting of sandy silt with gravel and medium stiff lean clay with sand to a depth of about 8.5 feet (Elevation 2.5 feet).

7.2.2.2 Native Soil

Below the pavement and fill, each of the borings encountered Bay Mud to depths of approximately 14 to 17 feet bgs (Elevation -3 to -7.5 feet); the Bay Mud is generally soft to medium stiff and highly compressible. At Borings R-11-005 and R-11-006, the Bay Mud is underlain by moderately compressible, soft to medium stiff fat clay; at Boring R-11-005, this compressible layer extends to a depth of about 25 feet (Elevation -14 feet) and at Boring R-11-006, this compressible layer extends to a depth of about 16 feet (Elevation -5.5 feet). The Bay Mud in Boring R-11-014 was immediately underlain by loose silty sand to a depth of about 16 feet (Elevation -5 feet) and moderately compressible, medium stiff fat clay to a depth of about 22 feet (Elevation -11 feet).

The subsurface conditions encountered in each of the borings below the moderately to highly compressible deposits generally consist of stiff to very stiff, lean and fat clay to the terminal depths of each boring (Elevation -40.5 to -70.5 feet).

Discontinuous granular soil interbeds were encountered within these stiff clays at several of the boring locations. Dense clayey gravel was encountered in Boring R-11-005 from depths of 28 to 35 feet bgs (Elevation -17 to -25). Medium dense clayey gravel was encountered in Boring R-11-006 between depths of 32 and 36 feet (Elevation -21.5 and -25.5 feet). In Boring R-11-007, medium dense clayey sand with gravel was encountered between depths of 35 and 44 feet (Elevation -25.5 and -34.5 feet) and very dense clayey gravel was encountered between depths of about 74 and 78 feet (Elevation -64.5 and -68.5 feet). In Boring R-11-008, medium dense clayey and silty sand was encountered between depths of about 35 and 42 feet (Elevation -25.5 and -29.5 feet); in addition, dense silty sand with gravel was encountered in this boring between depths of 60 and 64 feet (Elevation -49.5 and -53.5 feet) and very dense clayey gravel with sand was encountered at the bottom of this boring from depths of 79 to 80 feet bgs (Elevation -68.5 to -69.5 feet). Finally, medium dense to dense silty gravel and clayey sand with gravel was encountered in Boring R-11-010 below a depth of 39 feet (Elevation -27.5 feet) and extending to the bottom of the boring at 51.5 feet (Elevation -40.5 feet).

The record for CPT-11-009 suggests a predominantly fine-grained soil profile to the maximum depth explored, with Bay Mud likely extending to a depth of about 14 feet (Elevation -4 feet). The CPT record also suggests the presence of a sand interbed within the Bay Mud between depths of about 9 and 11 feet, and occasional silty sand interbeds below a depth of about 45 feet.

Bay Mud was encountered in Boring R-11-014 between depths of about 8 to 14 feet (Elevation 3 to -3 feet). Below the Bay Mud, this boring encountered loose silty sand to a depth of about 16 feet, underlain by compressible fat clay to a depth of about 22 feet. Predominantly stiff to very stiff lean clays with silty gravel interbeds were encountered below the fat clay to the maximum depth of the boring.

Below the fill, Boring 02-OS-79 encountered firm to soft organic clay to a depth of about 13 feet, underlain by stiff lean clay with sand to the bottom of the boring at a depth of about 30 feet.

7.2.3 Groundwater

Free groundwater was first encountered at depths ranging from about 5 to 14.5 feet (Elevation 5.5 to -4 feet); a final or stabilized groundwater level reading was not taken in any of these borings. Free groundwater was reportedly encountered at a depth of about 16 feet in Boring 02-OS-79 (2002).

A pore pressure dissipation test performed in CPT-11-009 suggests groundwater at a depth of about 1.7 feet (Elevation 8.5 feet). Test results are included in Appendix D.

In cohesive soils, as generally encountered at the site, a fairly long time would be required for the groundwater to seep into the borehole and attain an equilibrium position with the long-term hydrostatic groundwater table. Thus, the immediate readings obtained may or may not be representative of the actual groundwater table level.

Groundwater levels at the site are likely influenced by tidal fluctuations in the nearby San Francisco Bay, and by water levels in nearby Sanchez Creek and Easton Creek. In addition, seasonal fluctuations in the groundwater level should be anticipated throughout the year with variations in precipitation, evaporation, and surface runoff.

8.1 SITE CONDITIONS

Proposed RW314 will support approach fills adjacent to and southwest of the Broadway Overcrossing. Based on topographic information provided, the existing ground surface in the vicinity of RW314 ranges from approximately Elevation 10.5 to 12 feet.

8.2 SUBSURFACE CONDITIONS

8.2.1 Field Exploration

The subsurface conditions were investigated on September 28, 2011, by advancing one truck-mounted CPT, CPT-11-016, to a depth of 100 feet. In addition, rotary wash Borings R-11-017 and R-11-014, which were drilled on October 4 and 18, 2011, as part of our investigations for the Broadway Overcrossing and PG&E viaduct structure, were completed nearby to depths of 101.5 and 100 feet bgs, respectively.

8.2.2 Soil Conditions

8.2.2.1 Fill

The consistency and make up of the fill were not evaluated at CPT-11-016 since the upper 8 feet of the exploration was hand augered to minimize the potential of damaging existing utilities.

Borings R-11-014 and R-11-017 were advanced in unpaved areas of the site. Boring R-11-014 encountered fill consisting of sandy silt with gravel and medium stiff lean clay with sand to a depth of about 8.5 feet (Elevation 2.5 feet). Boring R-11-017 encountered silty clay fill to a depth of about 4 feet (Elevation 7 feet).

8.2.2.2 Native Soil

The record for CPT-11-016 suggests a predominantly fine-grained soil profile with Bay Mud likely extending to a depth of about 14 feet (Elevation -3 feet) and soft highly compressible fat clay located between depths of about 23 and 28 feet (Elevation -12 to -17 feet). The CPT record also suggests the presence of sand and silty sand interbeds between depths of about 15 and 23 feet and between depths of about 75 and 81 feet bgs.

Soft to medium stiff, highly compressible Bay Mud was encountered in each of the borings below the fill, to a depth of 13 feet (Elevation -2 feet) in Boring R-11-017 and 14.5 feet (Elevation -3.5 feet) in Boring R-11-014. The Bay Mud in Boring R-11-014 was immediately underlain by loose silty sand to a depth of about 16 feet (Elevation -5 feet) and moderately compressible, medium stiff fat clay to a depth of about 22 feet (Elevation -11 feet).

Predominantly stiff to very stiff lean clays were encountered below the Bay Mud in Boring R-11-017 to the terminal depth of the boring at 101.5 feet (Elevation -90 feet); a dense clayey sand with gravel interbed was encountered at this boring location between depths of about 50 and 56 feet (Elevation -39 and -45 feet).

Medium stiff to very stiff lean clays were encountered below the compressible deposits in Boring R-11-014 to a depth of about 54 feet (Elevation -43 feet), underlain by interbedded stiff to very stiff silt and lean to fat clay and dense to very dense silty sand, silty gravel and clayey sand to the terminal depth of the boring at 100 feet bgs (Elevation -89 feet).

8.2.3 Groundwater

Free groundwater was first encountered at a depth of 6 feet (Elevation 5 feet) in Boring R-11-014 and at a depth of 14.5 feet (Elevation -3.5 feet) in Boring R-11-017; a final or stabilized groundwater level reading was not taken in either of these borings.

A pore pressure dissipation test performed at CPT-11-016 suggests groundwater at a depth of about 0.5 feet (Elevation 10.5 feet). Test results are included in Appendix D.

In cohesive soils, as generally encountered at the site, a fairly long time would be required for the groundwater to seep into the borehole and attain an equilibrium position with the long-term hydrostatic groundwater table. Thus, the immediate readings obtained may or may not be representative of the actual groundwater table level.

Groundwater levels at the site are likely influenced by tidal fluctuations in the nearby San Francisco Bay, and by water levels in nearby Sanchez Creek and Easton Creek. In addition, seasonal fluctuations in the groundwater level should be anticipated throughout the year with variations in precipitation, evaporation, and surface runoff.

9.1 SITE CONDITIONS

RW315 and RW316 will retain fills for the on-ramp to southbound Highway 101 from Broadway. Based on topographic information provided, the existing ground surface in the vicinity of these walls ranges from approximately Elevation 11.5 to 12.5 feet.

9.2 SUBSURFACE CONDITONS

9.2.1 Field Exploration

The subsurface conditions were investigated on September 28 and October 5, 2011, by advancing CPT-11-019 to a depth of 80 feet and Boring R-11-018 to a depth of 81.5 feet. In addition, Boring R-11-017 and CPT-11-016, advanced as part of our investigations for the Broadway Overcrossing and PG&E viaduct structure, were completed nearby to depths of 101.5 and 100 feet, respectively.

9.2.2 Soil Conditions

9.2.2.1 Fill

Boring R-11-018 encountered fill consisting of gravelly silt with cobbles and stiff gravelly lean clay to a depth of about 8 feet (Elevation 3 feet). The record for CPT-11-019 suggests fill consisting of clean to silty sand to a depth of about 7 feet (Elevation 5 feet).

Boring R-11-017 encountered silty clay fill to a depth of about 4 feet (Elevation 7 feet).

The consistency and make up of the fill were not evaluated at CPT-11-016 since the upper 8 feet of the exploration was hand augered to minimize the potential of damaging existing utilities.

9.2.2.2 Native Soils

The records for CPT-11-019 and CPT-11-016 suggest predominantly fine-grained soil profiles with Bay Mud extending to a depth of about 14 feet at each location (Elevation -2 and -3 feet). Soft highly compressible fat clays are suggested between depths of about 23 to 28 feet bgs (Elevation -12 to -17 feet) in CPT-11-016. The record for CPT-11-016 also suggests the presence of sand and silty sand interbeds between depths of about 15 and 23 feet and between depths of about 75 and 81 feet; the record for CPT-11-019 suggests a thin sand layer just below the Bay Mud and a thicker sand layer between depths of about 72 to 75 feet.

Soft to medium stiff, highly compressible organic fat clay, known locally as Bay Mud, was encountered in each of the borings below the fill to a depth of about 13 feet (Elevation -2 feet).

Stiff to very stiff lean clay was encountered below the Bay Mud in Boring R-11-018 to a depth of about 24 feet (Elevation -13 feet), underlain by medium dense to dense clayey sand with gravel and poorly graded sand with gravel to a depth of about 33 feet (Elevation -22 feet). The sand was underlain by stiff to very stiff lean and sandy lean clay to a depth of about 56 feet (Elevation -45 feet), underlain by medium dense to dense poorly graded sand with gravel and clayey sand to a depth of about 69 feet (Elevation -58 feet). Very stiff to hard lean clay was

encountered below these granular deposits to the terminal depth of the boring at 81.5 feet bgs (Elevation -70 feet).

Predominantly stiff to very stiff lean clays were encountered below the Bay Mud in Boring R-11-017 to the terminal depth of the boring at 101.5 feet (Elevation -90 feet); a dense clayey sand with gravel interbed was encountered at this boring location between depths of about 50 and 56 feet (Elevation -39 and -45 feet).

9.2.3 Groundwater

Free groundwater was first encountered at a depth of 16 feet bgs (Elevation -5 feet) in Boring R-11-018 and at a depth of 14.5 feet (Elevation -3 feet) in Boring R-11-017; a final or stabilized groundwater level reading was not taken in either of these borings.

A pore pressure dissipation test at CPT-019 suggests groundwater at a depth of about 4.7 feet bgs (Elevation 7.5 feet); a pore pressure dissipation test at CPT-11-016 suggests groundwater at a depth of about 0.5 foot (Elevation 10.5 feet). Test results are included in Appendix D

In cohesive soils, as generally encountered at the site, a fairly long time would be required for the groundwater to seep into the borehole and attain an equilibrium position with the long-term hydrostatic groundwater table. Thus, the immediate readings obtained may or may not be representative of the actual groundwater table level.

Groundwater levels at the site are likely influenced by tidal fluctuations in the nearby San Francisco Bay, and by water levels in nearby Sanchez Creek and Easton Creek. In addition, seasonal fluctuations in the groundwater level should be anticipated throughout the year with variations in precipitation, evaporation, and surface runoff.

The US101/Broadway Interchange is located on the western margin of the San Francisco Bay block within the central portion of the Coast Ranges geomorphic province of California. Northwest-southeast-trending valleys and ridges characterize the regional morphology of the Coast Ranges province. These topographic features are controlled by folds and faults that resulted from the collision of the Farallon and North American plates and subsequent predominantly strike-slip faulting along the San Andreas fault system between the Pacific and North American plates. The San Francisco Bay block is a relatively stable, seismic block bounded by the San Andreas and Hayward faults to the west and east, respectively.

The project site is located just east and northeast of the historic San Francisco bay margin. The historic tidal flats have been covered with artificial fill to create the present day topography. Artificial fill covers the majority of the project area and is mapped from about Rollins Road extending north to the edge of the bay (Witter, et al, 2006; Brabb, et al, 1998). A portion of this geologic map covering the project area prepared by Brabb is included as Figure 3. Witter (2006) shows the artificial fill as being underlain by estuarine deposits (Bay Mud). South and southwest of Rollins Road, Quaternary deposits exposed at the surface are mapped by Witter (2006) as Holocene (less than 10,000 years old) alluvial fan deposits consisting of sand, silt and clayey silt, underlain by older Pleistocene alluvial fan and fluvial deposits consisting of gravel, sand and silt. Mapping by Brabb, (1998) classifies the deposits south of Rollins Road as the Pleistocene age Colma Formation consisting of fine to medium-grained sand with silt and clay. Bedrock consisting of Franciscan Complex sandstone outcrops is mapped approximately 1 mile south of the site. The depth to bedrock at the site is unknown; however bedrock is at a depth of 270 feet at the west end of the San Mateo Bridge (Goldman, 1969) and is estimated to be in the range of 150 to 200 feet deep at the project site.

11.1 SEISMIC DESIGN METHODOLOGY

The seismic design methodology adopted for this project is based on Caltrans Seismic Design Criteria (SDC), v 1.6, November 2010.

11.2 PEAK BEDROCK ACCELERATION

The closest active fault to this section of US101 is the San Andreas fault (SAN). This fault is designated with a Maximum Magnitude (M_{Max}) of 7.9 in the Caltrans 2007 fault database. The location of this fault is based on Caltrans ARS Online (2009). The horizontal distance from the site to the San Andreas fault is about 2.5 miles.

Table 11-1: Seismic Source Parameters

Fault	Type	M_{Max}	Distance* (miles)	Near Field Effects?
San Andreas (north coast segment)	strike-slip	7.9	2.5	Y
San Gregario-Palo Colorado	strike-slip	7.2	9.5	N
Hayward (northern section)	strike-slip	7.3	16.0	N
Monte Vista-Shannon	reverse	6.7	14.0	N

*The distances are based on Caltrans ARS Online (2009).

Figure 4, Regional Fault Map, shows the location of these faults relative to the project site.

For design, a site PGA of 0.68 g was estimated using Caltrans ARS Online tool; this value of PGA corresponds to a site specific average shear wave velocity of 820 feet per second (fps).

11.3 FAULT TYPE AND NEAR-FIELD SPECTRAL ACCELERATION INCREASES

The 2007 fault database that accompanies the 2007 Caltrans Deterministic PGA Map indicates that the nearby active faults have strike-slip displacement. Therefore, in accordance with Caltrans design procedures referenced above, no increase in design spectral accelerations is required for fault type. However, since the project site is located less than 9.3 miles from the nearest active fault, the design spectral accelerations should be modified to account for near-field effects as follows:

Period (sec)	Increase in Spectral Acceleration (%)
< 0.5	0
0.5 – 1.0	0 – 20 (determined by linear interpolation)
≥1	20

Since the fundamental periods of the proposed structures are unknown at this time, the spectral accelerations have not been adjusted for the effect of fundamental period. If the fundamental period of the structure is determined to be greater than 1.5 seconds, then an adjustment should be made in accordance with Caltrans design procedures.

11.4 DESIGN ACCELERATION RESPONSE SPECTRUM

The response spectrum for the site is estimated with spectral acceleration values generated using Caltrans ARS Online (2009). This method was developed by Caltrans Geo Research Group in partnership with United States Geological Survey (USGS), Pacific Earthquake Engineering Research (PEER) and California Department of Conservation. This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in Appendix B of Caltrans SDC.

The deterministic spectrum is determined as the average of median response spectra calculated using the Campbell-Bozorgnia (2008) and Chiou-Youngs (2008) ground motion prediction equations developed under the "Next Generation Attenuation" project coordinated through the PEER-Lifelines program. These equations are applied to all faults considered to be active in the last 750,000 years (late-Quaternary age) that are capable of producing a moment magnitude earthquake of 6.0 or greater. The probabilistic spectrum is obtained from the USGS (2008) National Hazard Map for 5% probability of exceedance in 50 years. Caltrans design spectrum is based on the larger of the deterministic and probabilistic spectral values. Both the deterministic and probabilistic spectra account for soil effects through incorporation of the parameter V_{s30}, the average shear wave velocity in the upper 100 feet of the soil profile. As discussed in Section 4, shear wave velocity tests were conducted in CPT-11-012 and CPT-11-016. Based on these tests, V_{s30} was estimated to be 820 feet per second. Appendix E presents a summary of the seismic response spectra analysis results.

The input values we selected for Caltrans ARS Online included:

- V_{s30} of 820 feet per second
- Maximum Moment Magnitude (M_{Max}) 7.9 (San Andreas fault)
- No ARS increase for fault-type or long period structure
- ARS increase for near-field effects

The calculated spectra using the Caltrans ARS Online tool for both deterministic and probabilistic methods are presented as the blue curve on Figure 5. Since the average shear wave velocity at the site is less than 1,000 feet per second, Caltrans requires that the calculated spectra be determined using the USGS Deaggregation tool; this curve is plotted in red on Figure 5. In cases where the calculated spectra for the two curves (Caltrans and USGS) differ by 10 percent or more for periods of less than 0.5 second, Caltrans requires that the USGS calculated spectra be used for design.

As shown on Figure 5A, the calculated spectral value for the 0.5 second period is about 1.3g based on Caltrans ARS and just over 1.4g based on the USGS deaggregation. Therefore, in accordance with Caltrans requirements, the USGS calculated spectra should be used for design (Figure 5B).

12.1 FAULT RUPTURE

Surface fault rupture tends to recur along existing fault traces. The highest potential for surface faulting is along existing fault traces that have had Holocene fault displacement. The California Geological Survey (formerly Division of Mines and Geology) has produced maps showing Alquist-Priolo Earthquake Fault Zones along faults with known Holocene activity that pose a potential surface faulting hazard. There are no Alquist-Priolo zones mapped in the vicinity of the project site. The closest active fault to the site is the San Andreas fault, approximately 2.5 miles to the west as shown on Figure 4. The potential for surface fault rupture at the site is considered remote.

12.2 LIQUEFACTION

Soil liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. In extreme cases, the soil particles can be suspended in groundwater, resulting in the deposit becoming mobile and fluid-like. Three conditions are generally required for liquefaction to occur: 1) a cohesionless soil of loose to medium dense relative density; 2) a saturated condition; and 3) rapid, large strain cyclic loading normally induced by earthquake ground shaking. Liquefaction can result in loss of foundation bearing capacity, differential settlements, and lateral spreading. Traditionally, a depth of 50 feet has been used as the depth of analysis for the evaluation of liquefaction.

In a regional study of the nine-county San Francisco Bay region for the U.S. Geological Survey, Witter et al. (2006) mapped the liquefaction susceptibility of the site soils in the project vicinity. The artificial fill overlying the Bay Mud found at the site is mapped as having “very high” liquefaction susceptibility. The Association of Bay Area Governments (ABAG, 2004) has also published a liquefaction susceptibility map based on mapping in the USGS Open File Report 00-444 by Knudsen et al (2000). The map also shows the project site as having “very high” liquefaction susceptibility. A copy of this map is included as Figure 6.

Potentially liquefiable deposits were encountered in many of the recent borings, ranging in thickness from about 1 to 4.5 feet. We estimated post-liquefaction ground surface settlement for a peak ground acceleration (PGA) of 0.68g and design earthquake Moment Magnitude, M_{MAX}, of 7.9, correcting the measured driving resistance (blow counts) in the field for hammer type, sampler size, overburden pressure, rod length, and fines content. We assumed a groundwater table at Elevation 6 feet for our analyses. Copies of these calculations are included in Appendix F. Results are summarized in the following Table 12-1.

Table 12-1: Estimated Post-Liquefaction Ground Surface Settlement at Borings

Boring Number	Material Type (USCS)	Depth to Top of Layer (feet)	Layer Thickness (feet)	Estimated Ground Surface Settlement (inches)
R-11-002	ML	6	2	¼
R-11-002	SP-SM	31	3	¾
R-11-007	ML	44.5	1	¼
R-11-008	SM	40.5	2	¼
R-11-014	SM	14.5	1.5	½
R-11-015	ML	19	2	¾
R-11-015	SP-SM	26	1	¼

Potentially liquefiable materials appear to have been encountered in Borings B-1 and B-3 drilled for the 1970 study. Based on those boring logs, the deposits include approximately 3 to 5 feet of loose to very loose and slightly compact silty sand and sandy silt in the upper 3 to 8 feet and approximately 5 feet of slightly compact silty sand between depths of about 40 and 45 feet. Potentially liquefiable soils were also encountered in the upper 13 feet of the soil profile in Boring 02-OS-79 from the 2002 study by others; this fill reportedly consisted of loose to medium dense silty sand underlain by medium dense clayey sand. Because the hammer efficiency was not included on the as-built LOTBs, we are not able to estimate the magnitude of post-liquefaction settlement that could be expected to occur at these boring locations.

We estimated post-liquefaction settlement at three CPT locations using the computer program LIQUEFY PRO for the same PGA, design earthquake, and groundwater depth. The CPTs generally encountered thin, interbedded potentially liquefiable silt and sand layers at several depths within the soil profile. At CPT-11-009, the potentially liquefiable soils were encountered between depths of about 9 to 11 feet and between depths of about 44 to 46 feet. At CPT-11-016, the potentially liquefiable deposits were encountered between depths of about 17 to 22 feet. Copies of these calculations are included in Appendix F. Results are summarized in the following table.

Table 12-2: Estimated Post-Liquefaction Ground Surface Settlement at CPTs

CPT Number	Estimated Ground Surface Settlement (inches)
CPT-11-009	¾
CPT-11-016	½
CPT-11-019	< ¼

Based on our analysis, the estimated ground surface settlement at proposed MSE Wall Nos. 205, 209, 315 and 316 could be on the order of ¼ to ¾ inch, and the estimated ground surface settlement at proposed MSE wall Nos. 15 and 314 could be on the order of ¾ to 1 inch. For Wall Nos. 38 and 39, we estimate about 1 inch of settlement could be due to liquefaction.

12.3 SUBSIDENCE AND SEISMIC COMPACTION

Subsidence typically occurs as a result of subsurface fluid extraction (e.g. groundwater, petroleum) or compression of soft, geologically young sediments. Groundwater extraction for high volume municipal and agricultural use has the potential to cause future ground subsidence in the region. However, we are not aware of subsidence in the area. No active petroleum wells are present within many miles of the site (California Division of Oil, Gas and Geothermal Resources, 2001).

Compaction settlement, or seismic densification, occurs when loose granular soils above the water table increase in density as a result of earthquake shaking. The soil densification can result in differential settlement because of variations in soil composition, thickness, and initial density. Occasional layers of granular soils were encountered within the unsaturated fills. These granular layers may be subject to cyclic densification during strong ground shaking, resulting in compaction settlement. However, since CDSM treatment is planned at all of the MSE wall locations, settlement due to seismic compaction of granular fills is not anticipated.

12.4 CONSOLIDATION SETTLEMENT

Settlement occurs when soil is loaded by a structure or embankment fill placed on top of the soil. This settlement can occur quickly in unsaturated and free-draining soils, and it can occur gradually when pore pressures in saturated soils, increased by vertical loading, gradually dissipate over time.

The Bay Mud and fat clays that underlie the site are very soft to medium stiff, have moderate to high compressibilities, and are normally to slightly overconsolidated. On this basis, we expect that settlement of these clays under the weight of the proposed embankment fills, ranging to 22 feet high, will be excessive, up to 17 inches beneath the tallest portions of the MSE retaining walls and up to about 7 inches at the proposed Broadway Overcrossing abutments. Since these native clays have low to very low permeabilities, the total estimated settlements will not be realized during a reasonable construction period without implementation of a surcharge program with wick drains. Based on results of laboratory consolidation testing, we estimate that the settlement period to reach 90 to 95% consolidation of the Bay Mud and underlying fat clays would be about 3 to 4 years. Settlement calculations are included in Appendix G.

We anticipate that this settlement period could be shortened to 8 to 12 months with surcharging and wickdrains, however consideration would need to be given to the potential adverse effects of surcharge loads and resulting settlement on existing nearby structures and underground utilities which are to remain.

Alternatively, the strength and compressibility characteristics of these underlying clays can be improved with use of cement deep soil mixing (CDSM) or equivalent, or the magnitudes of the predicted settlements could be reduced to tolerable amounts by using a very lightweight embankment fill alternative such as expanded polystyrene (EPS) blocks.

12.5 LANDSLIDE AND LATERAL SPREADING

US101 is located on relatively flat ground along the project alignment and is not subject to landsliding; therefore, landsliding is not a potential hazard.

Liquefaction induced lateral spreading occurs on gentle slopes underlain by loose sands and shallow groundwater. When liquefaction occurs, the unsaturated overburden can slide as intact blocks over the lower liquefied deposit. Surface displacements proceed downslope or toward a steep free face, such as a stream bank, with the formation of fissures and scarps. The geologic conditions conducive to lateral spreading are frequently found along streams and other waterfronts in recent alluvial or deltaic deposits as well as loosely placed, saturated sandy fills (Youd and Hoose, 1976).

As discussed in the liquefaction section of this report, pockets of potentially liquefiable fill were encountered at several of the exploration locations; in addition, potentially liquefiable native sands were identified below the Bay Mud at several exploration locations. Therefore, in our opinion, liquefaction induced lateral spreading is a potential hazard at the site.

The U.S. Geological Survey published a map with digitized locations of historic post-earthquake ground effects (Youd and Hoose, 1978, and Tinsley and others, 1998); this data is shown on the geologic map in USGS Open File Report 00-444 by Knudsen et al (2000). Based on review of these digitized locations, no historic failures have been documented at the project site, but sand boils were noted at a location about one mile east of the site following the Loma Prieta earthquake in 1989. In addition, settlement and ground cracking were noted about one mile northwest of the site following the 1906 earthquake.

Use of CDSM or equivalent extending through the potentially liquefiable soils across the project area would, in our opinion, reduce the potential for lateral spreading to affect new structures, pavements and underground utilities at the site.

12.6 FLOODING

The project site is located within the FEMA 100-year flood zone (Zone A) as shown on the ABAG Flood Hazard Map (2007). A copy of the ABAG flood hazard map is included as Figure 7.

Floodplain information on the project area is discussed in more detail in the Project Location Hydraulic Study Report (WRECO, 2011). The study identifies three areas of flooding potential as discussed below.

The first problematic flooding is in the vicinity of the northeastern landing of the Broadway Overcrossing. The source of this flooding is the relatively high tailwater elevation in the unlined channel northeast of the corner of Airport Boulevard and Bayshore Highway. The outfall from the storm drain system draining the flooded area is buried under the channel bottom. The combination of the high tailwater elevation in the channel relative to the storm drain system and the buried outfall prevents adequate conveyance, which results in water frequently ponding in the vicinity of the intersection of Bayshore Highway and Airport Boulevard.

Another area believed to experience flooding due to high tides is between the Crowne Plaza Hotel parking lot and the northbound US101 off-ramp to Airport Boulevard.

A third area subject to flooding is where overbank flow from Easton Creek has historically flooded an area between Bayshore Highway and the on-ramp from Bayshore Highway to northbound US101. The interchange reconstruction project has no impacts on the existing floodplains.

12.7 SCOUR

Because the proposed walls are located outside waterways, scour is not an issue for foundation design.

13.1 CORROSION

An assessment of the potential for corrosion of various buried foundation and pipe structures was performed by V&A. The results of their investigation are presented in Appendix H. The following paragraphs include their summary, conclusions, and recommendations.

13.2 SUMMARY

V&A was retained by URS Corporation to perform a soil corrosivity investigation for the proposed US101/Broadway Interchange Replacement Project in the City of Burlingame, San Mateo County. The objective of this investigation was to provide recommendations for corrosion control of structural foundation materials, primarily buried reinforced concrete, under consideration for retaining walls, metallic soil reinforcement backfill for MSE walls, and concrete barriers along the on ramps, off ramps, and frontage roads in the immediate vicinity of the Broadway Overcrossing.

The investigation was conducted in accordance with California Department of Transportation's Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch *Corrosion Guidelines*, Version 1.0, dated September 2003. These Guidelines consider representative soil or water samples to be corrosive to metallic or reinforced concrete structural elements if one or more of the following conditions exist:

1) The chloride concentration is 500 parts per million (ppm) or greater, and/or
2) The sulfate concentration is 2,000 ppm or greater, and/or
3) The pH is 5.5 or less.

Evaluation of the soil environment was made in terms of potential corrosion damage to buried reinforced concrete structures. Soil resistivity measurements were conducted by V&A in the field during the initial stages of the work. Soil corrosivity was determined for the proposed project structures' materials to a depth of 15 feet at proposed retaining wall locations. In addition, eight soil samples taken during the geotechnical investigation by URS were sent to Cooper Testing Laboratory in Palo Alto, California, for chemical analysis. The soil samples were analyzed for as received and minimum (saturated) resistivity, pH, and water-soluble chloride and sulfate ion concentrations. All of these chemical properties affect the corrosion rate of buried reinforced concrete structures. The results are summarized in the following table.

Table 13-1: Soil Corrosion Test Results Summary

Boring No.	**Depth (ft)**	Minimum Resistivity[2] (ohm-cm)	pH[3]	Chloride Content [1,4] (mg/kg)	Sulfate Content [1,5] (mg/kg)
R-11-005	3.5-5	1,151	7.9	90	542
R-11-007-1-3	5-7	1.952	7.9	13	6
R-11-008-1-3	5-7	2,517	8.0	<2	132
R-11-010-1-3	5-7	1,768	7.7	24	5,391
R-11-011	0-6	1,252	8.0	246	9
R-11-014-1	5-6.5	1,328	7.6	181	8
R-11-017-1-2	5-7	561	7.7	451	272
R-11-018-2-2	10-11.5	131	8.0	4,965	786
B-31[6]	9.5-19.5	61	8.1	8,325	1,094

The following information is provided as reference for the preceding Table 13-1:

1. mg/kg – milligrams per kilogram (ppm)
2. Minimum resistivity by Caltrans Method 643
3. pH by Caltrans Method 643
4. Chloride by Caltrans Method 422-modified
5. Sulfate by Caltrans Method 417-modified
6. Soil sample B-31 was previously reported in Parikh 2005 Geotechnical Design & Materials Report for the US101 Auxiliary Lanes project.

As shown in the preceding table, the eight soil samples taken from URS boreholes at selected points along the proposed MSE wall and concrete barriers west of US101 and analyzed at Cooper Testing Laboratory had minimum (saturated) resistivities that ranged from 61 to 2,517 ohm-cm. The soil pH values varied from 7.6 to 8.1. Water-soluble chlorides ranged from less than 2 to 8,325 mg/kg (ppm), and the water-soluble sulfate concentrations were from 6 to 5,391 mg/kg (ppm). One borehole soil sample from the current URS investigation (R-11-018-2-2) is considered *corrosive* based on the chloride content. One borehole soil sample (R-11-010-1-3) is *corrosive* based on the sulfate ion concentration as defined by the Caltrans *Corrosion Guidelines*. The other soil samples are *non-corrosive* based on the Caltrans *Corrosion Guidelines*.

13.3 CONCLUSIONS

- One soil boring sample had a soluble chloride concentration greater than 500 mg/kg. One soil boring sample had a soluble sulfate concentration greater than 2,000 mg/kg. According to the Caltrans *Corrosion Guidelines*, these soils are corrosive to buried steel and reinforced concrete structures.
- The project site is located within 1,000 feet of salt water or brackish water.

13.4 RECOMMENDATIONS

13.4.1 General

Corrosion protection against a marine atmosphere is required by the *Corrosion Guidelines* for above-ground steel and reinforced concrete structures at the proposed retaining walls and concrete barriers. Design of structures installed in these locations should include corrosion mitigation measures as detailed below.

13.4.2 Buried Reinforced Concrete Structures

Buried concrete structures should be constructed of durable concrete as described in ACI Standards 201.2R and 222R and Chapter 850.3, “Corrosion,” of the Caltrans *Highway Design Manual* (last updated September 28, 2011). Criteria for protecting reinforced concrete structures under corrosive conditions discussed in Caltrans Standard Special Provision (SSP) S8-C04, “Corrosion Control for Portland Cement Concrete” (a modification of Bridge Design

Specifications, Section 8, "Reinforced Concrete"), should be followed. These recommendations include, but are not limited to, the following for reinforced concrete in corrosive soil:

- Based on a worst-case corrosive soil with water-soluble sulfate content greater than 2,000 mg/kg (ppm) or water-soluble chloride content greater than 5,000 mg/kg (ppm), the following concrete compositional requirements are recommended per the Caltrans Standard Specifications updated July 28, 2011, Section 90-1.02H, "Concrete in Corrosive Environments":
  - ♦ The cementitious material used in the concrete must be a combination of Type II or Type V Portland cement and SCM (supplementary cementitious materials).
  - ♦ The concrete must contain at least 675 pounds of cementitious material per cubic yard.
  - ♦ The reduction of cementitious material content specified in Section 90-1.02E (2) is not allowed.
  - ♦ The specifications for SCM content in Section 90-1.02B (3) do not apply.
  - ♦ The cementitious material must be composed of one of the following by weight:
    - ◊ 25% natural pozzolan or fly ash with a CaO content of up to 10%, and 75% Portland cement,
    - ◊ 20% natural pozzolan or fly ash with a CaO content of up to 10%, 5% silica fume, and 75% Portland cement,
    - ◊ 12% silica fume, metakaolin, or UFFA (ultra-fine fly ash) and 88% Portland cement,
    - ◊ 50% GGBFS (ground granular blast furnace slag) and 50% Portland cement.
  - ♦ A maximum water-to-cementitious material ratio of 0.40 shall be used in the concrete.
- A minimum concrete cover of 2.5 inches and preferably 3 inches should be applied over all steel reinforcement. Local soil chloride and sulfate concentrations exceed 5,000 ppm and 2,000 ppm, respectively.
- Sand and water used in concrete mixtures should contain a maximum of 100 mg/kg (ppm) of water-soluble chloride ions and water-soluble sulfate ions. Sand and water pH shall be between 6.5 and 8.0. Potable water should be used in all concrete mixtures.
- Above-ground reinforced concrete structures within 1,000 feet of brackish or salt water are exposed to a corrosive marine atmosphere. A 3-inch concrete cover over unprotected reinforcing steel is recommended for all concrete structures exposed to this environment.

13.4.3 Reinforced Concrete Exposed to Marine Atmosphere

- Above-ground reinforced concrete structures within 1,000 feet of brackish or salt water are exposed to a corrosive marine atmosphere. The following minimum concrete cover over unprotected reinforcing steel is recommended for the concrete structures listed below:
  - ♦ 3 inches concrete cover for the following:
    - ◊ Footings and pile caps

◊ Walls, columns, and cast-in-place piles

♦ 2 inches of concrete cover for the precast piles and pile extensions

- This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.

13.4.4 Mechanically Stabilized Embankment and Metallic Soil Reinforcement Backfill

Non-corrosive backfill for mechanically stabilized embankments with metallic soil reinforcement shall meet the following requirements in accordance with the *Corrosion Guidelines*:

- Minimum resistivity greater than 2,000 ohm-cm as determined by California Test Method (CTM) 643.
- Chloride concentration less than 250 ppm as determined by CTM 422.
- Sulfate concentration less than 500 ppm as determined by CTM 417.
- A pH value between 5.5 and 10.0 as determined by CTM 643.
- Slag aggregate should not be used as a backfill due to high water-soluable sulfate concentrations.

14.1 GENERAL

Mechanically stabilized embankment (MSE) retaining walls are composed of a reinforced soil mass and discrete modular precast concrete face panels which are vertical or near vertical. The reinforced soil mass consists of selected backfill with metallic welded wire grid mat.

MSE walls can accommodate larger total and differential settlements than conventional gravity retaining walls, such as Caltrans Type 1 walls.

The 2011 borings and CPTs indicate that the proposed retaining wall locations are blanketed by several feet of fill placed for construction of the US101 roadway embankments, underlain by up to about 10 feet of soft to very soft, highly compressible organic fat clay (Bay Mud). In addition, at some exploration locations, the Bay Mud is underlain by soft and moderately compressible fat clay and discontinuous strata of potentially liquefiable granular deposits. As discussed in Section 12, we estimate that long-term consolidation settlement of the native clays could be on the order of up to 17 inches for the maximum retaining wall fill heights and that post-liquefaction settlement of the localized granular deposits could be about 1 inch.

Soil improvement consisting of Cement Deep Soil Mixing (CDSM) is currently proposed to reduce the magnitude of estimated post-liquefaction and long-term consolidation settlement beneath the retaining walls. CDSM ground typically consists of a regular grid of in-place columns that are placed in rows (treatment zones) aligned parallel to the longitudinal axis of an embankment. The horizontal extents and the pattern of the CDSM columns at the retaining walls is shown on the CDSM Plans, Figures 8A, 8B, and 8C. A more detailed discussion of CDSM ground improvement is presented in Section 16.

Based on our preliminary analyses, it is our opinion that CDSM treatment to a depth of about 25 feet bgs could reduce post-liquefaction settlement and consolidation settlement to about 1 to 1½ inches, depending on the retained fill heights. According to MSE wall builders and past Caltrans experience, this upper bound of the settlement estimate would be tolerable for typical MSE construction. CDSM treatment would be increased to a depth of about 50 feet bgs in the vicinity of bridge approaches/abutments, the existing PG&E transmission towers, and along the RW205 layout line where it passes in close proximity to existing CMU buildings at 1320 and 1322 Marsten Road; the objective of the deeper CDSM treatment would be to reduce anticipated settlements to less than about ½-inch, which we assume will be tolerable for these new and existing structures.

Based on as-built plans provided, we understand that the three PG&E towers are supported on spread footing foundations embedded about 15 feet bgs. As-built foundation information for the existing CMU buildings on Marston Road is not available through the City of Burlingame Building Department and has not been provided to us.

14.2 RETAINING WALL TYPES

The approximate maximum differential heights of soil (MDHS) where fill will be placed behind the proposed retaining walls are summarized in the following Table 14-1.

Table 14-1: Maximum Differential Soil Heights for Retaining Walls

Retaining Wall No.	Maximum Differential Soil Height (feet)	Station at MDHS Along Retaining Wall Layout Line
RW 15	20	7+08 (end of wall)
RW38	5	38+87 (end of wall)
RW39	9	40+13 (end of wall)
RW205	20	12+20
RW209	22	13+65 (end of wall)
RW314	22	14+59 (end of wall)
RW315	12	16+17 (end of wall)
RW316	12	116+17 (end of wall)

With CDSM or equivalent method of soil improvement as discussed above, from a geotechnical point of view, we consider MSE construction for these retaining walls to be feasible. For lower walls, RW38 and 39, more rigid Standard Plan Type 5 walls supported on CDSM improved subgrade are also feasible, because the post-construction settlement could be reduced to less than 1 inch. Although the Type 5 walls could be designed to meet the LRFD service and strength loading cases, the seismic coefficient (k_h) estimated for the site exceeds the Standard Plan design basis of 0.2. Therefore, the proposed Type 5 walls should be evaluated by the Structural Designer for the extreme load cases (earthquake loading) with the loads based on a site-specific k_h of 0.23. The latter value was agreed to with Caltrans Geotechnical Design West, where k_h = 1/3x0.68 = 0.23 (refer to Section 11.2 for PGA=0.68g).

The following sections present MSE wall geotechnical design parameters including wall materials, lateral earth pressures, global stability, bearing capacity and settlement estimates. Similar geotechnical design parameters for the Type 5 walls are presented in Section 15.

14.3 MSE RETAINING WALL PARAMETERS

MSE should be designed and constructed in accordance with Caltrans Standard Plans, XS Sheets, latest edition. Recommendations for the geotechnical aspects of the MSE wall design details are summarized in the following sections.

Prior to construction, the MSE retaining wall designer should submit his calculations to Caltrans for review to demonstrate that the design meets all requirements for internal retaining wall stability. The calculations should be signed and stamped by a registered Civil Engineer in the State of California.

14.3.1 Materials

The embankments behind the MSE walls are planned to be constructed either horizontal or at 2:1 (horizontal to vertical) maximum slopes. The MSE walls should be constructed with compacted, relatively clean, granular imported material meeting the requirements of Caltrans Standard Specifications Section 19-3, as shown on Caltrans Standard Drawing XS13-020-2 (January 2012), and the following criteria:

- Particle size ≤6 inches
- Amount passing the 3-inch Sieve, 78 to 100%
- Amount passing the No. 200 Sieve ≤ 25%
- Plasticity Index < 10
- Angle of Internal Friction, $\phi \geq 34$ degrees
- Sand equivalent ≥ 20

14.3.2 Lateral Earth Pressures

LRFD Service and Strength Loading

MSE retaining walls should be designed to resist lateral earth pressures imposed by the adjacent backfill. We recommend that the walls be designed to resist a minimum equivalent fluid pressure of 40 pounds per cubic foot (pcf) for horizontal backfill, and 68 pcf for sloping backfill as steep as 2:1 (horizontal:vertical). These recommendations are based on a clean granular material backfill placed within the MSE embankment having a minimum internal friction angle of 34 degrees, whereas the excavation zone behind the MSE wall consisting of clayey to silty sand fill with an equivalent minimum internal friction angle of 30 degrees.

Surcharge loads such as vehicular traffic would apply additional loads to the walls. For design purposes, a surcharge pressure equivalent to 2 feet of soil should be applied to account for traffic loads. A surcharge pressure of 240 pounds per square foot should be assumed for design.

The recommended pressures assume that no hydrostatic pressures will develop behind the retaining walls. The buildup of hydrostatic pressure behind the walls should be prevented by the inclusion of a positive drainage system. It is recommended that such a system consist of Pervious Backfill Material conforming to the requirements of Section 19-3 of the Caltrans Standard Specifications, latest edition, to a width of at least 12 inches behind the MSE walls in accordance with Caltrans Standard Detail Sheet (Mechanically Stabilized Embankment, Detail No. 7). Positive drainage for water collected in the backfill should be provided by means of drain pipe leading to a free draining outlet. MSE drainage is discussed in more detail in Section 14.3.6.

Earthquake Loading (LRFD Extreme)

Walls will also experience increased loads during earthquake shaking. The additional force to simulate earthquake loads is dependent upon the magnitude of ground surface acceleration and the height of the wall. To estimate the seismically induced force, we recommend that the magnitude of the dynamic lateral force developed during seismic loading be computed using the following equation:

$$\Delta P_{ae} = 10H^2$$

The units of the dynamic lateral force (ΔP_{ae}) are pounds per linear foot of wall. H is the wall height in units of feet. The dynamic lateral force should be assumed to act at 0.6H from the bottom of the wall and represent the resultant of a triangular pressure distribution. The recommended dynamic lateral force is based on a seismic coefficient (k_h) of 0.23.

14.3.3 MSE Wall Bearing Capacity, Global Stability, and Sliding Resistance

CDSM is proposed to a minimum depth of 25 feet below MSE retaining walls, which will increase the strength and, therefore, the bearing capacity of the very soft to medium stiff native clays that underlie the site. Because CDSM is composed of soil-cement columns constructed in grid patterns, the composite strength of the improved layer (minimum 25 feet thick) can be increased as needed by increasing the density of the columns and/or the depth of the grid. On this basis, we believe that CDSM for the project will provide the required ultimate bearing capacities for the planned MSE wall heights and embankment widths, and will achieve the required factors of safety for global stability.

Based on a composite CDSM improved soil block with assumed undrained shear strength of 3,000 psf, we estimate the bearing resistance at the base of the MSE walls to be as follows:

Table 14-2: Recommended Bearing Resistance (LRFD Load Combinations)

WSD (LRFD Service-I Limit State Load Combination)		LRFD		
		Service	Strength	Extreme Event
Permissible Gross Contact Stress (ksf)	**Allowable Gross Bearing Capacity (ksf)**	**Permissible Net Contact Stress (ksf)**	**Factored Gross Nominal Bearing Resistance (ksf)**	**Factored Gross Nominal Bearing Resistance (ksf)**
8.0	8.0	8.0	8.0	16.5

The following table presents the factors of safety for global retaining wall stability required by Caltrans for the 1) end of construction condition, 2) drained condition, and 3) pseudo-static condition.

Table 14-3: Required Minimum Factors of Safety for Foundations

Loading Condition	Required Minimum Factor of Safety
End of Construction (Undrained)	1.3
Long-Term (Drained)	1.5
Pseudo-static	1.1

Based on our preliminary analysis, the computed minimum (critical) factor of safety against global stability for the maximum proposed MSE heights, underlain by CDSM treated soil as planned, exceeds 2.0.

A friction coefficient of 0.35 (ultimate) should be assumed to exist at the base of the MSE walls to resist sliding; in our opinion, this represents a reasonable value for friction between the CDSM treated foundation soils and MSE wall embankment material.

14.3.4 Settlement

The total settlement of the MSE wall will be due to the settlement of the embankment itself and the settlement of the supporting soils. Given the composition and the degree of compaction of embankment materials, it is anticipated that fill settlement will be negligible and will occur during construction.

As discussed in Section 12 of this report, we estimate that post-construction liquefaction settlement could be on the order of up to 1 inch. In addition, the MSE walls will induce settlement in the supporting clays. If left untreated, long-term consolidation settlement of the native organic and fat clays could be as much as 17 inches for the maximum proposed fill heights. Settlement calculations are included in Appendix G.

Assuming that the upper 25 feet of the soil profile beneath each MSE wall is improved using CDSM or equivalent, we estimate that post-liquefaction and long-term consolidation settlement of the underlying untreated soils will be less than about 1 to 1½ inches.

14.3.5 Leveling Pad

In order to provide a uniform bearing pad and sliding resistance (along the soil block-foundation interface), we recommend soil be sub-excavated to a depth of 12 inches below the bottom of the leveling pad and the sub-excavation be backfilled with lean concrete or material conforming to Structural Backfill in accordance with Standard Specifications. The sub-excavation area should extend laterally at least 12 inches on both sides of the leveling pad.

14.3.6 Drainage

Corrosion will shorten the life of an MSE wall. Therefore, we recommend that an underdrain should be placed under the welded wire mat soil reinforcement to drain excess moisture away and reduce the potential for long-term corrosion as discussed in Section 13. Outlet pipes should be placed along the length of the underdrain at a spacing of no more than 200 feet to drain water to suitable discharge facilities. The outlets may be installed to drain through the facing panels, but placement under the leveling pad is preferred.

In addition, we recommend that inspection wires be installed in MSE walls as discussed in Caltrans Bridge Design Aids, Interim (September 2008), Section 3-8, Mechanically Stabilized Embankment.

14.4 EARTHWORK

14.4.1 General

All earthwork should be performed according to the current Standard Specifications of the State of California, Department of Transportation (Caltrans), and as described in the companion Geotechnical Design and Materials Report for the US101/Broadway Interchange Project, prepared by URS. Specifically, Section 16 “Clearing and Grubbing” and Section 19 “Earthwork” of these Specifications should be followed. Specific additions and modifications to those specification requirements are discussed in the following sections.

14.4.2 Site Preparation

Site preparation essentially consists of clearing and grubbing the site prior to construction of the retaining walls; these recommendations should be used in conjunction with the requirements presented in Section 16 of the Caltrans Standard Specifications.

All objectionable material within the retaining wall areas should be removed prior to grading operations. Areas to be filled should be cleared of existing structures. Also, tree stumps and roots over 1 inch in diameter should be excavated along with underground utilities. The resulting holes should be cleared of all loosened soils and backfilled with engineered fill. Before placing fill, the area should be stripped to a sufficient depth to remove all surface vegetation, organic laden topsoil, and debris. We estimate that stripping depths could vary between approximately 2 to 4 inches and the actual stripping depth should be determined in the field at the time of construction. Any stripped organic material should not be used as engineered fill. After the site has been properly stripped, the exposed surfaces in all areas to be filled should be scarified to a minimum depth of 6 inches and recompacted to the requirements for engineered fill.

14.4.3 Fill Material

In general, materials intended for use as fill should be a soil or soil/rock mixture that is free of organic matter and other deleterious substances, in accordance with the requirements of Section 19 of the Caltrans Standard Specifications. In addition, rock fragments greater than 6 inches in largest dimension or soil having a PI of more than 15 should not be allowed in the fill. All import material should meet these requirements and should be approved by the Geotechnical Engineer prior to construction. Asphalt concrete that is pulverized to meet the size requirements for fill material detailed above could be reused as fill.

14.4.4 Placement and Compaction of Fills

Subgrade preparation should consist of moisture conditioning the exposed subgrade and compacting to a minimum relative compaction of 95 percent in accordance with the provisions of Section 19-5 of the Standard Specifications. All embankment fill should be placed in thin lifts and compacted to a minimum relative compaction of 95 percent (ASTM D1557 or Caltrans 216, using the dry weight basis) in accordance with Sections 19-3, 19-5 and 19-6 of the Standard Specifications. We recommend that the relative compaction be measured on the basis of dry density.

15.1 STANDARD PLAN TYPE 5 WALL PARAMETERS

Type 5 walls should be designed and constructed in accordance with Caltrans Standard Plans, 2010 edition; Type 5 walls are appropriate at RW 38 and 39. Evaluation of the applicability of the geotechnical aspects of the Standard Plan wall design assumptions are summarized in the following sections.

15.1.1 Lateral Earth Pressures

LRFD Service and Strength Loading

Type 5 retaining walls should be designed to resist lateral earth pressures imposed by the adjacent backfill. We anticipate the imported fill with an average as compacted moist unit weight of 120 lb/ft^3 and friction angle, ϕ', to be greater than 34 degrees; thus, the resulting equivalent fluid pressure of the wall backfill should be equal to or less than 36 psf per lineal foot. Therefore, the Type 5 wall earth pressure parameters are applicable.

Surcharge loads such as vehicular traffic would apply additional loads to the walls. For design purposes, a surcharge pressure equivalent to 2 feet of soil should be applied to account for traffic loads. A surcharge pressure of 240 pounds per square foot should be assumed for design.

Earthquake Loading (LRFD Extreme)

Walls will also experience increased loads during earthquake shaking. The additional force to simulate earthquake loads is dependent upon the magnitude of ground surface acceleration and the height of the wall. To estimate the seismically induced force, we recommend that the magnitude of the dynamic lateral force developed during seismic loading be computed using the following equation:

$$\Delta P_{ae} = 10H^2$$

The units of the dynamic lateral force (ΔP_{ae}) are pounds per linear foot of wall. H is the wall height in units of feet. The dynamic lateral force should be assumed to act at 0.6H from the bottom of the wall and represent the resultant of a triangular pressure distribution. The recommended dynamic lateral force is based on a seismic coefficient (k_h) of 0.23.

15.1.2 Bearing Capacity, Global Stability, and Sliding Resistance

Based on Standard Plan Sheet RSP B3-4A, the net bearing stresses for the range of wall heights (6 to 12 feet) vary from 2,400 to 4,000 psf (strength limit state).

CDSM is proposed to a minimum depth of 25 feet below the retaining walls, which will increase the strength and, therefore, the bearing capacity of the very soft to medium stiff native clays that underlie the site. Because CDSM is composed of soil-cement columns constructed in grid patterns, the composite strength of the improved layer (minimum 25 feet thick) can be increased as needed by increasing the density of the columns and/or the depth of the grid. On this basis, we believe that CDSM for the project will provide the required ultimate bearing capacities for

the planned wall heights and embankment widths, and will achieve the required factors of safety for global stability.

Based on a composite CDSM improved soil block with assumed undrained shear strength of 3,000 psf, we estimate the bearing resistance at the base of the Type 5 walls to be as follows:

Table 15-1: Recommended Bearing Resistance (LRFD Load Combinations)

WSD (LRFD Service-I Limit State Load Combination)		LRFD		
		Service	Strength	Extreme Event
Permissible Gross Contact Stress (ksf)	**Allowable Gross Bearing Capacity (ksf)**	**Permissible Net Contact Stress (ksf)**	**Factored Gross Nominal Bearing Resistance (ksf)**	**Factored Gross Nominal Bearing Resistance (ksf)**
8.0	8.0	8.0	8.0	16.5

Based on our preliminary analysis, the computed minimum (critical) factor of safety against global stability for the maximum proposed wall heights, underlain by CDSM treated soil as planned, exceeds 2.0. This value should meet the Caltrans' required minimum factors of safety for retaining wall stability as presented in Table 14-3.

A friction coefficient of 0.35 (ultimate) should be assumed to exist at the base of the Type 5 walls to resist sliding; in our opinion, this represents a reasonable value for friction between the CDSM treated foundation soils and wall embankment material.

15.1.3 Settlement

The total settlement of the wall will be due to the settlement of the embankment itself and the settlement of the supporting soils. Given the composition and the degree of compaction of embankment materials, it is anticipated that fill settlement will be negligible and will occur during construction.

As discussed in Section 12 of this report, we estimate that post-construction liquefaction settlement could be on the order of up to 1 inch. In addition, the walls will induce settlement in the supporting clays. If left untreated, long-term consolidation settlement of the native organic and fat clays could be as much as 8 inches for the maximum proposed fill heights. Settlement calculations are included in Appendix G.

Assuming that the upper 25 feet of the soil profile beneath Wall RW 38 and 39 is improved using CDSM or equivalent, we estimate that post-liquefaction and long-term consolidation settlement of the underlying untreated soils will be less than 1 inch.

16.1 CEMENT DEEP SOIL MIXING

Cement deep soil mixing (CDSM) is a process whereby soil is improved by injecting cement grout through one or more augers that simultaneously mix the soil, forming in-place soil-cement columns. CDSM is performed in a regular grid of in-place columns to effectively improve the target soils with the layout typically consisting of blocks of CDSM columns that are placed in rows (treatment zones) aligned parallel to the longitudinal axis of an embankment. The blocks consist of exterior and interior walls formed by adjacent CDSM columns. Analysis of settlement and stability of CDSM improved soil ignores the strength of the soils within and between the blocks.

The CDSM mix is designed by a specialty contractor with the improved properties of the stabilized soil governed by a number of factors including soil type, slurry properties, mixing procedures and curing conditions. High strengths can be attained in the final soil-cement product, typically greater than 100 pounds per square inch (psi).

The challenges associated with CDSM construction include limitations on space for construction staging and rig operations, coordination during excavation and embankment reconstruction, assessing the effectiveness of the soil improvement, and evaluating the depth of penetration. Close coordination between the design team and the specialty CDSM contractor is important to avoid cost overruns and/or schedule impacts to the project.

To assess the effectiveness of the CDSM improvements, a detailed monitoring and testing program should be established. The program should include test sections utilizing several different mix designs with varied cement contents and water-cement ratios, monitoring of various parameters during CDSM construction, full depth coring of the completed CDSM columns, unconfined compressive strength testing on selected CDSM core samples, test borings prior to CDSM construction or adjacent to completed CDSM columns, and test redrilling of cured CDSM.

Special provisions for CDSM construction will be included as part of the final Geotechnical Design and Materials report for the Broadway Overcrossing project.

16.2 CONSTRUCTION DEWATERING

Free groundwater was encountered in each of the borings drilled in the vicinity of the proposed MSE and Type 5 retaining walls at depths ranging from about 5 to 16 feet bgs (Elevation 5.5 to -5 feet). These are the depths where free groundwater was first encountered during drilling and therefore do not necessarily represent a stabilized groundwater level at the boring locations.

Pore pressure dissipation tests at three CPT locations suggest groundwater depths ranging from 0.5 foot to 4.6 feet below existing grade, corresponding to Elevation 6.6 to 10.5 feet. Test results are included in Appendix D.

The estimated range of bottom of leveling pad elevations are summarized in the following table for each of the proposed MSE and Type 5 retaining walls.

Table 16-1: Bottom Elevations of Leveling Pad for MSE and Footing of Type 5 Retaining Walls

Retaining Wall	Bottom of MSE Wall Leveling Pad Elevation (feet)	Bottom of Type 5 Wall Footing Elevation (feet)
RW15	7	-
RW 38	-	7.2
RW 39	-	6.4
RW205	4.4	-
RW209	8	-
RW 314	8.5	-
RW 315	8.8	-
RW 316	8.4	-

As shown in the above table, it is likely that excavations for the MSE wall leveling pads and Type 5 wall footings will encounter free groundwater. Therefore, the Contractor should be prepared to dewater the excavations as necessary to provide a stable base for MSE and Type 5 wall construction.

It should be noted that the 2011 explorations were completed during the dry summer and fall seasons and higher groundwater levels might occur during the winter months. As discussed previously, groundwater encountered in the explorations does not represent a stabilized groundwater elevation and/or could represent perched conditions. In addition, fluctuations in the groundwater level could occur due to tidal action in the nearby San Francisco Bay, water level fluctuations in nearby Easton Creek or Sanchez Creek, and variations in rainfall or other factors not in evidence at the time the measurements were made during this investigation.

16.3 TEMPORARY EXCAVATIONS

We anticipate that construction of the MSE wall leveling pads and Type 5 wall footings will require excavations of up to about 8 feet vertically. Based on the 2011 explorations, it appears likely that excavation for leveling pads at RW Nos. 205 and 209 will be through the existing roadway embankment fills only. The top of the Bay Mud appears to be shallower in explorations within the southwestern quadrant of the interchange, in the vicinity of RW Nos. 15, 314, 315 and 316; therefore, excavation for these MSE wall leveling pads could encounter Bay Mud. For RW Nos. 38 and 39, footing excavations will likely be through existing fills.

Safety standards set by OSHA limit the height of the unshored vertical excavations to 5 feet if construction personnel will be working in the excavations. The set of guidelines published by OSHA (Department of Labor, Occupational Safety and Health Administration, 1999), classifies soils in detail as Type A, B, or C. In general, Type A soils are stronger, Type B soils are intermediate, and Type C soils are weaker. Based on the soil type, depth, and duration the excavation is open, and sequence of soils exposed in the excavation, OSHA recommends maximum allowable slopes. Based on the strengths of the soils encountered in our recent borings, the existing roadway embankment fills are generally considered to be OSHA Type B and Type C. On this basis, we recommend that temporary slopes up to 20 feet high in these soils be cut at no steeper than 1½:1 (horizontal:vertical).

We expect that OSHA guidelines for Type A soils would be applicable for excavations in soil stabilized with CDSM ground improvement. However, if excavations are made into untreated Bay Mud (i.e., no CDSM), then the Contractor's Engineer should determine the maximum slope inclination for cuts in Bay Mud overlain by existing fill. The Contractor's Engineer should submit his calculations to Caltrans for review prior to excavation.

We recommend that the Geotechnical Engineer be retained to review the conditions in temporary cut slopes as they are exposed during construction. Additional recommendations could be provided at that time regarding the advisability of different temporary slope inclinations in particular areas.

For locations where excavation with sloping sides is not viable because of space limitations or in areas where temporary slopes steeper than 1:1 are planned, shoring will be required. The Contractor should retain an experienced Registered Civil Engineer to design the shoring system.

16.4 EFFECTS OF CONSTRUCTION WORK ON ADJACENT STRUCTURES

Efforts should be made to minimize effects of construction work on adjacent structures. A settlement monitoring program, including video taping, should be implemented by the Contractor for adjacent existing structures and underground utilities, particularly before and during CDSM and embankment fill placement.

The opinions, conclusions and recommendations presented herein are based on the information obtained from field explorations made at widely separated locations, geologic site reconnaissance, and upon local experience and engineering judgment. The recommendations presented in this report are based on the assumption that the soil and geologic conditions at or between explorations do not deviate substantially from those encountered from the cone penetration tests and borings performed for this study.

The ground surface elevations at the exploratory locations are based on the topographic information presented on maps provided to us and global positioning system measurements. The station locations for the borings are based on survey information.

The opinions and recommendations presented in this report were developed with the standard of care commonly used as state of the practice in the profession. No other warranties are included, either express or implied, as to the professional advice included in this report.

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INDEX OF PLANS

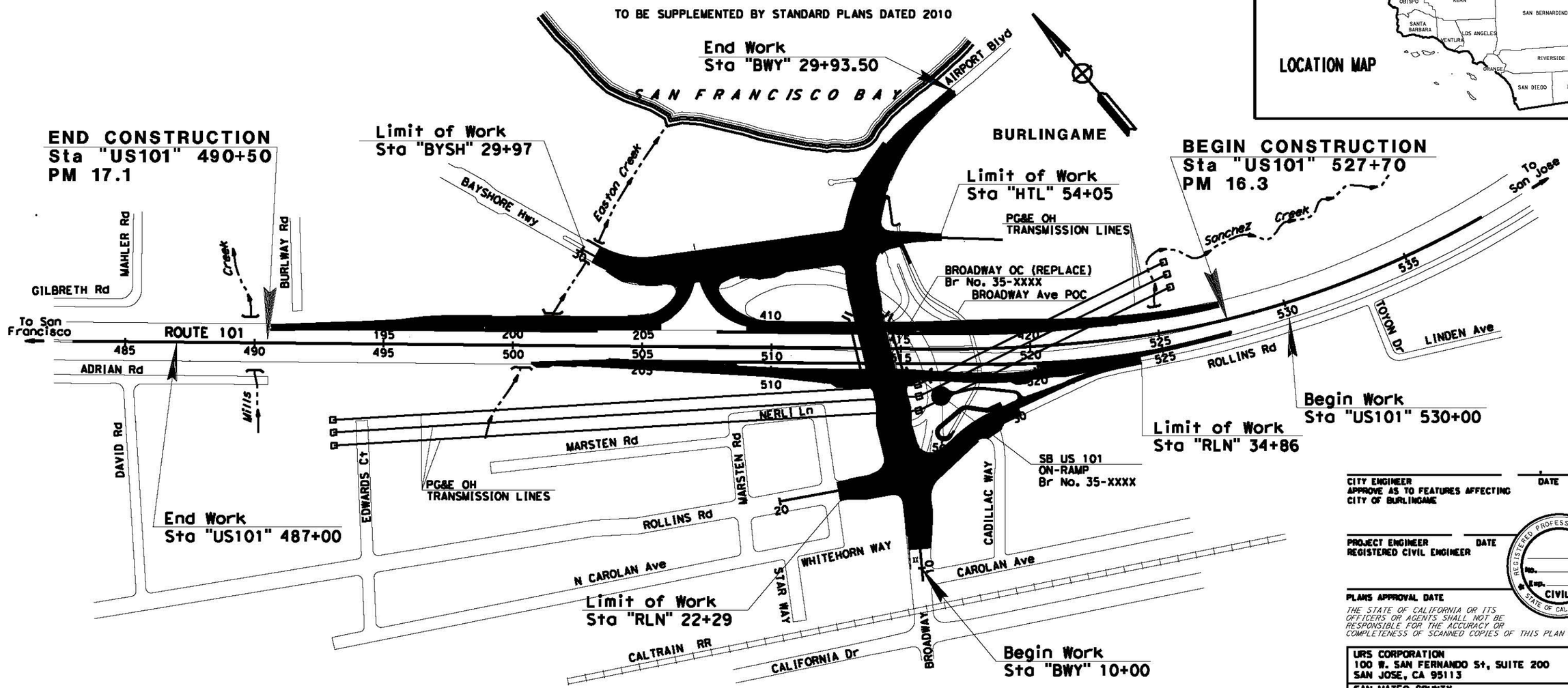
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ON AND ADJACENT TO
STATE HIGHWAY

IN SAN MATEO COUNTY
IN BURLINGAME
FROM 0.3 MILE NORTH OF ANZA BOULEVARD TO 0.9 MILE SOUTH OF MILLBRAE AVENUE

TO BE SUPPLEMENTED BY STANDARD PLANS DATED 2010

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.



PROJECT VICNITY MAP
FIGURE 1

NO SCALE

THE CONTRACTOR SHALL POSSESS THE CLASS (OR CLASSES) OF LICENSE AS SPECIFIED IN THE "NOTICE TO BIDDERS."

APPROVED AS TO IMPACT ON STATE FACILITIES AND CONFORMANCE WITH APPLICABLE STATE STANDARDS AND PRACTICES AND THAT TECHNICAL OVERSIGHT WAS PERFORMED.

CONSULTANT DESIGN ENGINEER: SCOTT KELSEY
CALTRANS DESIGN OVERSIGHT APPROVAL: X
REGISTRATION No. | LICENSE Exp. DATE | DATE SIGNED

CITY ENGINEER — DATE
APPROVE AS TO FEATURES AFFECTING CITY OF BURLINGAME

PROJECT ENGINEER — DATE
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER — No. — Exp. — CIVIL — STATE OF CALIFORNIA

PLANS APPROVAL DATE

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SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
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CONTRACT No.	04-235844
PROJECT ID	0400000684

LAST REVISION 12-23-11 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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SAN CARLOS, CA 94070-1306

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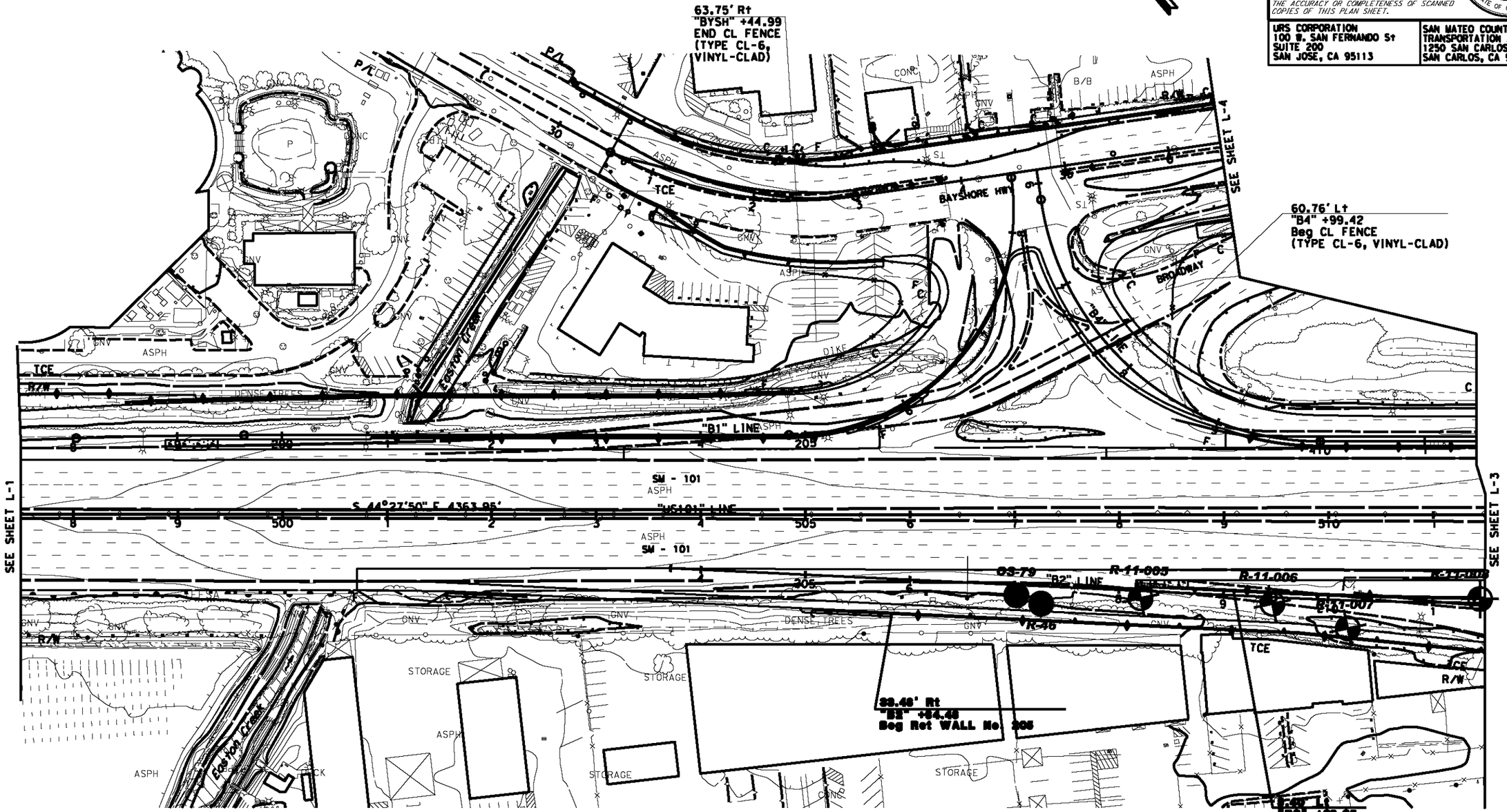

LEGEND

- As-Built Boring
- CPT for this study
- Boring for this study

SITE and EXPLORATION LOCATION PLAN
FIGURE 2a

LAYOUT
SCALE 1" = 50'

L-2

REVISED BY | DATE REVISED
CALCULATED-DESIGNED BY | CHECKED BY
CONSULTANT FUNCTIONAL SUPERVISOR
STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

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NOTE:
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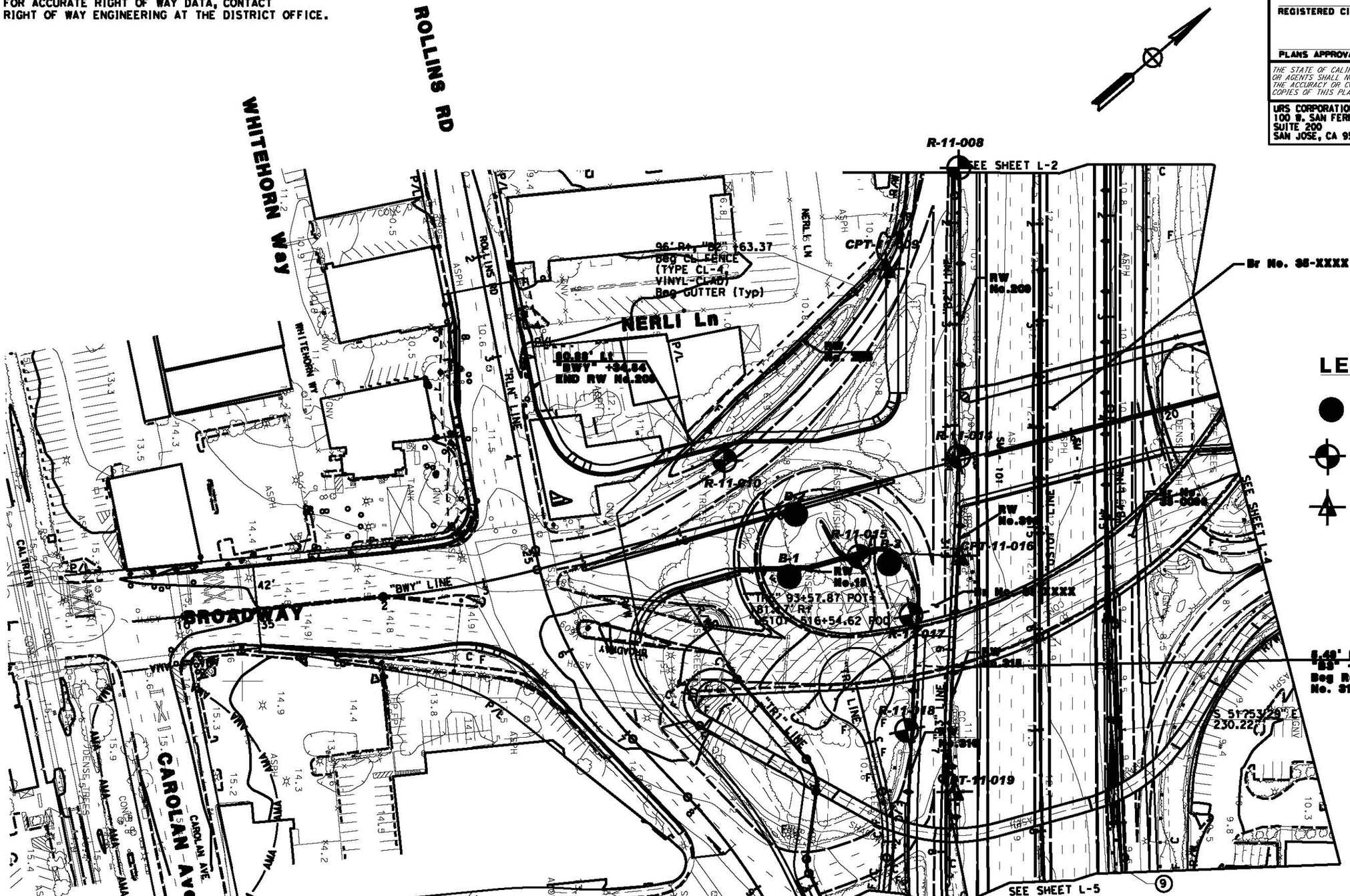

LEGEND

- As-Built Boring
- Boring for this study
- CPT for this study

SITE and EXPLORATION LOCATION PLAN
FIGURE 2b

LAYOUT
SCALE 1" = 50'

L-3

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

CONSULTANT FUNCTIONAL SUPERVISOR

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REVISED BY

DATE REVISED

LAST REVISION 12-23-11 DATE PLOTTED => $DATE TIME PLOTTED => $TIME

BORDER LAST REVISED 7/2/2010

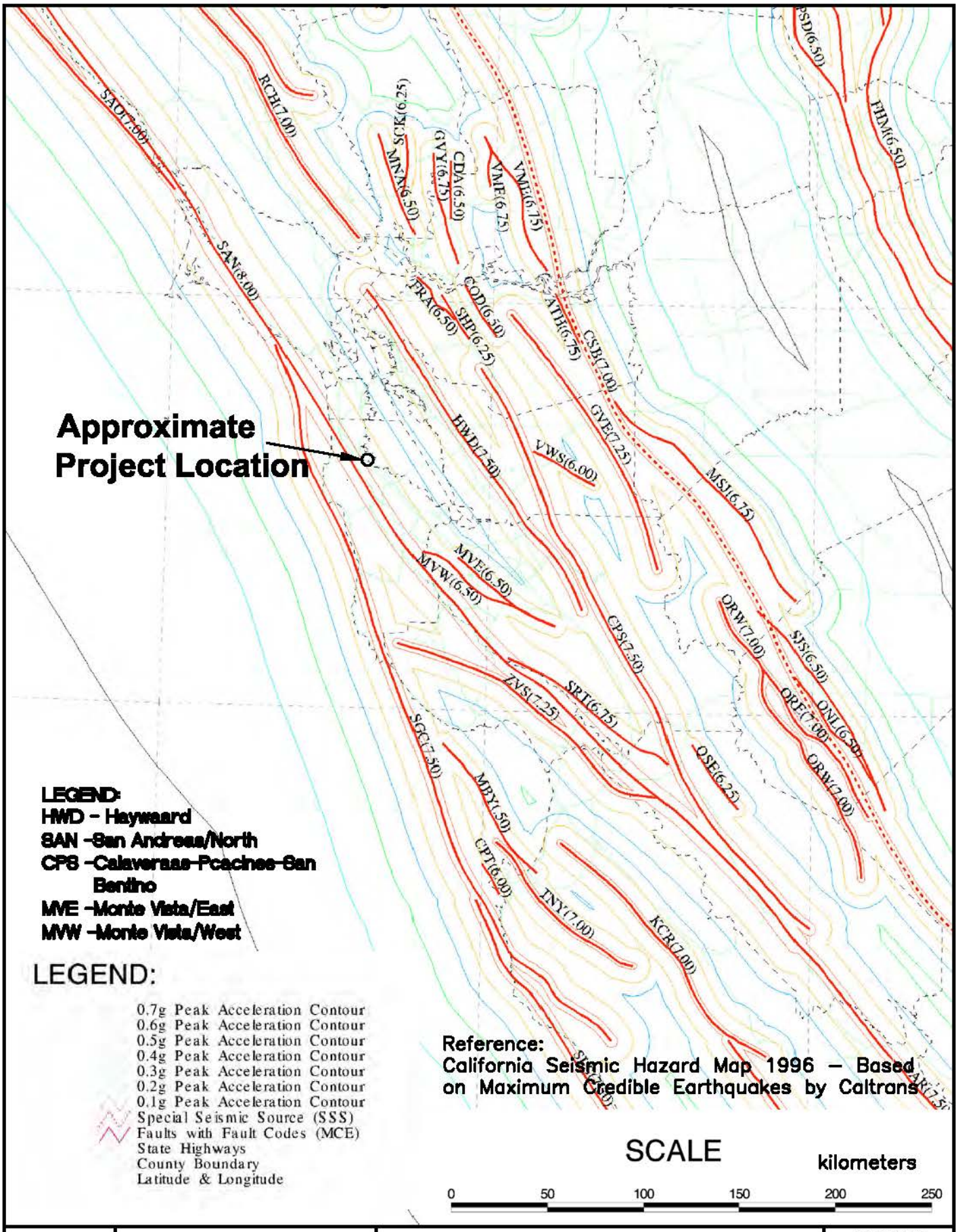
USERNAME => $USER
DGN FILE => $REQUEST

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

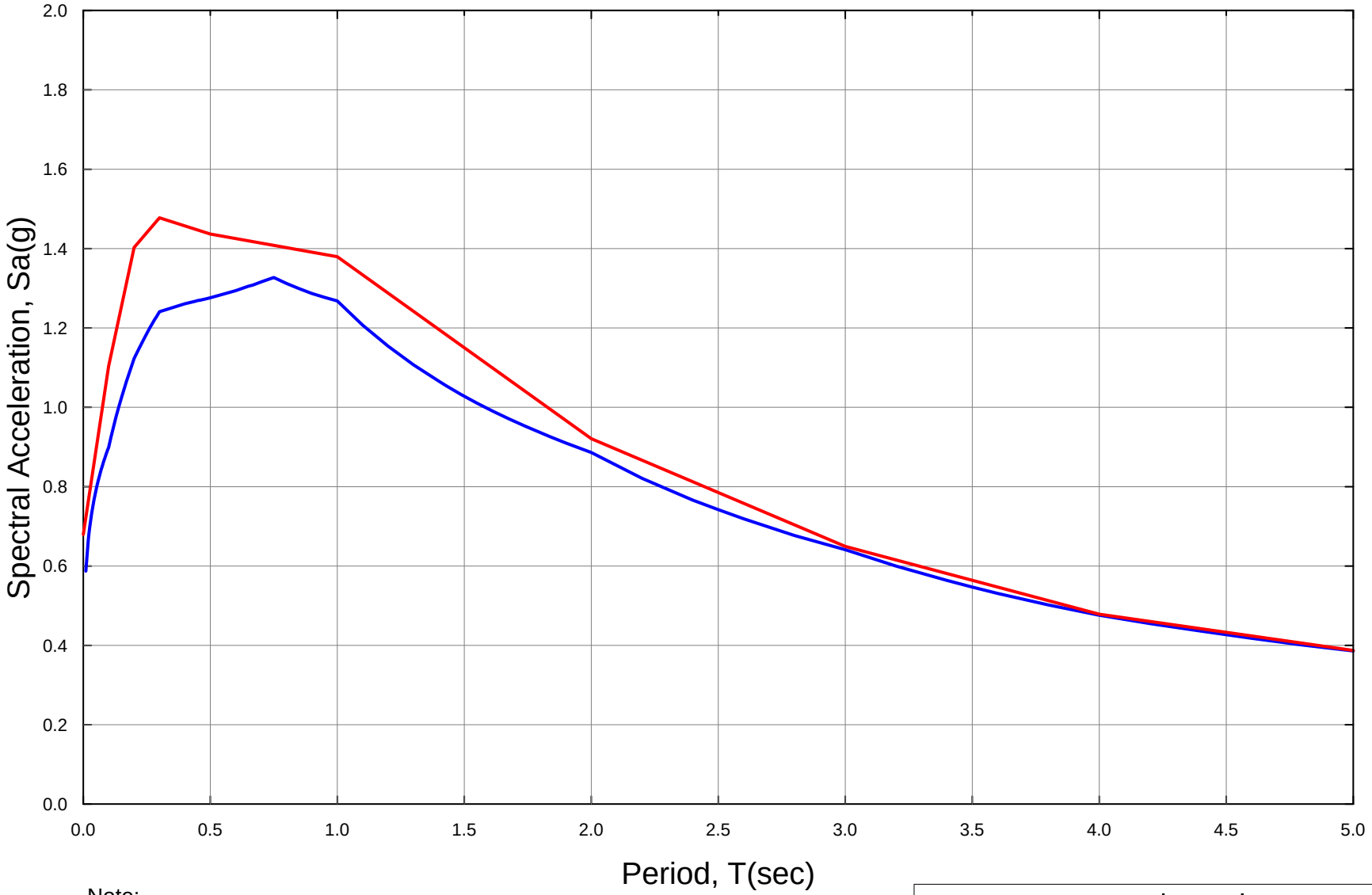
UNIT 0703

PROJECT NUMBER & PHASE 04000006841

URS	US 101/Broadway Interchange Reconstruction Project	GEOLOGY MAP	Not to Scale Figure 3 April 2009



URS	US 101/Broadway Interchange Reconstruction Project	REGIONAL FAULT MAP SAN MATEO COUNTY	Not to Scale Figure 4 April 2009



Note:
1. Site Location: LAT = 37.590061 LONG = -122.361241
2. V_{s30} = 820 feet per second

Legend
Caltrans ARS Online
USGS Deaggregation/Design Curve

Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**Acceleration Response Spectra Comparisons**	Figure 5A
URS			

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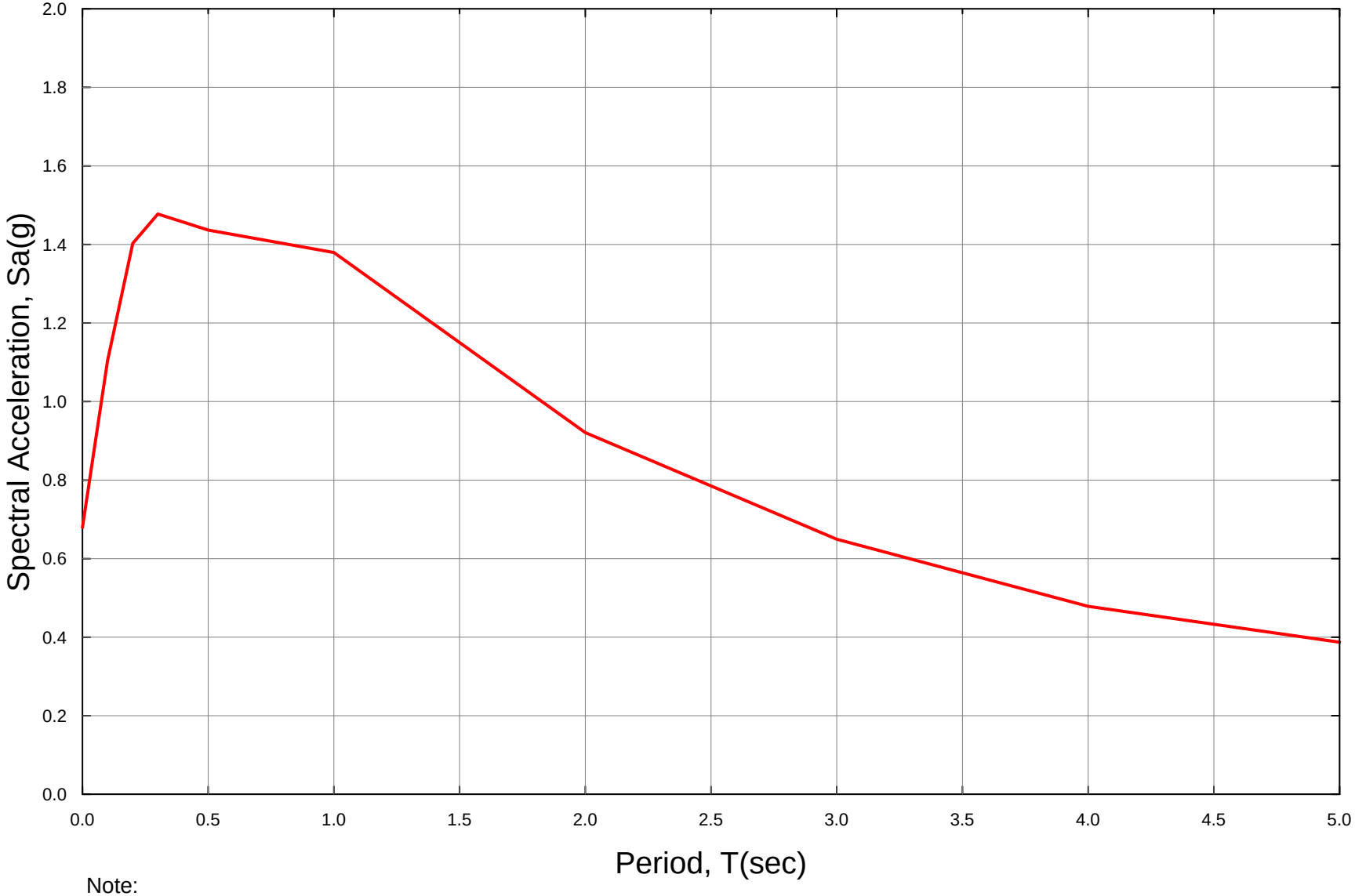


Note:
1. Site Location: LAT = 37.590061 LONG = -122.361241
2. V_{s30} = 820 feet per second

Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**Recommended Acceleration Response Spectra**	Figure 5B
URS			

W:\101BdwyPSE_28645286\450_Geotech\Analysis\ARS Online\Broadway OC (Replace)_ARS Design.grf

Susceptibility Level

- Very High
- High
- Moderate
- Low
- Very Low
- Major Roads
- Local Roads

Scale: 1 inch equals 0.33 miles

This map is intended for planning use only and is not intended to be site-specific. Rather, it depicts the general risk within neighborhoods and the relative risk from community to community. More detailed maps are needed for site development decisions.

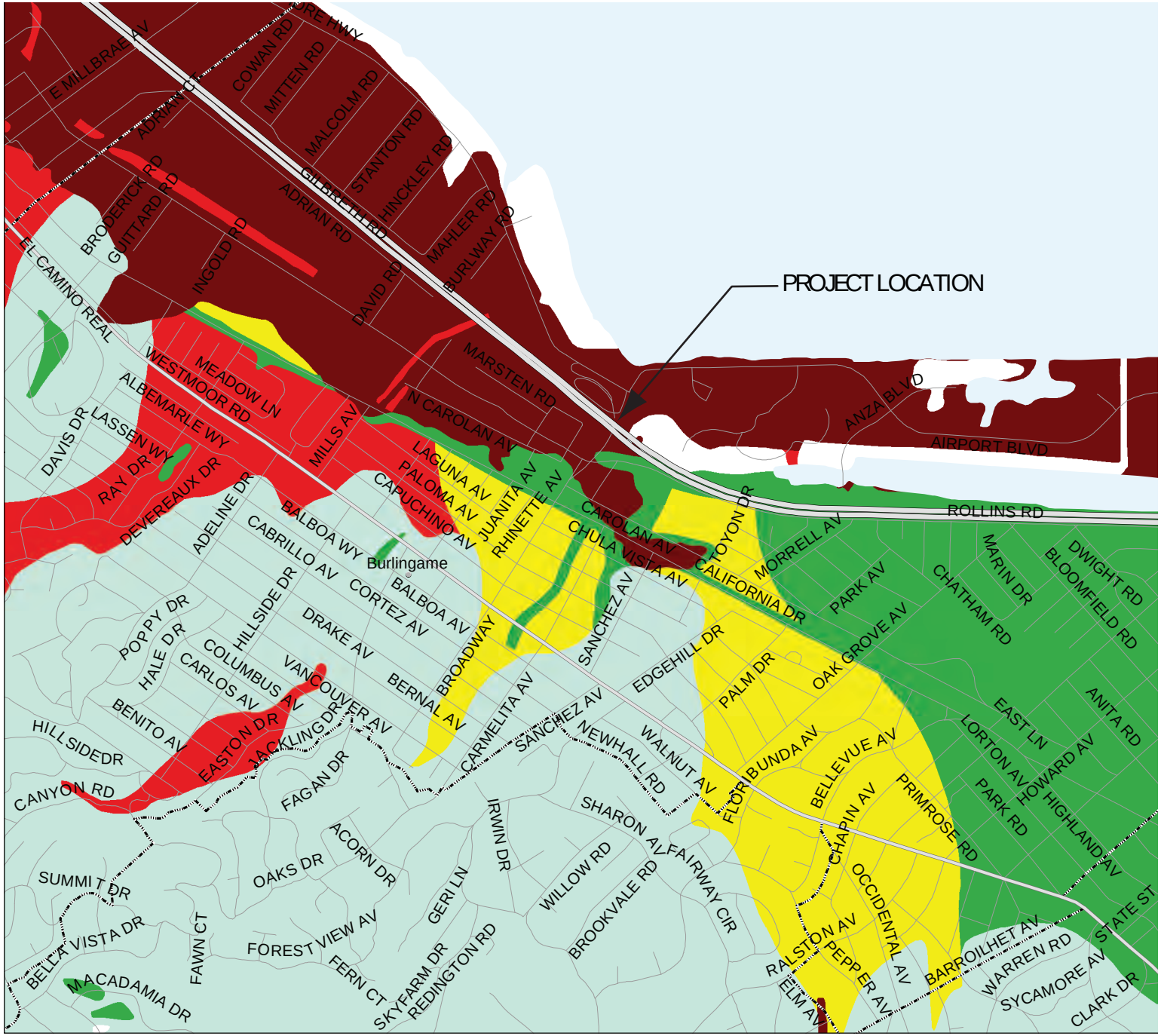
This map is available at http://quake.abag.ca.gov

Source:
This map is based on work by William Lettis & Associates, Inc. and USGS. USGS Open-File Report 00-444, Knudsen & others, 2000

For more information visit: http://geopubs.wr.usgs.gov/open-file/of00-444/

Map Prepared by the ABAG Earthquake Program. April 2004.

ABAG Geographic Information Systems



Project No. 28645286	Broadway Interchange Reconstruction U. S. 101 Burlingame, California	LIQUEFACTION SUSCEPTIBILITY MAP	Figure 6
URS			February 2012

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Flood Hazard Areas

- Zone V- (100 yr. Flood Zone)
- Zone A- (100 yr. Flood Zone)
- Zone X500- (500 yr. Flood Zone or other concerns)
- Urbanized Area

Shaded to show topographical relief

Detailed FEMA Explanation

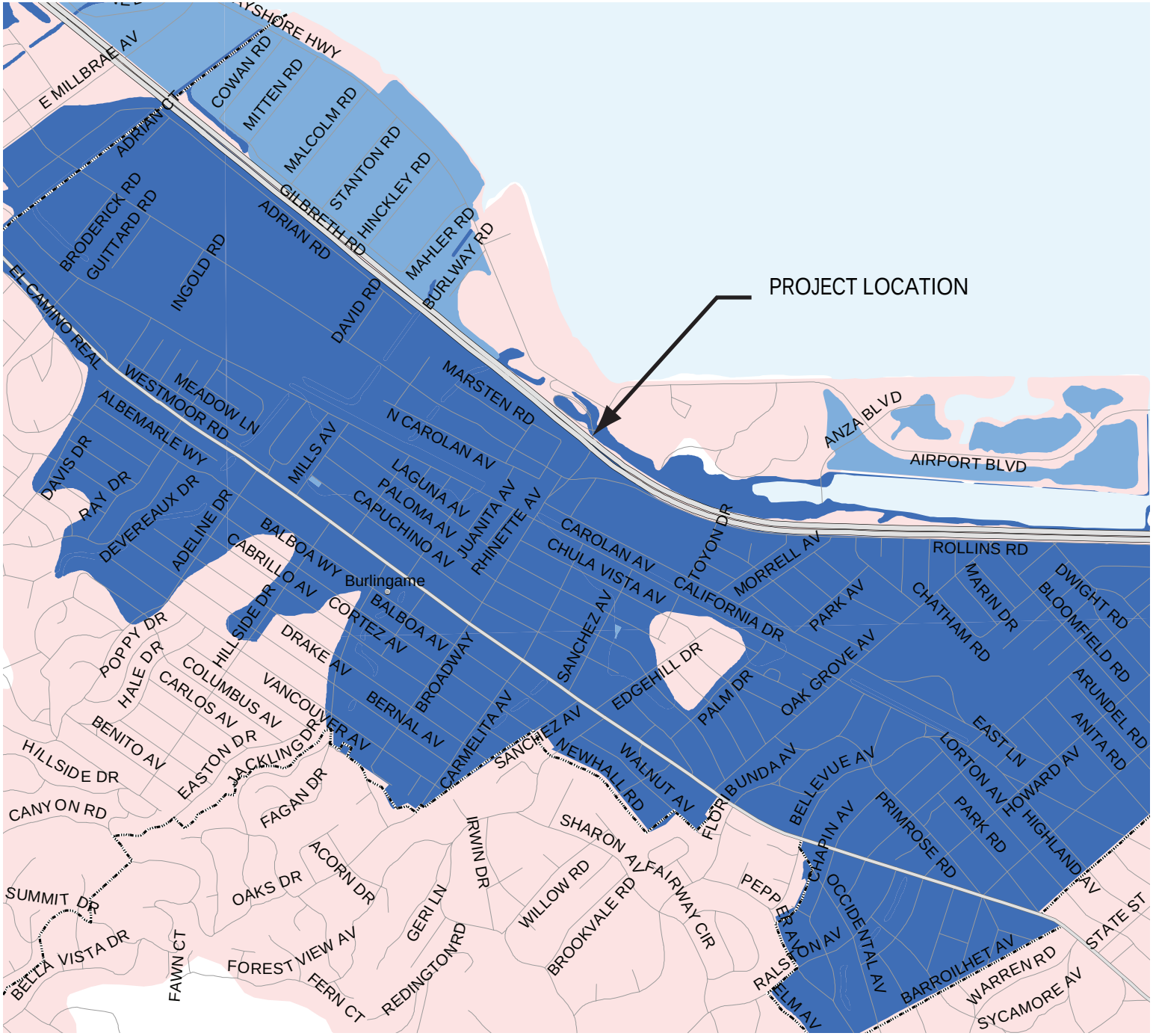
Flood Zone	Description
Zone V	This code identifies an area inundated by 1% annual chance flooding with velocity hazard (wave action).
Zone A	This code identifies an area inundated by 1% annual chance flooding.
Zone X500	This code identifies an area inundated by 0.2% annual chance flooding; an area inundated by 1% annual chance flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from 1% annual chance flooding.

N

Scale: 1 inch equals 0.32 miles

Source: FEMA Q3 Flood Data and ABAG.
The Q3 Flood Data do not replace the existing hardcopy FIRM, or, if one exists, Digital FIRM product.
The product has been designed to support planning activities.
A more detailed version of this map is available at http://quake.abag.ca.gov

ABAG Geographic Information Systems



Project No. 28645286	Broadway Interchange Reconstruction U. S. 101 Burlingame, California	FEMA FLOOD HAZARD AREAS MAP	Figure 7 February 2012

URS

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NOTES:

1. FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.
2. SEE C-27 FOR CEMENT DEEP SOIL MIXING DETAILS AND SECTION VIEWS.

LEGEND:

SOIL-CEMENT - 33% PATTERN

SOIL-CEMENT - 21% PATTERN

LIGHTWEIGHT EMBANKMENT MATERIAL (CELLULAR CONCRETE)

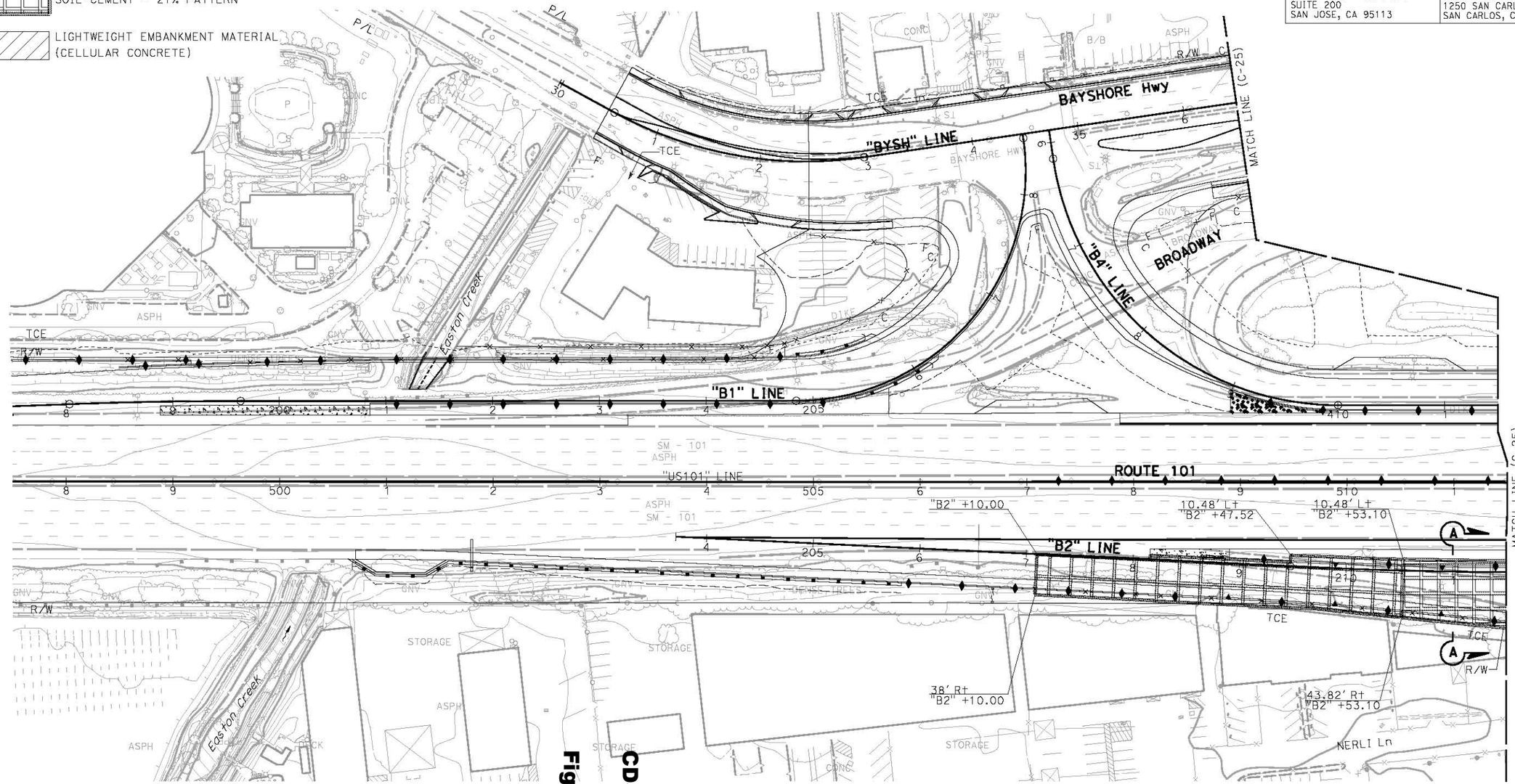

Figure 8A

CDSM Plan

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET C-1

CONSTRUCTION DETAILS
(SOIL TREATMENT)

SCALE 1" = 50'

C-24

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

CALCULATED-DESIGNED BY: ABHIJEET BHOI

CHECKED BY: ELIE-ABI-JAOUDE

REVISED BY

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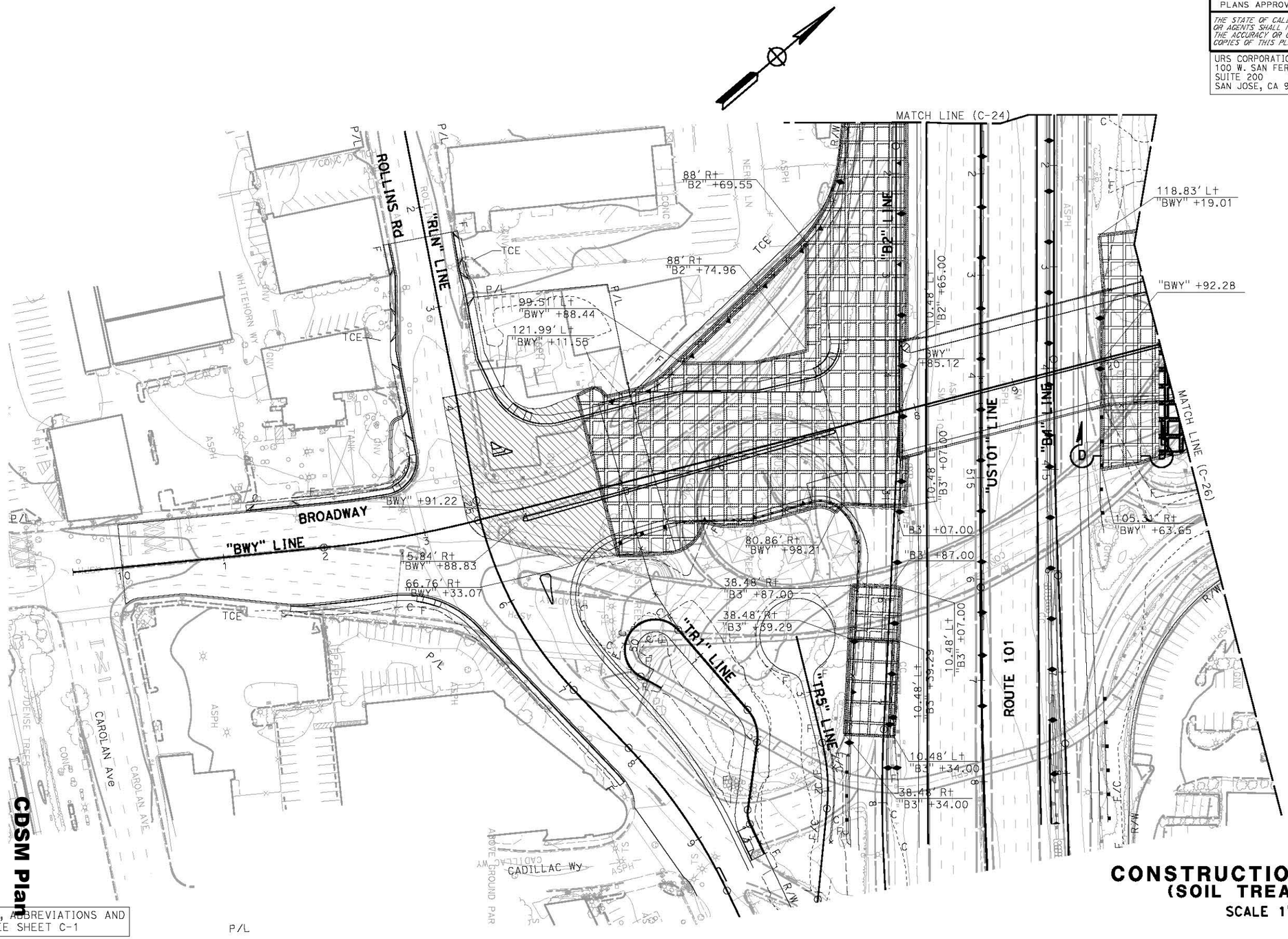

CONSTRUCTION DETAILS
(SOIL TREATMENT)
SCALE 1" = 50'

C-25

CDSM Plan

Figure 8B

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET C-1

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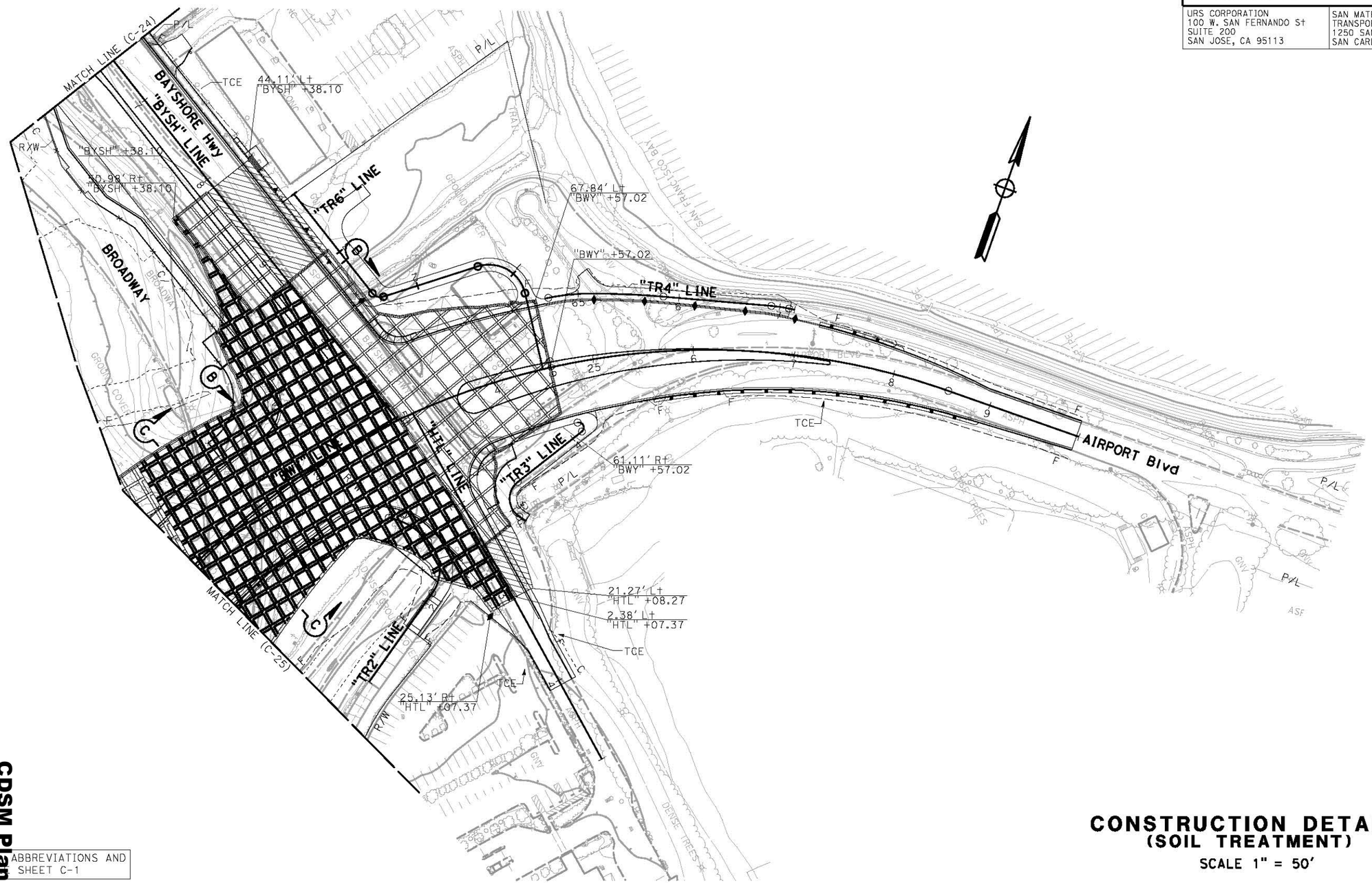

CONSTRUCTION DETAILS
(SOIL TREATMENT)

SCALE 1" = 50'

C-26

Figure 8C CDSM Plan

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET C-1

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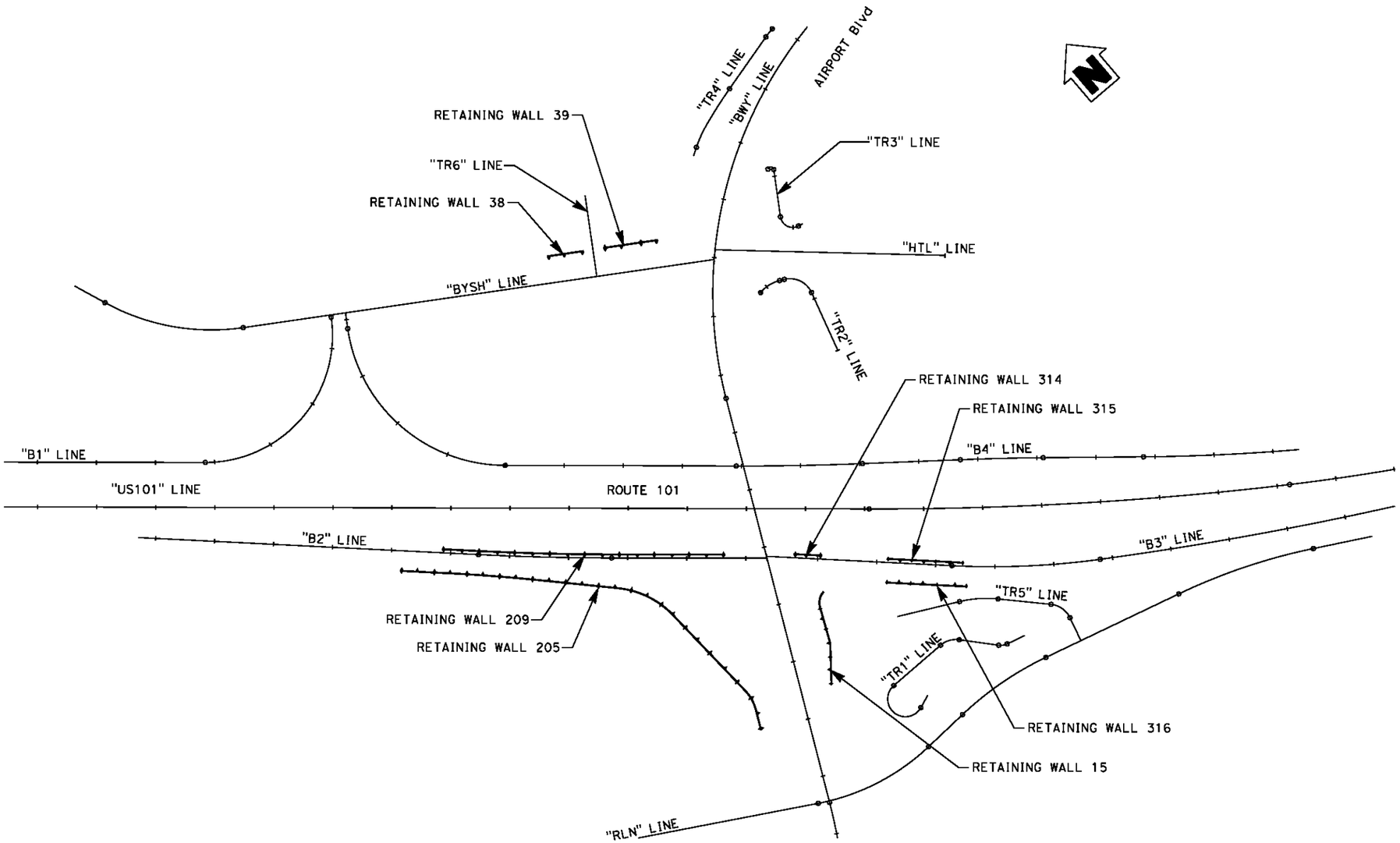

NOTES:

1. For "GENERAL NOTES", INDEX TO PLANS" and "STANDARD PLANS DATED 2010", see "INDEX TO PLANS" sheet.

X DESIGN OVERSIGHT	DESIGN	BY G.A.CARROLL	CHECKED H. HAKIMI	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 DESIGN VEHICLE
X SIGN OFF DATE	DETAILS	BY N. HUTTON	CHECKED X	LAYOUT	BY T. SILVA / CHECKED A. BHOJ
	QUANTITIES	BY X	CHECKED X	SPECIFICATIONS	BY D. HARNAGEL / PLANS AND SPECS COMPARED X

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG
PROJECT ENGINEER

BRIDGE NO. X
POST MILES X

RETAINING WALLS
KEY MAP

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 8-9-12

SHEET 2 OF 31

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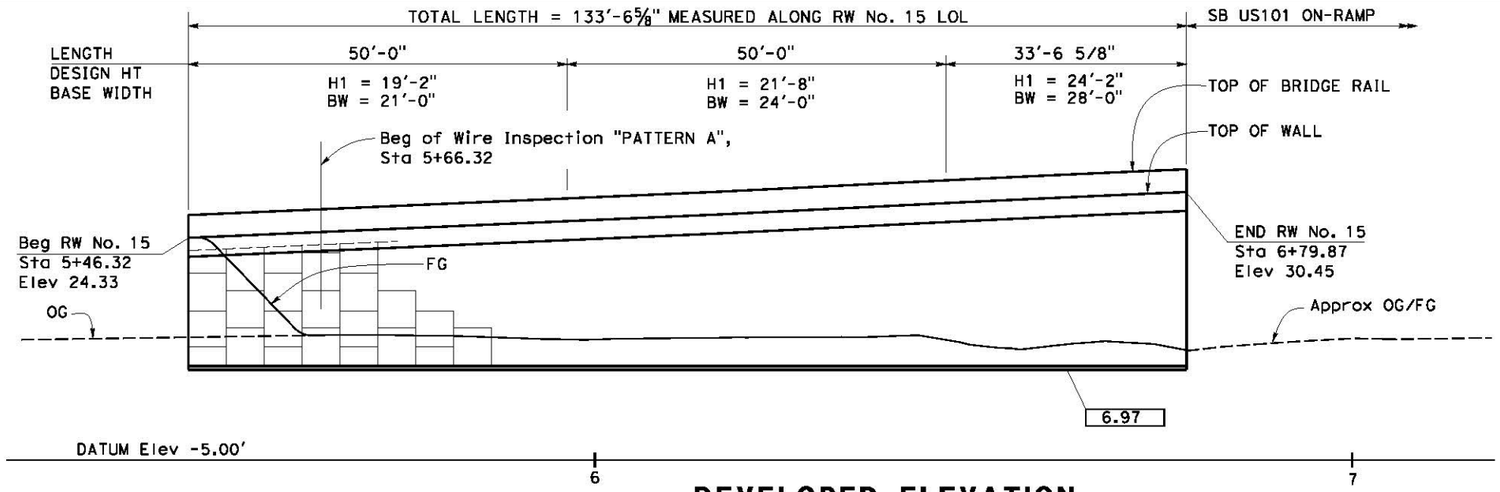

DEVELOPED ELEVATION

SCALE: 1" = 10'

ELEV AT TOP OF WALL

STA	ELEV
5+65.00	25.16
5+85.00	26.04
6+05.00	26.92
6+25.00	27.84
6+45.00	28.84
6+65.00	29.79

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

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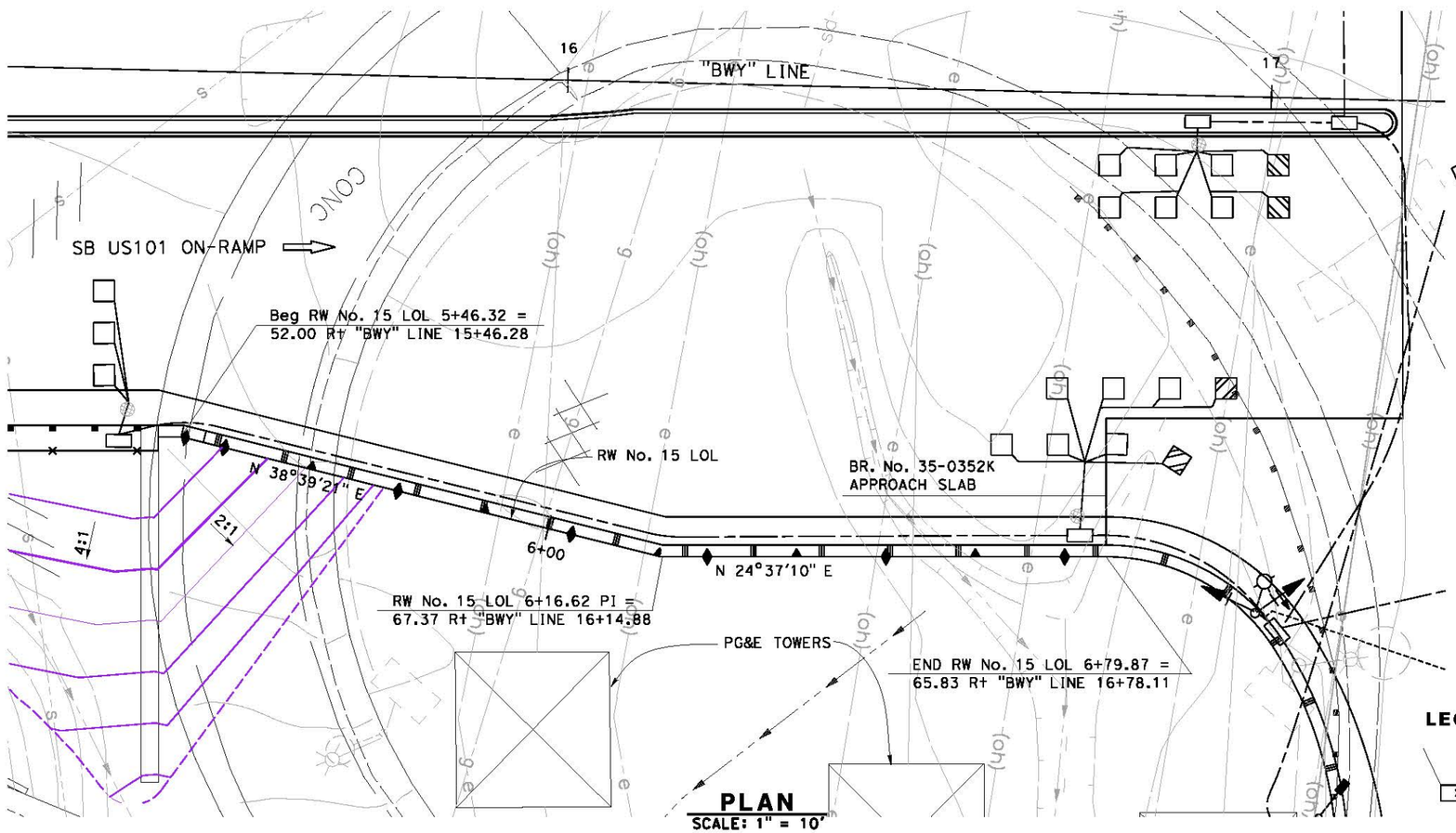
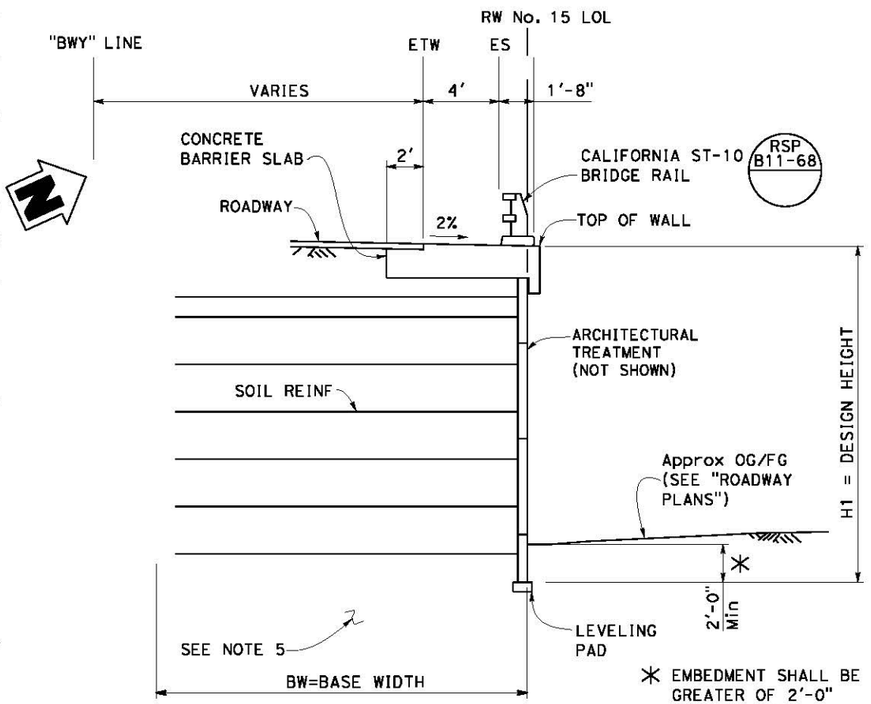
NOTES:

1. For general notes, see "GENERAL NOTES" sheet.
2. For MSE wall panel layout and wiremat details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 2" sheet.
3. For all other details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 1 THROUGH DETAILS No. 8" sheets.
4. For architectural details, see "ARCHITECTURE TREATMENT DETAILS No. 2" sheet.
5. For soil cement treatment under MSE walls, see "ROADWAY PLANS".
6. For details of Wire Inspection "PATTERN A", see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 8" sheet.



PLAN

SCALE: 1" = 10'



✳ EMBEDMENT SHALL BE GREATER OF 2'-0" OR 0.1 x H1

TYPICAL SECTION

NO SCALE

LEGEND:

⇨ Indicates direction of traffic

[xx.xx] Indicates elev at bottom of leveling pad

X DESIGN OVERSIGHT	DESIGN	BY G.A.CARROLL	CHECKED H. HAKIMI	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 DESIGN VEHICLE
X SIGN OFF DATE	DETAILS	BY N. HUTTON	CHECKED X	LAYOUT	BY T. SILVA / CHECKED A. BHOI
	QUANTITIES	BY X	CHECKED X	SPECIFICATIONS	BY D. HARNAGEL / PLANS AND SPECS COMPARED X

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG
PROJECT ENGINEER

BRIDGE NO. 35E0043
POST MILES X

RETAINING WALL No. 15
GENERAL PLAN

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 5-9-12

SHEET 3 OF 31

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER — X — DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — CHAO GONG — No. No. C53837 — Exp. 9-30-13 — CIVIL — STATE OF CALIFORNIA

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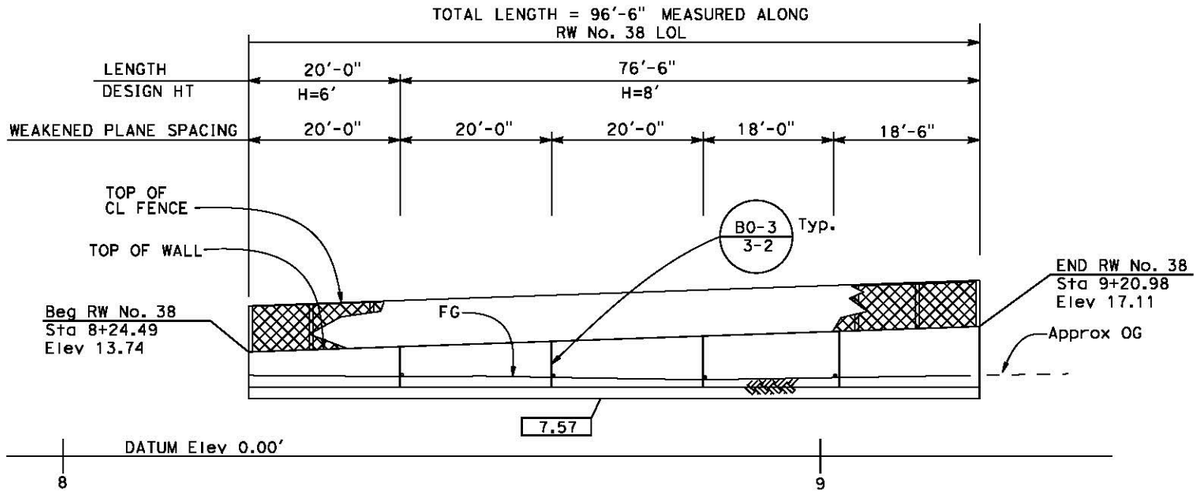
SMCTA
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997



MIRRORED ELEVATION

SCALE: 1" = 20'

LEGEND:

⇨ Indicates direction of traffic

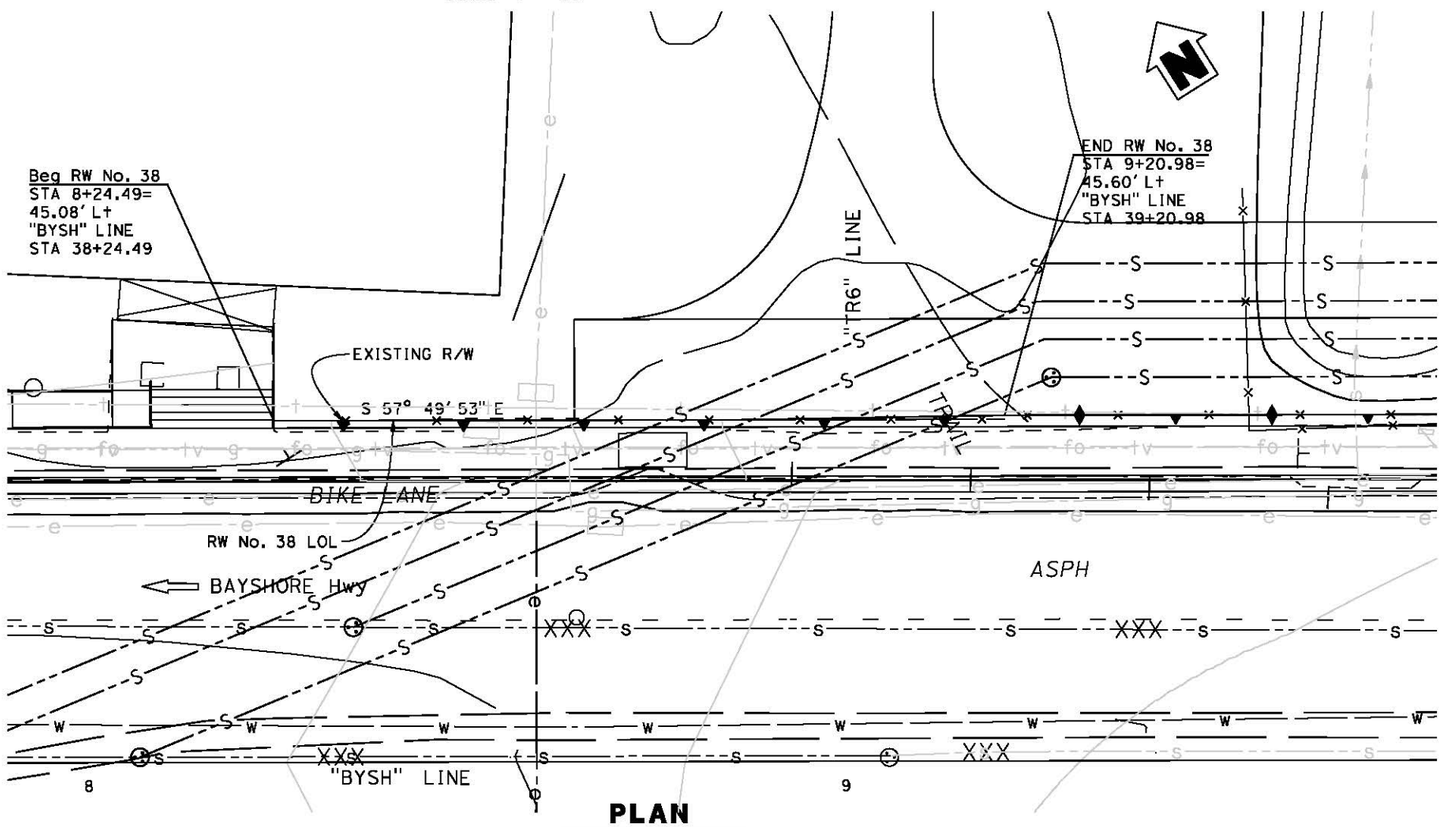
xx.xx — Indicates elev at bottom of leveling pad

NOTES:

1. For general notes, see "GENERAL NOTES" sheet.
2. For architectural details and shear key details, see "ARCHITECTURAL TREATMENT DETAILS No. 1" sheet.
3. For soil cement treatment under foundation, see "ROADWAY PLANS".

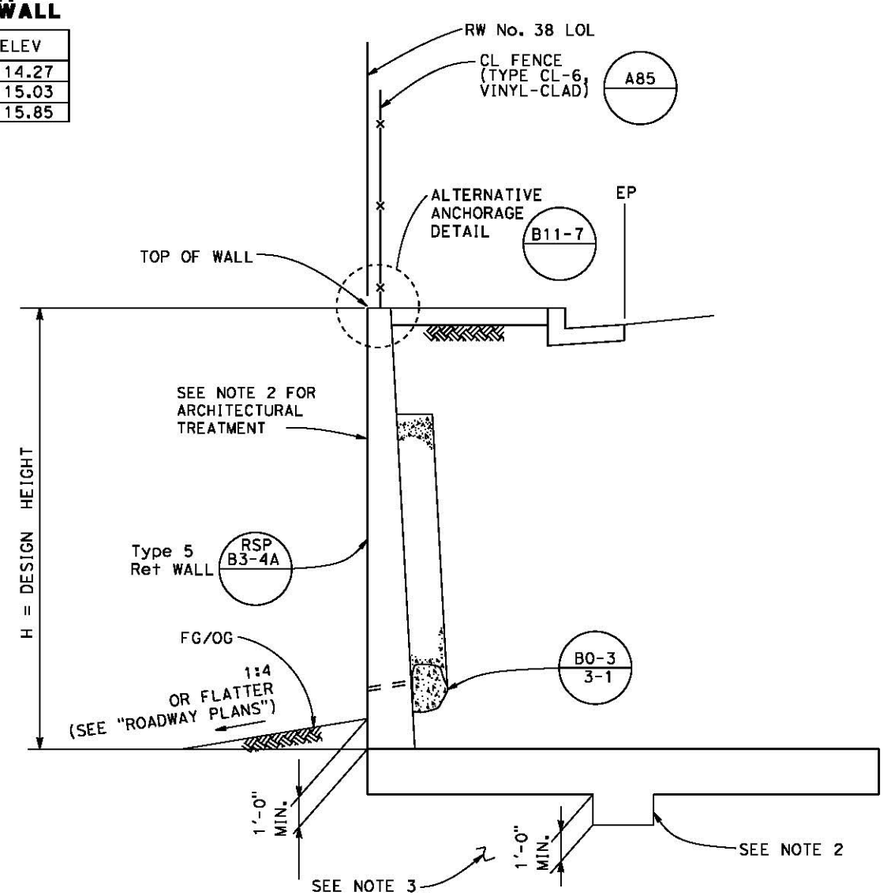
ELEV AT TOP OF WALL

STA	ELEV
8+40	14.27
8+60	15.03
8+80	15.85



PLAN

SCALE: 1" = 20'



TYPICAL SECTION

NO SCALE

X — DESIGN OVERSIGHT	DESIGN	BY G.A.CARROLL	CHECKED H. HAKIMI	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 DESIGN VEHICLE	
X — SIGN OFF DATE	DETAILS	BY N. HUTTON	CHECKED X	LAYOUT	BY T. SILVA	CHECKED A. BHOI
	QUANTITIES	BY X	CHECKED X	SPECIFICATIONS	BY D. HARNAGEL	PLANS AND SPECS COMPARED X

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG — PROJECT ENGINEER

BRIDGE NO. 35E0040 — POST MILES X

RETAINING WALL No. 38
GENERAL PLAN

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 — CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 8-9-12

SHEET 4 OF 31

FILE => $REQUEST

USERNAME => $USER — DATE PLOTTED => $DATE — TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER CHAO GONG No. No. C53837 Exp. 9-30-13 CIVIL STATE OF CALIFORNIA

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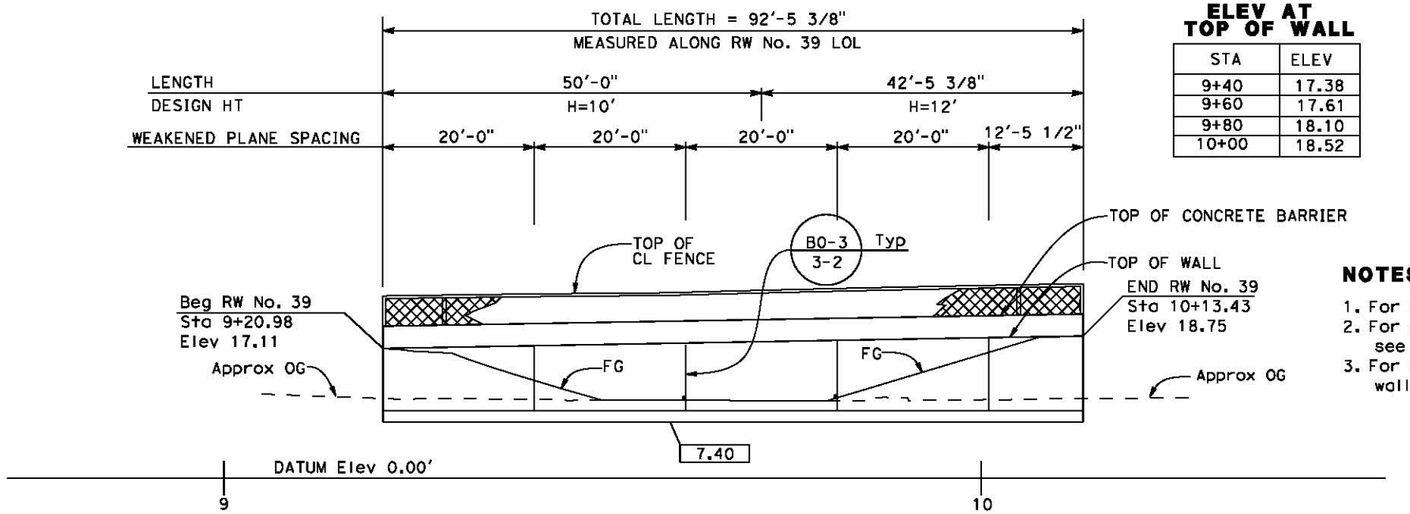
URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997



MIRRORED ELEVATION

SCALE: 1" = 20'

ELEV AT TOP OF WALL

STA	ELEV
9+40	17.38
9+60	17.61
9+80	18.10
10+00	18.52

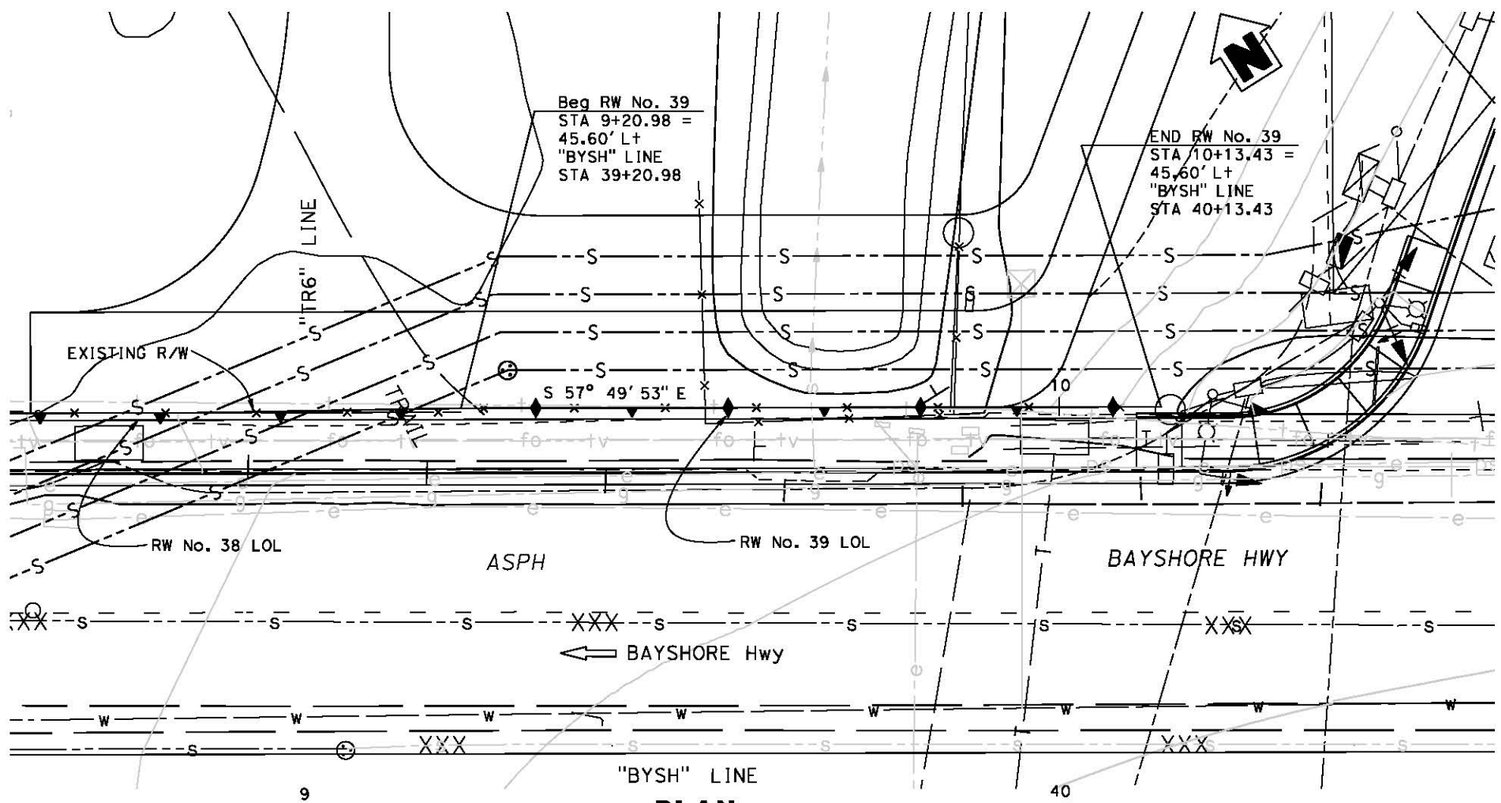
LEGEND:

Indicates direction of traffic

xx.xx Indicates elev at bottom of leveling pad

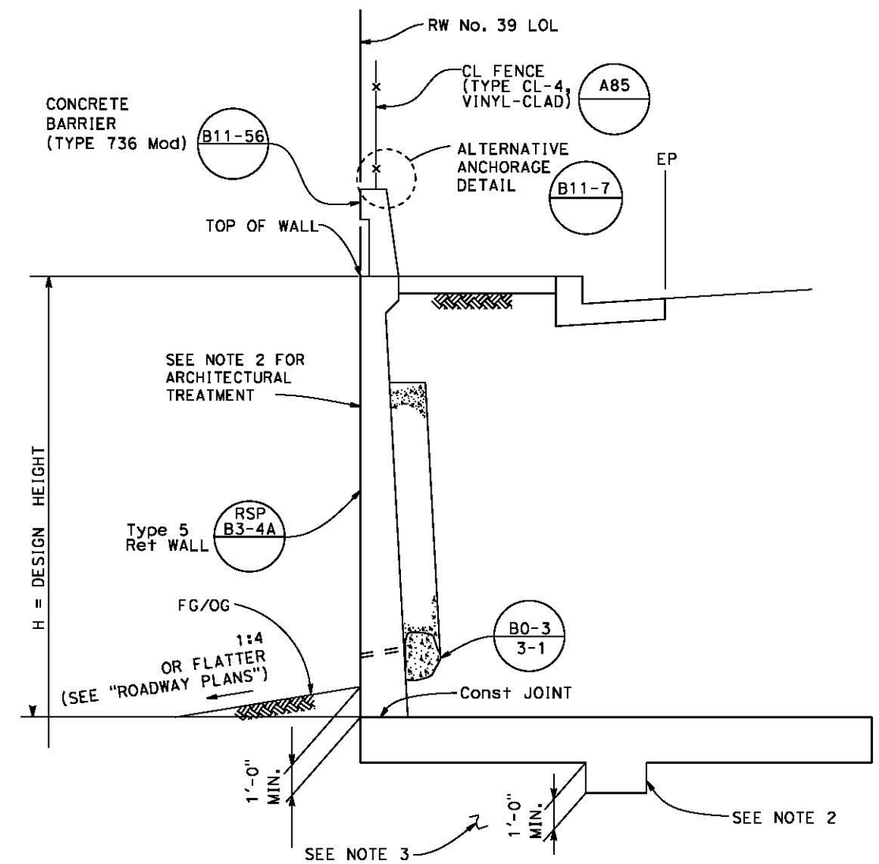
NOTES:

1. For general notes, see "GENERAL NOTES" sheet.
2. For architectural details and shear key details, see "ARCHITECTURAL TREATMENT DETAILS No. 1" sheet.
3. For soil cement treatment under foundation walls, see "ROADWAY PLANS".



PLAN

SCALE: 1" = 20'



TYPICAL SECTION

NO SCALE

X DESIGN OVERSIGHT	DESIGN	BY G.A.CARROLL	CHECKED H. HAKIMI	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 DESIGN VEHICLE
X SIGN OFF DATE	DETAILS	BY N. HUTTON	CHECKED X	LAYOUT	BY T. SILVA / CHECKED A. BHOI
	QUANTITIES	BY X	CHECKED X	SPECIFICATIONS	BY D. HARNAGEL / PLANS AND SPECS COMPARED X

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG
PROJECT ENGINEER

BRIDGE NO. 35E0041
POST MILES X

RETAINING WALL No. 39
GENERAL PLAN

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES 8-9-12

REVISION DATES | SHEET 5 OF 31

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER CHAO GONG No. No. C53837 Exp. 9-30-13 CIVIL STATE OF CALIFORNIA

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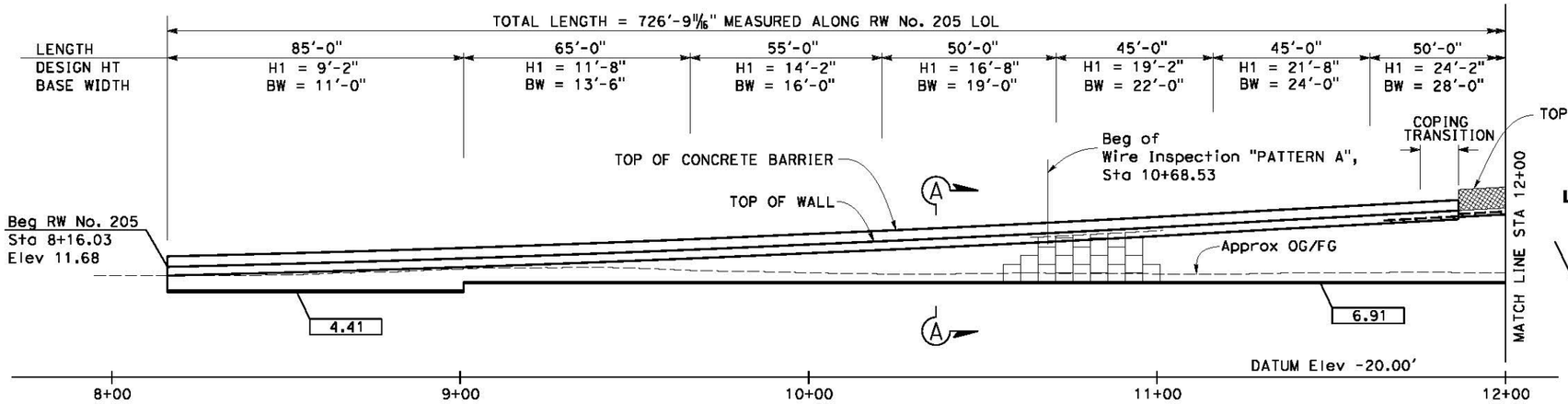
SAN CARLOS, CA 94070-1306

URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997



DEVELOPED ELEVATION

SCALE: 1" = 20'

LEGEND:

⇨ Indicates direction of traffic

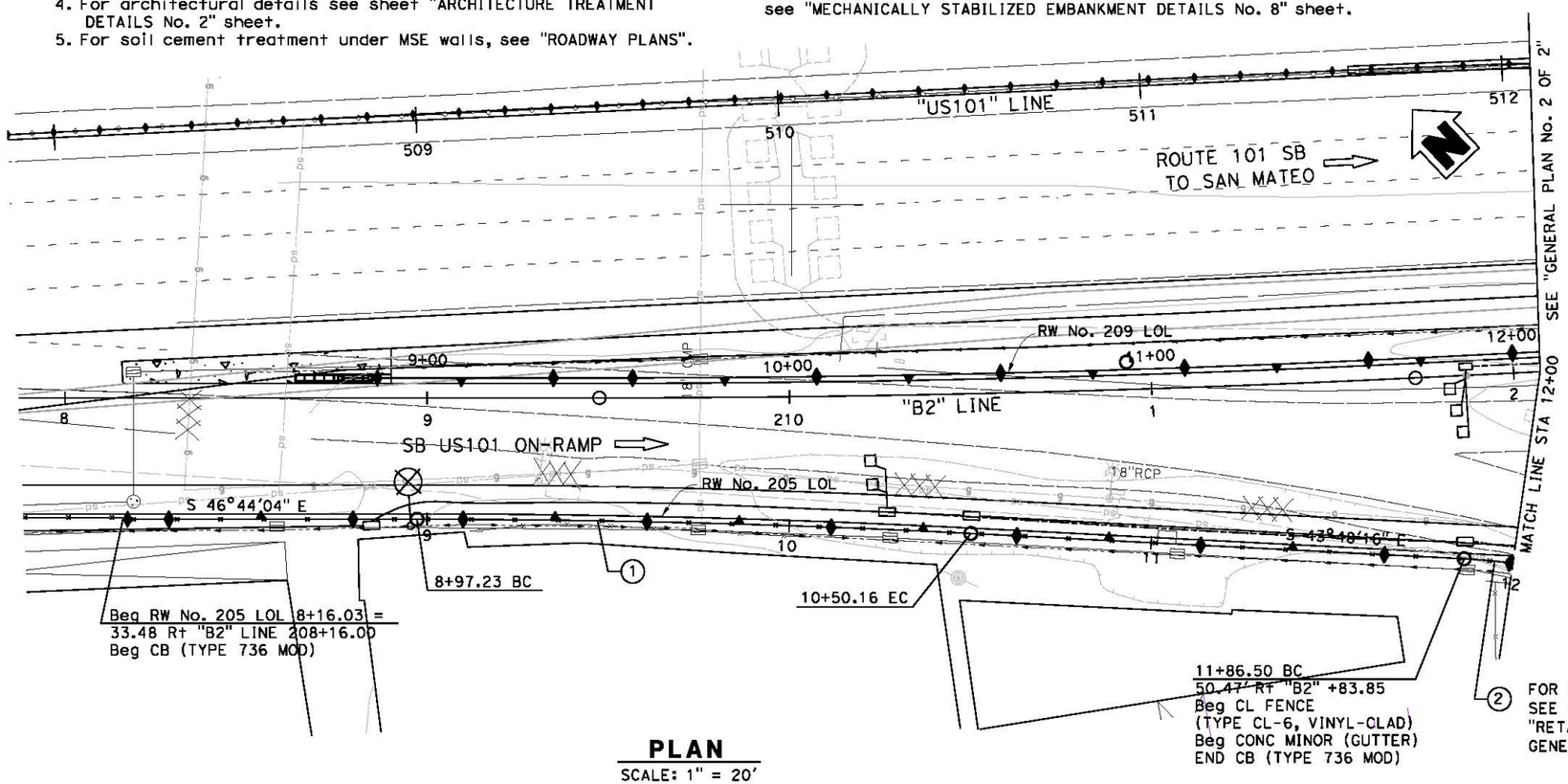
xx.xx Indicates elev at bottom of leveling pad

ELEV AT TOP OF WALL

STA	ELEV	STA	ELEV	STA	ELEV
8+20	11.77	10+60	20.95	13+00	25.29
8+40	12.27	10+80	21.98	13+20	21.99
8+60	12.82	11+00	23.07	13+40	18.65
8+80	13.42	11+20	24.21	13+60	15.25
9+00	14.08	11+40	25.35	13+80	14.63
9+20	14.78	11+60	26.42	14+00	17.12
9+40	15.55	11+80	27.53	14+20	19.70
9+60	16.36	12+00	28.54	14+40	22.27
9+80	17.23	12+20	29.49	14+60	24.25
10+00	18.14	12+40	30.32	14+80	25.19
10+20	19.02	12+60	30.65	15+00	24.34
10+40	19.96	12+80	28.47	15+20	23.34
				15+40	22.35

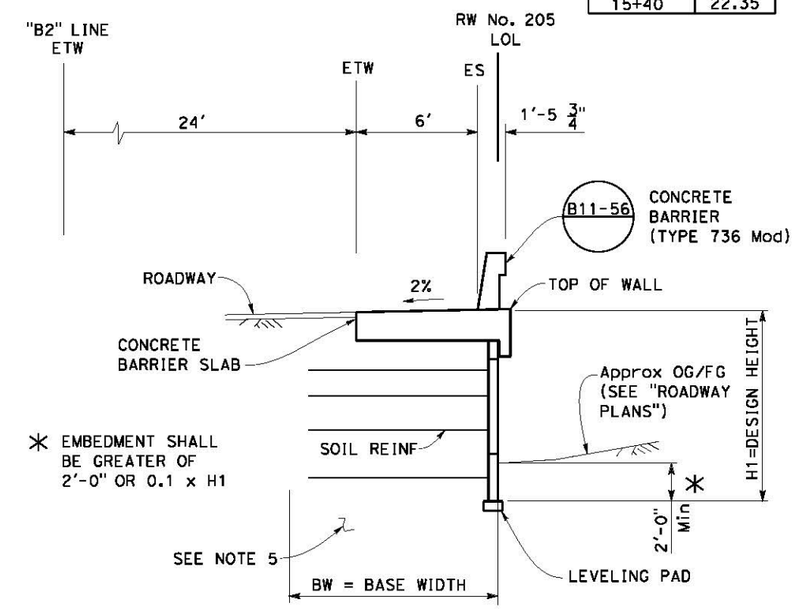
NOTES:

1. For general notes, see "GENERAL NOTES" sheet.
2. For MSE wall panel layout and wiremat details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 2" sheet.
3. For all other details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 1 THROUGH DETAILS No. 8" sheets.
4. For architectural details see sheet "ARCHITECTURE TREATMENT DETAILS No. 2" sheet.
5. For soil cement treatment under MSE walls, see "ROADWAY PLANS".
6. In case of overlapping the base width between different walls the contractor shall stagger the soil reinforcement layers, subject to approval by engineer. Soil reinforcement layers in overlapping zone shall be separated by at least 4" of soil.
7. For details of Wire Inspection "PATTERN A", see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 8" sheet.



PLAN

SCALE: 1" = 20'



STA 8+16.00 TO STA 11+86.50

SECTION A-A

NO SCALE

X DESIGN OVERSIGHT	DESIGN	BY G.A.CARROLL	CHECKED H. HAKIMI	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 DESIGN VEHICLE
X SIGN OFF DATE	DETAILS	BY N. HUTTON	CHECKED X	LAYOUT: BY T. SILVA	CHECKED A. BHOI
	QUANTITIES	BY X	CHECKED X	SPECIFICATIONS: BY D. HARNAGEL	PLANS AND SPECS COMPARED X

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG
PROJECT ENGINEER

BRIDGE NO. 35E0038
POST MILES X

RETAINING WALL No. 205
GENERAL PLAN No. 1

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 8-9-12

SHEET 6 OF 31

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER CHAO GONG No. No. C53837 Exp. 9-30-13 CIVIL STATE OF CALIFORNIA

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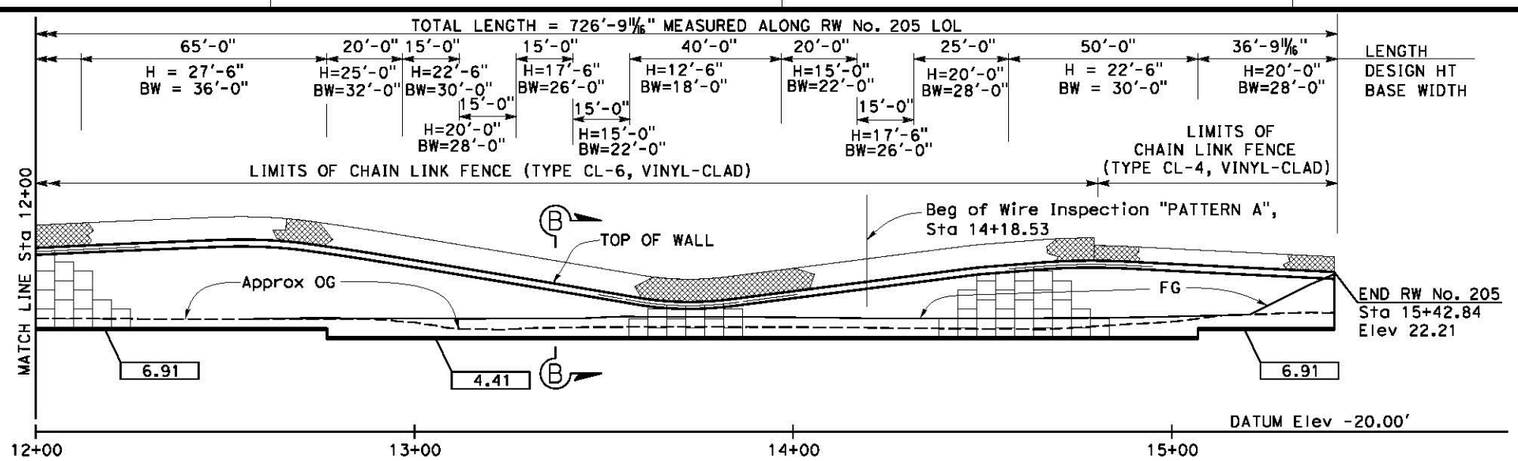
URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997



DEVELOPED ELEVATION

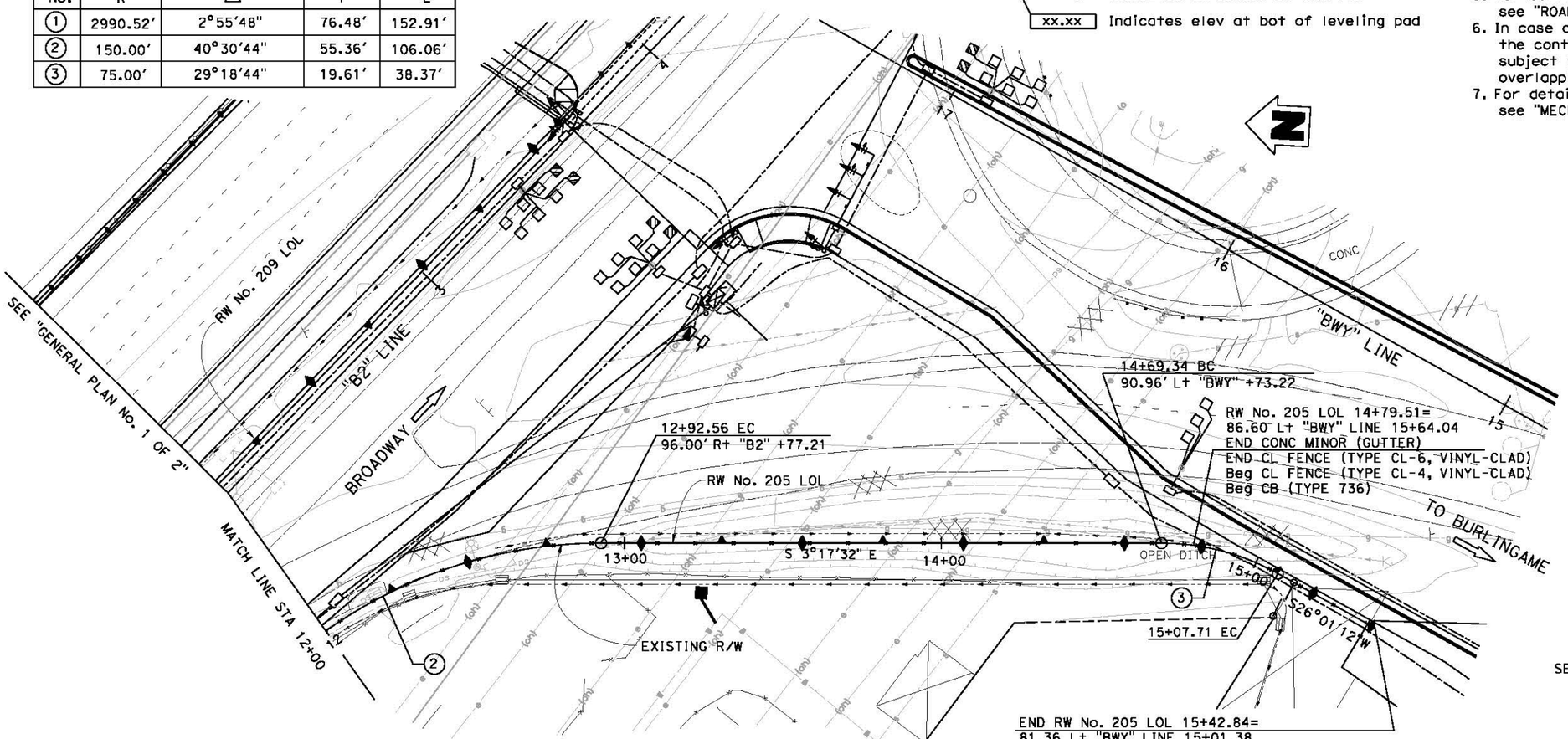
SCALE: 1" = 20'

CURVE DATA				
No.	R	Δ	T	L
1	2990.52'	2°55'48"	76.48'	152.91'
2	150.00'	40°30'44"	55.36'	106.06'
3	75.00'	29°18'44"	19.61'	38.37'

LEGEND:

Indicates direction of traffic

xx.xx Indicates elev at bot of leveling pad

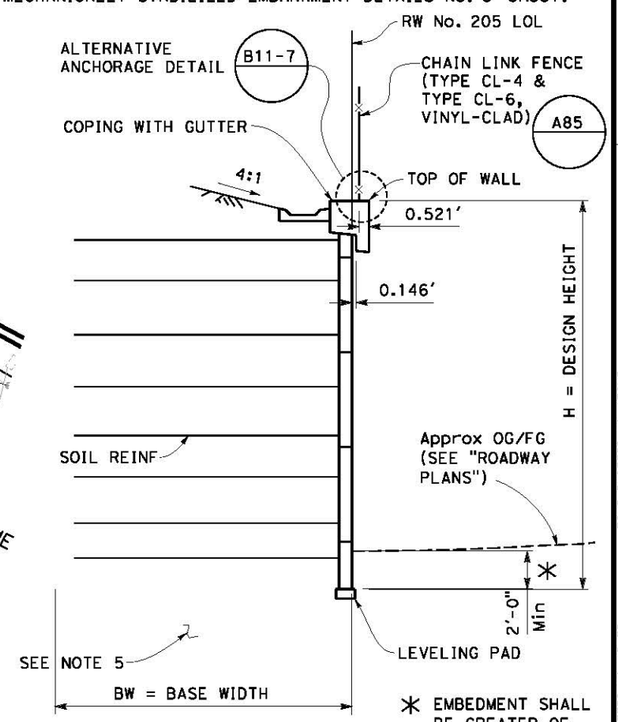


PLAN

SCALE: 1" = 20'

NOTES:

1. For general notes, see "GENERAL NOTES" sheet.
2. For MSE wall panel layout and wiremat details see. "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 2" sheet.
3. For all other details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 1 THROUGH DETAILS No. 8" sheets.
4. For architectural details, see "ARCHITECTURE TREATMENT DETAILS No. 2" sheet.
5. For soil cement treatment under MSE walls, see "ROADWAY PLANS".
6. In case of overlapping the base width between different walls the contractor shall stagger the soil reinforcement layers, subject to approval by engineer. Soil reinforcement layers in overlapping zone shall be separated by at least 4" of soil.
7. For details of Wire Inspection "PATTERN A", see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 8" sheet.



STA 11+86.50 TO 15+42.84

SECTION B-B

NO SCALE

X DESIGN OVERSIGHT	DESIGN	BY G.A.CARROLL	CHECKED H. HAKIMI	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 DESIGN VEHICLE	
X SIGN OFF DATE	DETAILS	BY N. HUTTON	CHECKED X	LAYOUT	BY T. SILVA	CHECKED A. BHOI
	QUANTITIES	BY X	CHECKED X	SPECIFICATIONS	BY D. HARNAGEL	PLANS AND SPECS COMPARED X

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG
PROJECT ENGINEER

BRIDGE NO. 35E0038
POST MILES X

RETAINING WALL No. 205
GENERAL PLAN No. 2

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 8-9-12

SHEET 7 OF 31

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER CHAO GONG No. No. C53837 Exp. 9-30-13 CIVIL STATE OF CALIFORNIA

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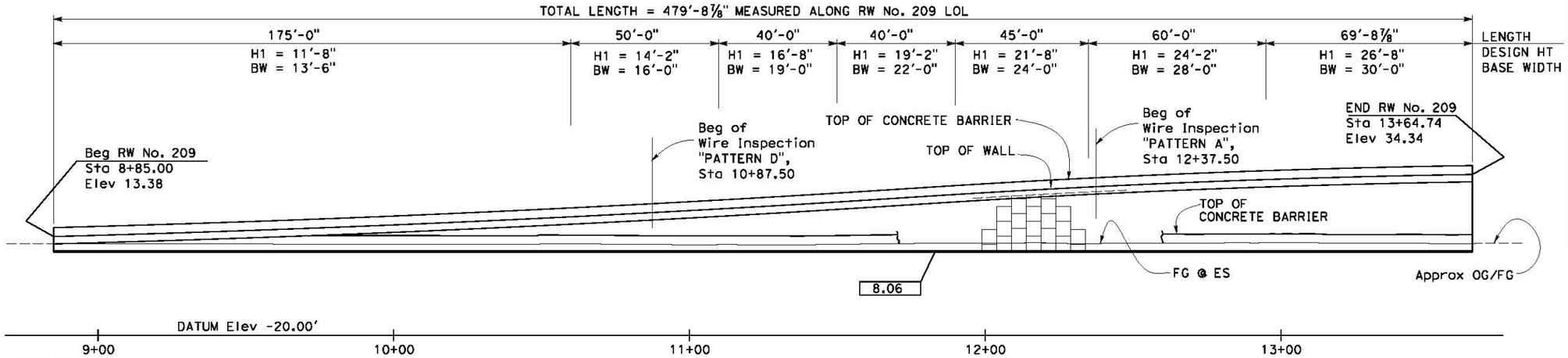
SAN CARLOS, CA 94070-1306

URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997



DEVELOPED MIRRORED ELEVATION

SCALE: 1" = 20'

NOTES:

1. For general notes, see "GENERAL NOTES" sheet.
2. For MSE wall panel layout and wiremat details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 2" sheet.
3. For all other details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 1 THROUGH DETAILS No. 8" sheets.
4. For architectural details, see "ARCHITECTURE TREATMENT DETAILS No. 2" sheet.
5. For soil cement treatment under MSE walls, see "ROADWAY PLANS".
6. In case of overlapping the base width between different walls the contractor shall stagger the soil reinforcement layers, subject to approval by engineer. Soil reinforcement layers in overlapping zone shall be separated by at least 4" of soil.
7. For details of Wire Inspection "PATTERN A" & "PATTERN D", see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 8" sheet.

CURVE DATA

No.	R	Δ	T	L
1	4594.52'	2°48'25"	112.56'	225.06'

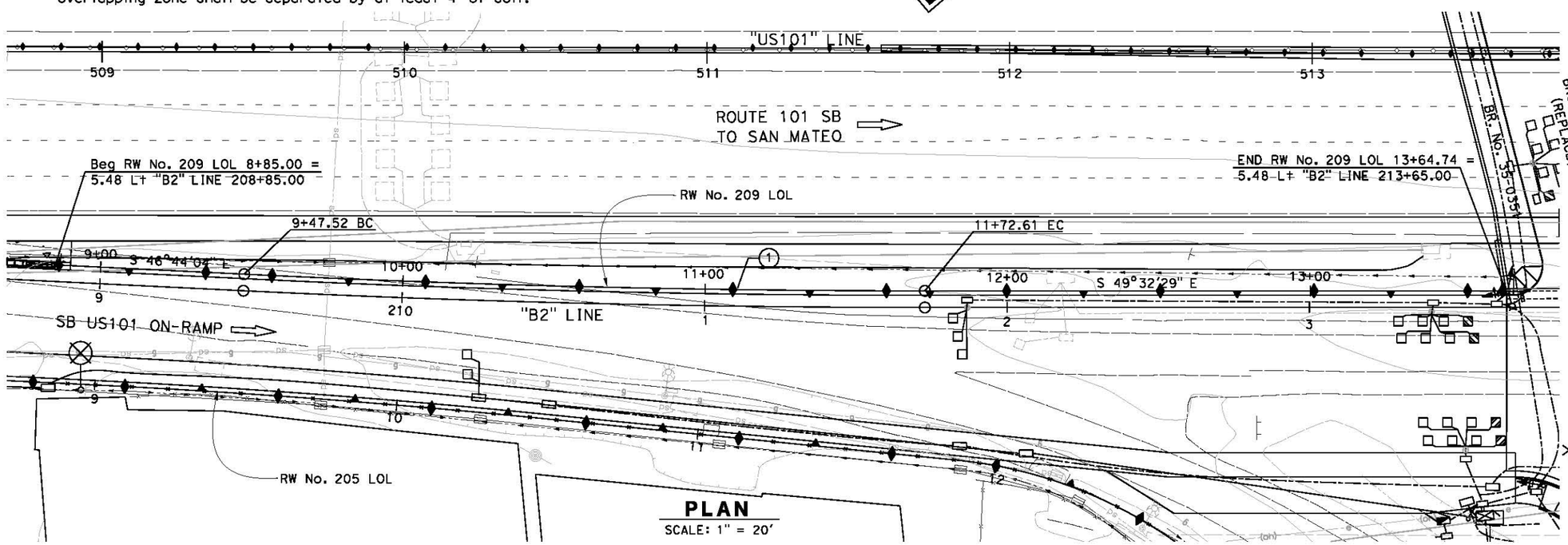
LEGEND:

Indicates direction of traffic

xx.xx Indicates elev at bottom of leveling pad

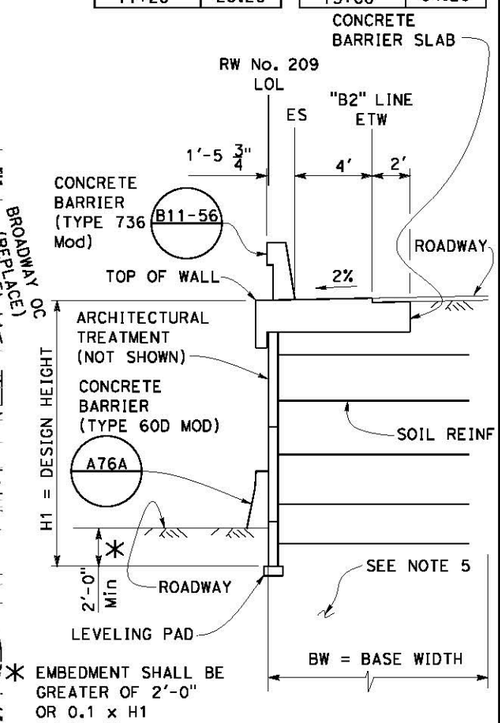
ELEV AT TOP OF WALL

STA	ELEV	STA	ELEV
9+00	13.80	11+40	24.44
9+20	14.40	11+60	25.68
9+40	15.05	11+80	26.95
9+60	15.74	12+00	28.19
9+80	16.50	12+20	29.32
10+00	17.30	12+40	30.35
10+20	18.17	12+60	31.26
10+40	19.08	12+80	32.08
10+60	20.05	13+00	32.78
10+80	21.07	13+20	33.38
11+00	22.14	13+40	33.88
11+20	23.26	13+60	34.26



PLAN

SCALE: 1" = 20'



TYPICAL SECTION

NO SCALE

X DESIGN OVERSIGHT	DESIGN	BY G.A.CARROLL	CHECKED H. HAKIMI	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 DESIGN VEHICLE		
X SIGN OFF DATE	DETAILS	BY N. HUTTON	CHECKED X	LAYOUT	BY T. SILVA	CHECKED A. BHOI	
	QUANTITIES	BY X	CHECKED X	SPECIFICATIONS	BY D. HARNAGEL	PLANS AND SPECS COMPARED X	

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG
PROJECT ENGINEER

BRIDGE NO. 35E0039
POST MILES X

RETAINING WALL No. 209
GENERAL PLAN

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 8-9-12

SHEET 8 OF 31

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER CHAO GONG No. C53837 Exp. 9-30-13 CIVIL STATE OF CALIFORNIA

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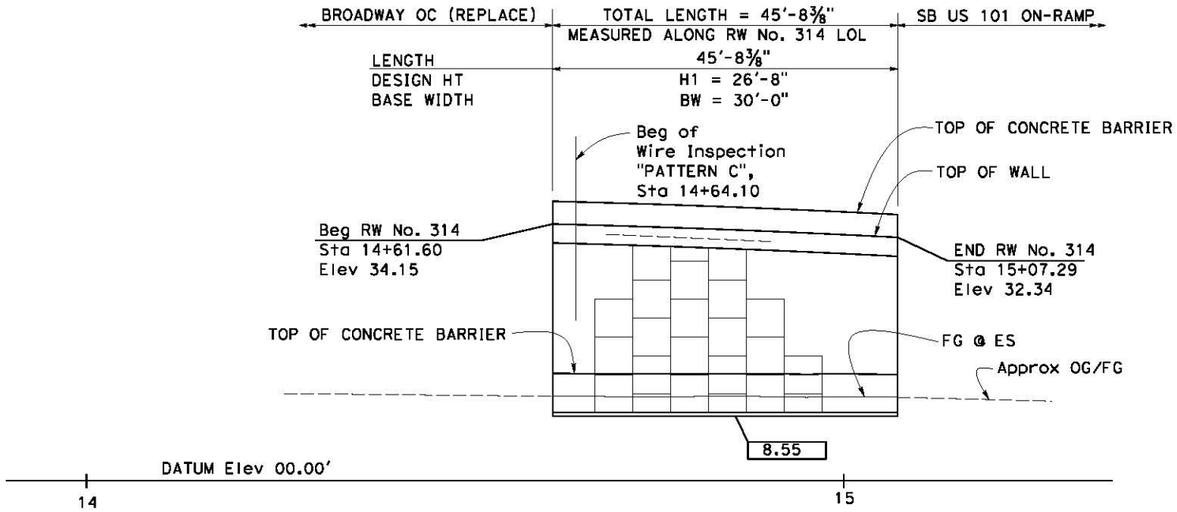


MIRRORED ELEVATION

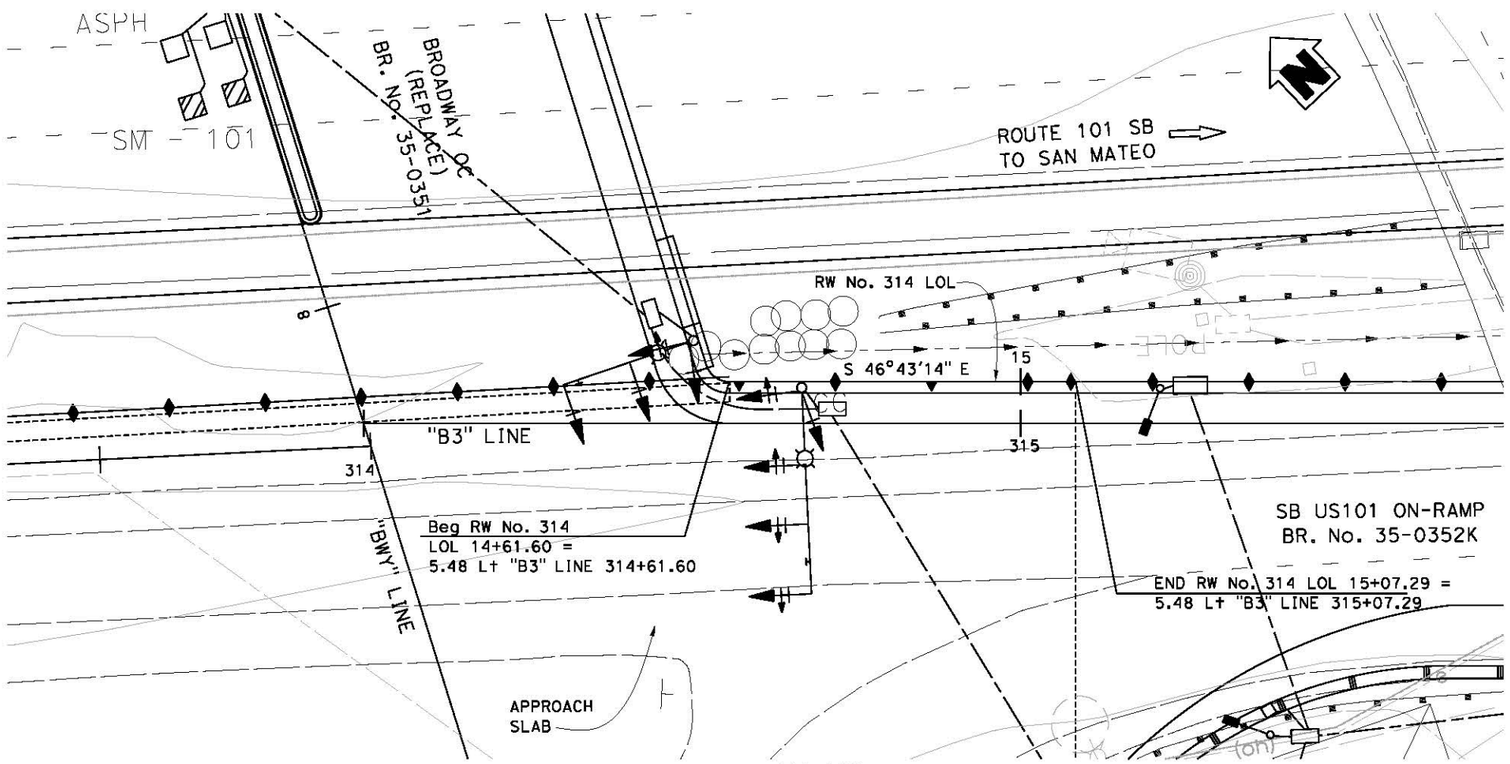
SCALE: 1" = 10'

NOTES:

1. For general notes, see "GENERAL NOTES" sheet.
2. For MSE wall panel layout and wiremat details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 2" sheet.
3. For all other details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 1 THROUGH DETAILS No. 8" sheets.
4. For architectural details, see "ARCHITECTURE TREATMENT DETAILS No. 2" sheet.
5. For soil cement treatment under MSE walls, see "ROADWAY PLANS".
6. For details of Wire Inspection "PATTERN C", see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 8" sheet.

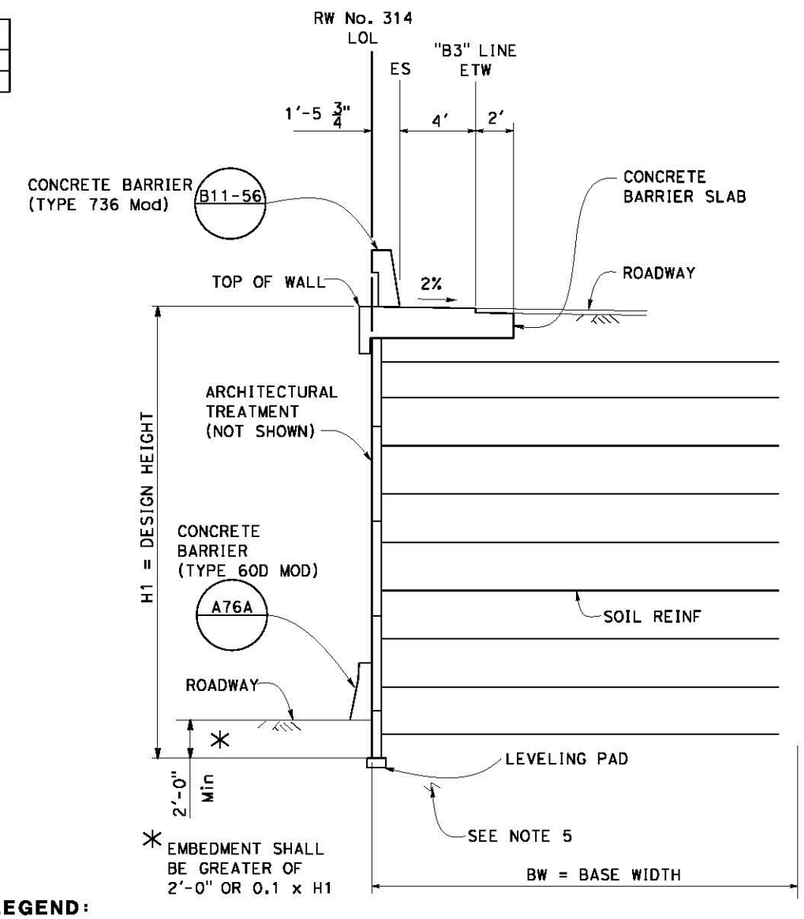
ELEV AT TOP OF WALL

STA	ELEV
14+80	33.58
15+00	32.72



PLAN

SCALE: 1" = 10'



LEGEND:

⇨ Indicates direction of traffic

XX.XX Indicates elev at bottom of leveling pad

TYPICAL SECTION

NO SCALE

X DESIGN OVERSIGHT	DESIGN	BY G.A.CARROLL	CHECKED H. HAKIMI	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 DESIGN VEHICLE
X SIGN OFF DATE	DETAILS	BY N. HUTTON	CHECKED X	LAYOUT	BY T. SILVA / CHECKED A. BHOJ
	QUANTITIES	BY X	CHECKED X	SPECIFICATIONS	BY D. HARNAGEL / PLANS AND SPECS COMPARED X

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG
PROJECT ENGINEER

BRIDGE NO. 35E0042
POST MILES X

RETAINING WALL No. 314
GENERAL PLAN

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

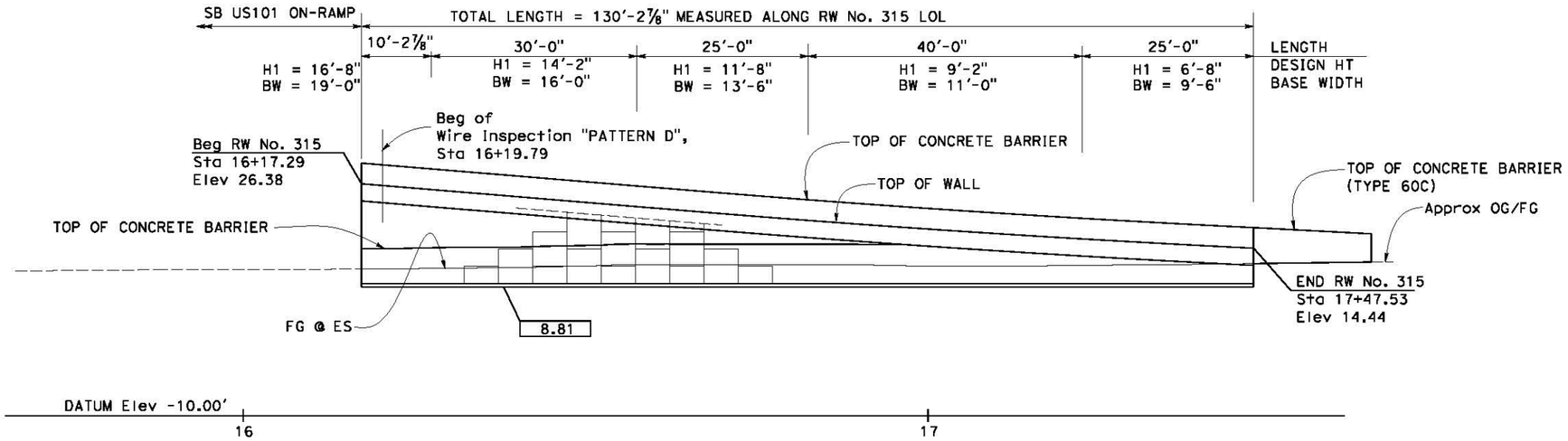
DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 8-9-12

SHEET 9 OF 31

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME



ELEV AT TOP OF WALL

STA	ELEV
16+40	21.96
16+60	20.30
16+80	18.69
17+00	17.24
17+20	15.95
17+40	14.82

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER CHAO GONG No. C53837 Exp. 9-30-13 CIVIL STATE OF CALIFORNIA

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SMCTA
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SAN CARLOS, CA 94070-1306

URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997

NOTES:

1. For general notes, see "GENERAL NOTES" sheet.
2. For MSE wall panel layout and wiremat details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 2" sheet.
3. For all other details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 1 THROUGH DETAILS No. 8" sheets.
4. For architectural details, see "ARCHITECTURE TREATMENT DETAILS No. 2" sheet.
5. For soil cement treatment under MSE walls, see "ROADWAY PLANS".
6. In case of overlapping the base width between different walls the contractor shall stagger the soil reinforcement layers, subject to approval by engineer. Soil reinforcement layers in overlapping zone shall be separated by at least 4" of soil.
7. For details of Wire Inspection "PATTERN D", see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 8" sheet.

DEVELOPED MIRRORED ELEVATION

SCALE: 1" = 10'

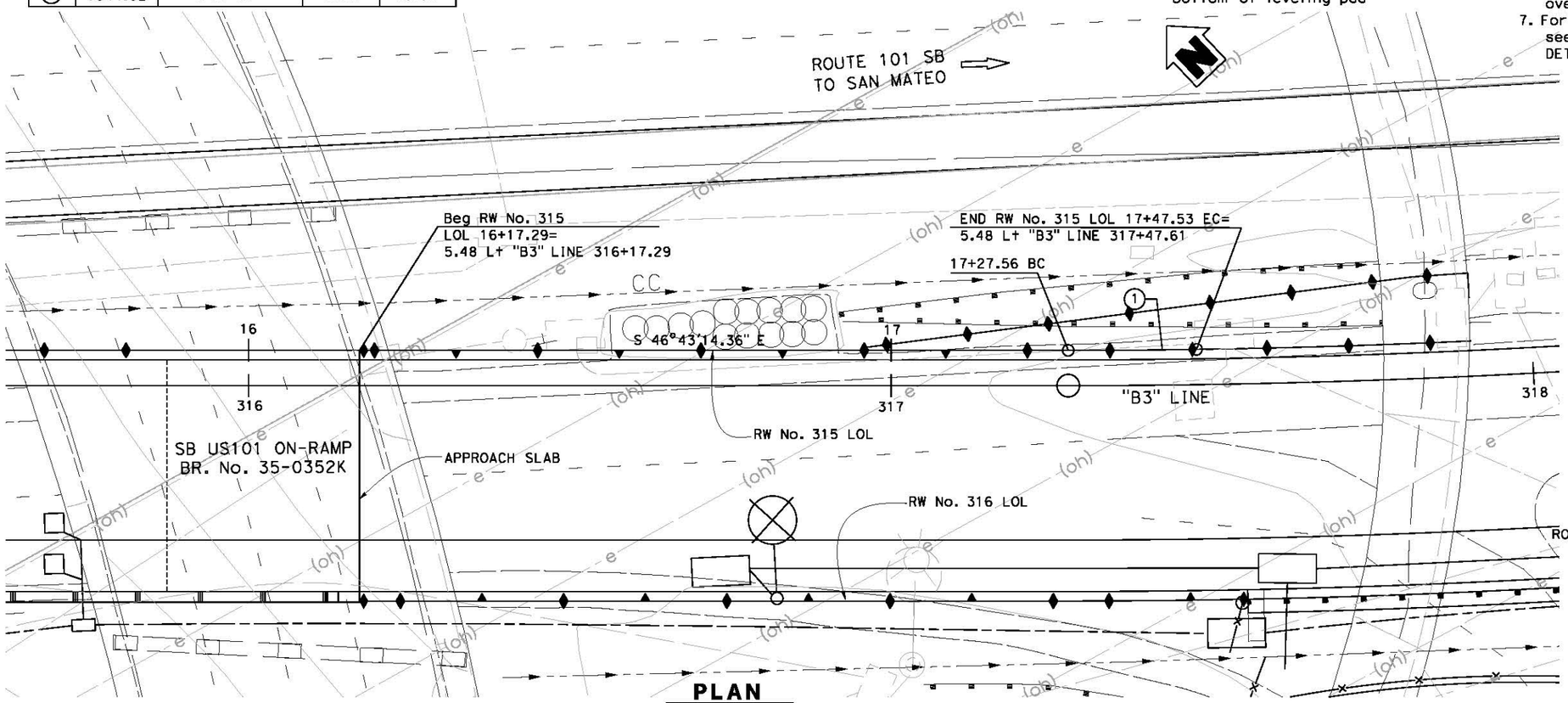
CURVE DATA

No.	R	Δ	T	L
1	1344.52'	0°51'04"	9.99'	19.97'

LEGEND:

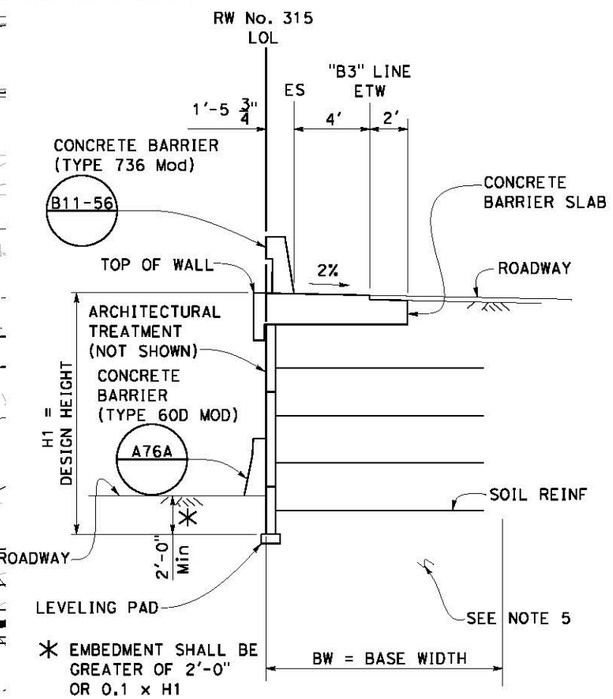
Indicates direction of traffic

xx.xx Indicates elev at bottom of leveling pad



PLAN

SCALE: 1" = 10'



TYPICAL SECTION

NO SCALE

X DESIGN OVERSIGHT	DESIGN	BY G.A.CARROLL	CHECKED H. HAKIMI	LOAD & RESISTANCE FACTOR DESIGN	LIVE LOADING: HL93 DESIGN VEHICLE	
X SIGN OFF DATE	DETAILS	BY N. HUTTON	CHECKED X	LAYOUT	BY T. SILVA	CHECKED A. BHOJ
	QUANTITIES	BY X	CHECKED X	SPECIFICATIONS	BY D. HARNAGEL	PLANS AND SPECS COMPARED X

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG
PROJECT ENGINEER

BRIDGE NO. 35E0044
POST MILES X

RETAINING WALL No. 315
GENERAL PLAN

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 5-9-12

SHEET 10 OF 31

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER CHAO GONG No. C53837 Exp. 9-30-13 CIVIL STATE OF CALIFORNIA

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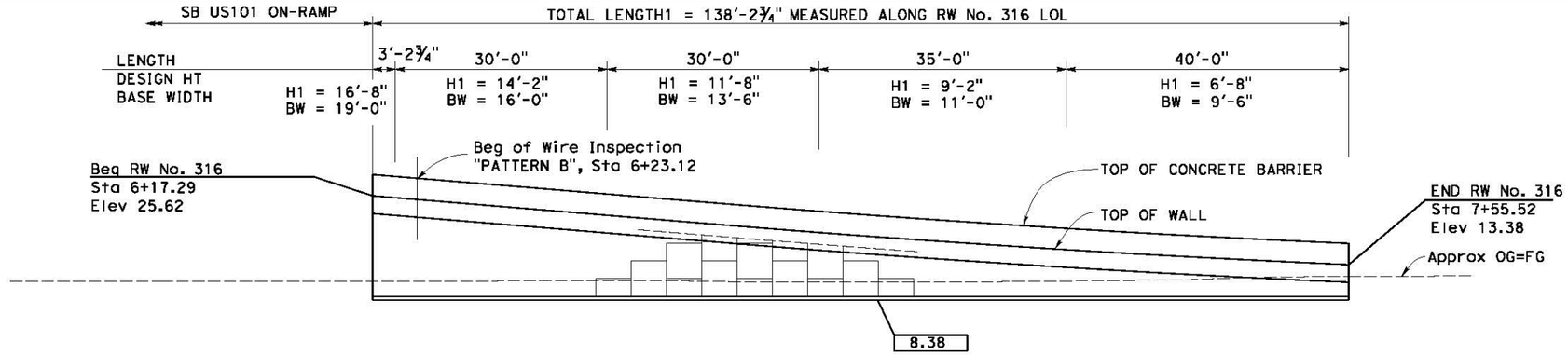
URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997



DEVELOPED ELEVATION

SCALE: 1" = 10'

ELEV AT TOP OF WALL

STA	ELEV
116+40	21.24
116+60	19.58
116+80	17.97
117+00	16.52
117+20	15.23
117+40	14.12

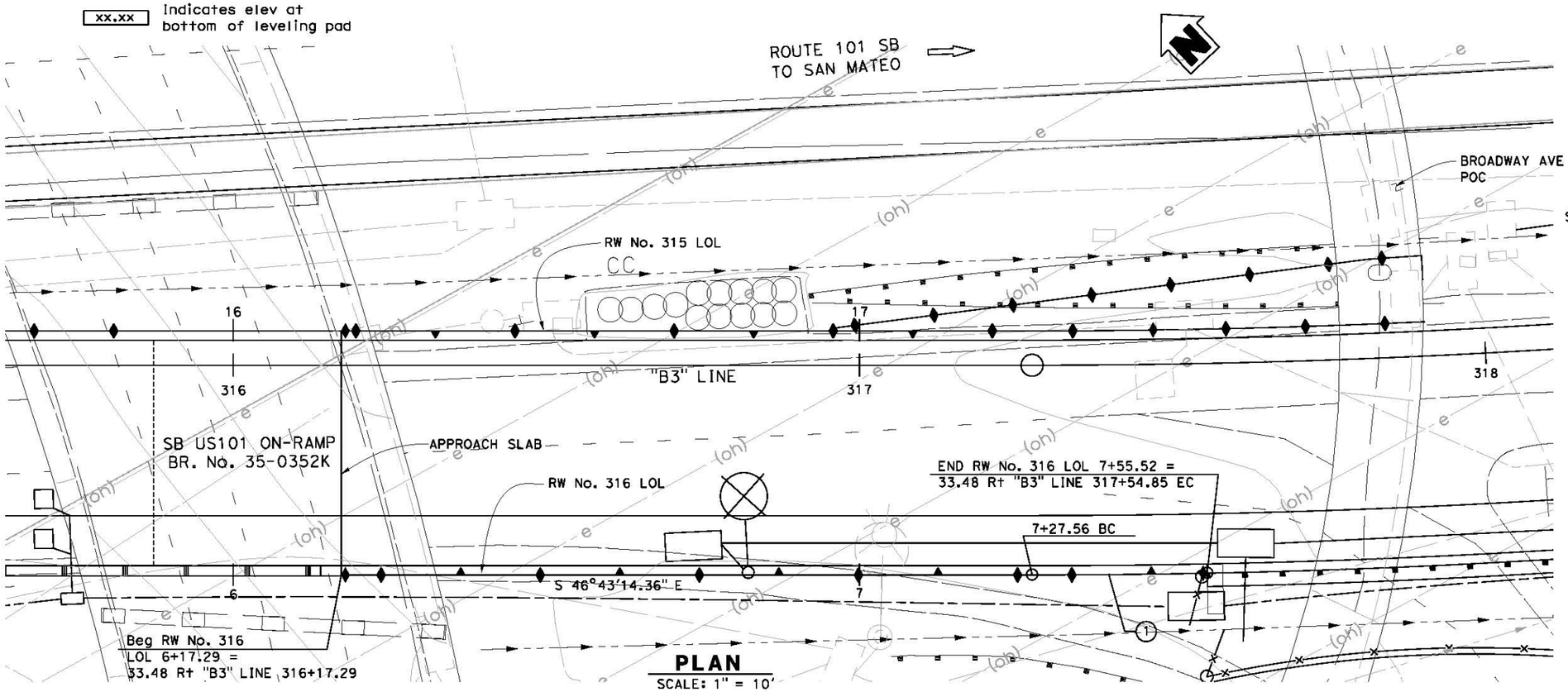
CURVE DATA

No.	R	Δ	T	L
1	1383.48'	1°09'29"	13.98'	27.96'

LEGEND:

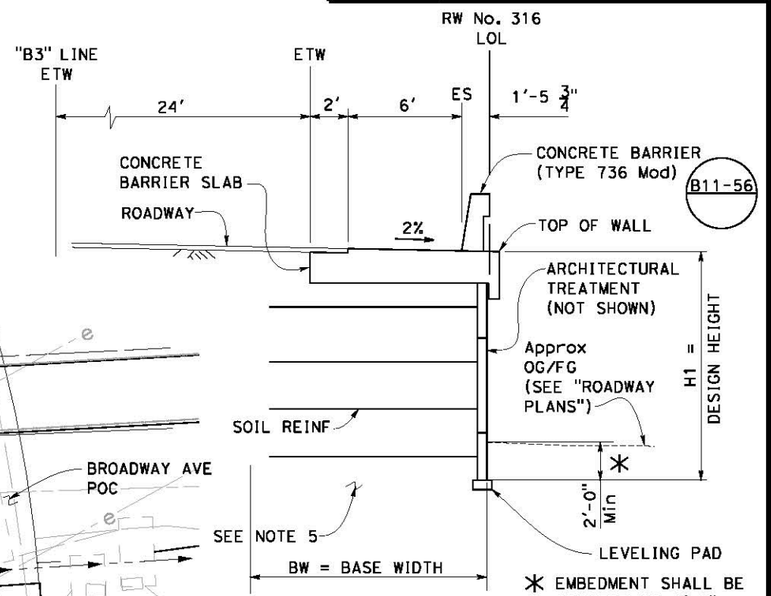
⇨ Indicates direction of traffic

xx.xx Indicates elev at bottom of leveling pad



PLAN

SCALE: 1" = 10'



* EMBEDMENT SHALL BE GREATER OF 2'-0" OR 0.1 x H1

TYPICAL SECTION

NO SCALE

NOTES:

1. For general notes, see "GENERAL NOTES" sheet.
2. For MSE wall panel layout and wiremat details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 2" sheet.
3. For all other details, see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 1 THROUGH DETAILS No. 8" sheets.
4. For architectural details, see "ARCHITECTURE TREATMENT DETAILS No. 2" sheet.
5. For soil cement treatment under MSE walls, see "ROADWAY PLANS".
6. In case of overlapping the base width between different walls the contractor shall stagger the soil reinforcement layers, subject to approval by engineer. Soil reinforcement layers in overlapping zone shall be separated by at least 4" of soil.
7. For details of Wire Inspection "PATTERN B", see "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 8" sheet.

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

	BY	CHECKED
DESIGN	G.A.CARROLL	H. HAKIMI
DETAILS	N. HUTTON	X
QUANTITIES	X	X

LOAD & RESISTANCE FACTOR DESIGN — LIVE LOADING: HL93 DESIGN VEHICLE

	BY	CHECKED
LAYOUT	T. SILVA	A. BHOI
SPECIFICATIONS	D. HARNAGEL	PLANS AND SPECS COMPARED X

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG
PROJECT ENGINEER

BRIDGE NO. 35E0045
POST MILES X

RETAINING WALL No. 316
GENERAL PLAN

DESIGN GENERAL PLAN SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 5-9-12

SHEET 11 OF 31

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER CHAO GONG No. No. C53837 Exp. 9-30-13 CIVIL STATE OF CALIFORNIA

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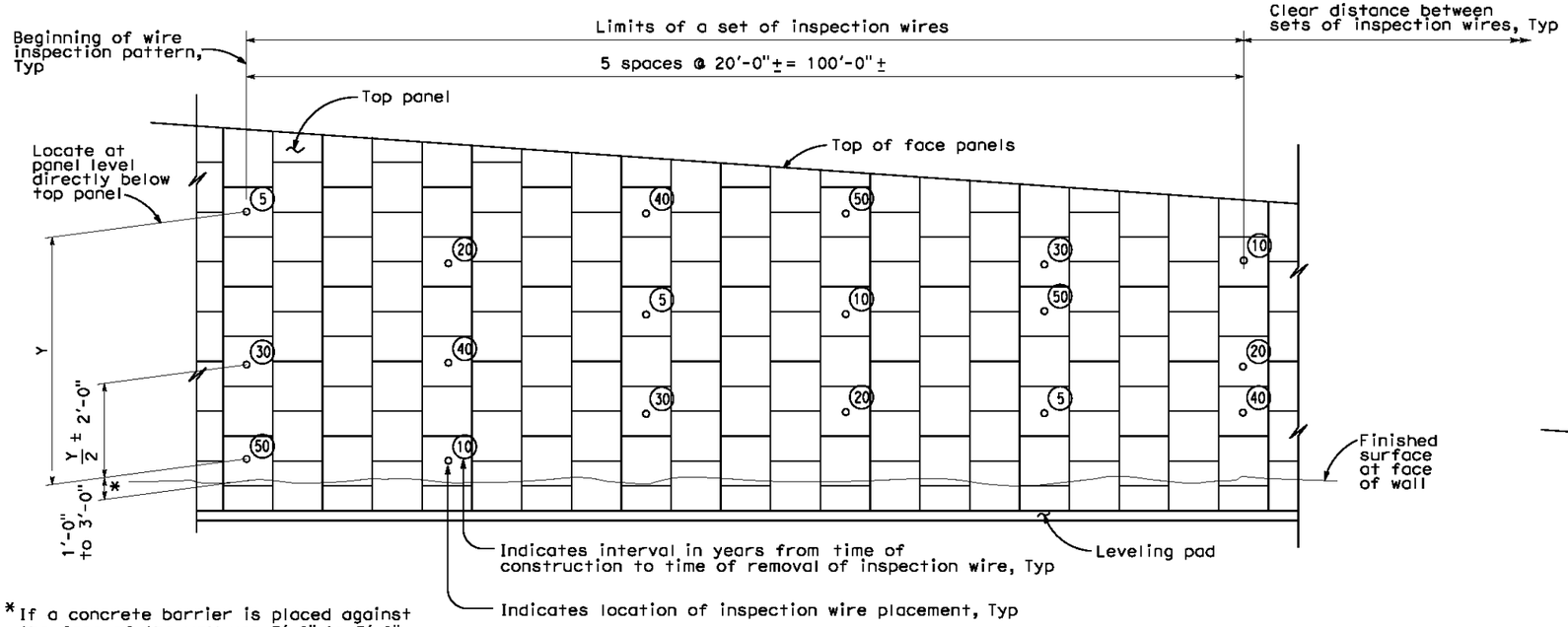
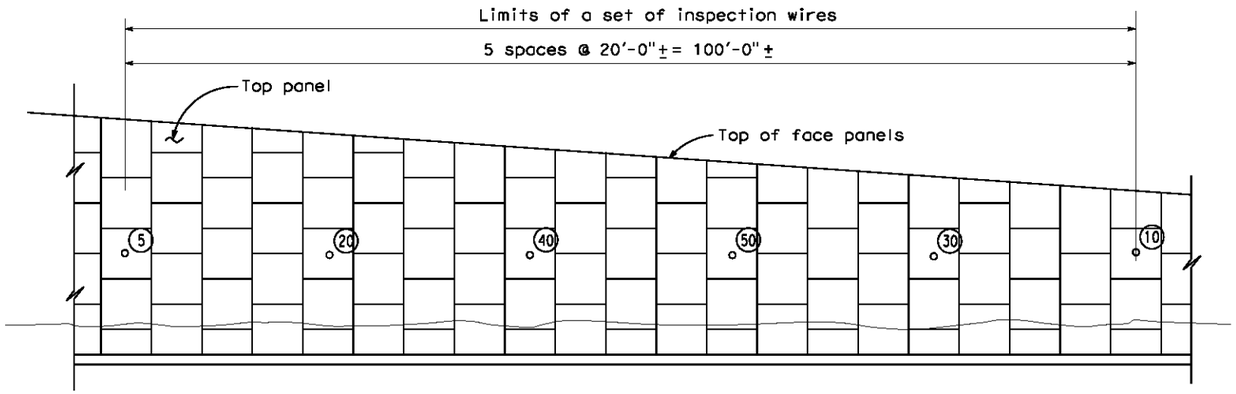
URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997

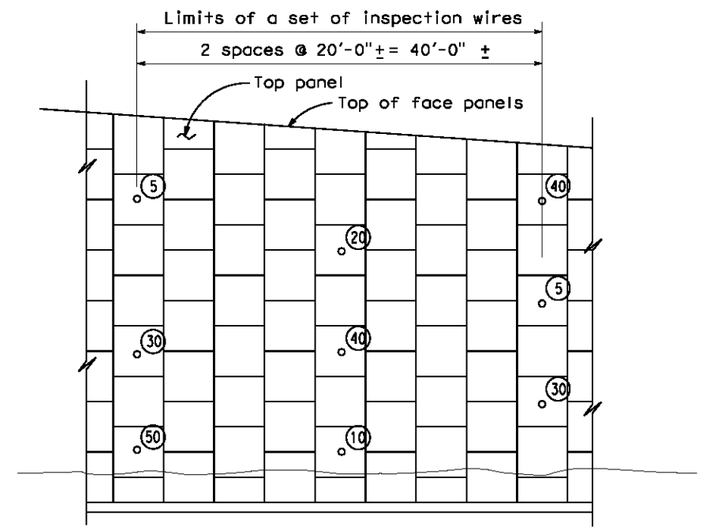


*If a concrete barrier is placed against the face of the wall use 3'-0" to 5'-0"

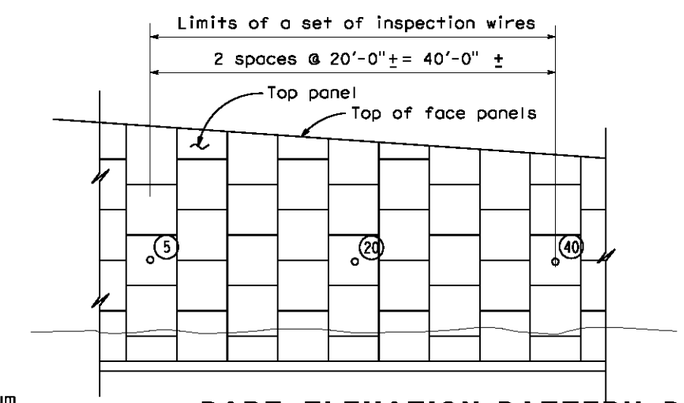
PART ELEVATION-PATTERN A



PART ELEVATION-PATTERN B



PART ELEVATION-PATTERN C



PART ELEVATION-PATTERN D

NOTES:

1. See sheet "MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 3" for additional details.
2. For walls with a design height greater than 17 feet, a set of eighteen inspection wires are required as shown on the typical layout. Sets of inspection wires along the LOL of a single MSE wall shall be spaced no greater than 500 feet apart.
3. Each set of eighteen inspection wires shall be placed in six columns spaced every four panels (20 feet apart) across the 100 foot long segment. Each column shall be approximately evenly distributed vertically and numbered according to the typical layout shown.
4. Walls which do not meet the design height requirement in Note 2 shall have a minimum of 6 inspection wires spaced at a maximum of every four panels (20 feet apart) across a length of wall segment not to exceed 100 feet. Similar to Note 2, sets of inspection wires along the LOL of a single MSE wall shall be spaced no greater than 500 feet apart.
5. Inspection wires shall be installed in a location that will be exposed above finished grade following the completion of the wall.
6. When there is at least 12ft space in front of the MSE wall face panel, inspection wires sets shall be optimized such that a set of inspection wires is located at areas of maximum wall height and such that an inspection wire set begins within 20 feet of each end of the wall.
7. Refer to project plans for location of wall segments where inspection wire placement is planned to be installed.

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

	BY	CHECKED
DESIGN	G. CARROLL	H. HAKIMI
DETAILS	N. HUTTON	CHECKED
QUANTITIES	X	CHECKED

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

C. GONG
PROJECT ENGINEER

BRIDGE NO. X
POST MILES X

RETAINING WALLS

MECHANICALLY STABILIZED EMBANKMENT DETAILS No. 8

DESIGN DETAIL SHEET (ENGLISH) (REV. 03/14/12)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841
CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 8-9-12

SHEET 19 OF 31

FILE => $REQUEST

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER X No. X Exp. X CIVIL STATE OF CALIFORNIA

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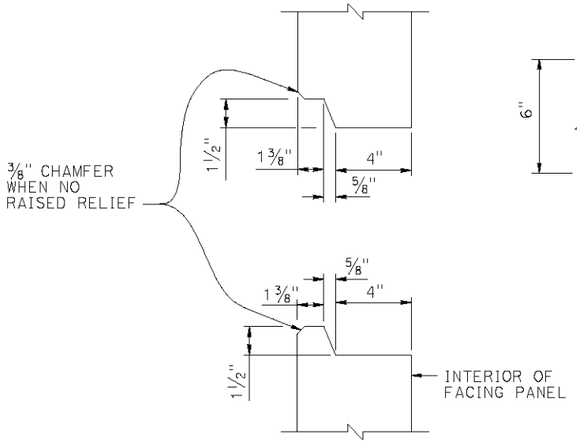
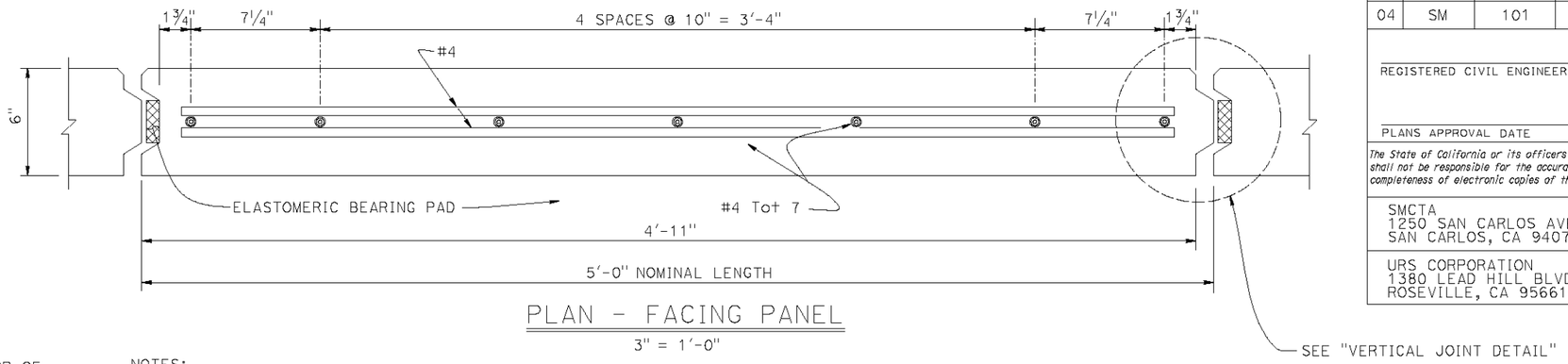
ROSEVILLE, CA 95661-2997



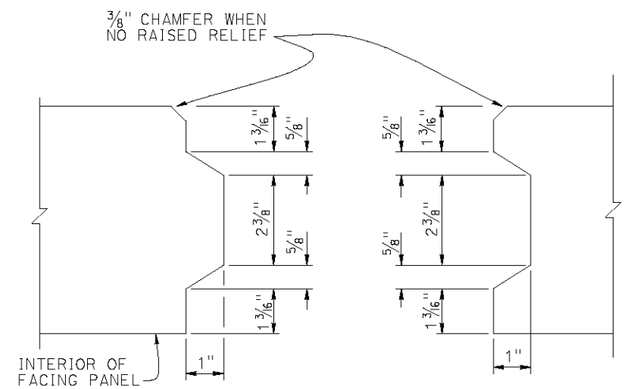
HORIZONTAL JOINT DETAIL
3" = 1'-0"



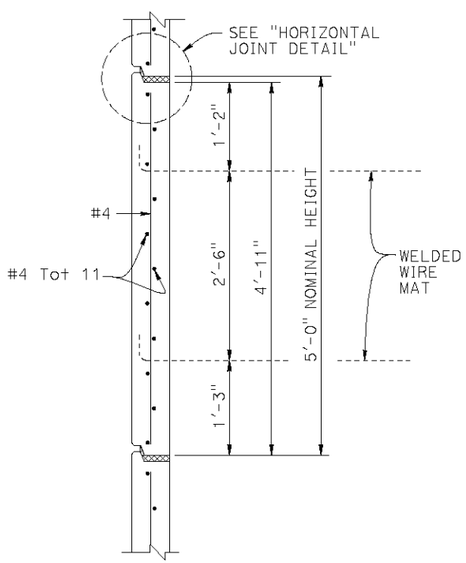
PLAN - FACING PANEL
3" = 1'-0"

NOTES:

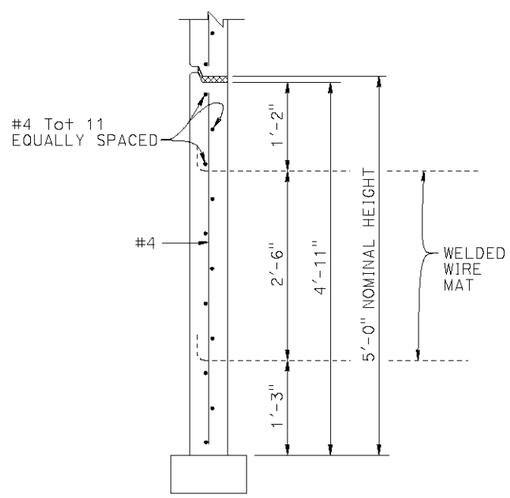
1. Architectural treatment not shown
2. Place reinforced elastomeric bearing pads in all of the panel joints between the panels. Place one in each vertical joint where the horizontal joints intersect. Place two per panel in each horizontal joint:
   3/4" x 2 3/8" x 6" for vertical joints
   3/4" x 4" x 6" for horizontal joints
3. Bond a strip of filter fabric, 1'-0" wide, over the full length of all panel joints
4. Top layer of welded wire mats attached parallel to top of panel when top of wall is angled or curved as shown elsewhere in "STRUCTURE PLANS"
5. Eliminate mid level mat when closer than 6" to top mat, continue variable dimension between remaining mats



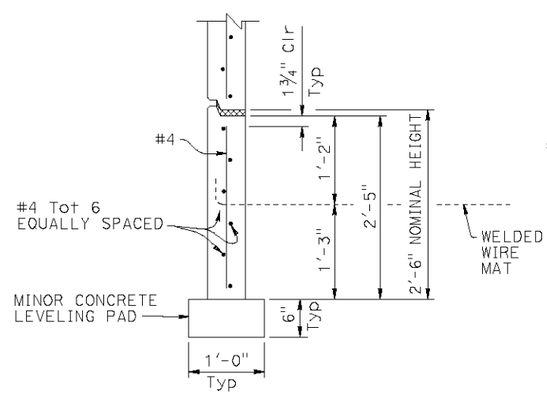
VERTICAL JOINT DETAIL
6" = 1'-0"



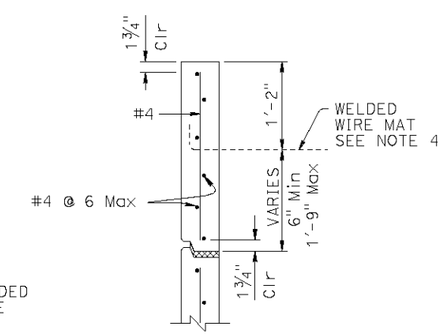
INTERMEDIATE PANEL
1" = 1'-0"



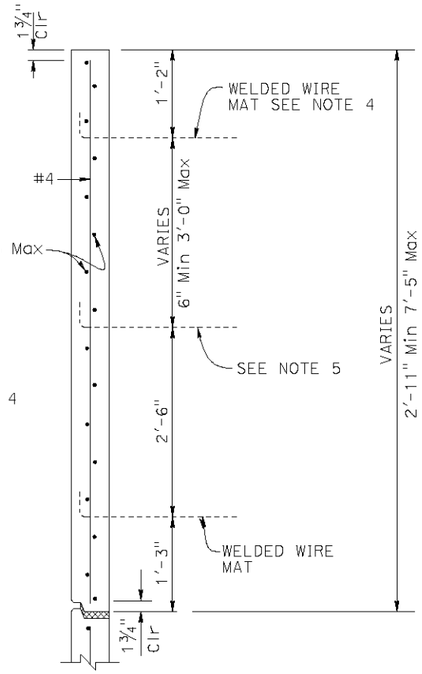
BOTTOM PANEL
1" = 1'-0"



BOTTOM HALF PANEL
1" = 1'-0"



TOP HALF PANEL
1" = 1'-0"



TOP PANEL WITH MULTIPLE MATS
1" = 1'-0"

X DESIGN OVERSIGHT		DESIGN	BY X	CHECKED X	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
X SIGN OFF DATE		DETAILS	BY X	CHECKED X	
		QUANTITIES	BY X	CHECKED X	

X PROJECT ENGINEER

BRIDGE NO. N/A
POST MILES X

MECHANICALLY STABILIZED EMBANKMENT
DETAILS No. 1

DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES				SHEET	OF
X				X	X

FILE => ...\0400000684qa011.dgn

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER X No. X Exp. X CIVIL STATE OF CALIFORNIA

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ROSEVILLE, CA 95661-2997

GENERAL NOTES
LOAD & RESISTANCE FACTOR DESIGN

DESIGN: AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS, 4th EDITION WITH CALIFORNIA AMENDMENTS

LIVE LOAD: SURCHARGE = 240 lb/ft^2

SOIL PARAMETERS:

INTERNAL DESIGN $\phi = 34°$, $\gamma = 120\ lb/ft^3$

EXTERNAL DESIGN ϕ(RETAINED BACKFILL) = 30°, $\gamma = 120\ lb/ft^3$

ϕ(FOUNDATION) = 30°

$K_h = 0.23$

PRECAST CONCRETE PANELS:

f'c = 4,000 psi (CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS)

fy = 60,000 psi (YIELD STRENGTH OF REINFORCEMENT)

SOIL REINFORCEMENT:

WELDED WIRE MATS: fy = 65,000 psi (YIELD STRENGTH)

COUPLER: fy = 36,000 psi (YIELD STRENGTH)

CORROSION RATE = 1.1 mils/year

REINFORCED CONCRETE:

f'c = 3,600 psi, EXCEPT AS NOTED (CONCRETE COMPRESSIVE STRENGTH AT 28 DAYS)

fy = 60,000 psi (YIELD STRENGTH OF REINFORCEMENT)

MSE = MECHANICALLY STABILIZED EMBANKMENT

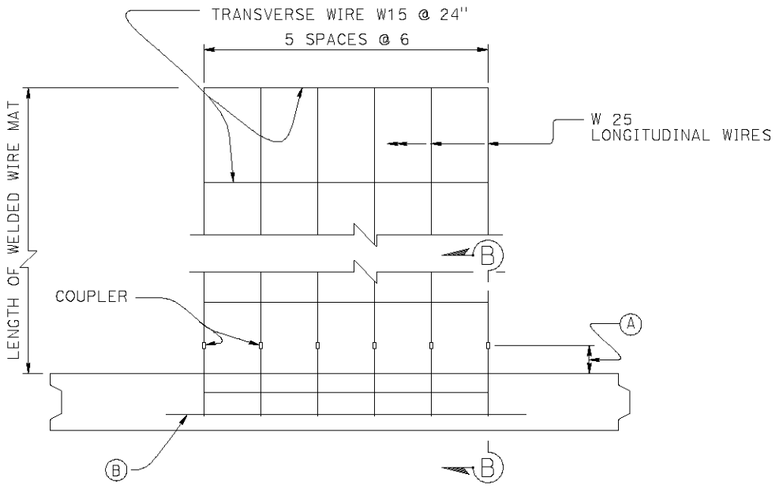
NOTES:

(A) DISTANCE AS REQUIRED TO PERMIT COUPLER TO BE SWAGED

(B) PLACE #4 × 3'-2", CENTERED ON CONNECTOR MAT, BUT NOT WELDED TO IT

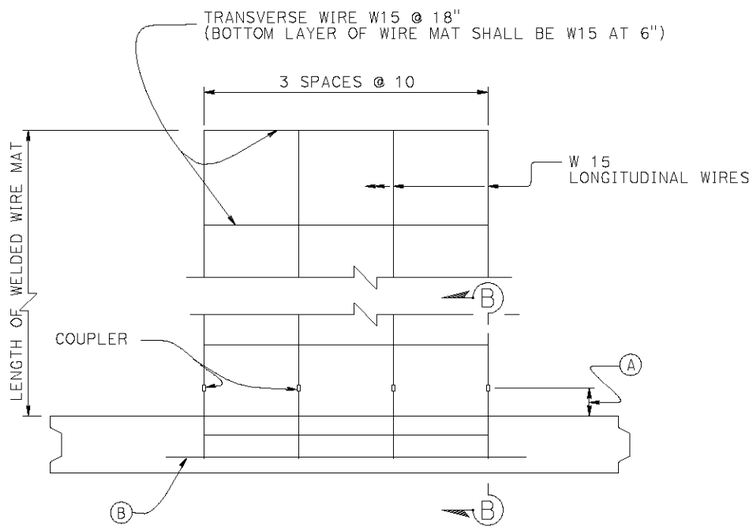
NOTES:

1. PANEL REINFORCEMENT NOT SHOWN.
2. DENOTES * BUTTONHEADED AT COUPLER END.
3. ARCHITECTURAL TREATMENT NOT SHOWN.



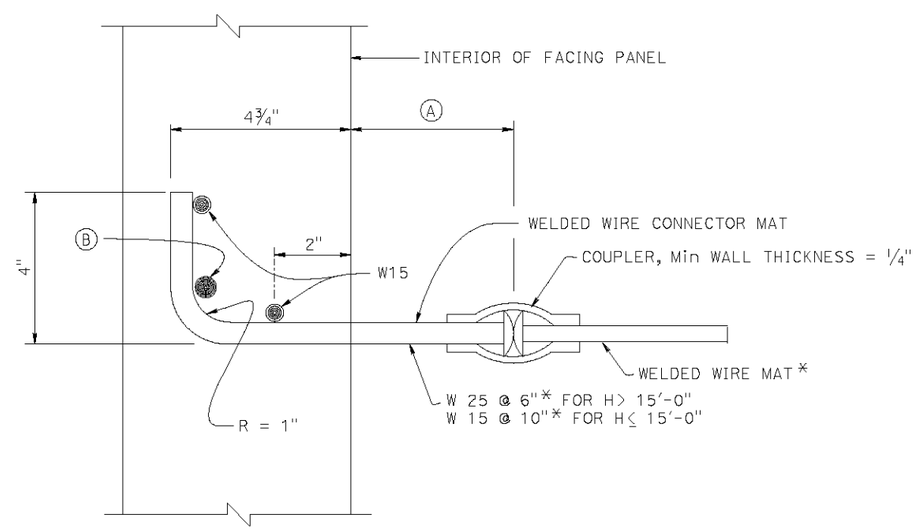
PLAN OF PANEL WITH DESIGN HEIGHT H> 15'-0"

1½" = 1'-0"



PLAN OF PANEL WITH DESIGN HEIGHT H≤ 15'-0"

1½" = 1'-0"



SECTION B-B

6" = 1'-0"

X DESIGN OVERSIGHT		DESIGN	BY X	CHECKED X	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
X SIGN OFF DATE		DETAILS	BY X	CHECKED X	
		QUANTITIES	BY X	CHECKED X	

X PROJECT ENGINEER

BRIDGE NO. N/A

POST MILES X

MECHANICALLY STABILIZED EMBANKMENT
DETAILS No. 2

DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703

PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES X | SHEET X | OF X

FILE => ...\04000006841qa012.dgn

USERNAME => nadine.hu; DATE PLOTTED => 6/12/2012 TIME PLOTTED => 3:49:07 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER X No. X Exp. X CIVIL STATE OF CALIFORNIA

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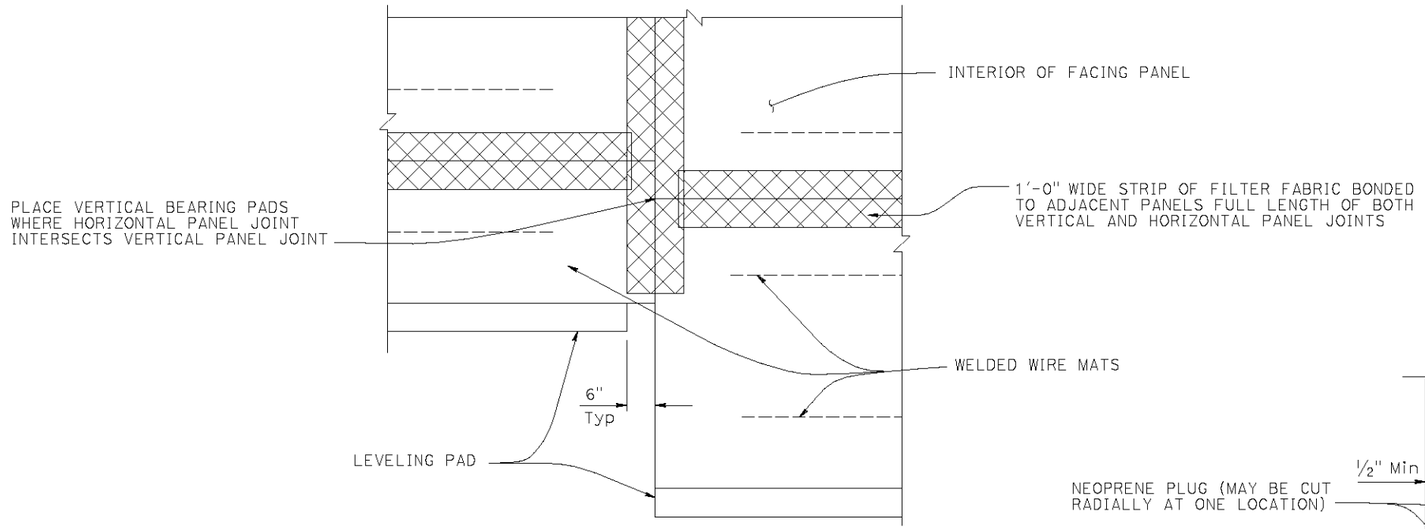
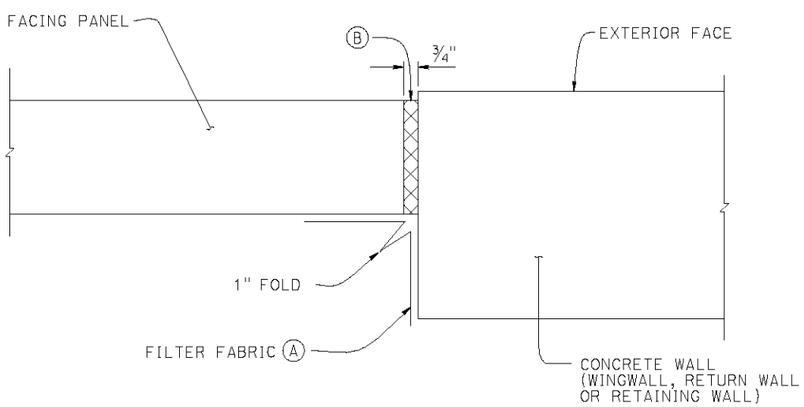


PART ELEVATION

3/4" = 1'-0"



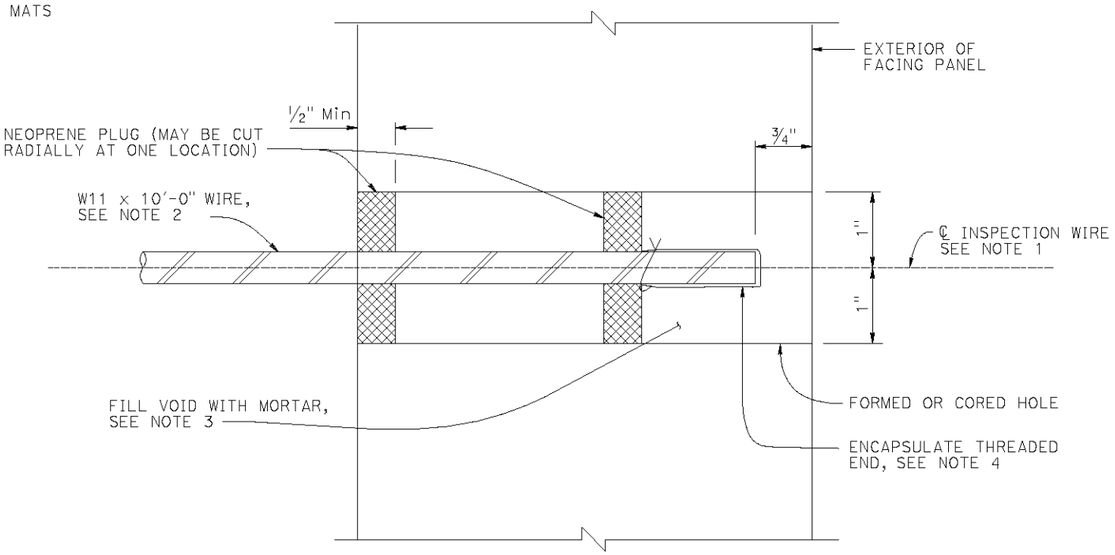
MSE FACING PANEL-TO-CONCRETE WALL JOINT DETAIL

3" = 1'-0"

NOTES:

A. BOND A STRIP OF FILTER FABRIC, 1'-6" WIDE, TO BACK OF MSE PANELS AND THE ADJACENT CONCRETE WALL FOR ENTIRE LENGTH OF VERTICAL JOINT

B. BOND EXPANSION JOINT MATERIAL TO THE CONCRETE WALL



SECTION THRU INSPECTION WIRE

NO SCALE

NOTES:

1. CENTER INSPECTION WIRE IN FACING PANEL.
2. FABRICATED INSPECTION WIRE FROM W11 WIRE REPRESENTATIVE OF THE WELDED WIRE MATS, WITH 3/8" Ø 16 UNC THREADS FOR AT LEAST 1 1/2" OF ONE END.
3. PLACE INSPECTION WIRE HORIZONTAL AND PERPENDICULAR TO THE WALL PANEL PRIOR TO BACKFILLING.
4. ENCAPSULATE THREADED END WITH CORROSION INHIBITING MASTIC, VINYL COVERING, AND SECURE WITH PLASTIC TIE.
5. UNC = UNIFIED COARSE THREADS

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

	BY	CHECKED
DESIGN	X	X
DETAILS	X	X
QUANTITIES	X	X

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

X
PROJECT ENGINEER

BRIDGE NO. N/A
POST MILES X

MECHANICALLY STABILIZED EMBANKMENT
DETAILS No. 3

DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES X | SHEET X | OF X

FILE => ...\040000684qa013.dgn

USERNAME => nadine.hu; DATE PLOTTED => 6/12/2012 TIME PLOTTED => 1:20:49 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

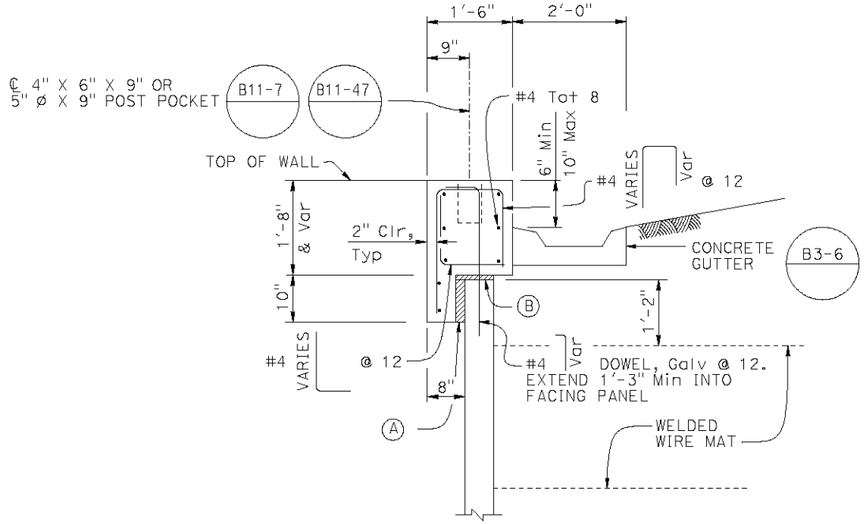
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER X No. X Exp. X CIVIL STATE OF CALIFORNIA

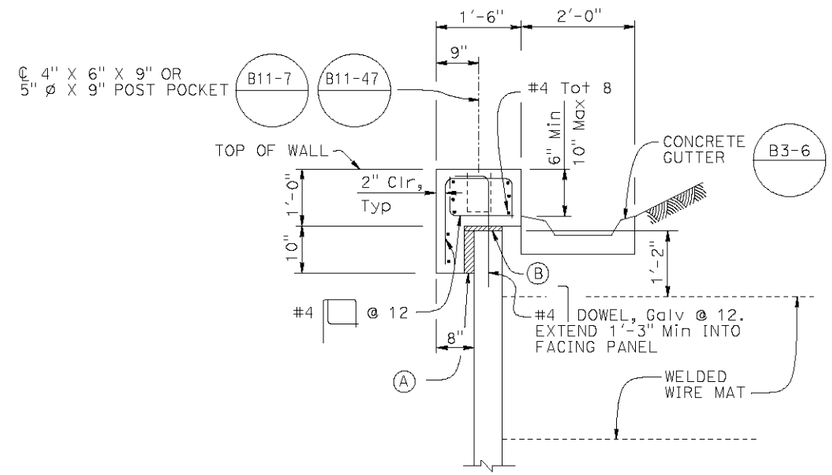
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

SMCTA
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997



SECTION A-A
BEGINNING OF COPING TRANSITION
3/4" = 1'-0"



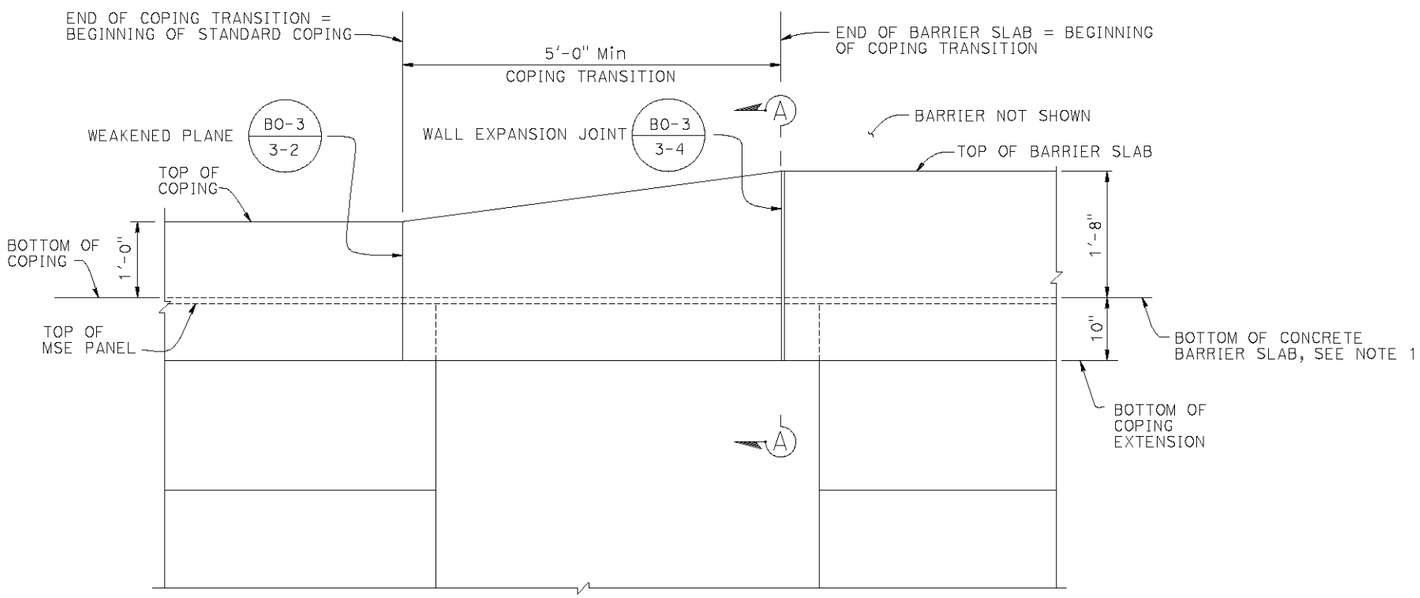
STANDARD COPING
3/4" = 1'-0"

NOTES:

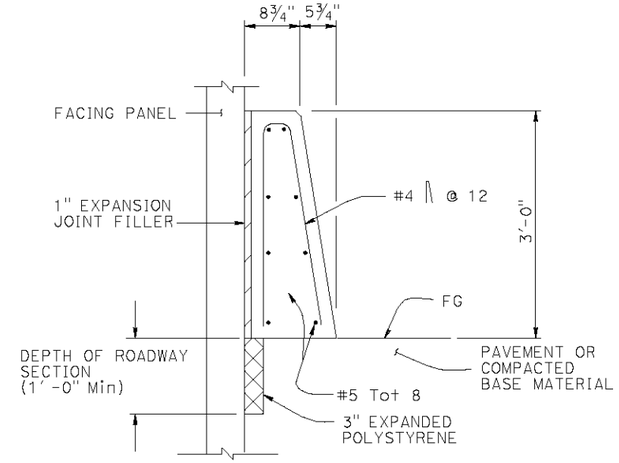
1. For Barrier slab details see "CONCRETE BARRIER SLAB DETAILS" xs12-090
2. Concrete gutter optional as needed
3. Install cable railing or chain link railing when indicated

(A) 2" Expanded Polystyrene

(B) 1" Expanded Polystyrene



TRANSITION FROM COPING TO BARRIER SLAB
1" = 1'-0"



CONCRETE BARRIER TYPE 60D (MOD)
AT FACE OF MSE
1" = 1'-0"

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

	BY	CHECKED
DESIGN	X	X
DETAILS	X	X
QUANTITIES	X	X

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

X
PROJECT ENGINEER

BRIDGE NO. N/A
POST MILES X

MECHANICALLY STABILIZED EMBANKMENT
DETAILS No. 4

DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES				SHEET	OF
X				X	X

FILE => ...\0400000684qa014.dgn

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER X No. X Exp. X CIVIL STATE OF CALIFORNIA

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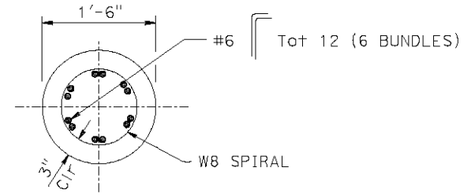
SAN CARLOS, CA 94070-1306

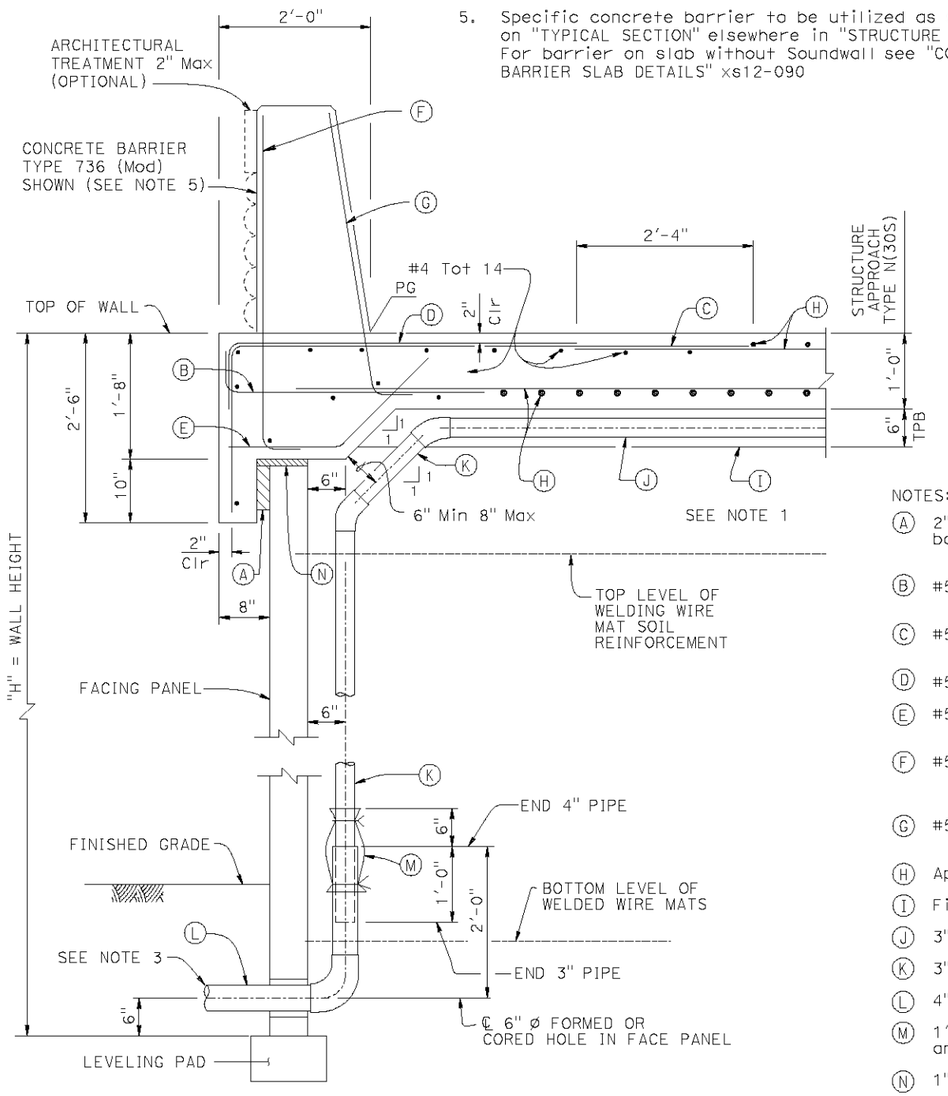
URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997

NOTES:

1. Low end of subgrade drain shown, at high end install cap at end of 3" slotted pipe. Subgrade drain located at end of Structure Approach slab, see "STRUCTURE PLANS"
2. Not all barrier reinforcement shown
3. For outlet details, see "STRUCTURE PLANS"
4. At acute corners of approach slab, bend reinforcement as required to clear expansion joint
5. Specific concrete barrier to be utilized as shown on "TYPICAL SECTION" elsewhere in "STRUCTURE PLANS". For barrier on slab without Soundwall see "CONCRETE BARRIER SLAB DETAILS" xs12-090



SECTION A-A
1" = 1'-0"



SECTION AT TOP OF MSE WITH STRUCTURE APPROACH SLAB AND CONCRETE BARRIER
1" = 1'-0"

NOTES:

(A) 2" Expanded Polystyrene recessed 2" into barrier slab at front of MSE facing panel

(B) #5 6¼" 3'-4" @ 12

(C) #5 6'-10⅝" @ 12

(D) #5 4'-7" @ 12 bundled with (C) bars

(E) #5 @ 12

(F) #5 6¼" @ 16 (To be in place prior to Approach Slab concrete)

(G) #5 6¼" @ 8 (To be in place prior to Approach Slab concrete)

(H) Approach Slab reinforcement

(I) Filter fabric

(J) 3" Plastic pipe (slotted)

(K) 3" Plastic pipe and fitting (unslotted)

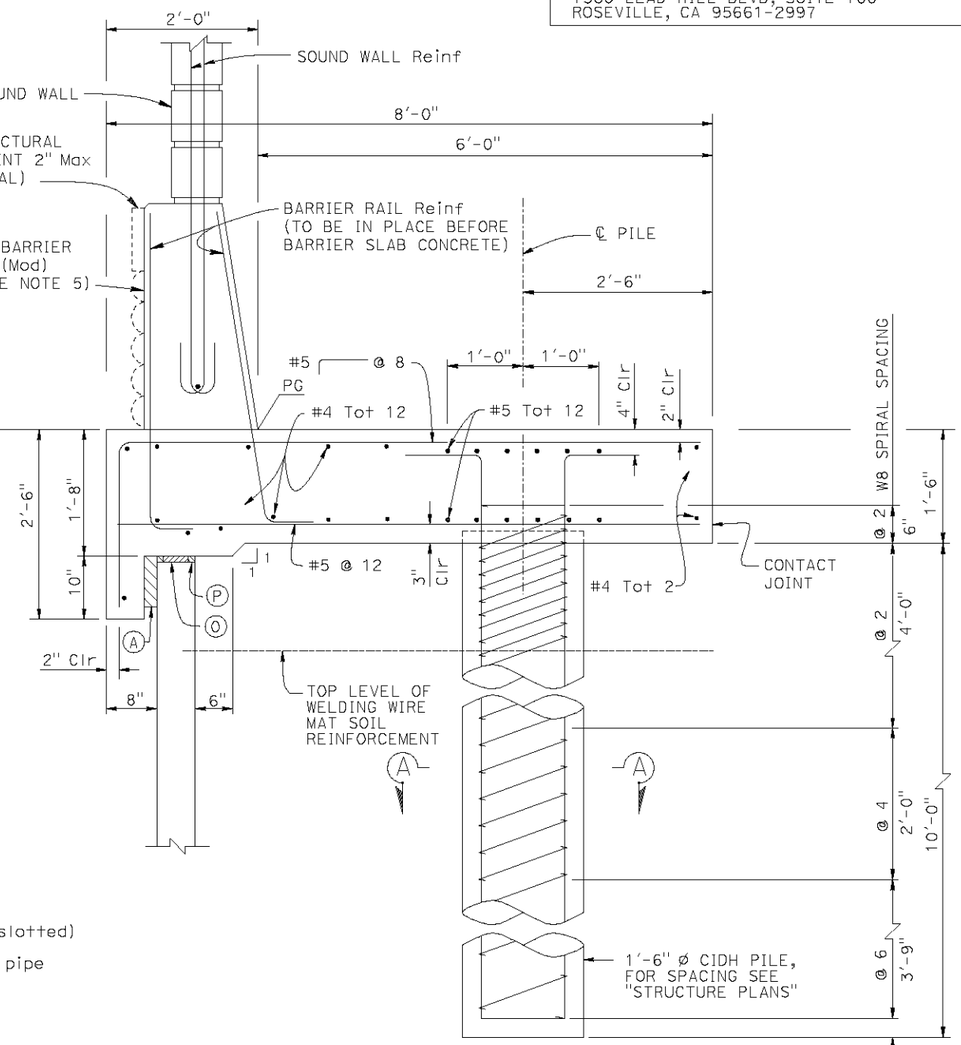
(L) 4" Schedule 80 PVC outlet pipe and fittings (unslotted)

(M) 1'-0" wide x 2'-0" filter fabric wrapped around pipe and secured with nylon ties

(N) 1" Expanded Polystyrene

(O) Place elastomeric bearing pads ¾" x 4" x 6" every 1'-8" Min bonded to top of MSE facing panel

(P) ¾" Expanded Polystyrene



SECTION AT TOP OF MSE WITH SOUND WALL AND CONCRETE BARRIER
1" = 1'-0"

X
DESIGN OVERSIGHT
X
SIGN OFF DATE

	BY	CHECKED
DESIGN	X	X
DETAILS	X	X
QUANTITIES	X	X

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

X
PROJECT ENGINEER

BRIDGE NO. N/A
POST MILES X

MECHANICALLY STABILIZED EMBANKMENT
DETAILS No. 5

DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES X | SHEET X OF X

FILE => ...\0400000684qa015.dgn

USERNAME => nadine_nuñez PLOTTED => 6/12/2012 TIME PLOTTED => 1:27:12 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101			

REGISTERED CIVIL ENGINEER X DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER X No. X Exp. X CIVIL STATE OF CALIFORNIA

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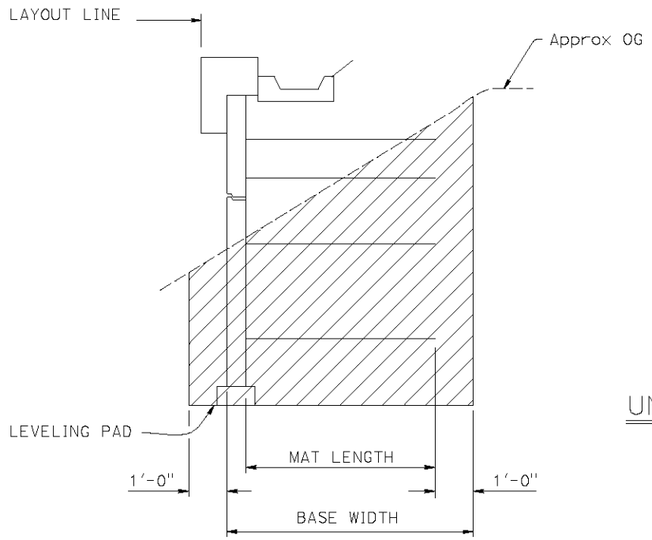
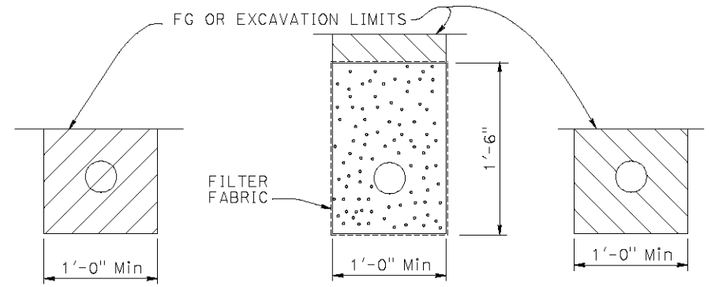
SMCTA
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

URS CORPORATION
1380 LEAD HILL BLVD, SUITE 100
ROSEVILLE, CA 95661-2997



LIMITS OF EXCAVTION

½" = 1'-0"



OUTLET PIPE CLEANOUT PIPE

EXCAVATION BACKFILL

UNPERFORATED OUTLET OR CLEAN OUT PIPE FOR UNDERDRAIN

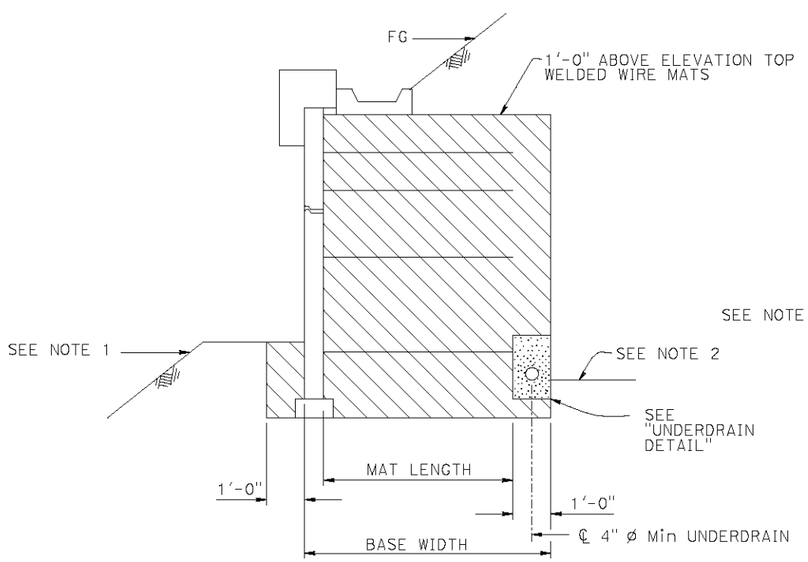
NO SCALE

NOTES:

1. Limits to FG except to GP when in roadway section
2. Locate underdrain behind bottom level of welded wire mats wherever possible, or at elevation needed to drain, as shown elsewhere on plans
3. Place perforated pipe underdrain of diameter shown elsewhere on plans or minimum 4" ø smoothed wall PVC or minimum 8" ø corrugated HDPE
4. Maximum spacing of outlet pipe is 200 feet
5. At sags in profile of underdrain, install outlet pipe for each direction of flow

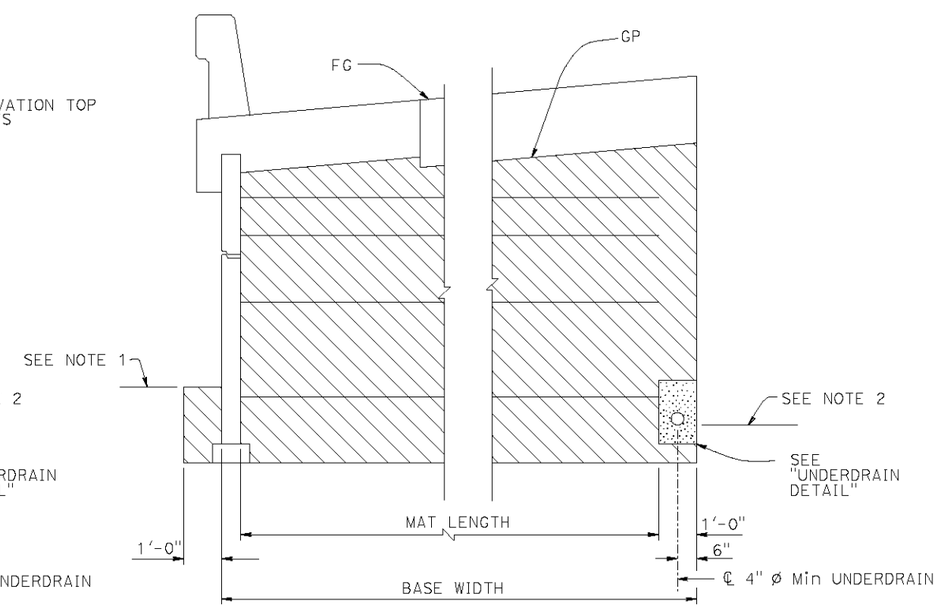
LEGEND:

- Limits of Structure Excavation
- Limits of Structure Backfill
- Limits of Permeable Material



SLOPING FINISHED SURFACE

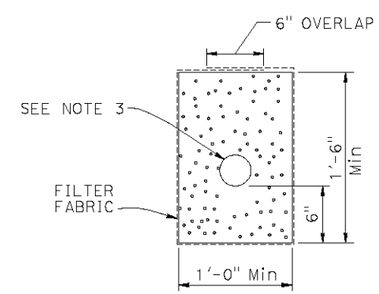
½" = 1'-0"



ROADWAY SECTION

½" = 1'-0"

LIMITS OF BACKFILL



UNDERDRAIN DETAIL

X DESIGN OVERSIGHT		DESIGN	BY X	CHECKED X	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION
X SIGN OFF DATE		DETAILS	BY X	CHECKED X	
		QUANTITIES	BY X	CHECKED X	

X PROJECT ENGINEER

BRIDGE NO. N/A

POST MILES X

MECHANICALLY STABILIZED EMBANKMENT

DETAILS No. 6

DESIGN DETAIL SHEET (ENGLISH) (REV.7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES X | SHEET X | OF X

FILE => ...\0400000684qa016.dgn

USERNAME => nadine_hu DATE PLOTTED => 6/12/2012 TIME PLOTTED => 3:38:27 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL — DATE 01/15/13

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Stephen Huang — No. C 42289 — Exp. 03/31/14 — CIVIL — STATE OF CALIFORNIA

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URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

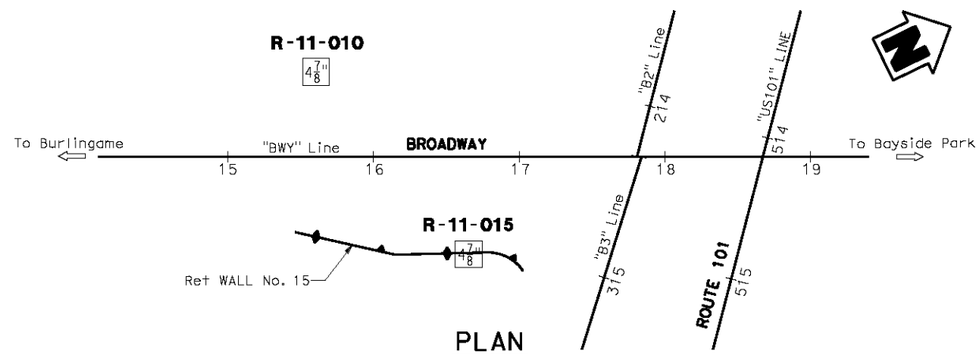
BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83.

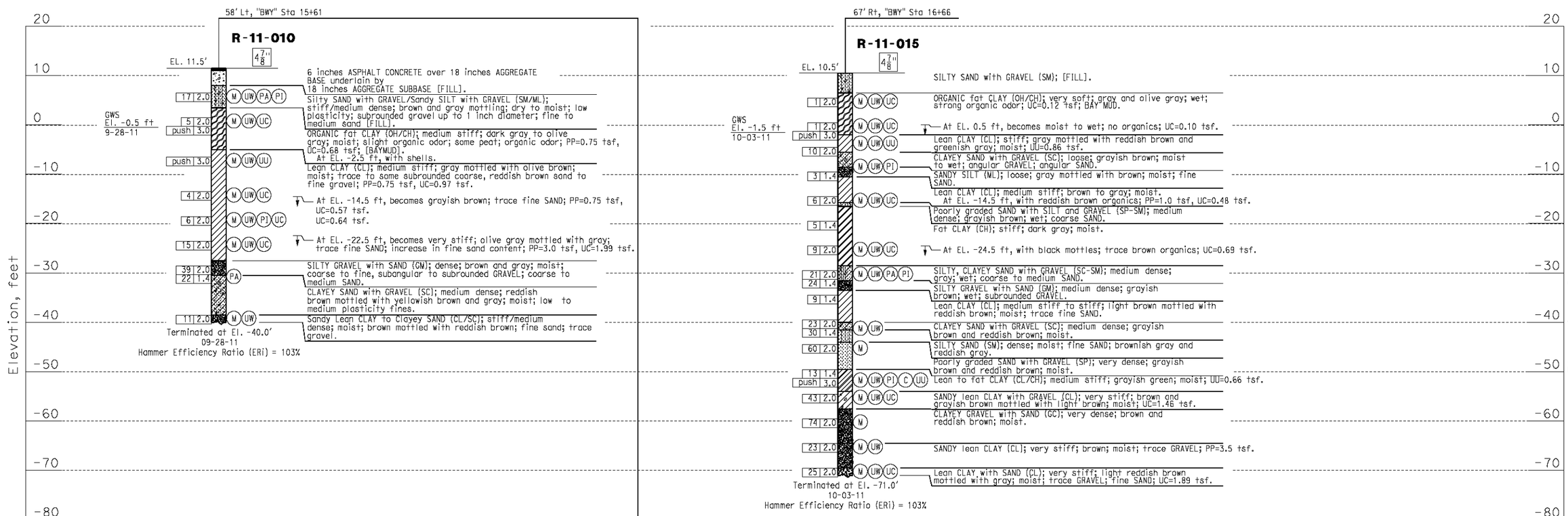
BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

1. This LOTB Sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).
2. Standard Penetration test sampler I.D. = 1.44 inch (1.4)
   Modified California sampler I.D. = 1.96 inch (2.0)
   Thin-walled Shelby tube sampler I.D. = 2.97 inch (3.0).
3. UC and UU values reported are undrained shear strengths in tsf.



PLAN
1" = 50'



PROFILE
Ver. 1" = 10'
Hor. 1" = 25'

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. HUANG — PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:		

BRIDGE NO. 35E0043 — POST MILES X

RETAINING WALL No. 15
LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES — REVISION DATES 06-14-12 11-14-12 01-09-13 — SHEET — OF

FILE => RW15-ltb01.dgn

USERNAME => madhu_thu — DATE PLOTTED => 1/9/2013 — TIME PLOTTED => 10:21:54 AM

DIVISION OF ENGINEERING SERVICES - GEOTECHNICAL SERVICES

As-Built Log of Test Borings sheet is considered an informational document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date confirm that this is a true and accurate copy of the original document. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

DIST.	COUNTY	ROUTE	MILE POST-TOTAL PROJECT	Sheet No.	Total Sheets
04	SM	101	16.3/17.1		

REGISTERED GEOTECHNICAL ENGINEER — DATE

DATE PLOTTED => 1/9/2013

RETAINING WALL No. 15

LOG OF TEST BORINGS (2 OF 2)

NOTE: A COPY OF THIS LOG OF TEST BORINGS IS AVAILABLE AT OFFICE OF STRUCTURE MAINTENANCE ANDINVESTIGATIONS, SACRAMENTO, CALIFORNIA

CU: 04
EA: 235844

BRIDGE No. 35-0351

Sheet ___ of ___

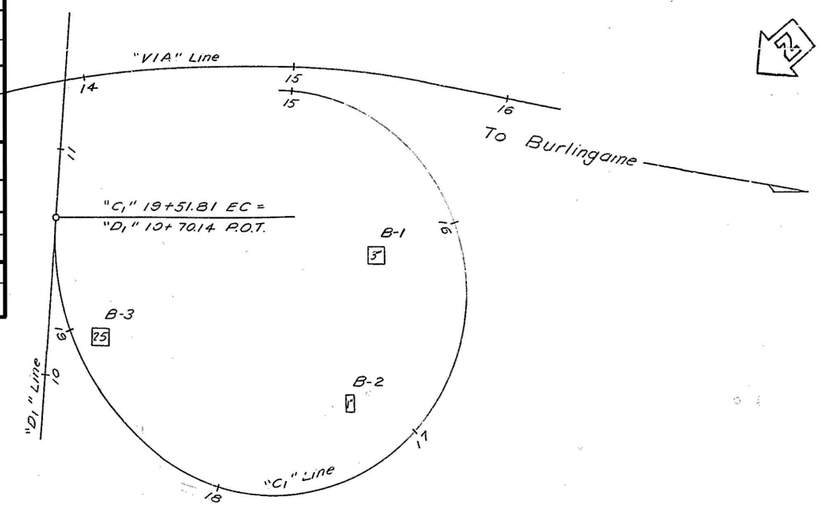
Boring	Station	Offset from "BWY" Line
B-1	15+94	68.9 Rt
B-2	16+15	10.9 Rt
B-3	16+92	81.5 Rt

DIST.	COUNTY	ROUTE	POST MILES—TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.6	62	62

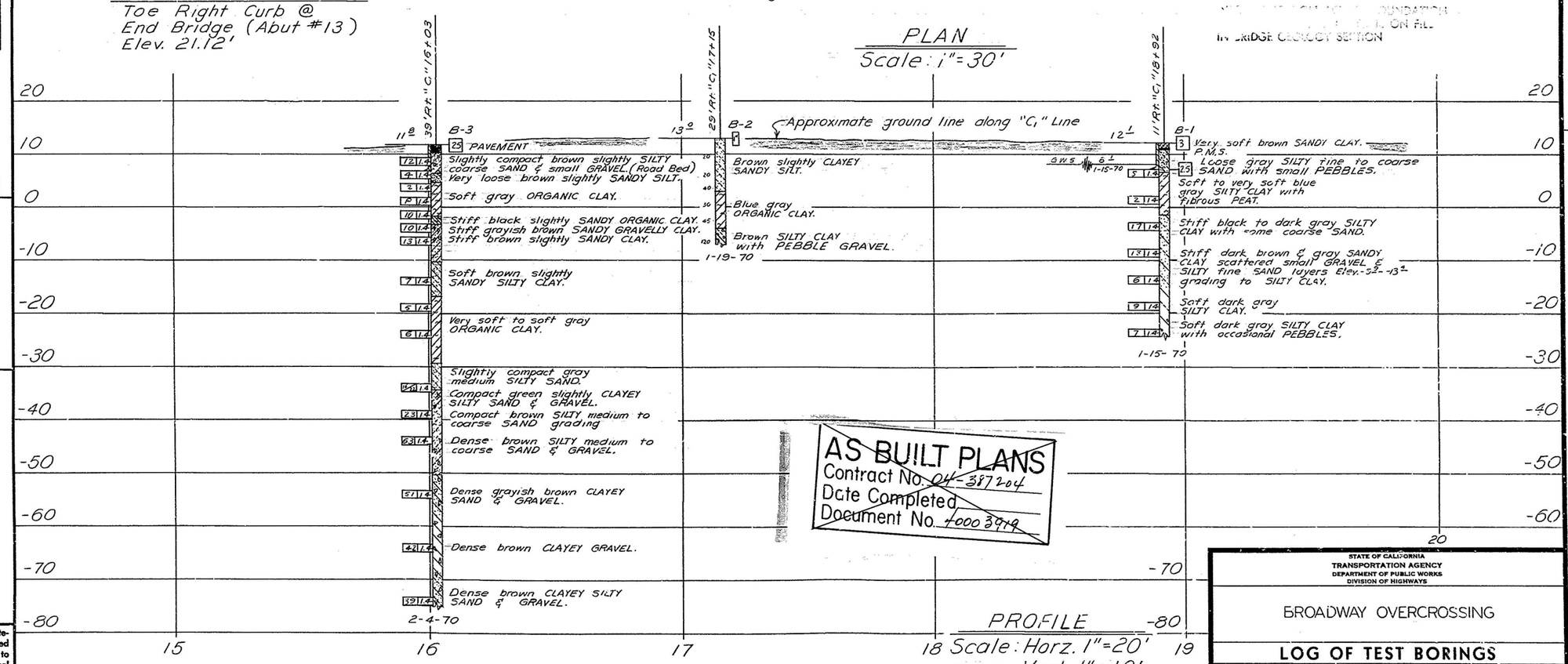
BRIDGE ENGINEER — REGISTERED CIVIL ENGINEER NO. 5946

DATE APPROVED: September 14, 1976

REGISTERED PROFESSIONAL ENGINEER
Stephen Huang
No. C 42289
Exp. 03/31/14
CIVIL
STATE OF CALIFORNIA



PLAN
Scale: 1" = 30'



PROFILE
Scale: Horz. 1" = 20'
Vert. 1" = 10'

AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 4000 3919

LEGEND OF BORING OPERATIONS

LEGEND OF EARTH MATERIALS

CLASSIFICATION OF MATERIAL BASED ON STANDARD GRADE SIZE LIMITS

NOTE: Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

FIELD STUDY By G. Miller 2-70
DRAWN By S. Kawakami 2-70
CHECKED W. Miller 2-70
Approval Recommended by L.F. Sommers, Engineering Geologist 1975

BRIDGE DEPARTMENT
ENGINEERING GEOLOGY SECTION

62

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING

LOG OF TEST BORINGS

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
35-96	16.6		10	10

REVISION DATES (PRELIMINARY STAGE ONLY) 2/16/70

WO 387201
CU 04205

Disregard prints bearing earlier revision dates

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF PUBLIC WORKS.

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL — DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Stephen Huang — No. C 42289 — Exp. 03/31/12 — GEOTECHNICAL — STATE OF CALIFORNIA

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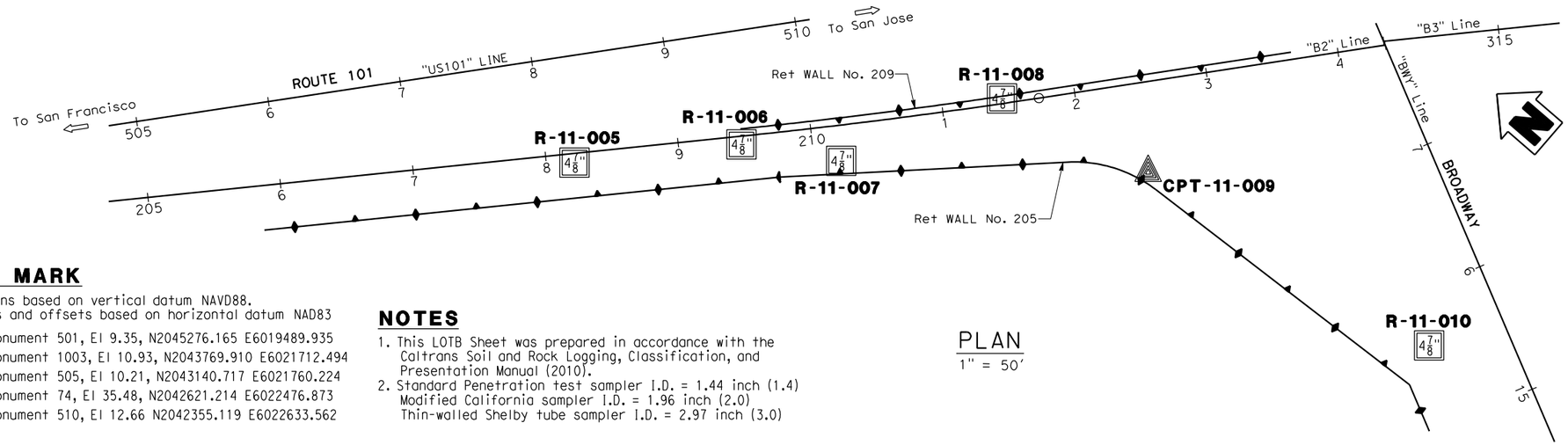
SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306



PLAN
1" = 50'

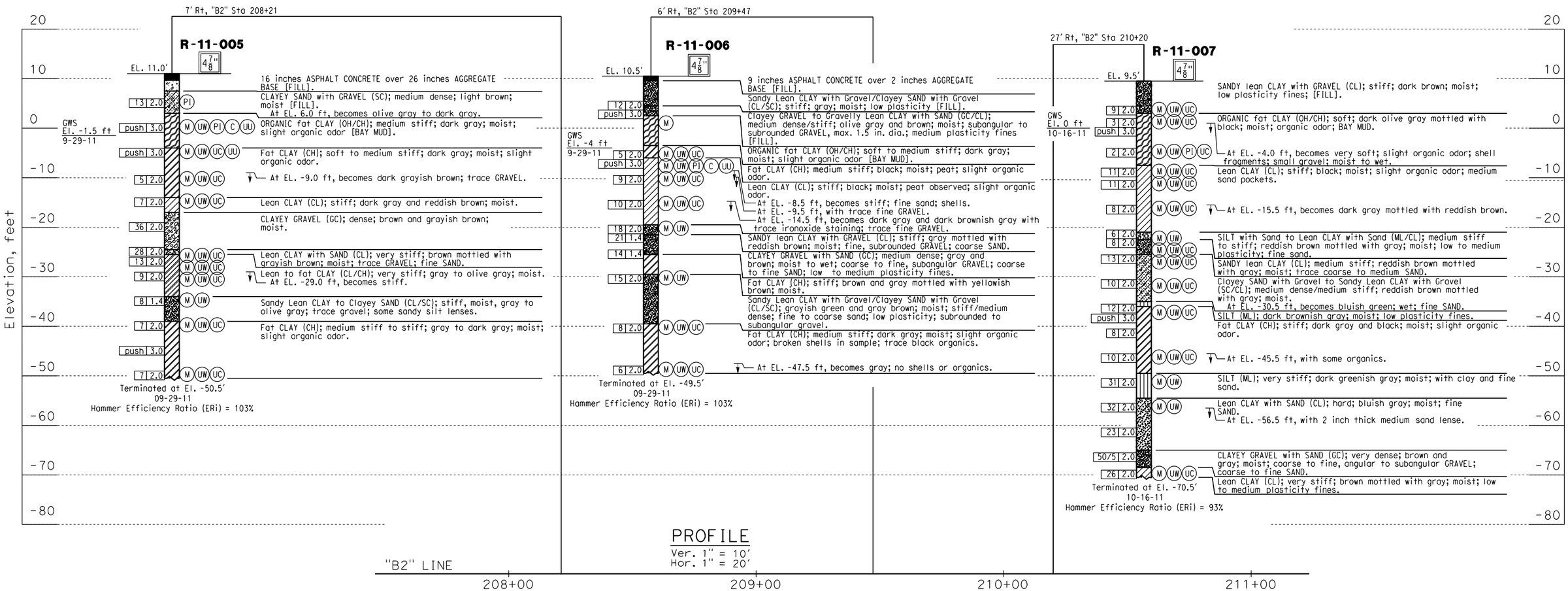
BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

1. This LOTB Sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).
2. Standard Penetration test sampler I.D. = 1.44 inch (1.4)
   Modified California sampler I.D. = 1.96 inch (2.0)
   Thin-walled Shelby tube sampler I.D. = 2.97 inch (3.0)



PROFILE
Ver. 1" = 10'
Hor. 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG	S. HUANG	BRIDGE NO. XX-XXXX
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:	PROJECT ENGINEER	POST MILES X-XX

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

RETAINING WALL No. 205

LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 01-24-12 — SHEET — OF

FILE => ...\QC-Geotech\LOTB\LOTB-04.dgn

USERNAME => binh_vuong DATE PLOTTED => 2/1/2012 TIME PLOTTED => 9:05:49 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/12 GEOTECHNICAL STATE OF CALIFORNIA

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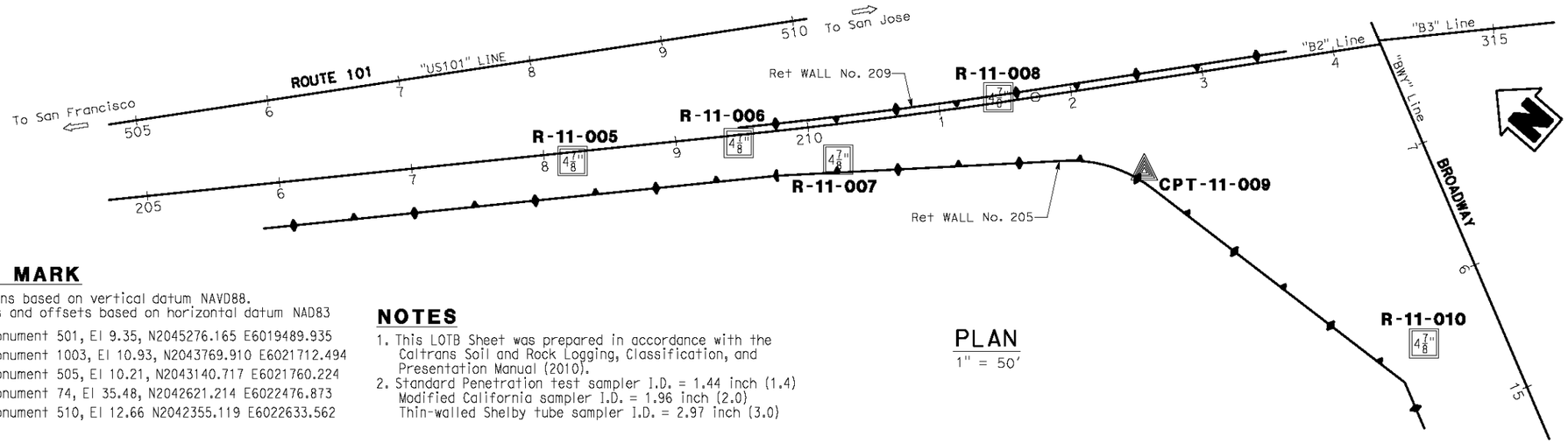
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306



BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

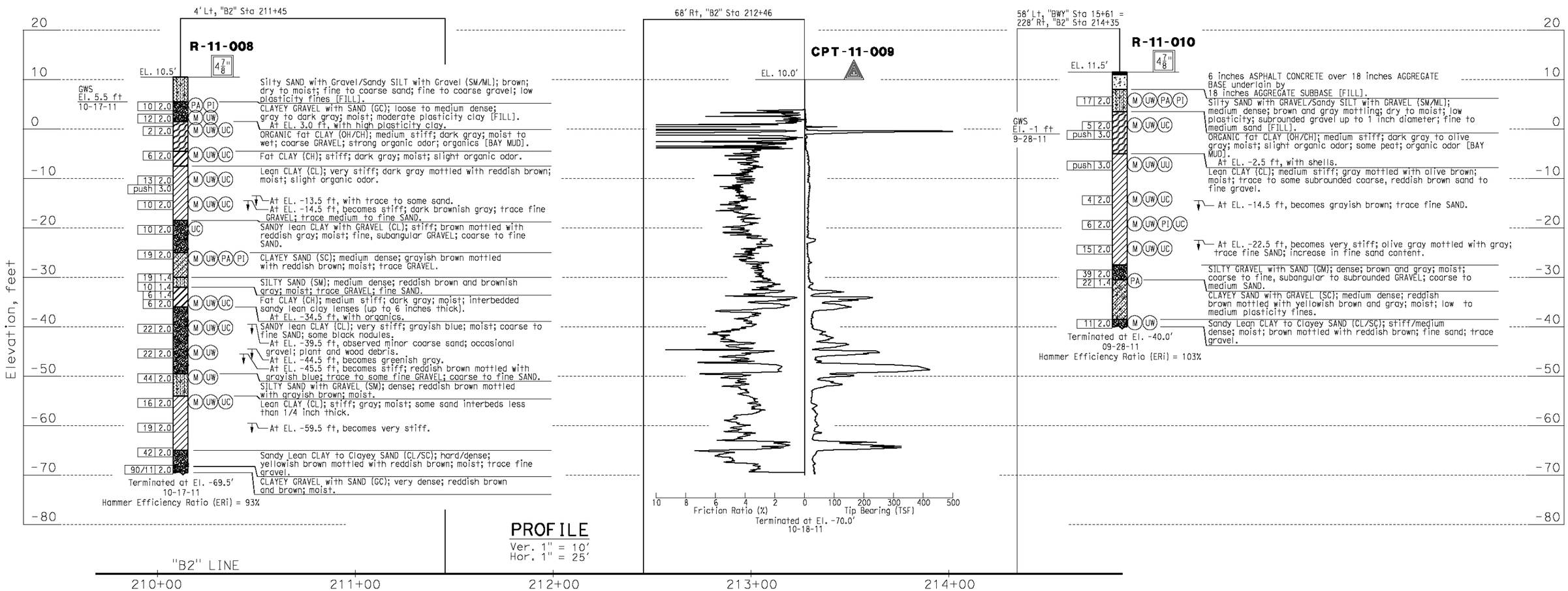
BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

1. This LOTB Sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).
2. Standard Penetration test sampler I.D. = 1.44 inch (1.4)
   Modified California sampler I.D. = 1.96 inch (2.0)
   Thin-walled Shelby tube sampler I.D. = 2.97 inch (3.0)

PLAN

1" = 50'



PROFILE

Ver. 1" = 10'
Hor. 1" = 25'

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. HUANG
PROJECT ENGINEER

BRIDGE NO. XX-XXXX
POST MILES X-XX

RETAINING WALL No. 205
LOG OF TEST BORINGS 2 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES 01-24-12

REVISION DATES | SHEET | OF

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USERNAME => bian_vuong DATE PLOTTED => 2/1/2012 TIME PLOTTED => 9:06:20 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL — DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Stephen Huang — No. C 42289 — Exp. 03/31/12 — GEOTECHNICAL — STATE OF CALIFORNIA

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URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

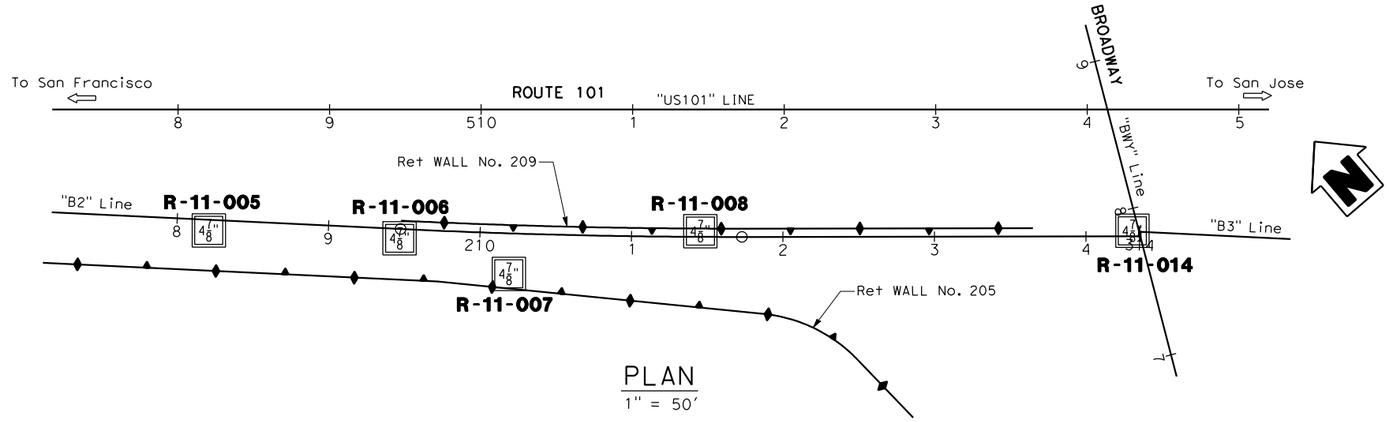
BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

1. This LOTB Sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).
2. Standard Penetration test sampler I.D. = 1.44 inch (1.4)
   Modified California sampler I.D. = 1.96 inch (2.0)
   Thin-walled Shelby tube sampler I.D. = 2.97 inch (3.0)



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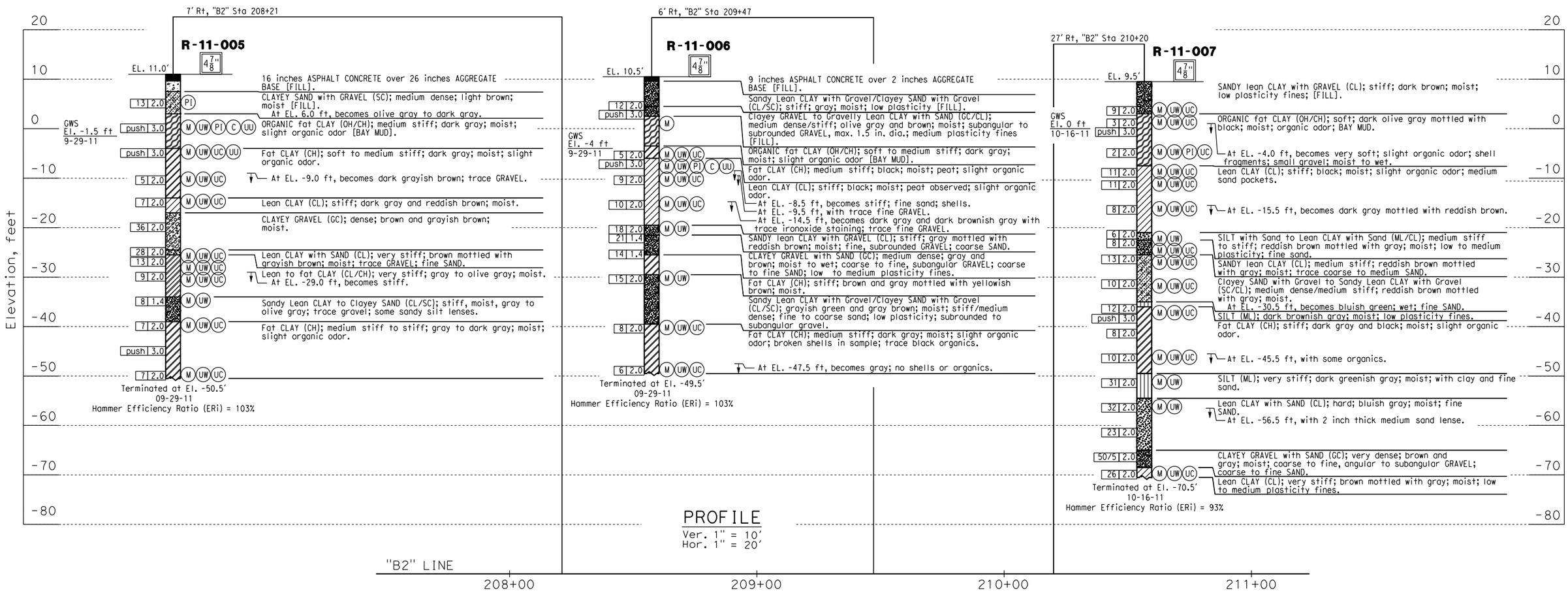

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG — FIELD INVESTIGATION BY:
SIGN OFF DATE	CHECKED BY	A. M. MOORE	DATE:

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. HUANG — PROJECT ENGINEER

BRIDGE NO. XX-XXXX
POST MILES X-XX

RETAINING WALL No. 209
LOG OF TEST BORINGS 1 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 01-24-12

REVISION DATES | SHEET | OF

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USERNAME => binh_vuong DATE PLOTTED => 2/1/2012 TIME PLOTTED => 9:06:52 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/12 GEOTECHNICAL STATE OF CALIFORNIA

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URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

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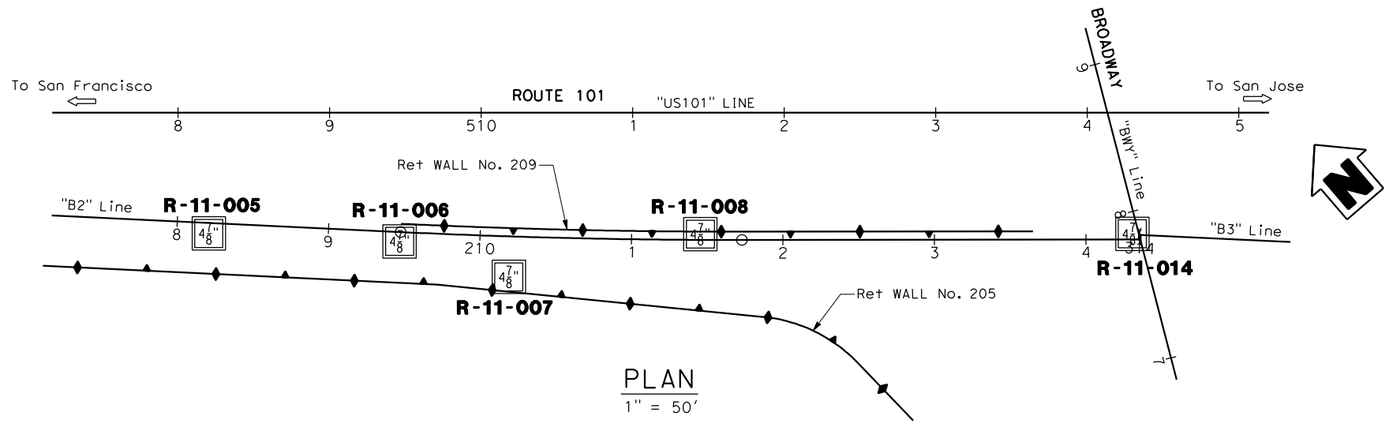
   Thin-walled Shelby tube sampler I.D. = 2.97 inch (3.0)



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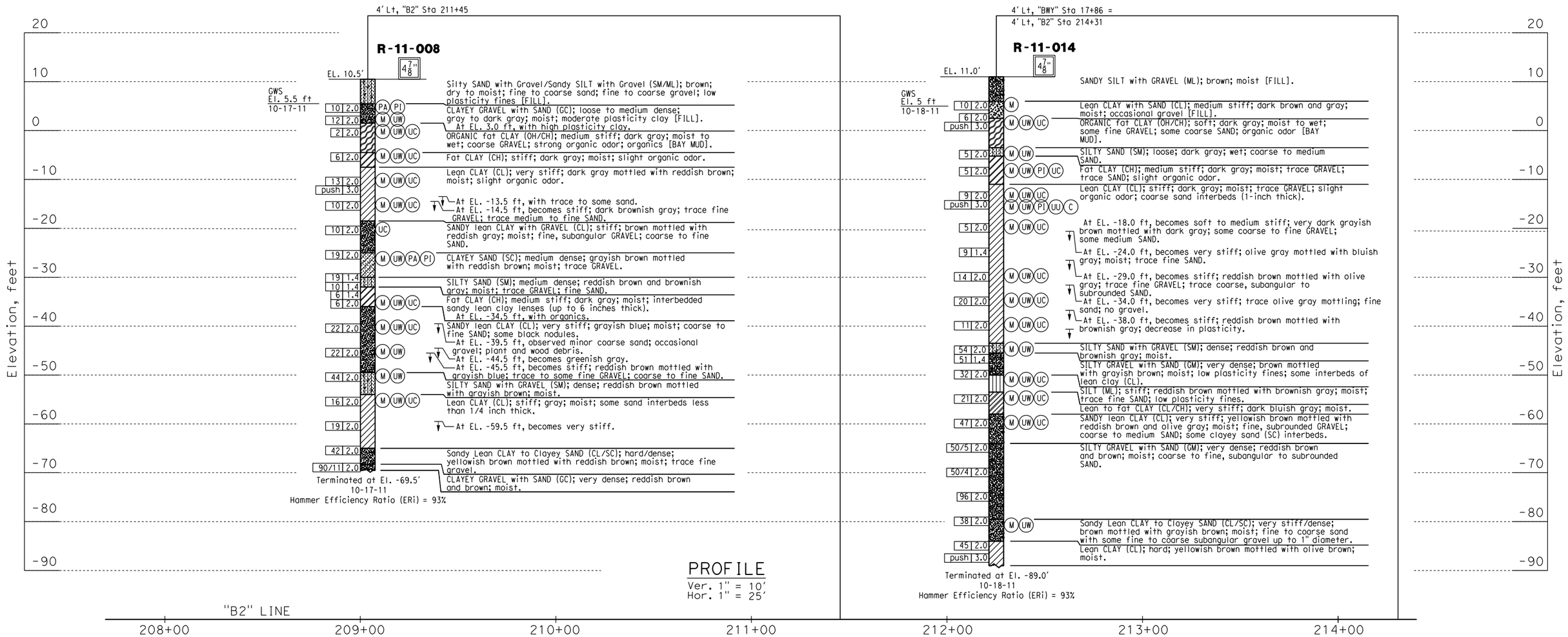

PROFILE
Ver. 1" = 10'
Hor. 1" = 25'

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. HUANG
PROJECT ENGINEER

BRIDGE NO. XX-XXXX
POST MILES X-XX

RETAINING WALL No. 209
LOG OF TEST BORINGS 2 OF 2

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES 01-24-12

REVISION DATES | SHEET | OF

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USERNAME => binh_vuong DATE PLOTTED => 2/1/2012 TIME PLOTTED => 9:07:31 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL — DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER — Stephen Huang — No. C 42289 — Exp. 03/31/12 — GEOTECHNICAL — STATE OF CALIFORNIA

URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

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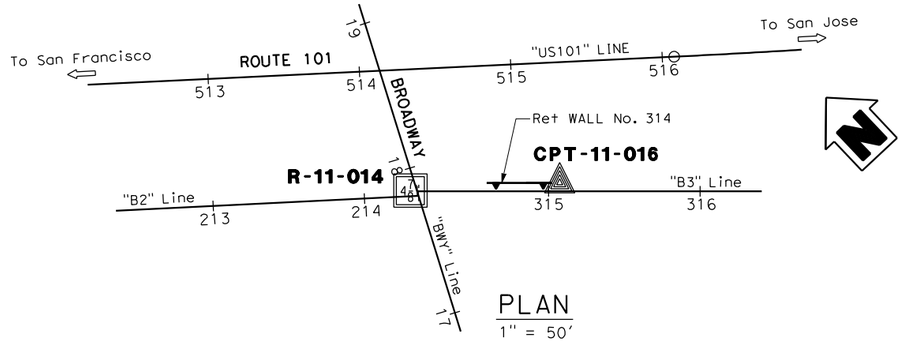
   Modified California sampler I.D. = 1.96 inch (2.0)
   Thin-walled Shelby tube sampler I.D. = 2.97 inch (3.0)



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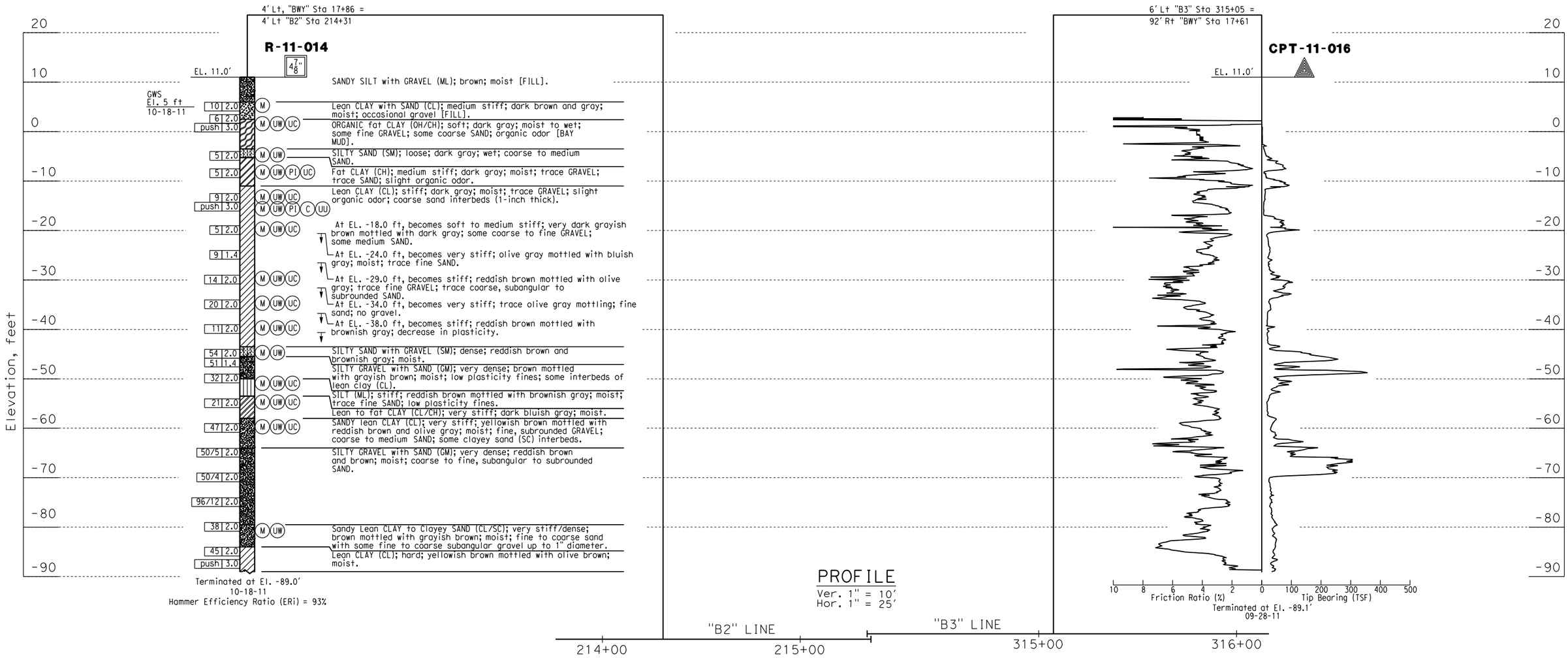

PROFILE
Ver. 1" = 10'
Hor. 1" = 25'

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. HUANG	BRIDGE NO. XX-XXXX
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:		PROJECT ENGINEER	POST MILES X-XX

RETAINING WALL No. 314
LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 01-24-12

REVISION DATES — SHEET — OF

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/12 GEOTECHNICAL STATE OF CALIFORNIA

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URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

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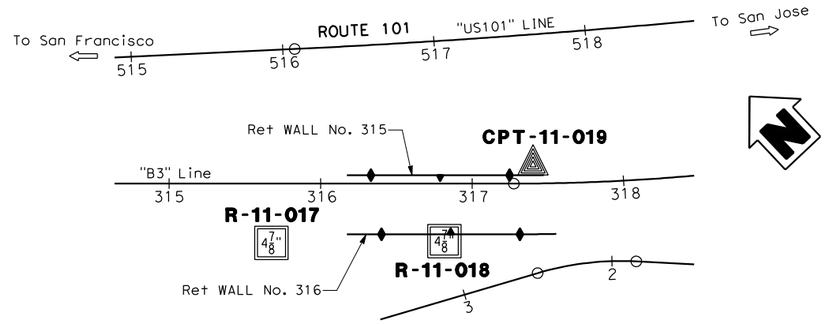
   Thin-walled Shelby tube sampler I.D. = 2.97 inch (3.0)



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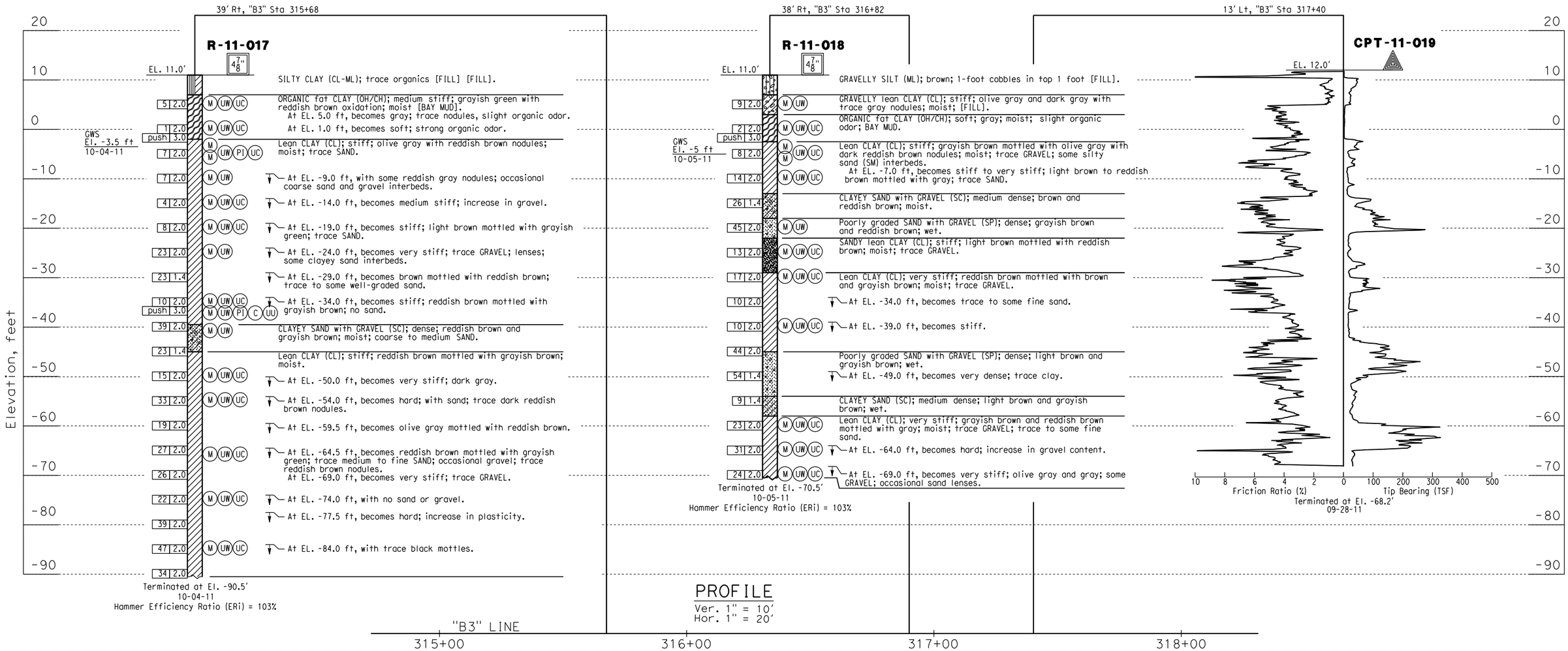

PROFILE
Ver. 1" = 10'
Hor. 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. HUANG
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:		PROJECT ENGINEER

BRIDGE NO. XX-XXXX
POST MILES X-XX

RETAINING WALL No. 315
LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 01-24-12

REVISION DATES | SHEET | OF

FILE => ...\QC-Geotech\LOTB\LOTB-09.dgn

USERNAME => binh_vuong DATE PLOTTED => 2/1/2012 TIME PLOTTED => 9:08:24 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

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REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/12 GEOTECHNICAL STATE OF CALIFORNIA

URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
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BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

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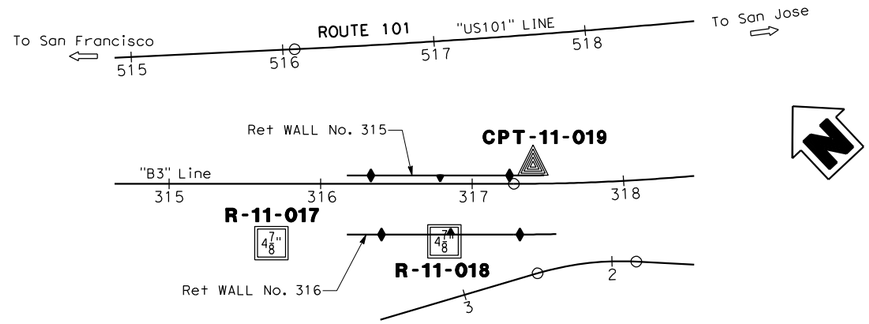

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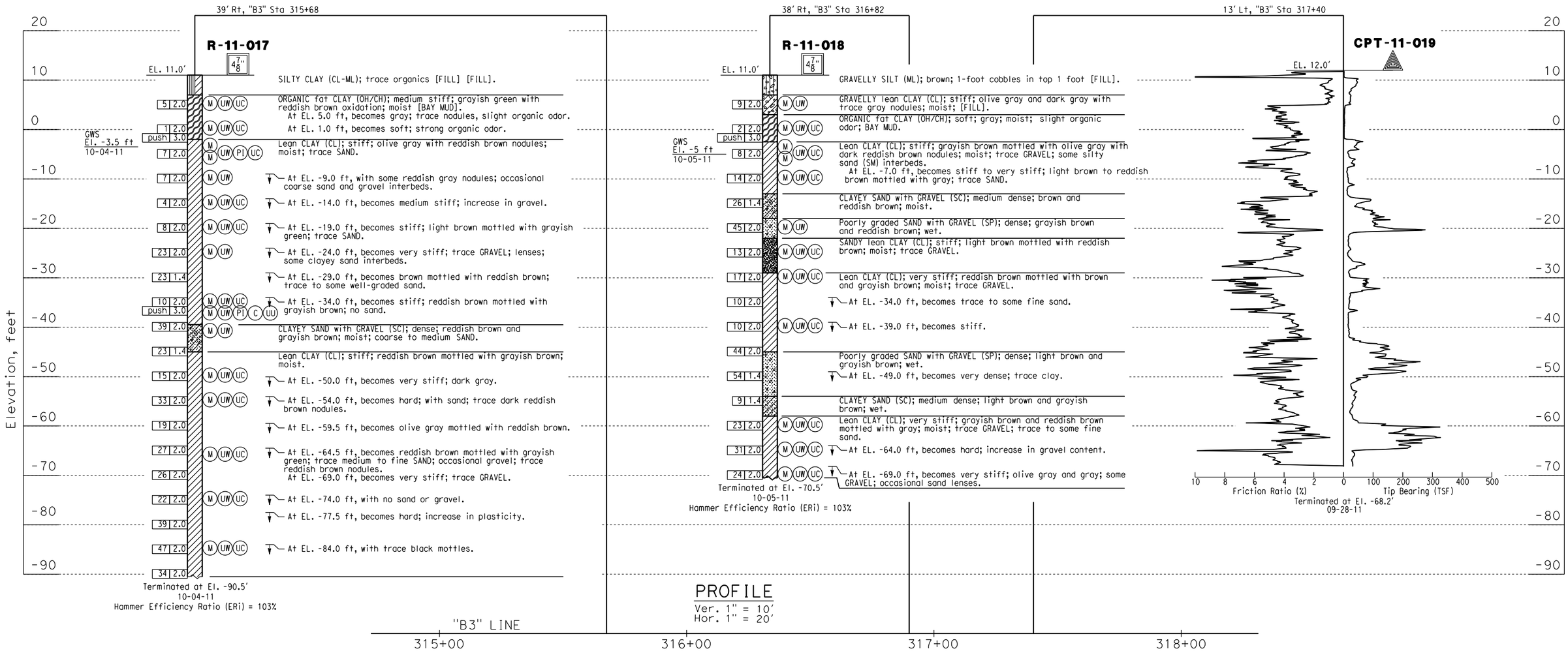

PROFILE
Ver. 1" = 10'
Hor. 1" = 20'

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. HUANG PROJECT ENGINEER
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:		

BRIDGE NO. XX-XXXX
POST MILES X-XX

RETAINING WALL No. 316
LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 01-24-12

REVISION DATES | SHEET | OF

FILE => ...\QC-Geotech\LOTB\LOTB-10.dgn

USERNAME => binh_vuong DATE PLOTTED => 2/1/2012 TIME PLOTTED => 9:08:49 AM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/12 GEOTECHNICAL STATE OF CALIFORNIA

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URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
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BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

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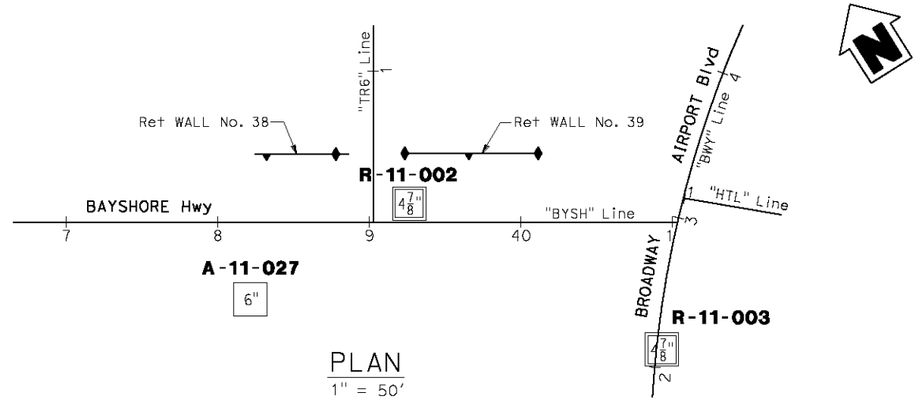

PLAN
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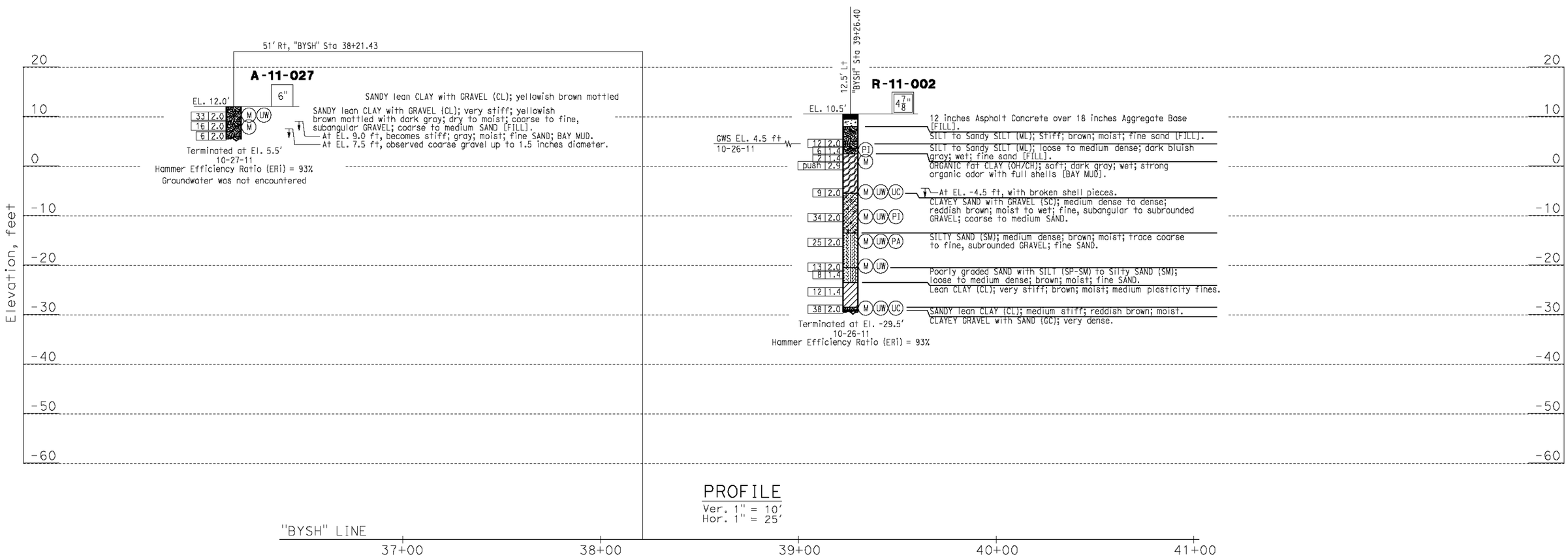

PROFILE
Ver. 1" = 10'
Hor. 1" = 25'

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. HUANG	BRIDGE NO. XX-XXXX	RETAINING WALL No. 38
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:		PROJECT ENGINEER	POST MILES X-XX	LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES 06-14-12

REVISION DATES | SHEET | OF

FILE => LOTB-12.dgn

USERNAME => binh_vuongDATE PLOTTED => 6/15/2012 TIME PLOTTED => 2:59:33 PM

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/12 GEOTECHNICAL STATE OF CALIFORNIA

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URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
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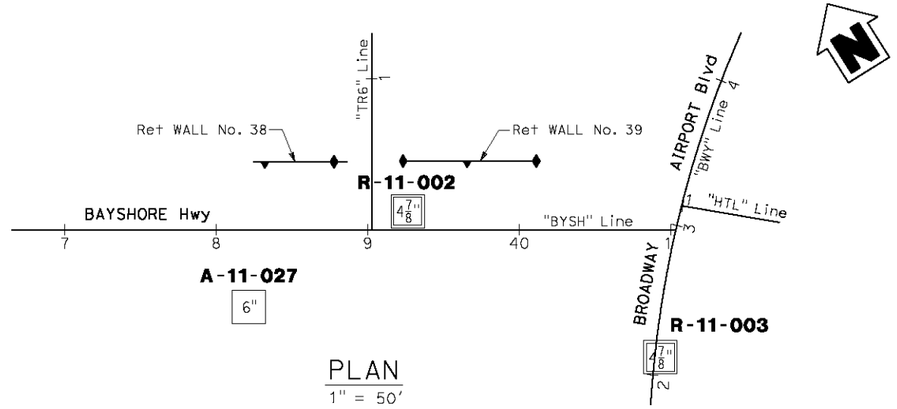

PLAN
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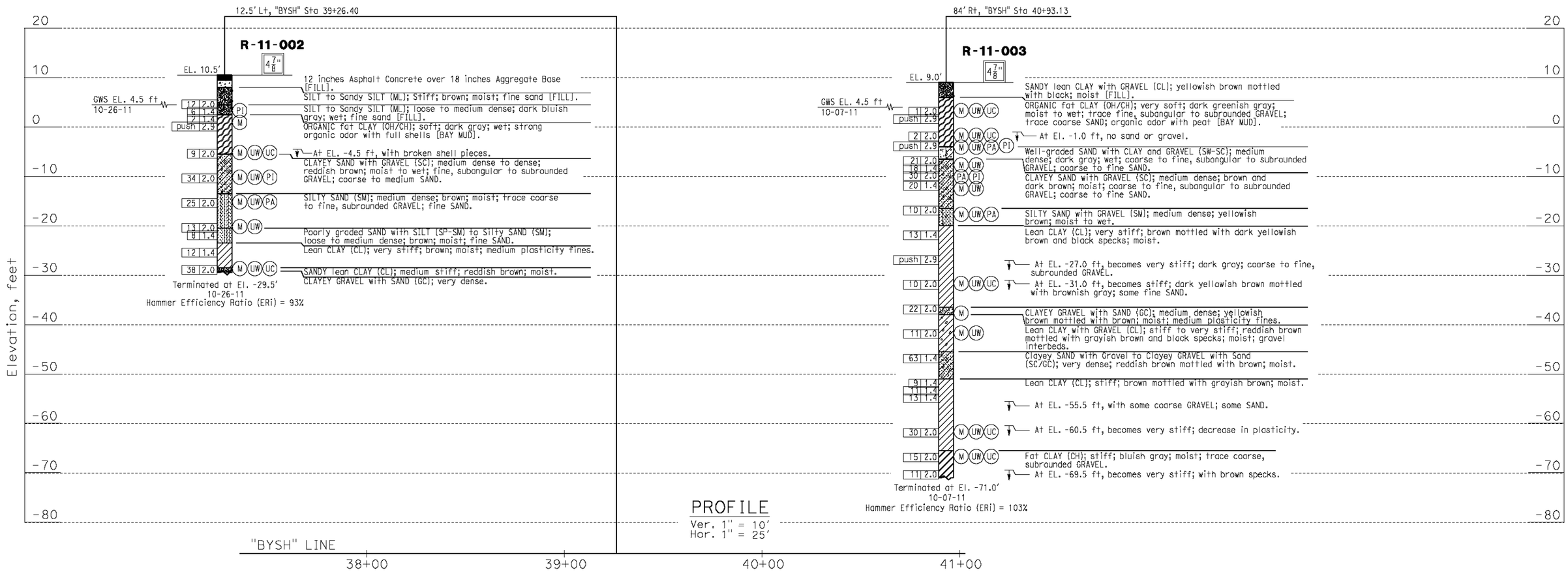


PROFILE
Ver. 1" = 10'
Hor. 1" = 25'

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:

PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION

S. HUANG
PROJECT ENGINEER

BRIDGE NO. XX-XXXX
POST MILES X-XX

RETAINING WALL No. 39
LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 06-14-12 SHEET OF

FILE => LOTB-13.dgn

USERNAME => binh_vuongDATE PLOTTED => 6/15/2012 TIME PLOTTED => 3:00:15 PM

TABLE C-1
SUMMARY OF LABORATORY TEST RESULTS

						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	5.0														26	14	12			
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	10.0														81	30	51	1333	83	50
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	15.0																	947	31.8	87
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	20.5																	1410	32.7	85
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	25.0																	2620	24.4	101
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	36.0																	5350	14.4	122
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	37.0																	5920	23.2	103
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	40.0																	2910	38.1	83
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	45.0																		22	105
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	50.0																	1940	37.2	84
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	60.0																	2520	45.9	76
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	8.8																		64.7	
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	15.0																	1500	37.8	82
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	16.5														39	16	23	2203	26.9	95
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	20.0																	3200	27.6	96
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	25.0																	3660	26.5	99
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	30.0																		17	116
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	40.0																		19	110
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	50.0																	1670	43.6	77
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	58.5																	1370	56.9	66
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	5.0																	2200	13.8	124
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	7.5																	750	47.2	73
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	13.5														74	28	46	430	71.9	57
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	17.5																	3730	27.2	97
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	20.0																	3440	24.4	100
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	25.0																	2630	27.3	97
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	31.0																	530	20.1	110
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	32.0																			
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	32.3																	1250	20	111
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	35.0																	1160	15.2	115
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	40.0																	1840	25.7	98
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	46.0																	2400	30.4	92
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	55.0																	1340	45.8	75
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	60.0																		18	112

TABLE C-1
SUMMARY OF LABORATORY TEST RESULTS

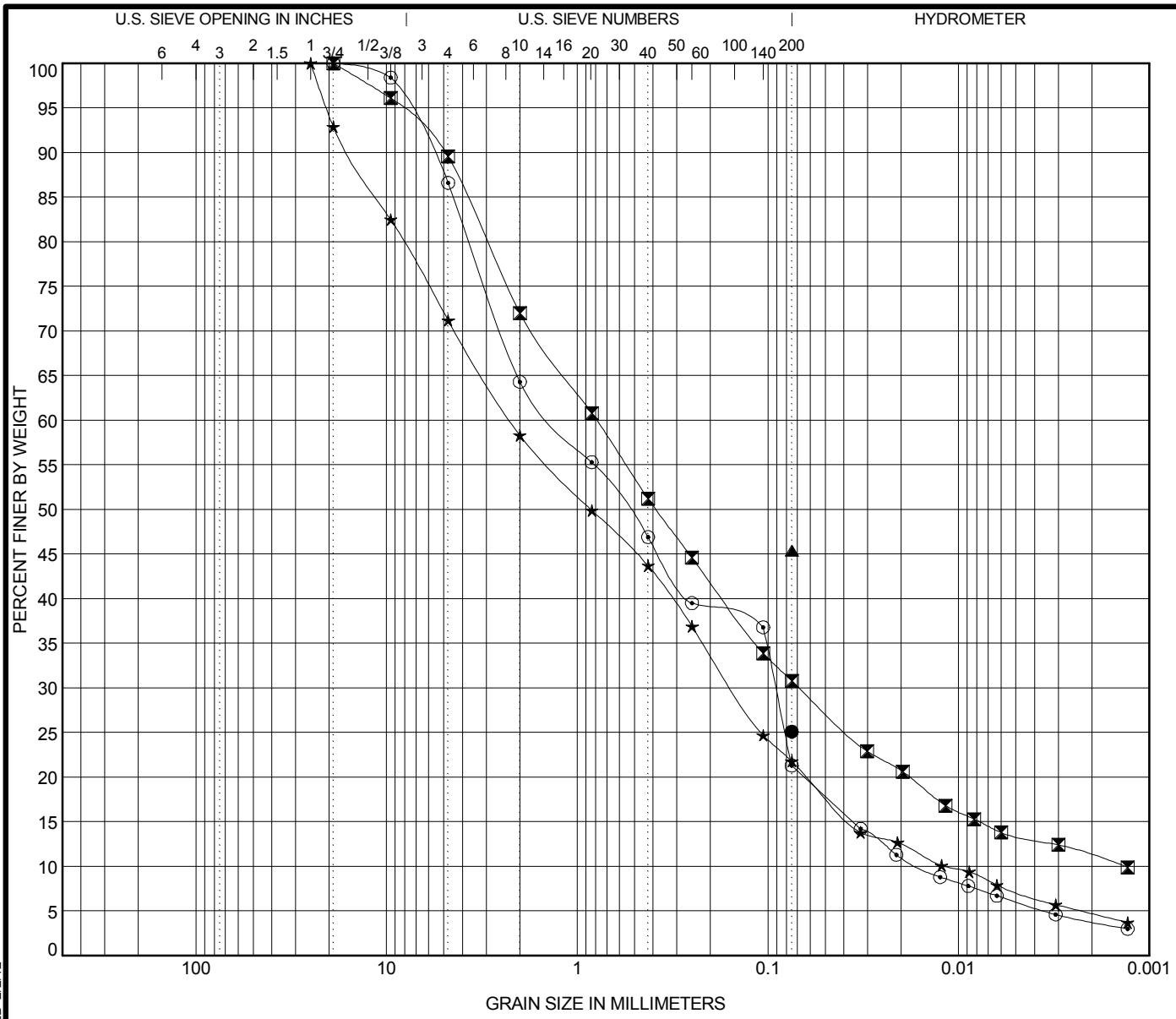
						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	65.0																		16.8	115
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	78.5																	4370	27.3	103
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	5.0												25		25	13	12			
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	7.5																		13.2	123
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	10.0																	1580	75.5	54
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	15.0																	2780	30.2	93
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	20.0																	4810	26.3	101
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	25.0																	3060	19.1	111
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	30.0																	2590		
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	36.0			100	98	96	90	75	65	56	47	38	31		33	17	16		16.1	117
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	45.0																	1740	58.3	65
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	50																	5520	18.9	113
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	55																		21.7	106
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	60																		16.1	118
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	65																	2400	25.4	98
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	5												45		25	22	3	3130	17.5	100
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	10																	1360	73.6	56
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	18																	1941	20.7	106
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	25																	1140	25.0	103
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	30														30	16	14	1280	26.5	100
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	35																	3980	17.3	117
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	41.5			93	87	83	71	61	53	47	39	30	22							
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	50																	850	16.5	123
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	5																		21.7	
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	8.7																	320	64.0	62
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	15																		22.3	104
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	18.5														58	20	38	1730	35.9	86
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	23.5																	3170	26.7	97
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	25														40	17	23	2166	22.3	103
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	30																	770	20.8	109
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	40																	2760	21.5	106
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	45																	7280	23.7	103
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	50																	2640	30.6	92
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	55																		11.2	128

TABLE C-1
SUMMARY OF LABORATORY TEST RESULTS

						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	61.2																	3570	24.3	101
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	65																	5050	31.1	92
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	70																	4990	15.5	118
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	91																		18.1	113
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	5																	490	87.0	49
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	10																	400	95.8	47
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	13.5																	3421	18.8	110
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	15														31	15	16			
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	16.2																		13.5	122
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	25																	1910	28.0	96
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	35																	2750	30.4	93
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	40			100	99	98	87	69	59	51	42	38	21		21	17	4		13.1	124
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	51																		20.9	107
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	55																		10.2	
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	61.5														47	17	30	2648	32.4	86
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	65																	5820	16.3	116
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	70																		11.2	
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	75																		16.4	116
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	80																	7550	17.5	114
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	5																	1110	67.6	59
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	10																	580	97.2	46
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	13.5																		24.0	
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	15														35	17	18	2080	22.5	105
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	20																		18.5	112
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	25																	1630	21.3	106
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	30																	3400	20.9	106
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	35																		18.2	112
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	45																	3250	28.4	96
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	46.5														37	17	20	3881	25.4	100
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	51																		11.1	124
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	60																	5110	21.2	106
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	65																	10320	15.8	116
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	76																	8280	16.0	116
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	85																	7310	19.8	111

TABLE C-1
SUMMARY OF LABORATORY TEST RESULTS

						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	95																	13270	14.7	118
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	5																		8.4	128
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	10																	980	89.2	49
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	13.8																		26.0	
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	15																	2530	19.2	111
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	20																	4170	18.3	113
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	30																		12.8	124
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	35																	2930	16.7	116
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	40																	4960	23.5	103
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	50																	2090	27.1	97
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	70																	4690	16.7	122
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	75																	9120	18.0	114
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	80																	5640	16.3	115



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Identification/Depth (ft)		Classification	LL	PL	PI	Cc	Cu
●	R-11-008	5.0	CLAYEY SAND	25	13	12		
⊠	R-11-008	36.0	CLAYEY SAND	33	17	16	4.39	590.41
▲	R-11-010	5.0	SILTY SAND	25	22	3		
★	R-11-010	41.5	CLAYEY SAND with GRAVEL				0.90	191.16
⊙	R-11-015	40.0	SILTY, CLAYEY SAND	21	17	4	0.39	82.03

	Sample Identification/Depth (ft)		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-11-008	5.0	0.075						25.1	
⊠	R-11-008	36.0	19	0.794	0.068	0.001	10.4	58.8	17.4	13.4
▲	R-11-010	5.0	0.075						45.4	
★	R-11-010	41.5	25	2.241	0.154	0.012	28.8	49.4	14.6	7.2
⊙	R-11-015	40.0	19	1.321	0.091	0.016	13.4	65.3	15.3	6.0

URS

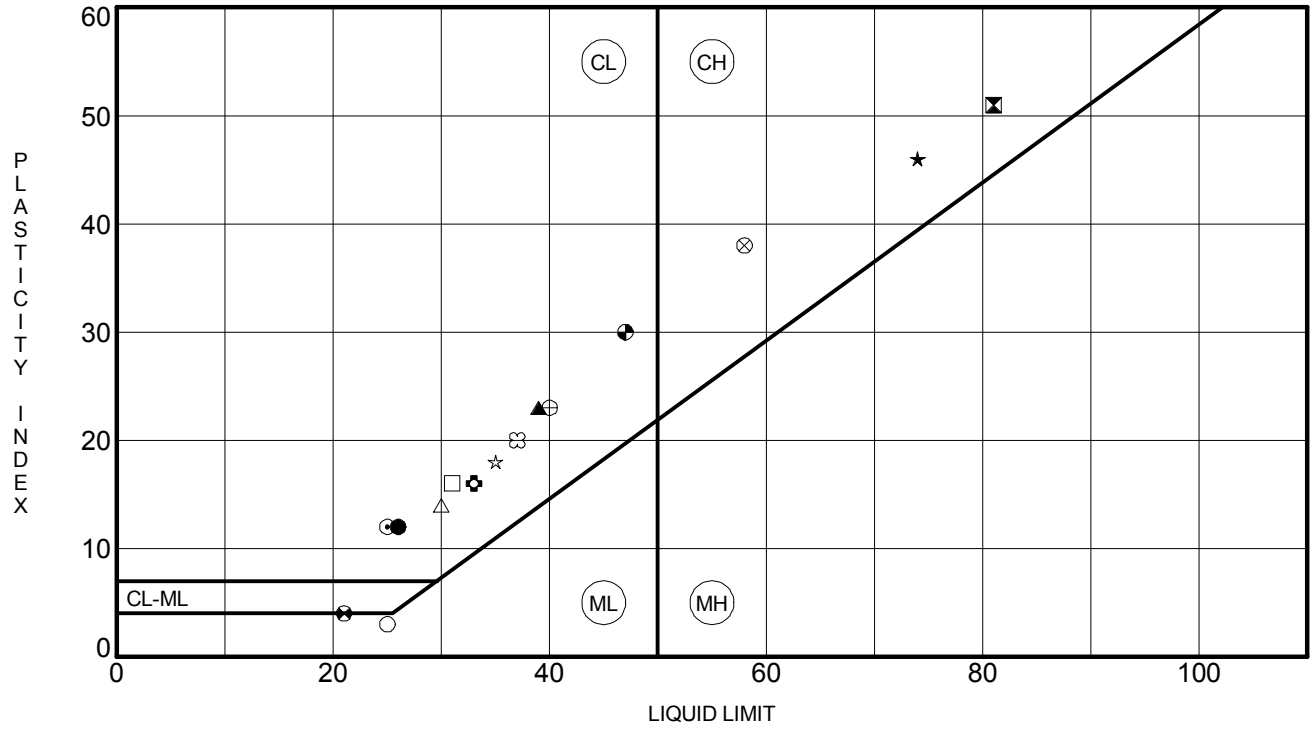
San Jose Office

100 W. San Fernando, Ste 200
San Jose, CA 95113

GRAIN SIZE DISTRIBUTION

Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS GRAIN SIZE 28645286-BROADWAY INTERCHANGE RECONSTRUCTION SM.GPJ SNJ_CT.GLB 2/2/12



	Sample Identification/Depth (ft)		LL	PL	PI	Fines	Classification
●	**R-11-005**	**5.0**	**26**	**14**	**12**		**CLAYEY SAND with GRAVEL (SC)**
⧗	**R-11-005**	**10.0**	**81**	**30**	**51**		**ORGANIC fat CLAY (CH)**
▲	**R-11-006**	**16.5**	**39**	**16**	**23**		**Lean CLAY (CL)**
★	**R-11-007**	**13.5**	**74**	**28**	**46**		**ORGANIC fat CLAY (CH)**
⊙	**R-11-008**	**5.0**	**25**	**13**	**12**	**25**	**CLAYEY SAND (SC)**
✿	**R-11-008**	**36.0**	**33**	**17**	**16**	**31**	**CLAYEY SAND (SC)**
○	**R-11-010**	**5.0**	**25**	**22**	**3**	**45**	**SILTY SAND (SM)**
△	**R-11-010**	**30.0**	**30**	**16**	**14**		**Lean CLAY (CL)**
⊗	**R-11-014**	**18.5**	**58**	**20**	**38**		**Fat CLAY (CH)**
⊕	**R-11-014**	**25.0**	**40**	**17**	**23**		**Lean CLAY (CL)**
□	**R-11-015**	**15.0**	**31**	**15**	**16**		**CLAYEY SAND with GRAVEL (SC)**
❀	**R-11-015**	**40.0**	**21**	**17**	**4**	**21**	**SILTY, CLAYEY SAND (SC-SM)**
◕	**R-11-015**	**61.5**	**47**	**17**	**30**		**Lean to fat CLAY (CL/CH)**
☆	**R-11-017**	**15.0**	**35**	**17**	**18**		**Lean CLAY (CL)**
✿	**R-11-017**	**46.5**	**37**	**17**	**20**		**Lean CLAY (CL)**

URS

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ATTERBERG LIMITS RESULTS

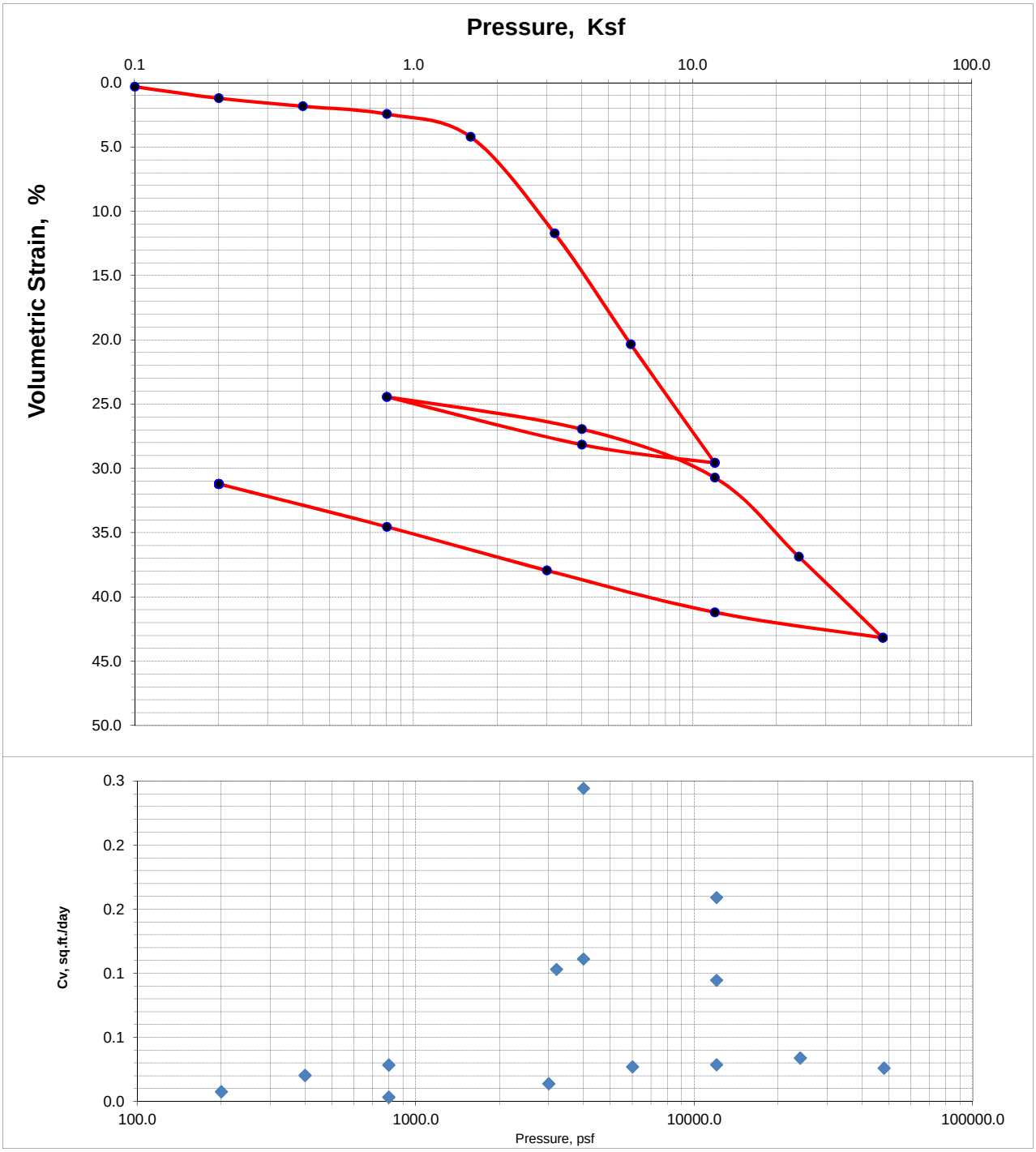
Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS ATTERBERG LIMITS 28645286-BROADWAY INTERCHANGE RECONSTRUCTION SM.GPJ SNJ CT.GLB 2/2/12

CONSOLIDATION TEST

Boring Number	R-11-005	Sample Number	3	Depth (ft)	10-12.5	
Soil Description	Dark olive gray fat clay with organics					

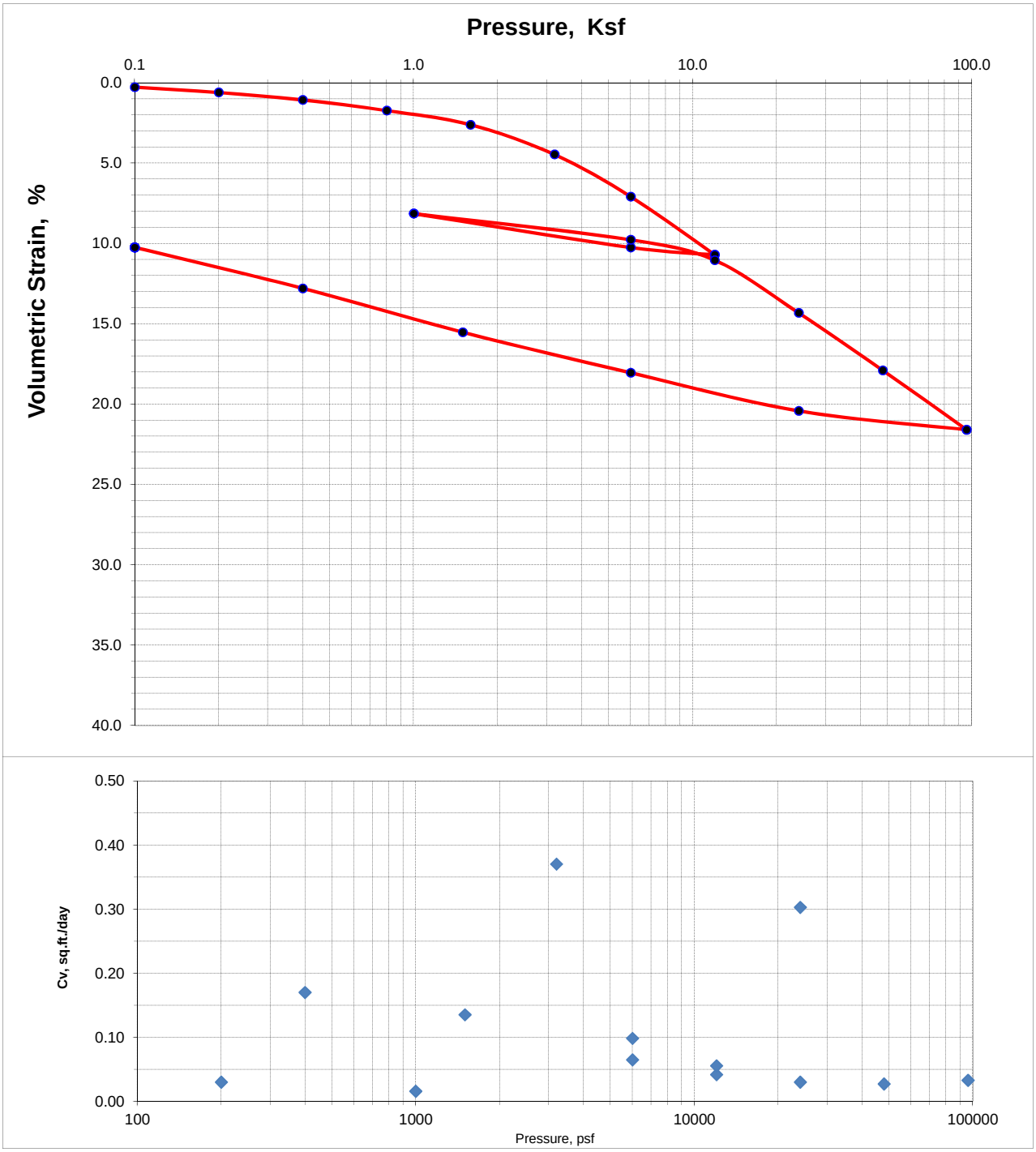
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	84.0	93.0	2.336	97.1	1.00	2.420	(assumed) 2.70	81	51
Final	46.4	111.0	1.224	102.4	0.667				



28645286.02

CONSOLIDATION TEST

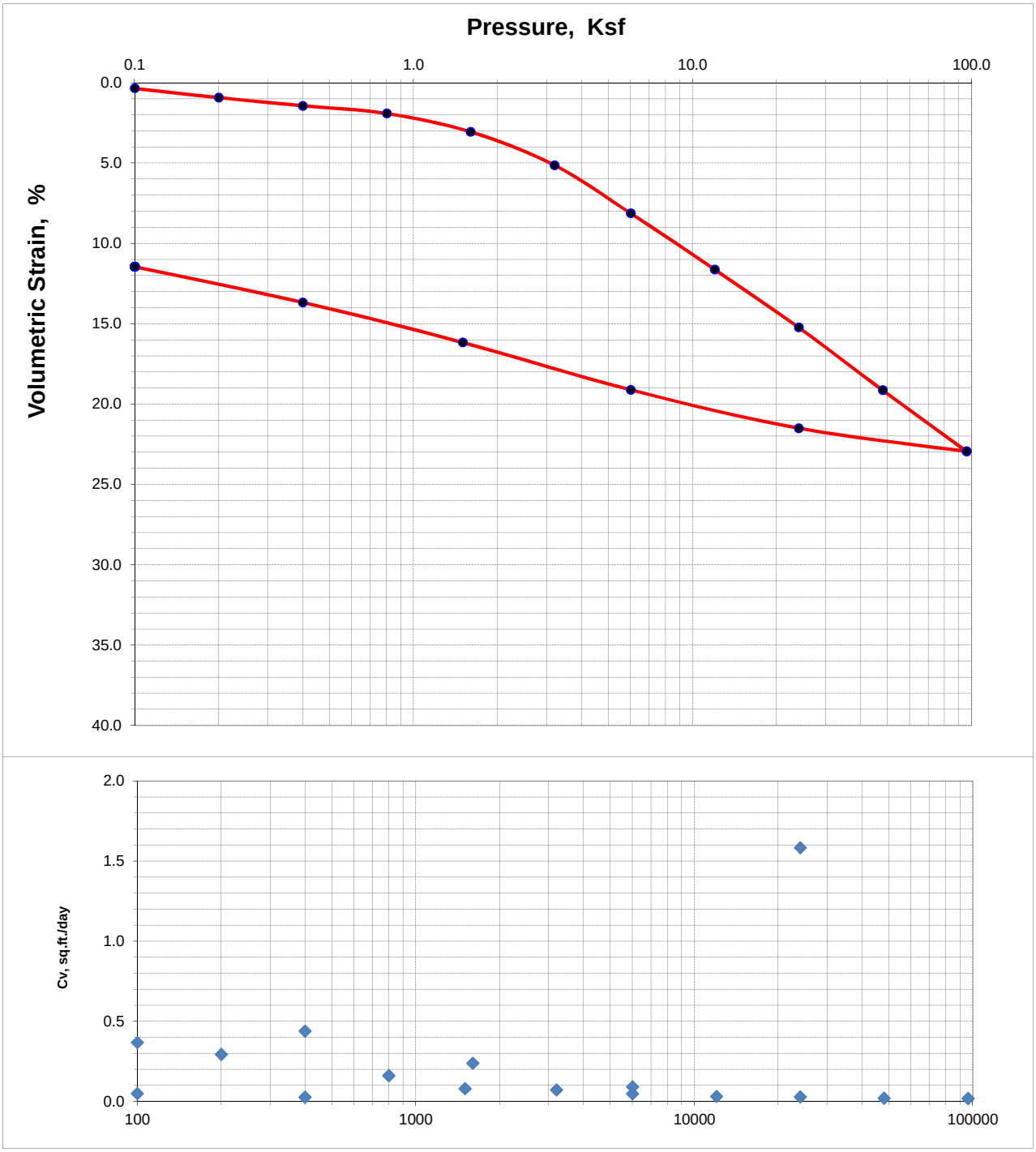
Boring Number	R-11-006	Sample Number	4	Depth (ft)	16.5-19				
Soil Description	Dark olive gray lean clay								
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	23.5	124.1	0.677	93.5	1.00	2.420	(assumed) 2.70	39	23
Final	19.6	132.7	0.521	101.8	0.907				



28645286.02

CONSOLIDATION TEST

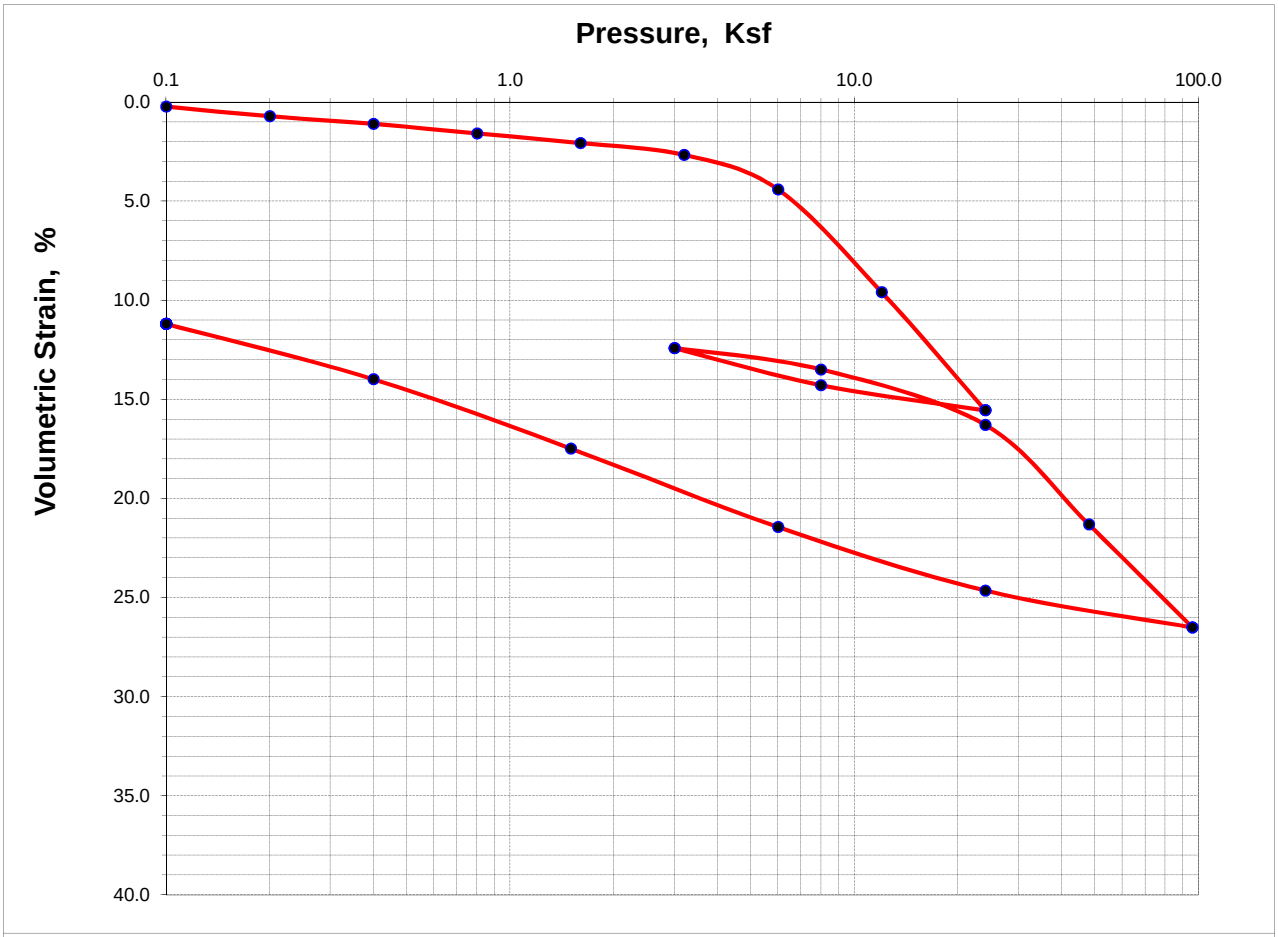
Boring Number	R-11-014	Sample Number	7	Depth (ft)	25-27.5			
Soil Description	Dark olive gray lean clay							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	26.0	123.8	0.715	98.0	1.00	2.420	(assumed) 2.70	40	23
Final	18.5	134.5	0.485	102.7	0.866				

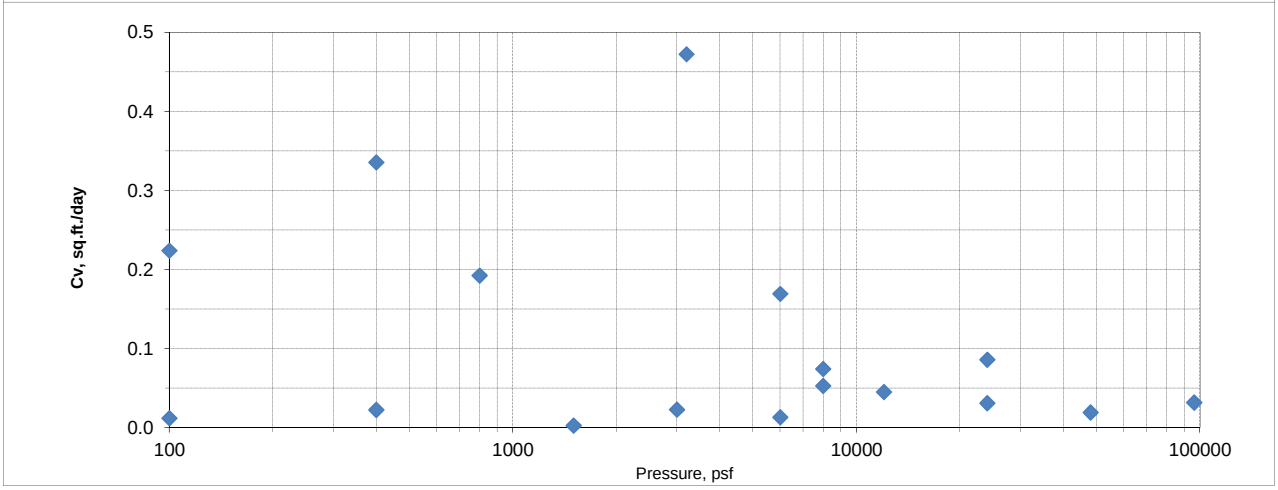


28645286.02

CONSOLIDATION TEST

Boring Number	R-11-015	Sample Number	16	Depth (ft)	61.5-64			
Soil Description	Olive gray lean clay							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	31.6	119.1	0.863	98.9	1.00	2.420	(assumed) 2.70	47	30
Final	23.4	128.9	0.615	102.9	0.867				





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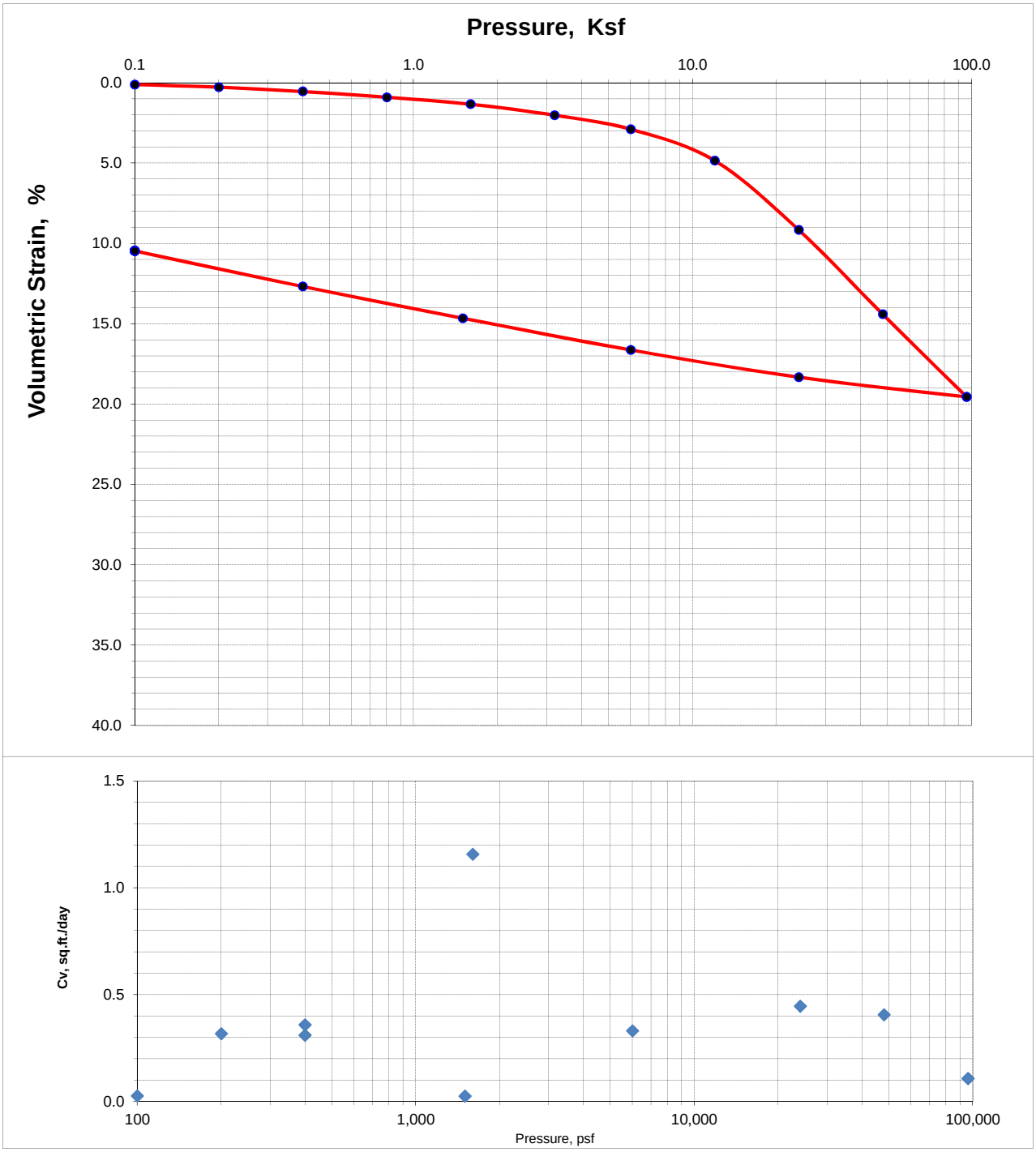
CONSOLIDATION TEST

Boring Number	R-11-017	Sample Number	11	Depth (ft)	46.5-49			
Soil Description	Grayish brown lean clay							
	Water Content, %	Total Unit Weight, pcf	Void Ratio	Saturation %	Height in	Diameter in	Specific Gravity	Liquid Limit, %	Plasticity Index, %
Initial	26.1	122.7	0.734	96.1	1.00	2.420	(assumed) 2.70	37	20
Final	19.8	132.6	0.523	102.1	0.878				



28645286.02

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-005
Sample # : 3
Depth (ft) : 10-12.5
Date tested : 11/29/11
Soil : Dark olive gray fat clay with organics

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

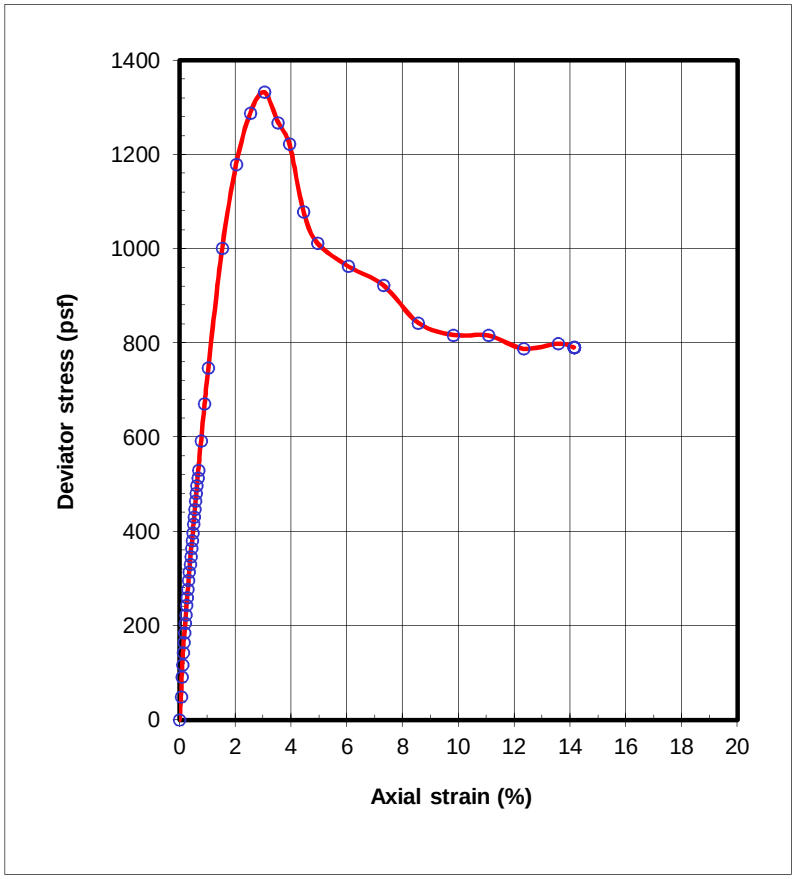
Specimen:

Total wt. =	930.0	gms	
Ht. =	5.980	in	
Ave dia. =	2.857	in	
Area =	6.412	sq.in	
Volume =	628.3	c.c.	
Shearing rate =	0.04	inch/min	
Shearing rate =	0.75	%/min	
Gs (assumed) =	2.70		

Test Report:

Void ratio =	2.334	
Ht/Dia ratio =	2.09	
Moisture =	82.7	%
Total density =	92.4	pcf
Dry density =	50.5	pcf
Saturation =	95.7	%
Chamber pressure =	1000	psf
Max. deviator stress =	1333	psf
Strain @ failure =	3.04	%

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	2.2	0.05	49.5
0.003	4.0	0.07	90.8
0.005	5.2	0.10	117.2
0.006	6.4	0.12	142.9
0.007	7.3	0.15	164.0
0.009	8.3	0.17	185.3
0.010	9.1	0.20	205.0
0.012	9.9	0.22	222.7
0.013	10.8	0.25	242.8
0.015	11.6	0.27	259.9
0.016	12.4	0.30	277.5
0.018	13.2	0.32	296.5
0.019	14.0	0.35	314.1
0.021	14.8	0.37	330.5
0.022	15.5	0.40	347.0
0.024	16.3	0.42	364.2
0.025	17.0	0.45	380.9
0.027	17.7	0.47	396.7
0.028	18.6	0.50	415.8
0.030	19.3	0.52	431.0
0.031	20.0	0.55	447.2
0.033	20.8	0.57	464.0
0.034	21.5	0.60	480.4
0.036	22.3	0.62	497.7
0.037	23.0	0.65	513.4
0.039	23.8	0.67	530.5
0.045	26.6	0.77	592.9
0.052	30.1	0.90	670.7
0.060	33.6	1.02	747.2
0.090	45.3	1.53	1001.6
0.120	53.6	2.03	1178.8
0.150	58.9	2.53	1288.6
0.180	61.2	3.04	1332.5
0.210	58.5	3.53	1268.0
0.234	56.6	3.94	1222.1
0.264	50.3	4.44	1078.6
0.294	47.4	4.95	1011.9
0.360	45.6	6.05	962.9
0.435	44.3	7.30	922.7
0.510	41.0	8.56	842.7
0.585	40.3	9.81	816.9
0.661	40.8	11.07	815.9
0.736	40.0	12.32	788.0
0.810	41.1	13.57	798.7
0.844	41.0	14.13	790.6



UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-005
Sample # : 4
Depth (ft) : 15-17.5
Date tested : 11/29/11
Soil : Dark olive gray fat clay

Data Reduction:

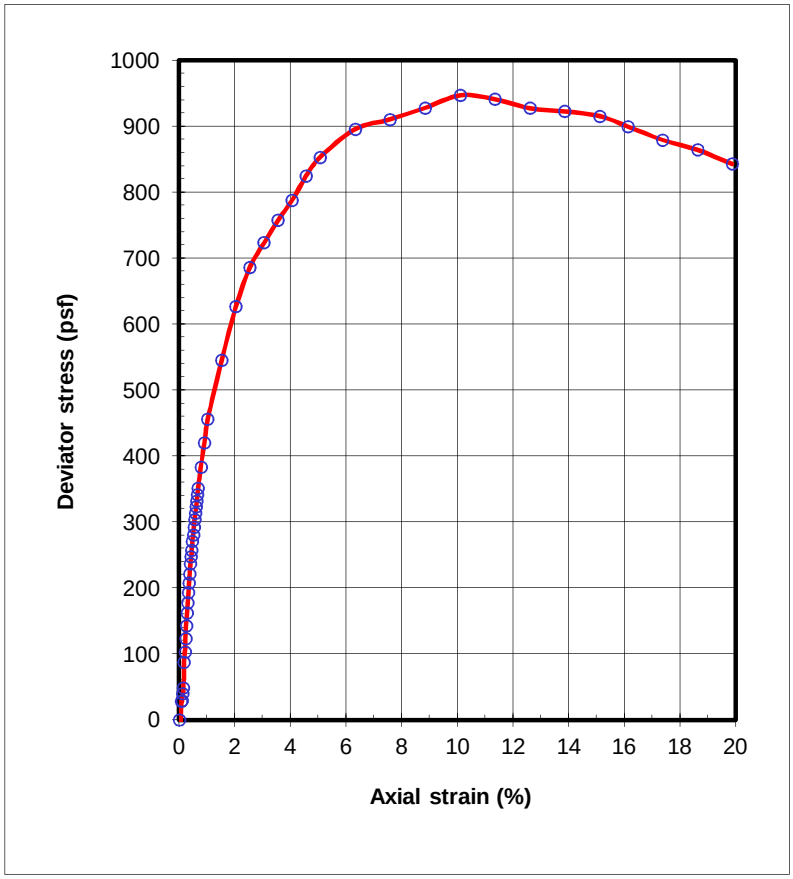
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:

Total wt. =	1088.7	gms
Ht. =	5.730	in
Ave dia. =	2.837	in
Area =	6.322	sq.in
Volume =	593.7	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.940	
Ht/Dia ratio =	2.02	
Moisture =	31.8	%
Total density =	114.4	pcf
Dry density =	86.8	pcf
Saturation =	91.3	%
Chamber pressure =	1100	psf
Max. deviator stress =	947	psf
Strain @ failure =	10.09	%



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.002		0.00	0.0
0.001	-0.4	0.05	-9.5
0.003	1.2	0.08	28.2
0.004	1.3	0.10	28.6
0.006	1.7	0.13	39.3
0.007	2.1	0.15	48.1
0.008	3.8	0.18	86.8
0.010	4.5	0.20	103.2
0.011	5.4	0.23	123.2
0.013	6.3	0.25	142.6
0.014	7.1	0.28	161.7
0.016	7.8	0.30	178.0
0.017	8.5	0.33	193.4
0.018	9.2	0.35	207.7
0.020	9.8	0.38	221.5
0.021	10.4	0.40	236.8
0.023	10.9	0.43	247.0
0.024	11.4	0.45	257.4
0.026	12.0	0.48	270.9
0.027	12.4	0.50	280.8
0.028	12.9	0.53	292.0
0.030	13.4	0.55	303.5
0.031	13.8	0.58	313.5
0.033	14.3	0.60	322.9
0.034	14.7	0.63	332.0
0.036	15.1	0.65	341.2
0.037	15.5	0.68	350.8
0.043	17.0	0.78	383.1
0.050	18.6	0.90	420.2
0.057	20.2	1.03	456.4
0.086	24.3	1.53	545.5
0.115	28.1	2.04	627.1
0.144	30.9	2.55	686.4
0.173	32.8	3.05	723.8
0.202	34.5	3.56	758.1
0.231	36.1	4.06	788.0
0.260	37.9	4.57	824.8
0.288	39.5	5.07	853.4
0.361	42.0	6.32	895.7
0.433	43.3	7.58	910.7
0.504	44.7	8.83	928.1
0.577	46.3	10.09	947.1
0.648	46.6	11.35	941.0
0.720	46.6	12.60	927.7
0.792	47.0	13.86	922.8
0.864	47.4	15.11	915.5
0.922	47.1	16.12	899.9
0.993	46.7	17.36	879.6
1.065	46.6	18.62	864.2

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-006
Sample # : 4
Depth (ft) : 16.5-19
Date tested : 11/29/11
Soil : Dark olive gray lean clay

Data Reduction:

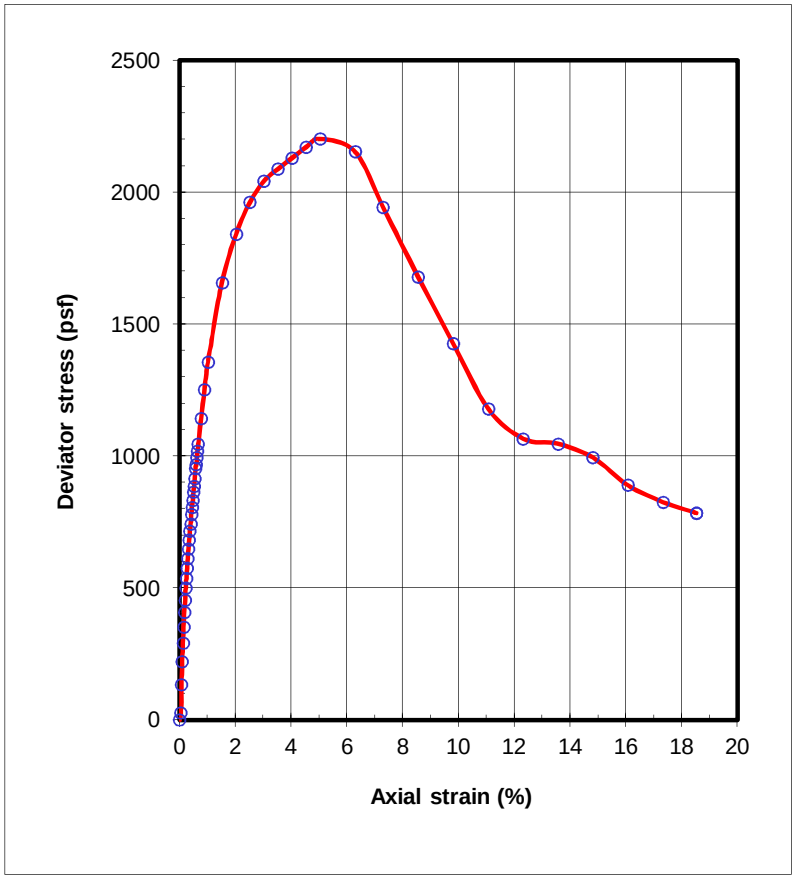
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:

Total wt. =	1262.6	gms
Ht. =	6.210	in
Ave dia. =	2.863	in
Area =	6.442	sq.in
Volume =	655.5	c.c.
Shearing rate =	0.05	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.780	
Ht/Dia ratio =	2.17	
Moisture =	27.0	%
Total density =	120.2	pcf
Dry density =	94.7	pcf
Saturation =	93.4	%
Chamber pressure =	1450	psf
Max. deviator stress =	2203	psf
Strain @ failure =	5.04	%



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	1.2	0.05	27.3
0.003	6.0	0.07	133.8
0.005	9.9	0.10	220.0
0.006	13.0	0.12	290.6
0.008	15.8	0.14	352.6
0.009	18.2	0.17	406.2
0.011	20.3	0.19	452.9
0.012	22.4	0.22	499.5
0.014	24.0	0.24	535.7
0.015	25.8	0.27	574.2
0.017	27.5	0.29	612.0
0.019	29.0	0.32	646.9
0.020	30.6	0.34	681.5
0.022	32.1	0.37	714.6
0.023	33.4	0.39	742.9
0.025	35.0	0.42	778.9
0.026	36.2	0.44	805.1
0.028	37.4	0.47	833.0
0.029	38.8	0.49	863.4
0.031	39.8	0.52	885.9
0.033	41.1	0.54	914.7
0.034	42.9	0.57	952.9
0.036	43.5	0.59	967.6
0.037	44.7	0.62	993.6
0.039	45.9	0.64	1019.9
0.040	47.1	0.67	1045.4
0.046	51.5	0.77	1141.8
0.054	56.6	0.89	1252.9
0.062	61.3	1.02	1355.5
0.093	75.3	1.52	1657.2
0.125	84.1	2.03	1842.4
0.155	90.1	2.52	1962.7
0.187	94.3	3.03	2043.7
0.218	96.9	3.53	2088.7
0.249	99.3	4.03	2130.2
0.281	101.8	4.54	2171.5
0.312	103.8	5.04	2203.3
0.390	102.8	6.29	2153.2
0.452	93.7	7.30	1942.7
0.530	82.1	8.55	1678.9
0.608	70.7	9.81	1426.3
0.686	59.3	11.06	1179.4
0.764	54.4	12.32	1065.7
0.841	54.2	13.56	1046.6
0.919	52.2	14.81	994.4
0.997	47.4	16.07	889.3
1.075	44.7	17.32	825.5
1.149	43.1	18.52	784.1

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-010
Sample # : 4
Depth (ft) : 18-20.5
Date tested : 11/29/11
Soil : Dark brown fat clay

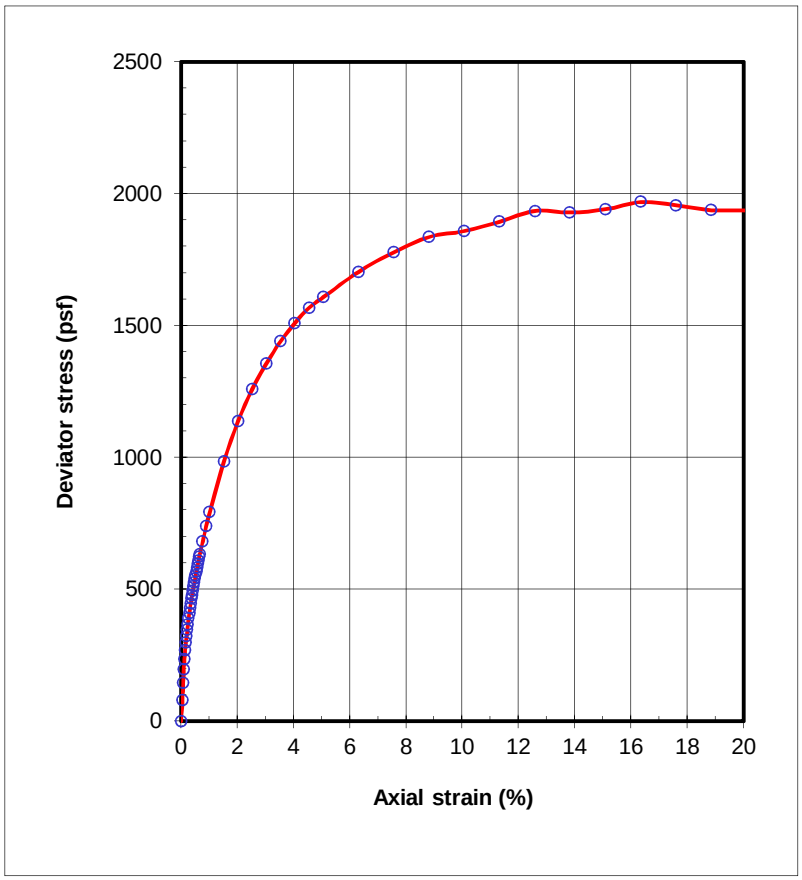
Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt. =	1268.9	gms
Ht. =	5.960	in
Ave dia. =	2.840	in
Area =	6.337	sq.in
Volume =	618.9	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.589	
Ht/Dia ratio =	2.10	
Moisture =	20.6	%
Total density =	127.9	pcf
Dry density =	106.0	pcf
Saturation =	94.6	%
Chamber pressure =	1300	psf
Max. deviator stress =	1941	psf
Strain @ failure =	15.09	%



Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	3.5	0.05	80.1
0.003	6.4	0.07	145.4
0.004	8.7	0.10	197.2
0.006	10.4	0.12	235.3
0.007	11.9	0.15	268.9
0.009	13.1	0.17	297.1
0.010	14.2	0.20	322.0
0.012	15.3	0.22	346.4
0.013	16.2	0.25	367.0
0.015	17.2	0.27	390.2
0.016	18.1	0.30	410.6
0.018	19.0	0.32	429.5
0.019	19.7	0.35	446.1
0.021	20.6	0.37	465.4
0.022	21.1	0.40	478.3
0.024	21.8	0.42	494.0
0.025	22.6	0.45	511.0
0.027	23.2	0.47	525.4
0.028	23.9	0.50	541.4
0.030	24.5	0.52	552.7
0.031	25.1	0.55	567.1
0.033	25.8	0.57	582.2
0.034	26.4	0.60	596.6
0.036	26.9	0.62	608.0
0.037	27.6	0.65	622.1
0.039	28.1	0.67	634.0
0.045	30.2	0.77	682.0
0.052	32.8	0.90	738.6
0.059	35.3	1.02	793.9
0.090	44.0	1.53	984.8
0.120	51.1	2.03	1137.9
0.149	56.8	2.53	1258.0
0.179	61.5	3.03	1356.0
0.210	65.7	3.54	1440.4
0.240	69.2	4.04	1509.0
0.270	72.3	4.55	1568.1
0.300	74.5	5.06	1607.7
0.374	80.0	6.31	1703.3
0.450	84.7	7.57	1778.3
0.524	88.6	8.82	1836.2
0.599	91.0	10.07	1858.7
0.674	94.0	11.32	1893.9
0.748	97.4	12.58	1934.5
0.823	98.5	13.83	1929.0
0.898	100.6	15.09	1940.5
0.973	103.6	16.34	1968.9
1.047	104.4	17.60	1955.5
1.122	105.1	18.85	1937.6

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-014
Sample # : 7
Depth (ft) : 25-27.5
Date tested : 11/30/11
Soil : Dark olive gray lean clay

Data Reduction:

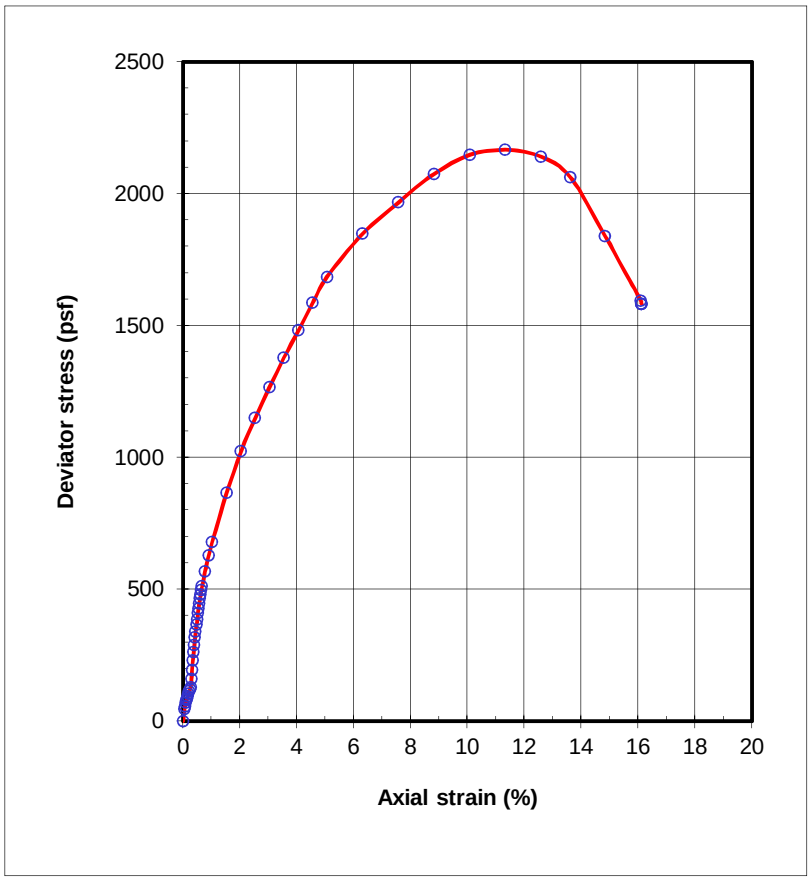
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt. =	1252.6	gms
Ht. =	5.970	in
Ave dia. =	2.840	in
Area =	6.337	sq.in
Volume =	620.0	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.634	
Ht/Dia ratio =	2.10	
Moisture =	22.3	%
Total density =	126.1	pcf
Dry density =	103.1	pcf
Saturation =	94.9	%
Chamber pressure =	1650	psf
Max. deviator stress =	2166	psf
Strain @ failure =	11.33	%

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	2.0	0.05	45.4
0.003	2.4	0.07	55.5
0.004	3.0	0.10	69.0
0.006	3.5	0.12	79.7
0.007	3.8	0.15	85.6
0.009	4.2	0.17	95.2
0.010	4.6	0.20	103.5
0.012	5.0	0.22	114.2
0.013	5.4	0.25	121.9
0.015	5.7	0.27	129.0
0.016	7.0	0.30	158.8
0.018	8.6	0.32	195.0
0.019	10.1	0.35	229.1
0.021	11.6	0.37	262.5
0.022	12.8	0.40	288.8
0.024	14.0	0.42	317.1
0.025	15.0	0.45	340.3
0.027	16.1	0.47	365.1
0.028	17.0	0.50	385.0
0.030	18.1	0.52	409.0
0.031	18.9	0.55	427.0
0.033	19.7	0.57	446.0
0.034	20.6	0.60	465.4
0.036	21.3	0.62	480.8
0.037	22.1	0.65	498.1
0.039	22.7	0.67	512.2
0.045	25.1	0.77	566.2
0.052	27.9	0.90	627.8
0.060	30.2	1.02	679.6
0.090	38.7	1.53	865.2
0.120	45.9	2.04	1022.6
0.150	51.9	2.54	1150.4
0.180	57.5	3.04	1266.3
0.210	62.9	3.55	1378.3
0.241	68.0	4.06	1481.7
0.271	73.1	4.56	1586.1
0.301	78.1	5.06	1684.3
0.376	86.8	6.32	1848.8
0.451	93.7	7.57	1967.2
0.525	100.1	8.82	2074.8
0.600	105.1	10.08	2147.1
0.675	107.5	11.33	2166.1
0.750	107.8	12.58	2140.4
0.812	105.1	13.62	2062.3
0.885	95.1	14.84	1839.5
0.960	83.6	16.10	1593.7
0.961	83.0	16.12	1582.2



UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-015
Sample # : 3
Depth (ft) : 11.5-14
Date tested : 11/29/11
Soil : Dark olive brown lean clay with gravel

Data Reduction:

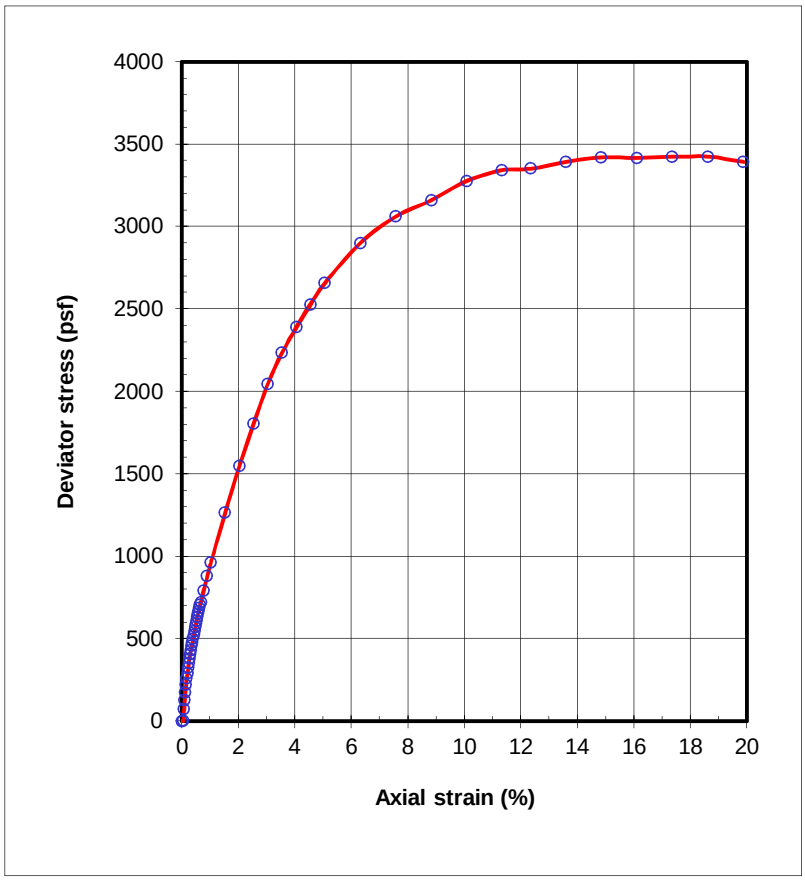
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt. =	1288.2	gms
Ht. =	5.930	in
Ave dia. =	2.837	in
Area =	6.322	sq.in
Volume =	614.4	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.530	
Ht/Dia ratio =	2.09	
Moisture =	18.8	%
Total density =	130.8	pcf
Dry density =	110.2	pcf
Saturation =	95.8	%
Chamber pressure =	850	psf
Max. deviator stress =	3421	psf
Strain @ failure =	14.84	%

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	0.2	0.05	3.9
0.003	3.2	0.07	72.2
0.005	5.6	0.10	127.1
0.006	7.7	0.12	174.7
0.007	9.7	0.15	219.7
0.009	11.4	0.17	258.1
0.010	12.8	0.20	290.7
0.012	14.3	0.22	324.4
0.013	15.6	0.25	354.3
0.015	16.7	0.27	380.1
0.016	17.9	0.30	405.4
0.018	18.9	0.32	430.2
0.019	20.1	0.35	455.7
0.021	21.1	0.37	478.8
0.022	22.1	0.40	500.7
0.024	23.1	0.42	524.0
0.025	24.1	0.45	546.1
0.027	25.1	0.47	569.3
0.028	26.0	0.50	588.2
0.030	26.9	0.52	609.5
0.031	27.9	0.55	631.0
0.033	28.7	0.57	650.4
0.034	29.5	0.60	667.6
0.036	30.3	0.62	686.1
0.037	31.2	0.65	704.9
0.039	32.0	0.67	723.1
0.045	35.1	0.77	793.1
0.052	39.0	0.90	879.2
0.059	42.6	1.02	960.8
0.089	56.4	1.53	1264.8
0.119	69.4	2.04	1547.4
0.149	81.3	2.54	1804.0
0.179	92.7	3.04	2046.4
0.209	101.7	3.54	2234.7
0.239	109.4	4.05	2389.8
0.268	116.3	4.55	2528.0
0.298	122.9	5.05	2657.2
0.373	136.0	6.31	2901.0
0.448	145.5	7.57	3062.3
0.522	152.2	8.83	3160.2
0.596	160.0	10.08	3277.8
0.671	165.5	11.33	3342.8
0.730	167.9	12.33	3351.9
0.805	172.4	13.59	3392.9
0.879	176.4	14.84	3421.1
0.954	178.8	16.10	3417.5
1.028	181.9	17.36	3423.5
1.103	184.8	18.61	3425.1



Signet Testing Labs

UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-015
Sample # : 16
Depth (ft) : 61.5-64
Date tested : 11/30/11
Soil : Olive gray lean clay

Data Reduction:

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

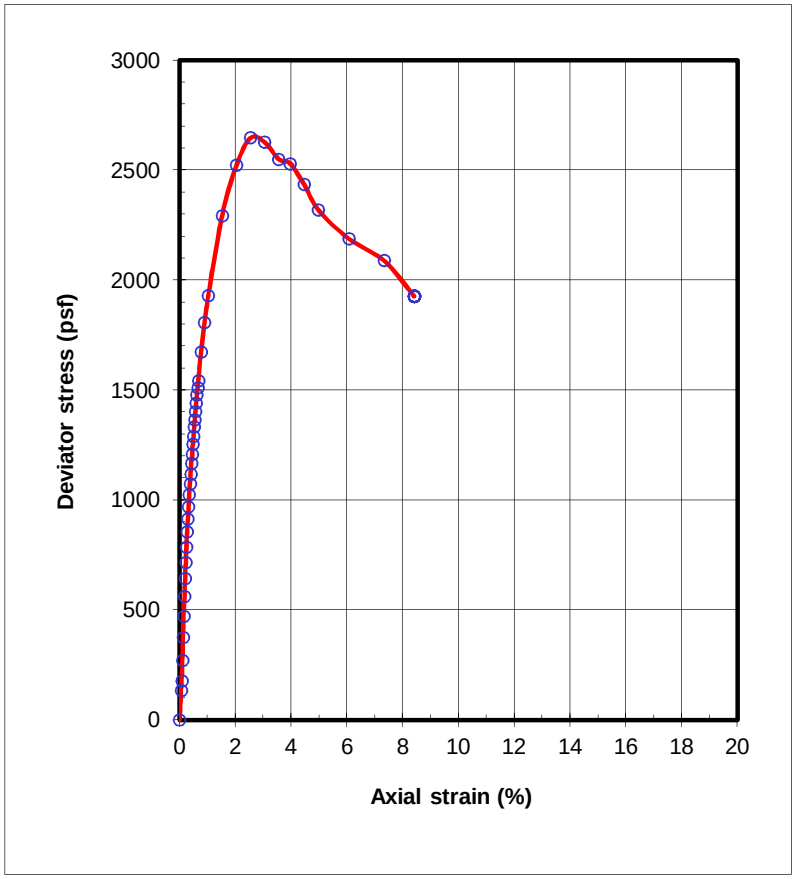
Specimen:

Total wt. =	1124.1	gms
Ht. =	5.970	in
Ave dia. =	2.833	in
Area =	6.308	sq.in
Volume =	617.1	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.962	
Ht/Dia ratio =	2.11	
Moisture =	32.4	%
Total density =	113.7	pcf
Dry density =	85.9	pcf
Saturation =	90.9	%
Chamber pressure =	3950	psf
Max. deviator stress =	2648	psf
Strain @ failure =	2.55	%

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	5.8	0.05	132.6
0.003	7.8	0.07	177.7
0.005	11.9	0.10	271.1
0.006	16.4	0.12	374.6
0.007	20.7	0.15	472.0
0.009	24.7	0.17	562.8
0.011	28.2	0.20	643.0
0.012	31.5	0.22	717.1
0.013	34.6	0.25	787.3
0.015	37.5	0.27	854.5
0.016	40.1	0.30	912.8
0.018	42.7	0.32	970.6
0.019	45.0	0.35	1023.3
0.021	47.2	0.37	1073.2
0.022	49.2	0.40	1119.3
0.024	51.3	0.42	1166.2
0.025	53.1	0.45	1207.6
0.027	55.2	0.47	1253.2
0.028	56.8	0.50	1290.7
0.030	58.7	0.52	1332.1
0.031	60.2	0.55	1366.6
0.033	61.9	0.57	1404.4
0.034	63.5	0.60	1441.6
0.036	65.1	0.62	1477.6
0.037	66.7	0.65	1512.2
0.039	68.1	0.67	1544.0
0.045	73.9	0.77	1673.9
0.052	79.9	0.90	1808.4
0.060	85.4	1.02	1928.8
0.090	102.1	1.53	2295.4
0.121	112.8	2.04	2523.5
0.151	119.0	2.55	2648.3
0.181	118.7	3.05	2627.7
0.211	115.8	3.56	2550.2
0.236	115.4	3.97	2530.3
0.265	111.8	4.46	2438.1
0.295	107.0	4.96	2321.5
0.361	102.1	6.07	2188.5
0.436	98.7	7.33	2089.1
0.501	92.1	8.41	1926.5



UNCONSOLIDATED UNDRAINED COMPRESSION TEST - ASTM D2850

Client : URS
Project : Broadway Interchange Reconstruction
Job # : 28645286.02
Boring # R-11-017
Sample # : 11
Depth (ft) : 46.5-49
Date tested : 11/30/11
Soil : Grayish brown lean clay

Data Reduction:

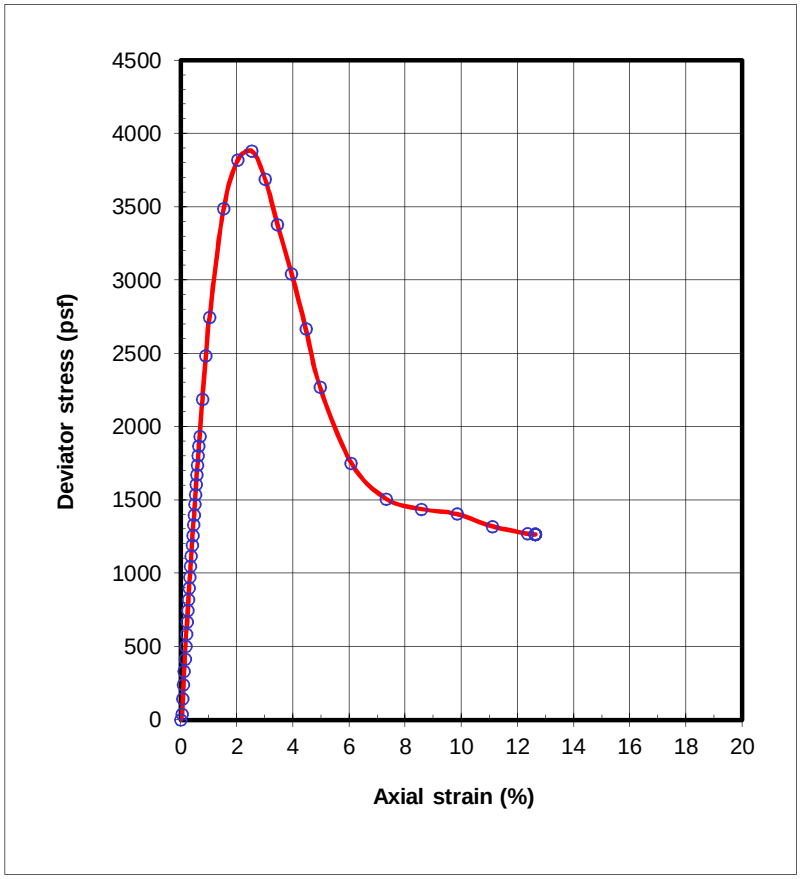
Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

Specimen:			
Total wt. =	1249.5	gms
Ht. =	5.970	in
Ave dia. =	2.843	in
Area =	6.352	sq.in
Volume =	621.4	c.c.
Shearing rate =	0.04	inch/min
Shearing rate =	0.75	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	0.682	
Ht/Dia ratio =	2.10	
Moisture =	25.3	%
Total density =	125.5	pcf
Dry density =	100.1	pcf
Saturation =	100.0	%
Chamber pressure =	3000	psf
Max. deviator stress =	3881	psf
Strain @ failure =	2.54	%

Dial Read.	Load Read.	Axial Strain (%)	Deviator Stress (psf)
-0.001		0.00	0.0
0.002	1.7	0.05	38.4
0.003	6.4	0.07	145.4
0.005	10.6	0.10	240.9
0.006	14.6	0.12	330.7
0.007	18.4	0.15	416.5
0.009	22.2	0.17	502.4
0.010	25.9	0.20	585.3
0.012	29.5	0.22	666.4
0.013	33.0	0.25	745.3
0.015	36.3	0.27	821.4
0.016	39.7	0.30	897.9
0.018	43.0	0.32	971.5
0.019	46.4	0.35	1047.3
0.021	49.5	0.37	1118.1
0.022	52.7	0.40	1190.6
0.024	55.8	0.42	1258.9
0.025	59.0	0.45	1330.6
0.027	62.0	0.47	1398.7
0.028	65.2	0.50	1469.9
0.030	68.2	0.52	1537.6
0.031	71.2	0.55	1606.3
0.033	74.1	0.57	1671.0
0.034	77.2	0.60	1739.4
0.036	80.0	0.62	1801.8
0.037	83.0	0.65	1869.2
0.039	85.9	0.67	1933.7
0.045	97.3	0.77	2188.0
0.052	110.5	0.90	2482.8
0.060	122.5	1.02	2747.6
0.090	156.4	1.53	3490.3
0.120	172.1	2.03	3821.5
0.150	175.6	2.54	3880.6
0.178	167.9	3.00	3691.8
0.204	154.5	3.45	3380.8
0.234	139.8	3.95	3044.1
0.264	123.2	4.45	2668.6
0.295	105.4	4.96	2270.1
0.361	82.3	6.07	1752.9
0.436	71.8	7.32	1508.0
0.510	69.4	8.57	1438.1
0.586	68.7	9.83	1404.2
0.661	65.5	11.09	1319.9
0.736	64.0	12.34	1270.8
0.752	63.9	12.62	1265.1



LANKELMA

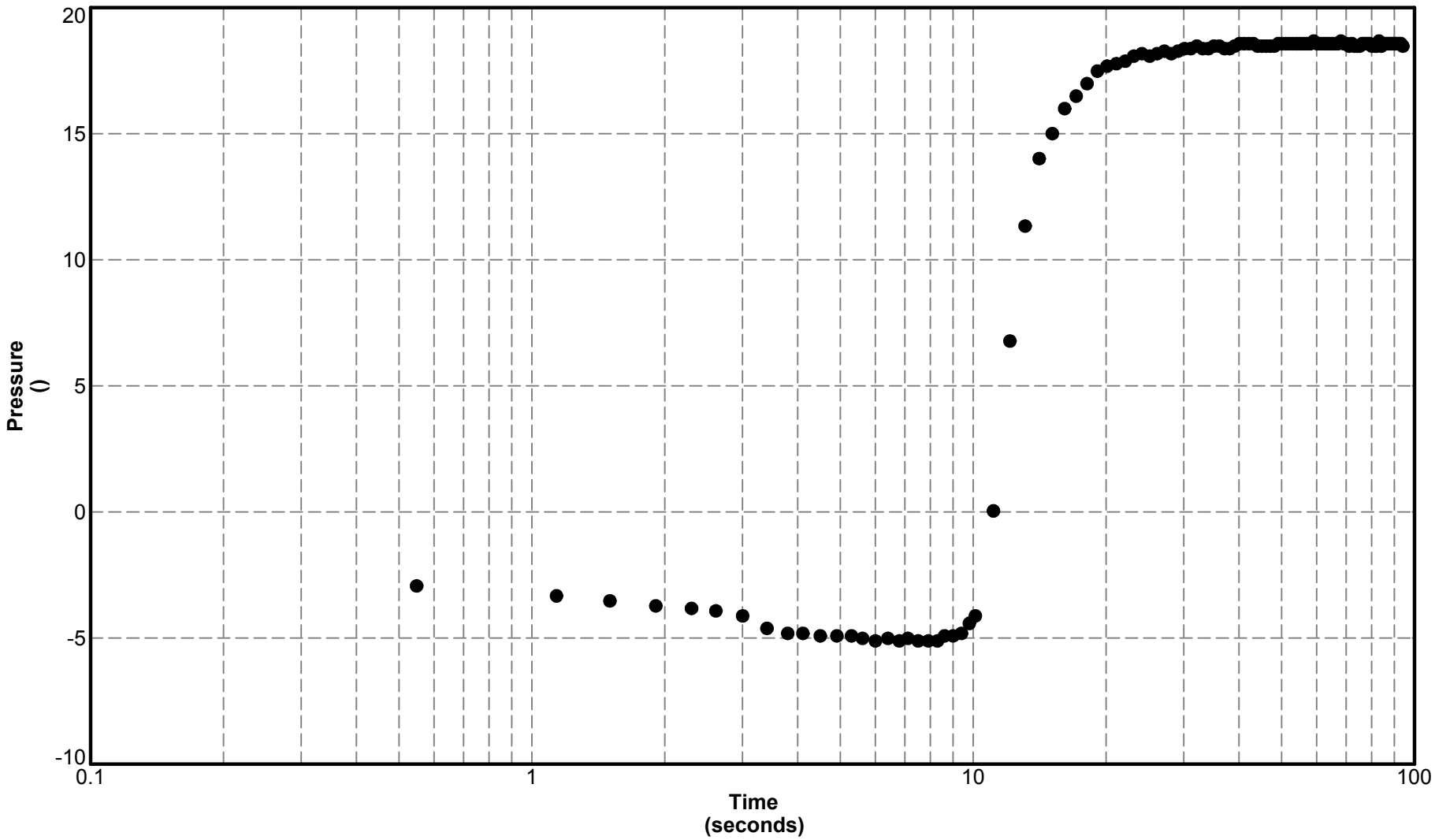
BIRP
(Burlingame,California)
Project Number :17326636

Pore Pressure Dissipation:

Date: Oct. 18, 2011
Estimated Water Depth: 1.7
Rig/Operator: JT | VB

Northing: N/A
Easting: N/A
Elevation: N/A

Total Depth: 79.9 ft
Termination Criteria:
Test Depth: 44.5 ft



CPT-11-009

LANKELMA

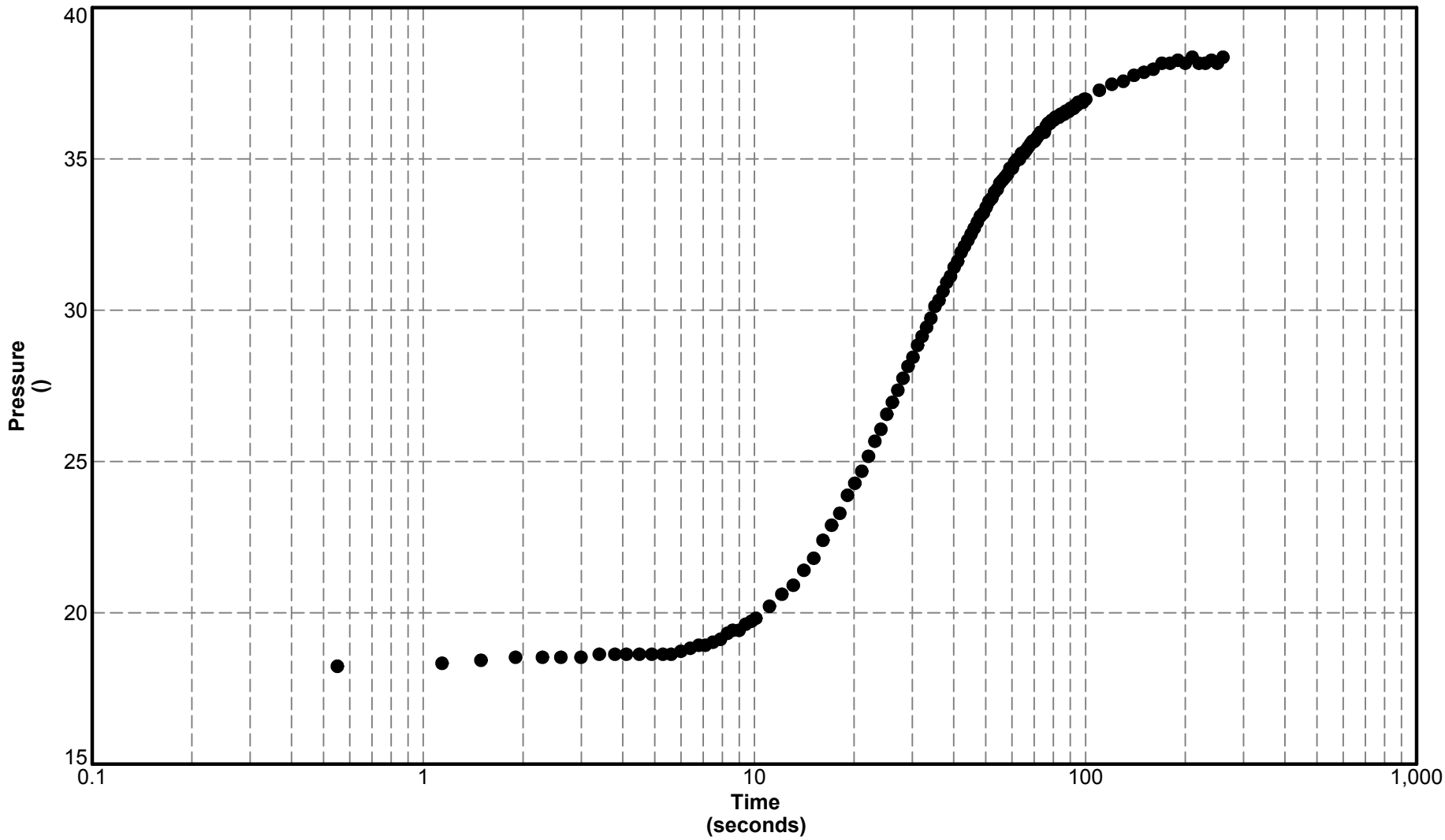
BIRP
(Burlingame,California)
Project Number :17326636

Pore Pressure Dissipation:

Date: Oct. 17, 2011
Estimated Water Depth: 3.4
Rig/Operator: JT | VB

Northing: N/A
Easting: N/A
Elevation: N/A

Total Depth: 93.7 ft
Termination Criteria:
Test Depth: 93.1 ft



CPT-11-012

LANKELMA

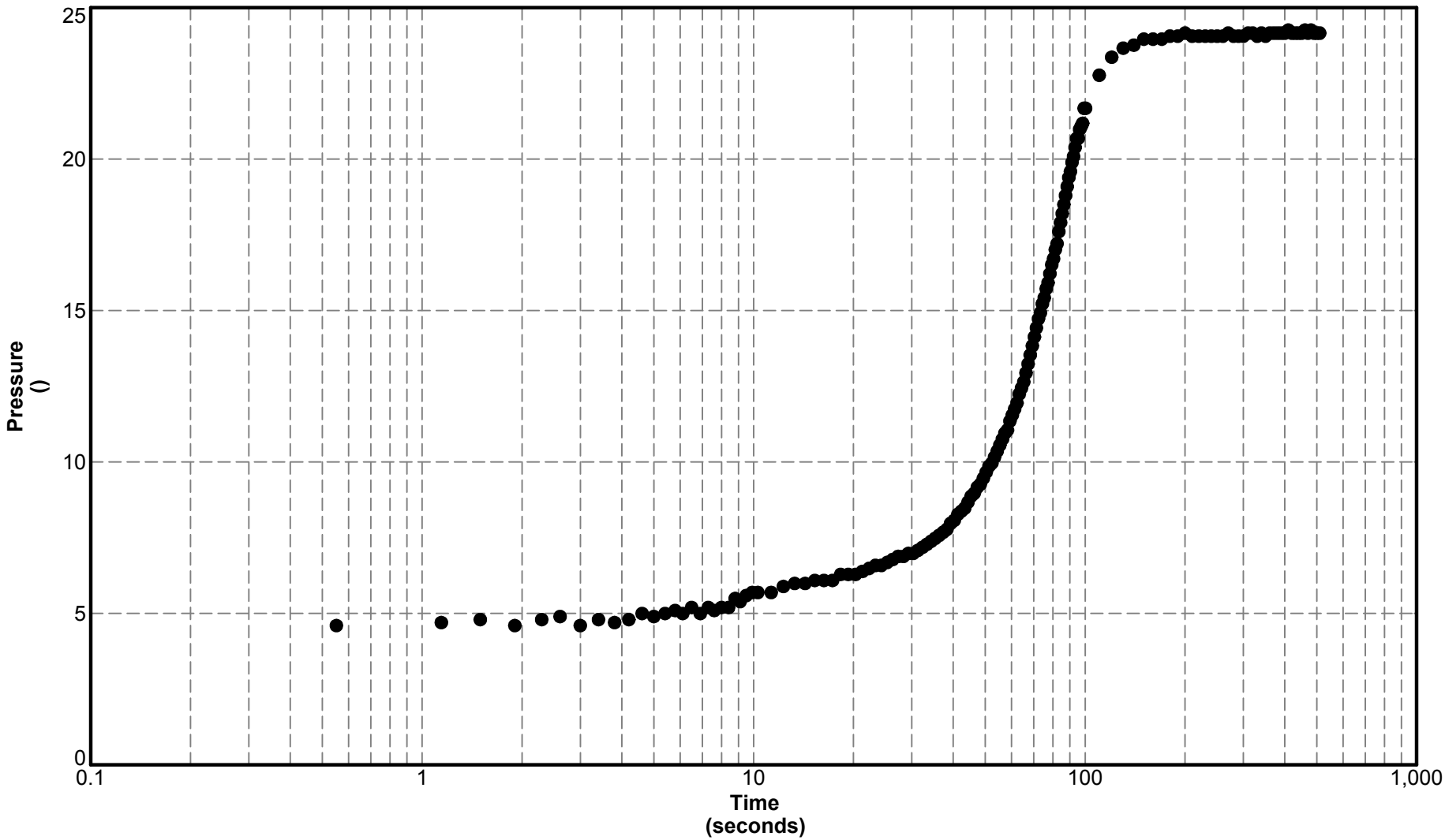
BIRP
(Burlingame,California)
Project Number :17326636

Pore Pressure Dissipation:

Date: Sep. 28, 2011
Estimated Water Depth: 0.5
Rig/Operator: JT | VB

Northing: N/A
Easting: N/A
Elevation: N/A

Total Depth: 100.1 ft
Termination Criteria: Target Depth
Test Depth: 55.8 ft



CPT-11-016

LANKELMA

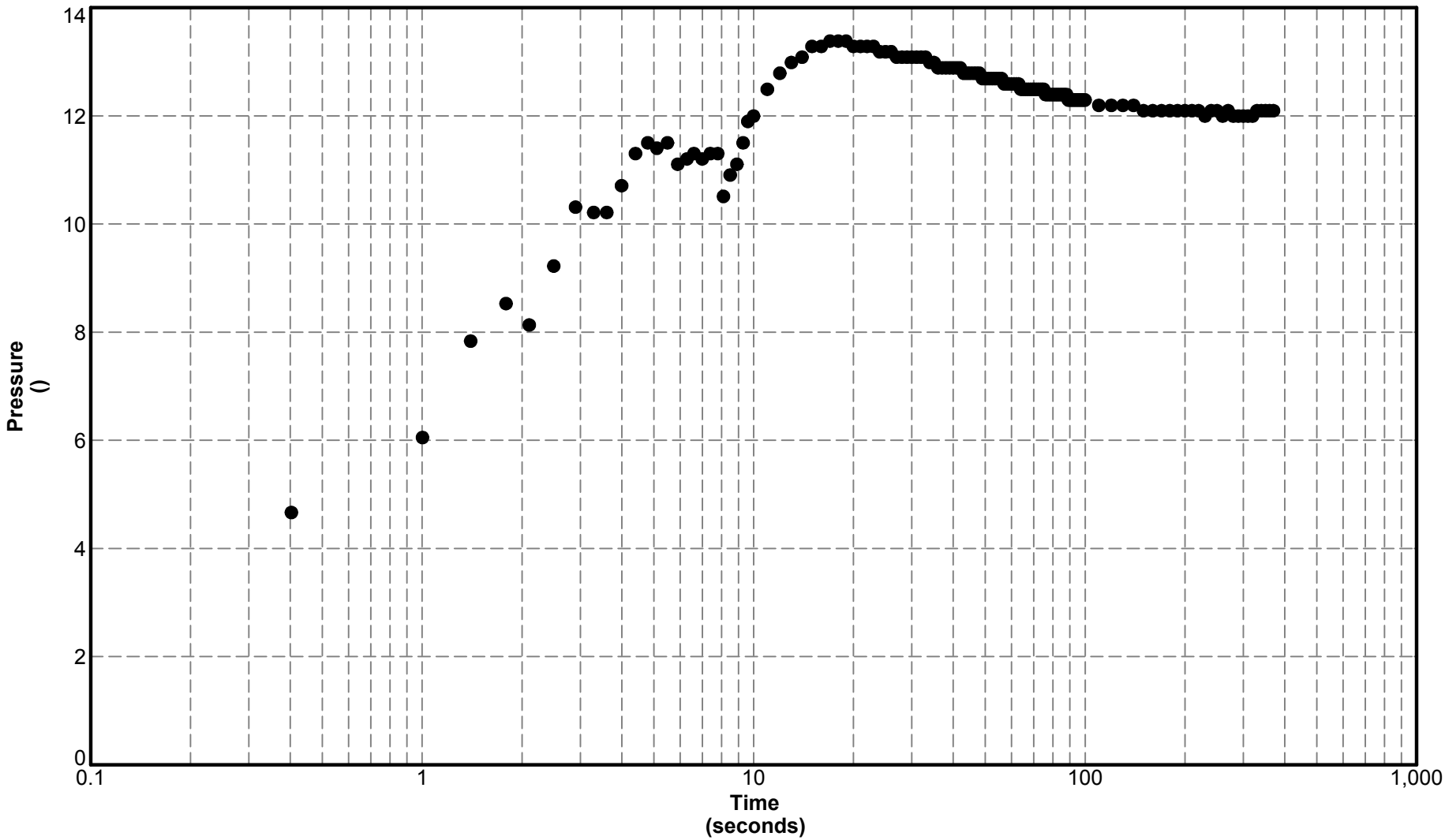
BIRP
(Burlingame,California)
Project Number :17326636

Pore Pressure Dissipation:

Date: Sep. 28, 2011
Estimated Water Depth: 4.6
Rig/Operator: JT | VB

Northing: N/A
Easting: N/A
Elevation: N/A

Total Depth: 80.2 ft
Termination Criteria: Target Depth
Test Depth: 32.4 ft



CPT-11-019

LANKELMA

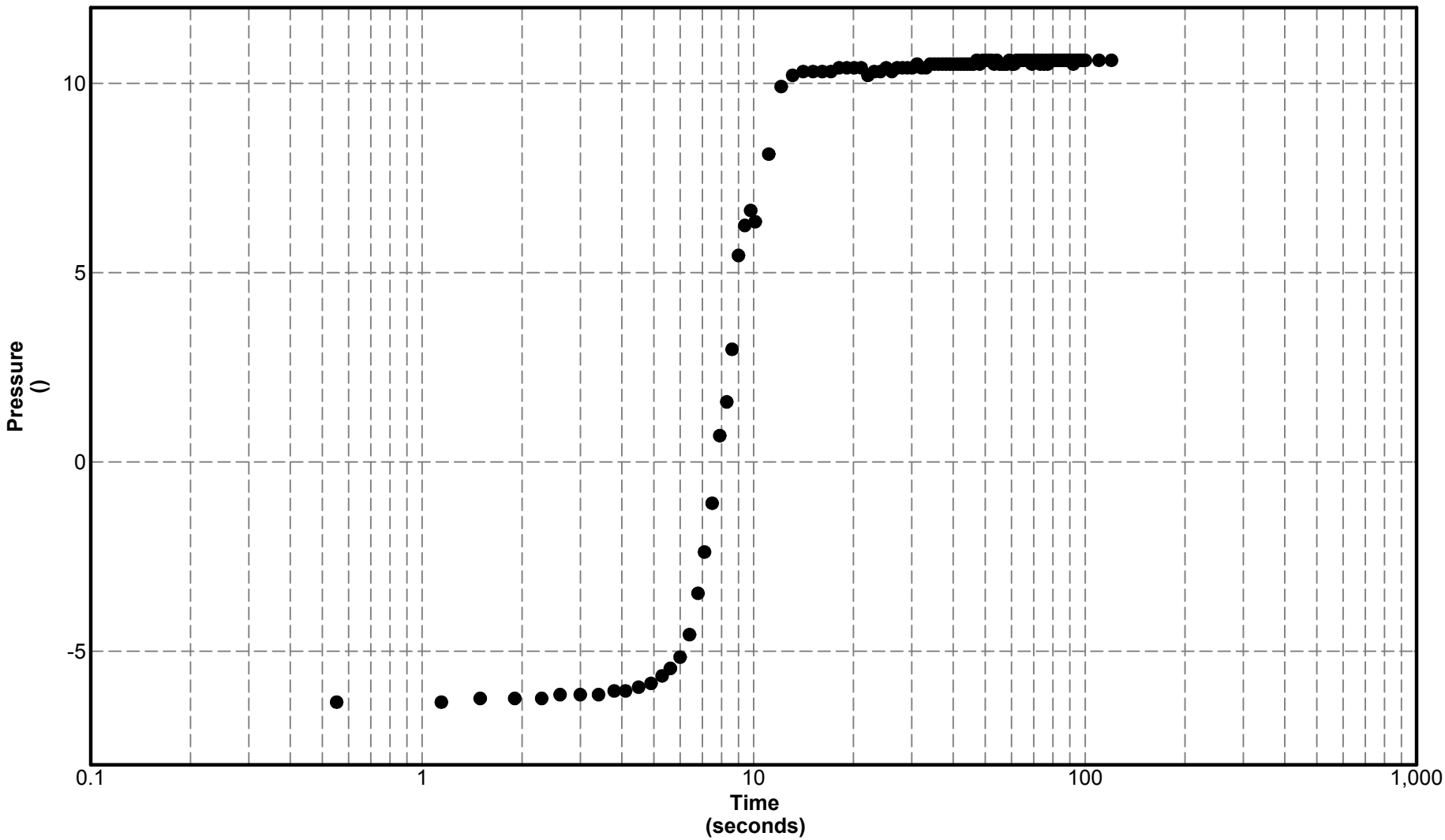
BIRP
(Burlingame,California)
Project Number :17326636

Pore Pressure Dissipation:

Date: Sep. 27, 2011
Estimated Water Depth: 5.6
Rig/Operator: JT | VB

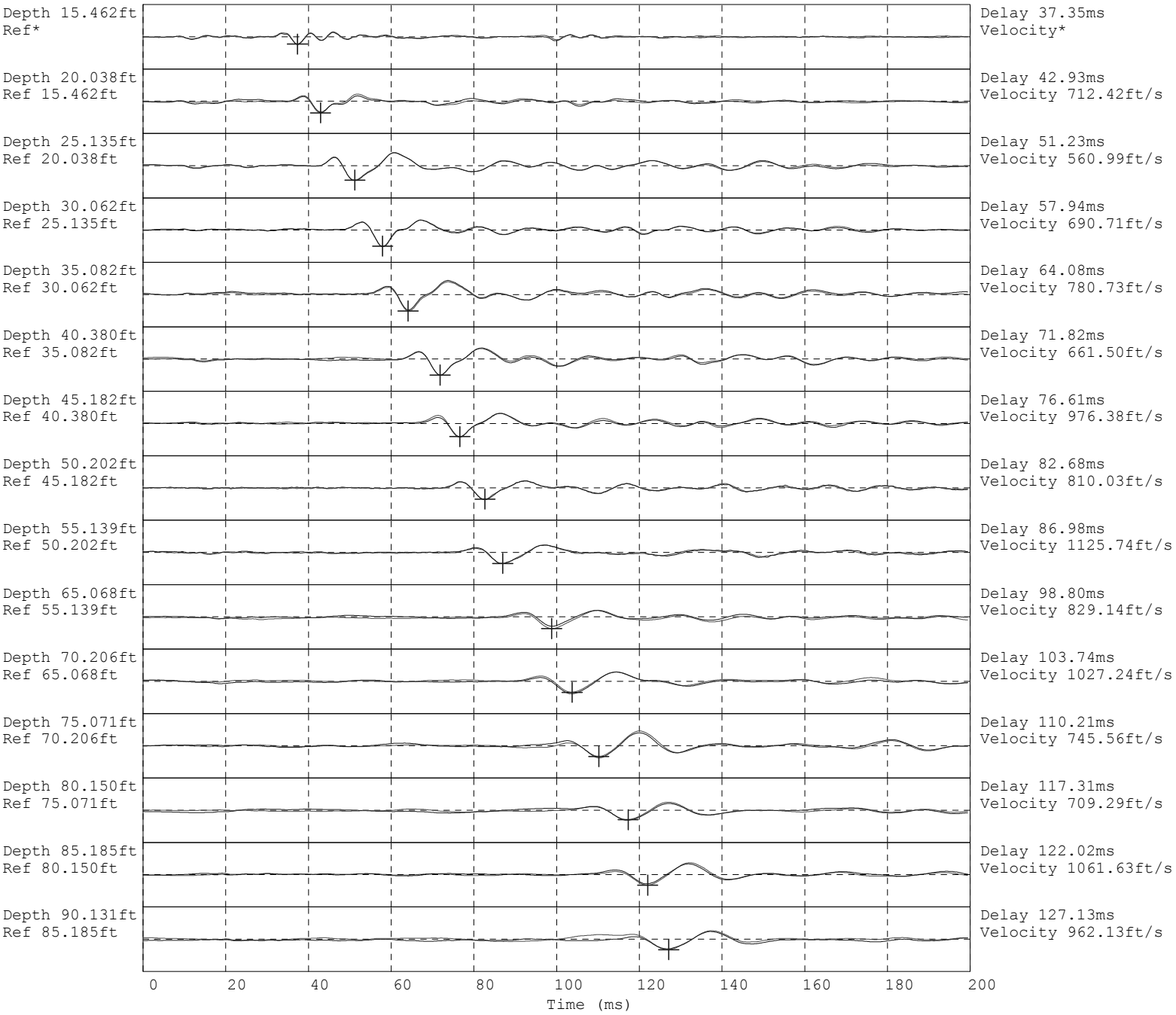
Northing: N/A
Easting: N/A
Elevation: N/A

Total Depth: 50.2 ft
Termination Criteria: Target Depth
Test Depth: 30.1 ft



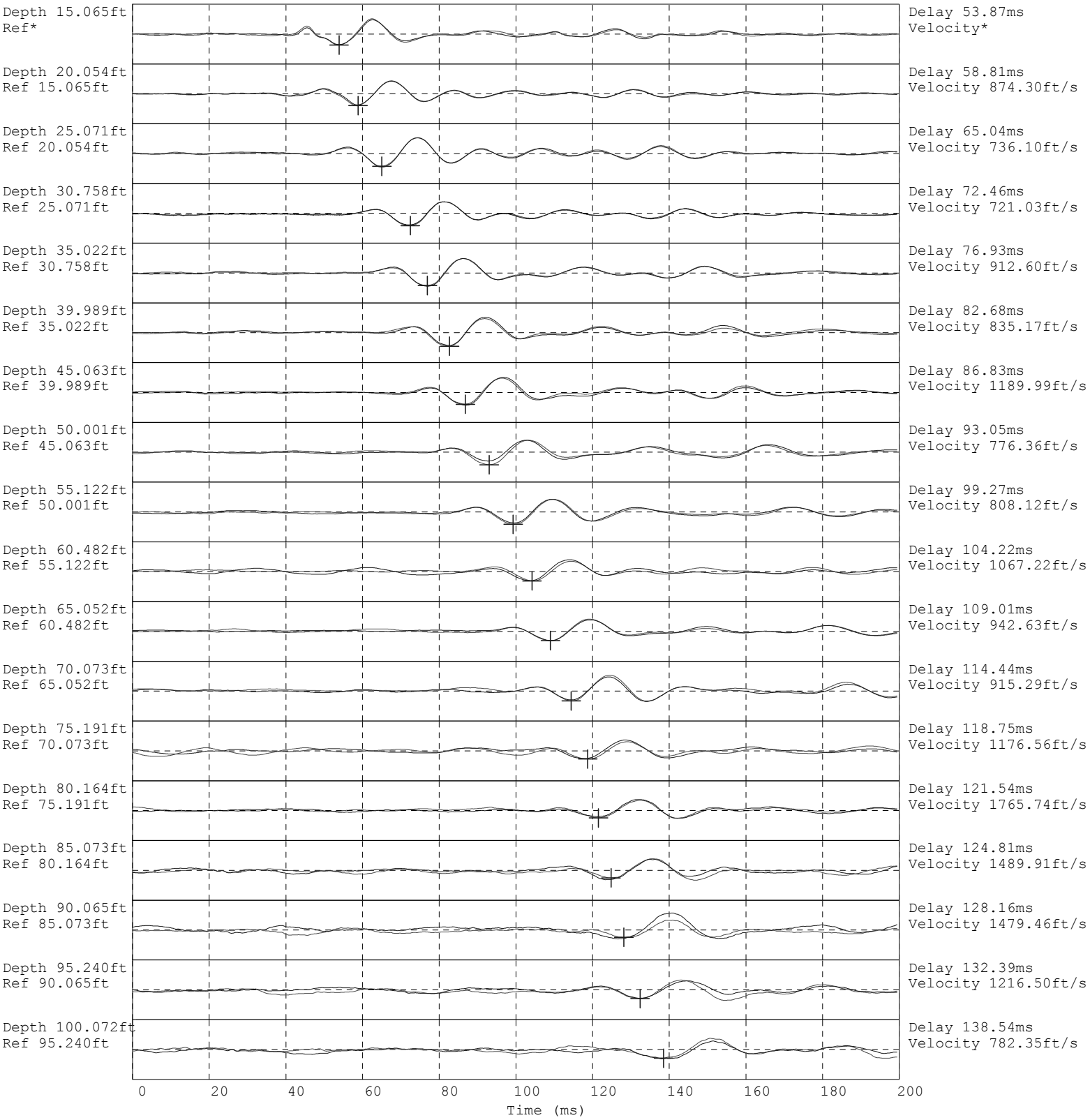
CPT-11-039

S-Wave CPT-11-012
BIRP SCPT



Hammer to Rod String Distance 3.05 (m)
* = Not Determined

S-Wave CPT-11-016
BIRP SCPT



Hammer to Rod String Distance 3.05 (m)
* = Not Determined

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This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in *Appendix B of Caltrans Seismic Design Criteria*. More...

SELECT SITE LOCATION

Latitude: 37.59006138 Longitude: -122.36124068 V_{S30}: 250 m/s Calculate

Done Internet 100%

ARS Online - Windows Internet Explorer

http://dap3.dot.ca.gov/shake_stable/index.php

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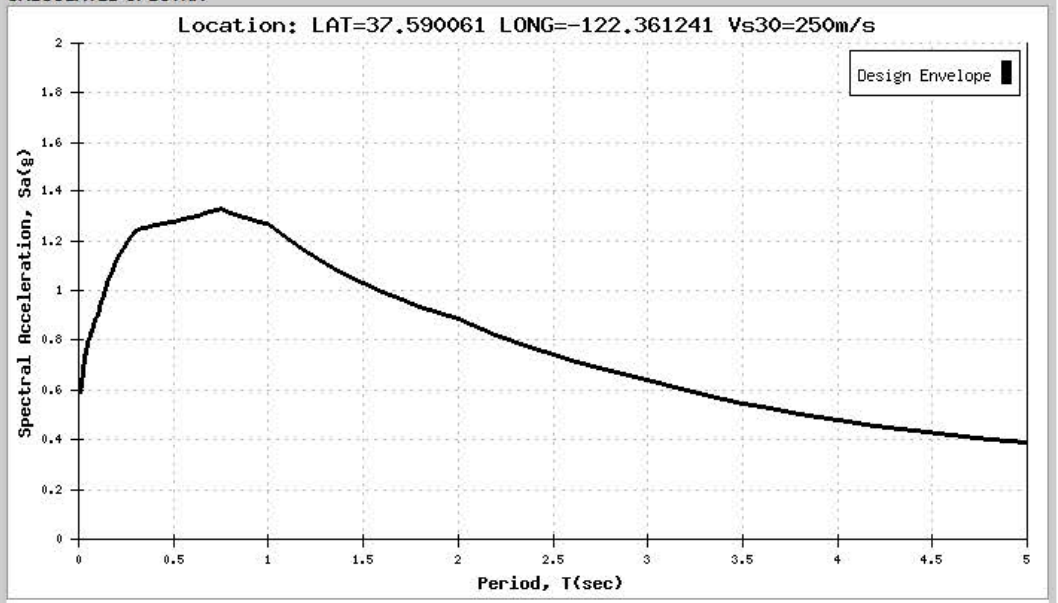
CALCULATED SPECTRA



View Tabular Data | Remove Envelope | Hide Near Fault Adjustment | Axis Scale

Printer Friendly View | Show Basin Factor

Apply Near Fault Adjustment To:

NOTE: Caltrans SDC requires application of a Near Fault Adjustment factor for sites less than 25 km (Rrup) from the causative fault.

☑ Deterministic Spectrum Using

4.37 Km San Andreas fault zone (Peninsula section)

☑ Probabilistic Spectrum Using

3.6 Km (Recommend Performing Deaggregation To Verify)

◉ Show Spectrum with Adjustment Only

○ Show Spectrum with and without near fault Adjustment

OK

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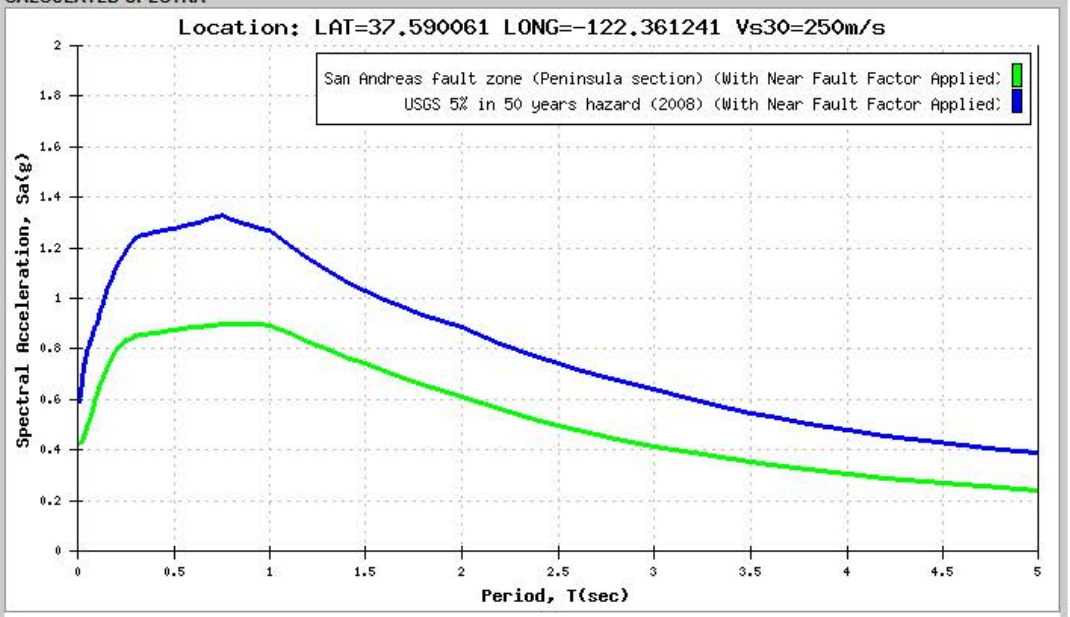
CALCULATED SPECTRA



View Tabular Data | Show Envelope Only | Hide Near Fault Adjustment | Axis Scale

Printer Friendly View | Show Basin Factor

Apply Near Fault Adjustment To:

NOTE: Caltrans SDC requires application of a Near Fault Adjustment factor for sites less than 25 km (Rrup) from the causative fault.

☑ Deterministic Spectrum Using

4.37 Km San Andreas fault zone (Peninsula section)

☑ Probabilistic Spectrum Using

3.6 Km (Recommenc Performing Deaggregation To Verify)

◉ Show Spectrum with Adjustment Only

○ Show Spectrum with and without near fault Adjustment

OK

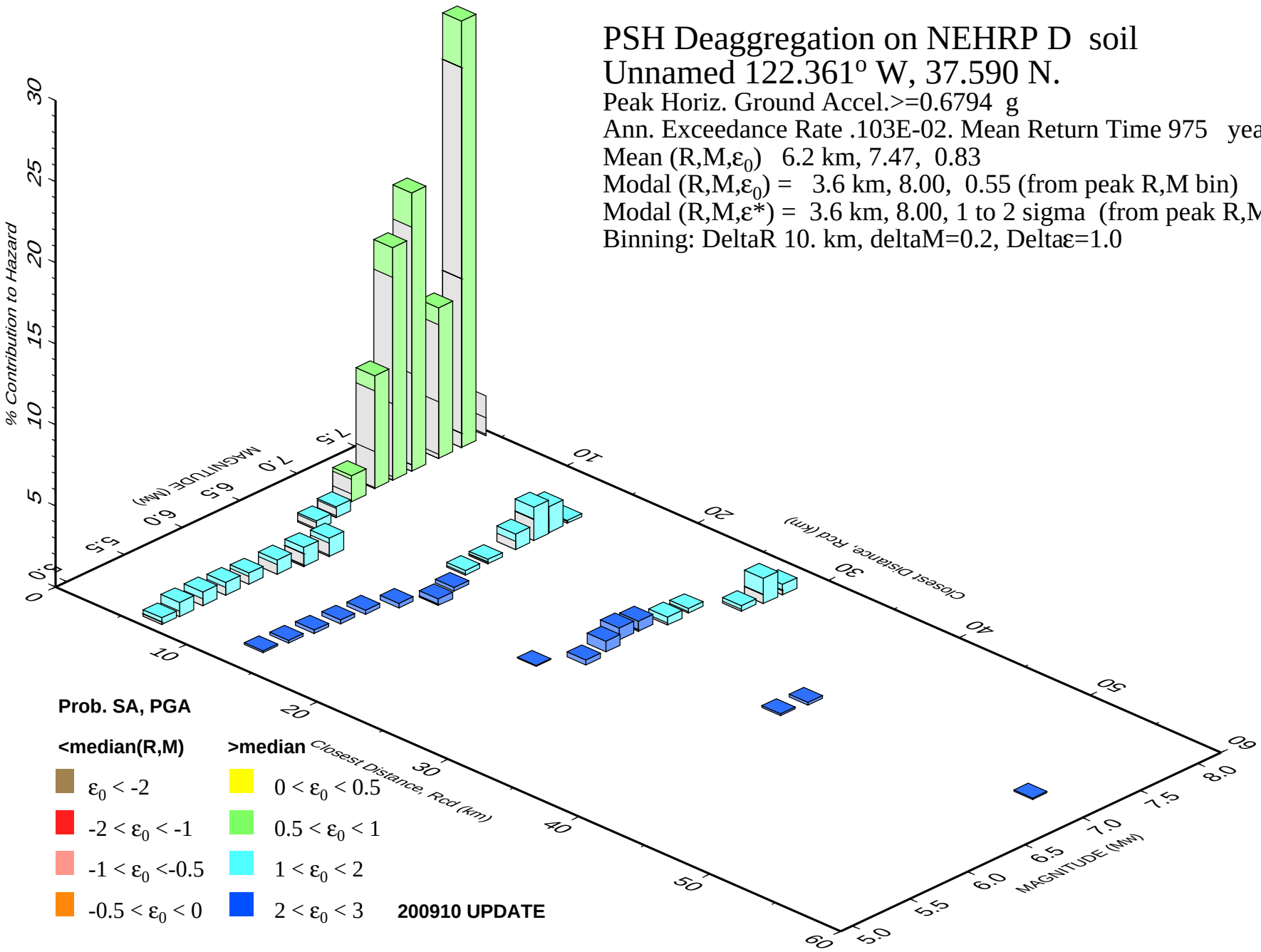
Done | Internet | 100%

Estimate of Shear Wave Velocity
Vs30
U.S. 101 Broadway Interchange Reconstruction

PointID	Depth	BottomDepth	Velocity	Layer Thickness (ft)	D/V			
CPT-11-012	5	19	712.42	14	0.019651			
CPT-11-012	19	24	560.99	5	0.008913			
CPT-11-012	24	29	690.71	5	0.007239			
CPT-11-012	29	34	780.73	5	0.006404			
CPT-11-012	34	39	661.5	5	0.007559			
CPT-11-012	39	44	976.38	5	0.005121			
CPT-11-012	44	49	810.03	5	0.006173			
CPT-11-012	49	54	1125.74	5	0.004442	Vs30=	807	ft/sec
CPT-11-012	54	64	829.14	10	0.012061		246	m/sec
CPT-11-012	64	69	1027.24	5	0.004867			
CPT-11-012	69	74	745.56	5	0.006706			
CPT-11-012	74	79	709.29	5	0.007049			
CPT-11-012	79	84	1061.63	5	0.00471			
CPT-11-012	84	99	962.13	15	0.01559			
CPT-11-016	8	19	874.3	11	0.012581			
CPT-11-016	19	24	736.1	5	0.006793			
CPT-11-016	24	29	721.03	5	0.006935			
CPT-11-016	29	34	912.6	5	0.005479			
CPT-11-016	34	39	835.17	5	0.005987			
CPT-11-016	39	44	1189.99	5	0.004202			
CPT-11-016	44	49	776.36	5	0.00644			
CPT-11-016	49	54	808.12	5	0.006187			
CPT-11-016	54	59	1067.12	5	0.004686	Vs30=	964	ft/sec
CPT-11-016	59	64	942.63	5	0.005304		294	m/sec
CPT-11-016	64	69	915.29	5	0.005463			
CPT-11-016	69	74	1176.56	5	0.00425			
CPT-11-016	74	79	1765.74	5	0.002832			
CPT-11-016	79	84	1489.91	5	0.003356			
CPT-11-016	84	89	1479.46	5	0.00338			
CPT-11-016	89	94	1216.5	5	0.00411			
CPT-11-016	94	99	782.35	5	0.006391			

PSH Deaggregation on NEHRP D soil
Unnamed 122.361° W, 37.590 N.

Peak Horiz. Ground Accel.>=0.6794 g
Ann. Exceedance Rate .103E-02. Mean Return Time 975 years
Mean (R,M,ε_0) 6.2 km, 7.47, 0.83
Modal (R,M,ε_0) = 3.6 km, 8.00, 0.55 (from peak R,M bin)
Modal (R,M,ε*) = 3.6 km, 8.00, 1 to 2 sigma (from peak R,M,ε bin)
Binning: DeltaR 10. km, deltaM=0.2, Deltaε=1.0



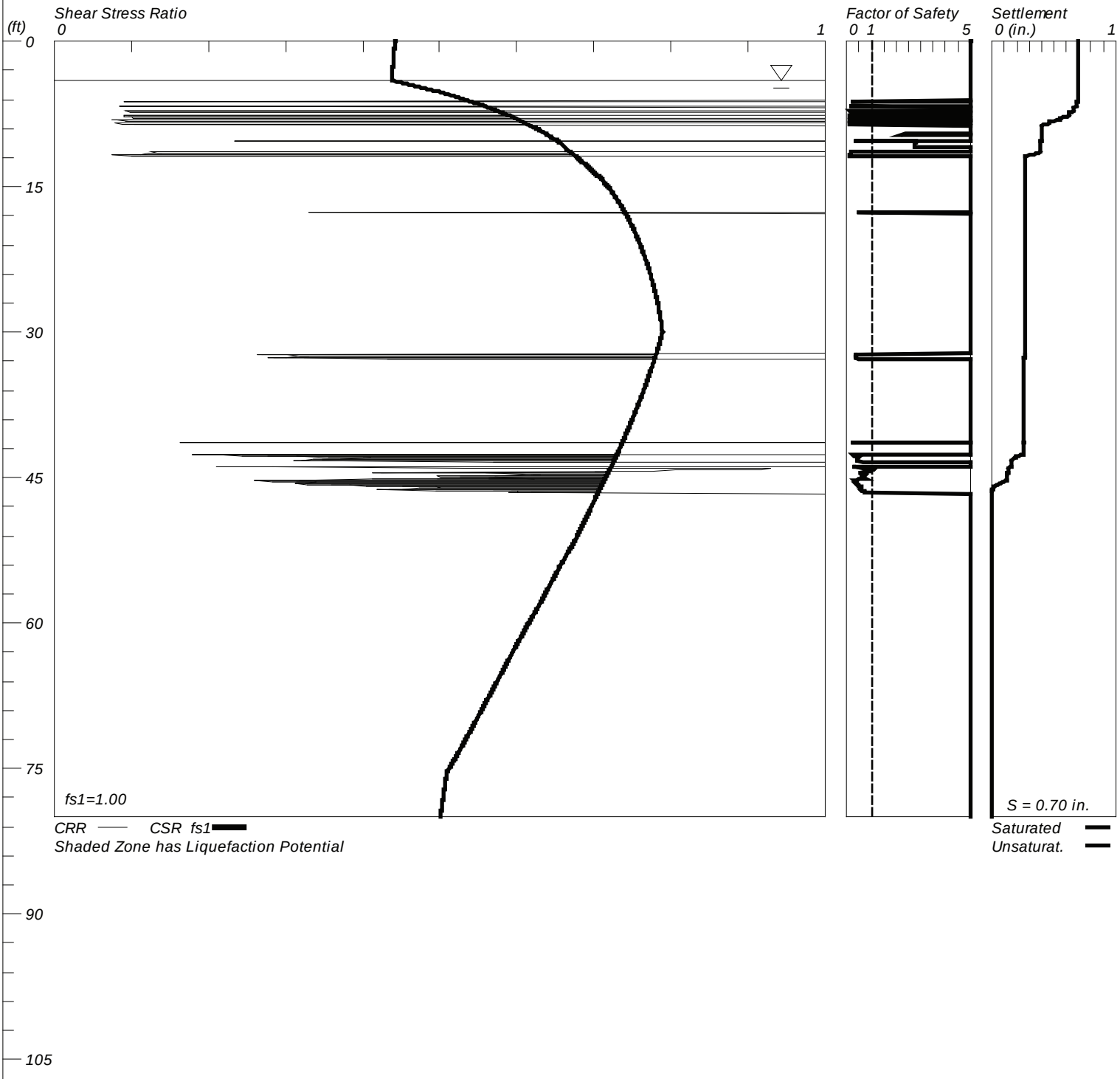
GMT 2012 Jan 22 17:16:24 **Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on soil with average vs= 250. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted**

LIQUEFACTION ANALYSIS

Broadway Interchange Reconsturction

Hole No.=CPT-11-009 Water Depth=4 ft Surface Elev.=10 ft

Magnitude=7.9
Acceleration=0.68g

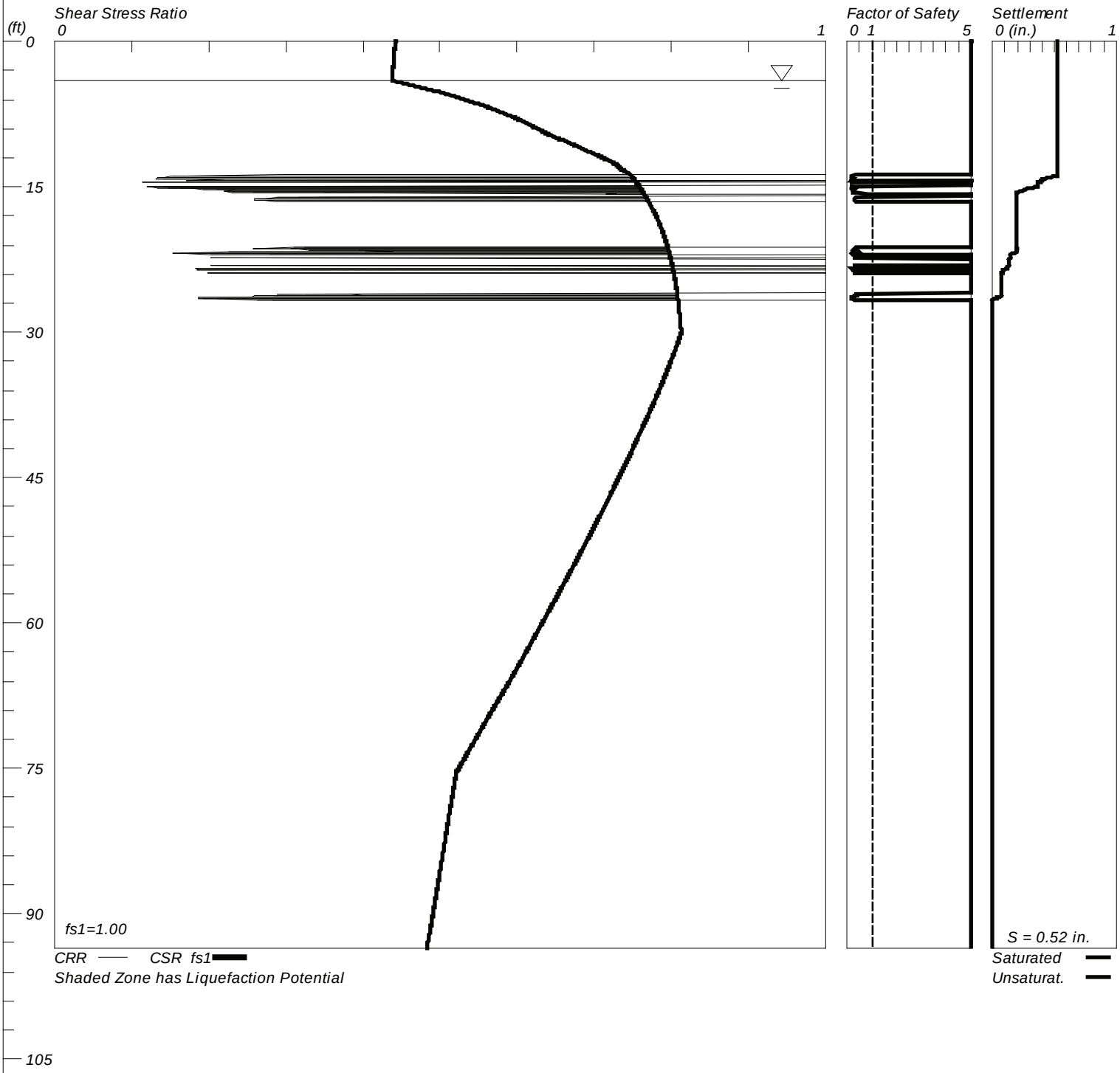


LIQUEFACTION ANALYSIS

Broadway Interchange Reconstruction

Hole No.=CPT-11-012 Water Depth=4 ft Surface Elev.=10 ft

Magnitude=7.9
Acceleration=0.68g



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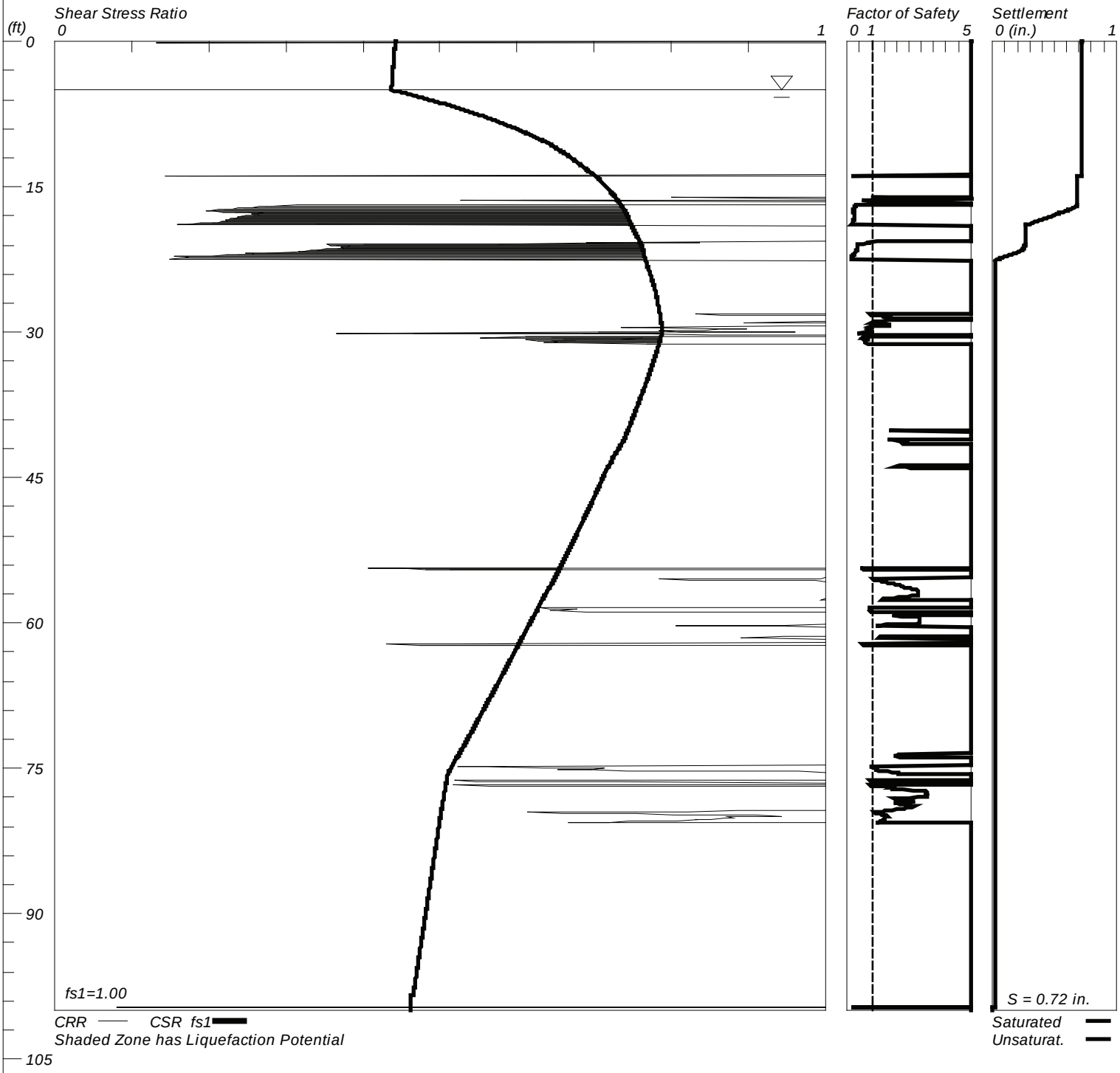
LIQUEFACTION ANALYSIS

Broadway Interchange Reconstruction

Hole No.=CPT-11-016 Water Depth=5 ft Surface Elev.=11 ft

Magnitude=7.9
Acceleration=0.68g



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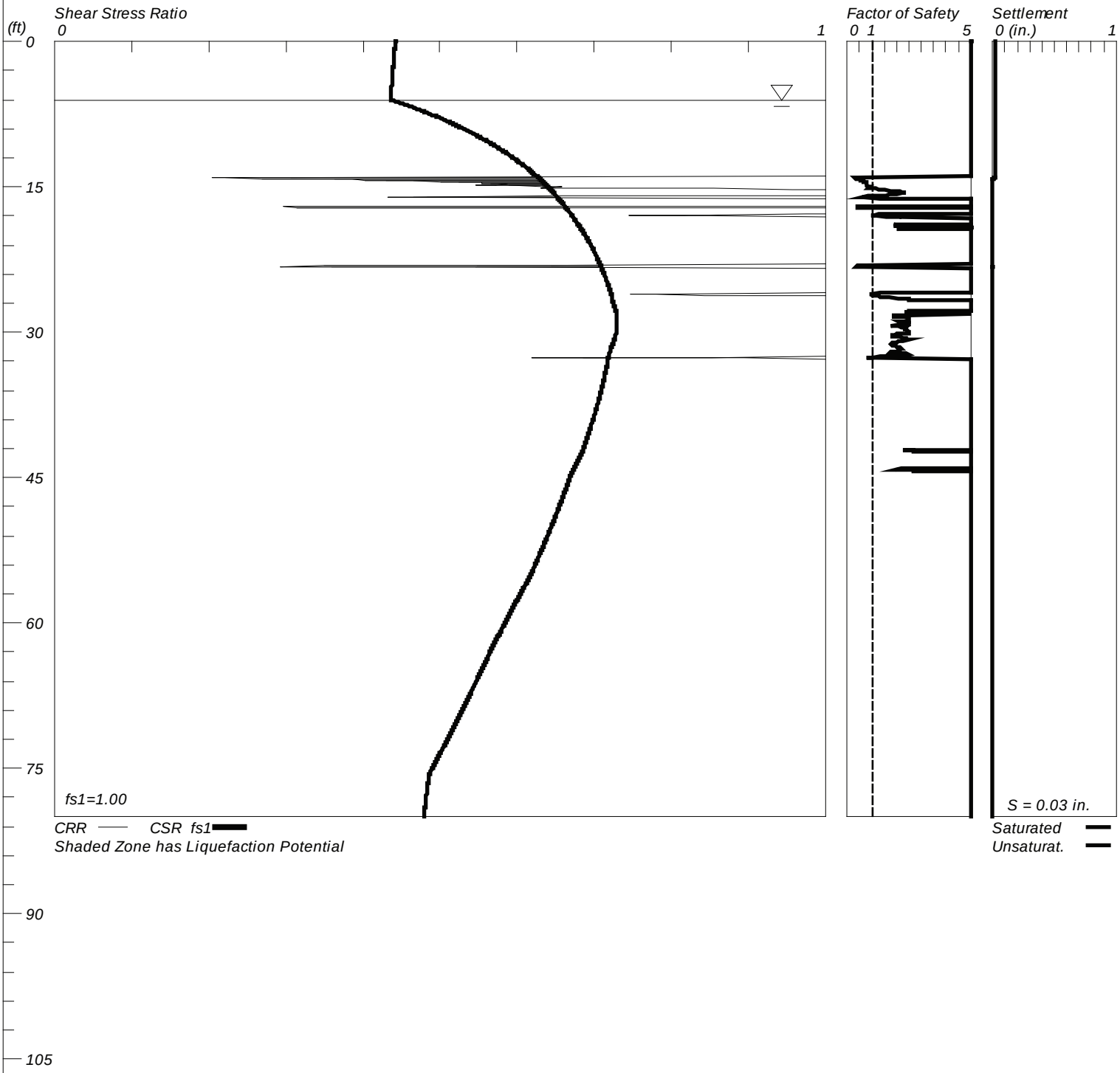
LIQUEFACTION ANALYSIS

Broadway Interchange Reconstruction

Hole No.=CPT-11-019 Water Depth=6 ft Surface Elev.=12 ft

Magnitude=7.9
Acceleration=0.68g



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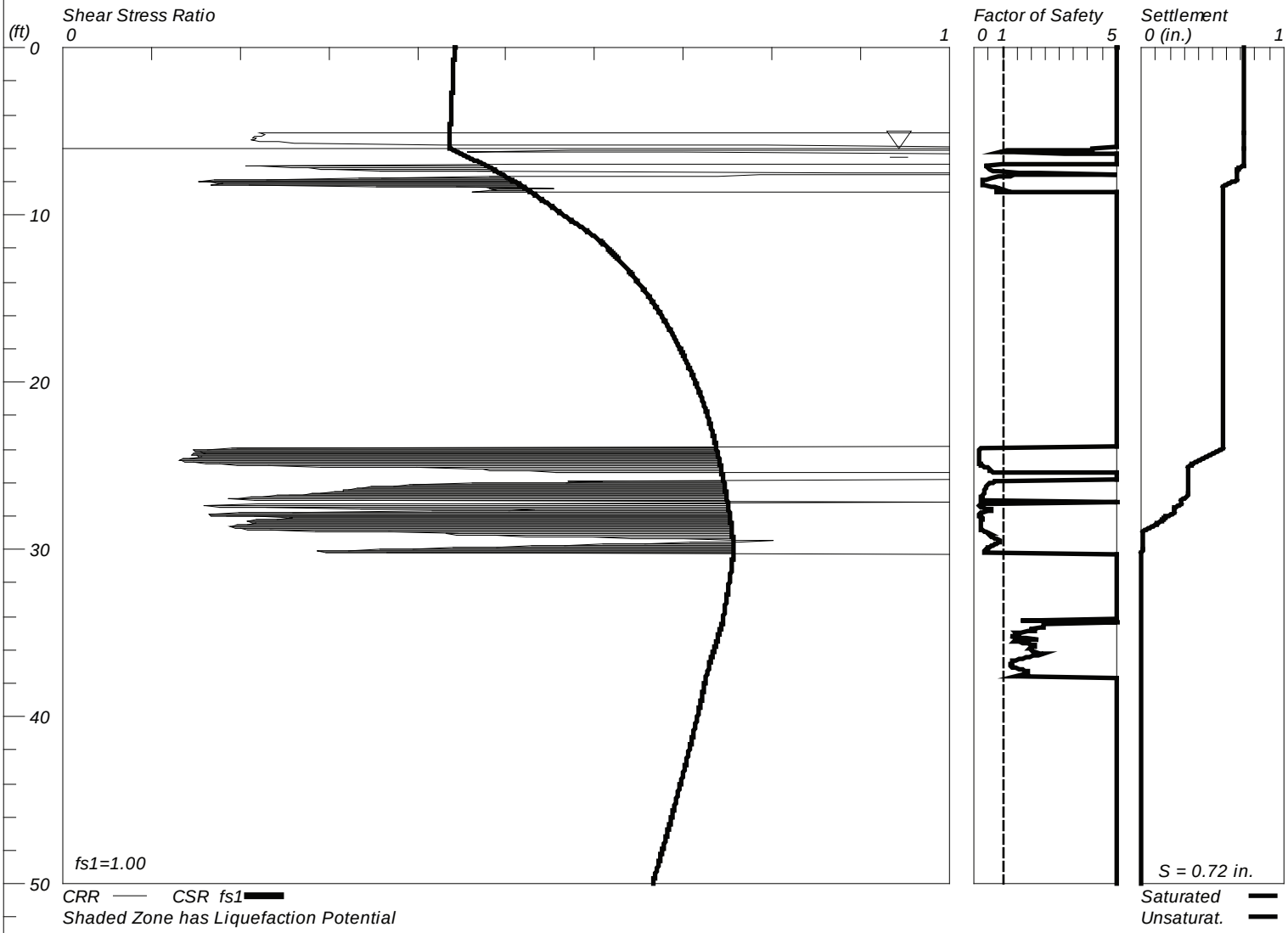
LIQUEFACTION ANALYSIS

Broadway Interchange Reconstruction

Hole No.=CPT-11-039 Water Depth=6 ft Surface Elev.=12 ft

Magnitude=7.9
Acceleration=0.68g



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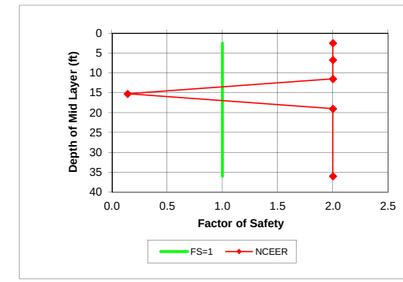
LIQUEFACTION ANALYSIS

Project	Broadway Interchange Reconstruction
Project No.	28645286
Boring No.	R-11-014

PGA =	0.68	
M_w =	7.9	
GWT during EQ	5.0	ft
Sampler:	Symbol	Corr. Factor
SPT	S	1
Mod.Cal	M	0.8
California	C	0.7
Mag. Weighting Factor($CSR_M/CSR_{M=7.5}$)		1.16

Note: Cells in Red must be input

Hammer type :	Type		C_E	Code	C_E
	Donut		0.75	1	3
	Safety		1	2	
	Auto		1.55	3	
Borehole Diameter:	(inch)	(mm)	C_B		C_B
	2.5-4.5	65-115	1	1	1
	6	150	1.05	2	
	8	200	1.15	3	
Rod Length:	(feet)	(m)	C_R		
	Default			999	
Sampling Method:	Type		Cs		
	Stand		1		
	No liners		1.2		



Note: F.S. greater than 2 is set to be equal to 2

Layer Number	Soil Type	γ_m	At Bottom of Layer Depth		At Center of Layer Depth		σ_o	EQ u	EQ σ'_o	r_d	EQ CSR	N raw	Sampler	N SPT	Fines Content	C_{fines}	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60-cs}$	$CRR^*_{7.5,1tsf}$	Magnitude Scaling Factor NCEER K_m Lower	Upper	Middle	Overburden Correction K_σ	Above GWT?	F.S.	Liquefy ?	F.S=1.0
	(USCS)	pcf	ft	m	ft	m	psf	psf	psf						%		EQ					during EQ	Critical						NCEER	NCEER	
1	ML	120	5.0	1.52	2.5	0.76	300	0	300	0.996	0.440													0.88	0.84	0.86	1.000	Y	2.00	N	1
2	CL	120	8.5	2.59	6.8	2.06	810	109	701	0.986	0.504													0.88	0.84	0.86	1.000	N	2.00	N	1
3	OH/CH	100	14.5	4.42	11.5	3.51	1,320	406	914	0.976	0.623													0.88	0.84	0.86	1.000	N	2.00	N	1
4	SM	125	16.0	4.88	15.3	4.65	1,714	640	1,074	0.968	0.683	6	M	5	20	1.20	1.36	1.55	1.00	0.85	1.00	10	0.112	0.88	0.84	0.86	1.000	N	0.14	Liquef	1
5	CH	115	22.0	6.71	19.0	5.79	2,153	874	1,279	0.959	0.714													0.88	0.84	0.86	1.000	N	2.00	N	1
6	CL	125	50.0	15.24	36.0	10.97	4,248	1,934	2,313	0.883	0.717													0.88	0.84	0.86	0.986	N	2.00	N	1

Layer Number	Depth to Bot. Layer	Thickness	σ_o	u	σ'_o	r_d	$(N_1)_{60-cs}$	Liquefy ?	τ_{cyc}	$CSR_{M=7.5}$	CSR_M	Volumetric Strain**	Settl.
		ft	psf	psf	psf			NCEER	psf	τ_{cyc}/σ'_o	τ_{cyc}/σ'_o	%	in
1	5.0	5.0	300	0	300	0.996	0.0	N	132.1	0.440	0.51		
2	8.5	3.5	810	109	701	0.986	0.0	N	353.1	0.504	0.59		
3	14.5	6.0	1,320	406	914	0.976	0.0	N	569.4	0.623	0.73		
4	16.0	1.5	1,714	640	1,074	0.968	10.3	Liquef	733.3	0.683	0.79	2.4	0.43
5	22.0	6.0	2,153	874	1,279	0.959	0.0	N	912.8	0.714	0.83		
6	50.0	28.0	4,248	1,934	2,313	0.883	0.0	N	1658.6	0.717	0.83		

Total Settlement (inch) = 0.43

* Note: The equation used to obtain $CRR_{7.5}$ is not valid for corrected $(N_1)_{60}$ higher than 30. According to NCEER 1997, the soil layer with corrected $(N_1)_{60}$ higher than 30 blows per foot is unlikely to be susceptible to liquefaction.

** Note: These values were obtained from a chart for estimation of volumetric strain in saturated sands based on a cyclic stress ratio and standard penetration resistance (Tokimatsu and Seed, 1987).
See figure 9.53 from "Geotechnical Earthquake Engineering" by S. Kramer.

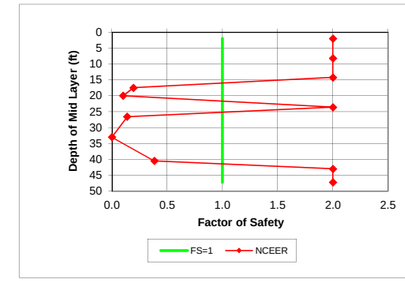
LIQUEFACTION ANALYSIS

Project	Broadway Interchange Reconstruction
Project No.	28645286
Boring No.	R-11-015

PGA =	0.68	
M_w =	7.9	
GWT during EQ	4.5	ft
Sampler:	Symbol	Corr. Factor
SPT	S	1
Mod.Cal	M	0.8
California	C	0.7
Mag. Weighting Factor($CSR_M/CSR_{M=7.5}$)		1.16

Note: Cells in Red must be input

Hammer type :	Type		C_E	Code	C_E
	Donut		0.75	1	3
	Safety		1	2	
	Auto		1.72	3	
Borehole Diameter:	(inch)	(mm)	C_B		C_B
	2.5-4.5	65-115	1	1	1
	6	150	1.05	2	
	8	200	1.15	3	
Rod Length:	(feet)	(m)	C_R		
	Default			999	
Sampling Method:	Type		Cs		
	Stand		1		
	No liners		1.2		



Note: F.S. greater than 2 is set to be equal to 2

Layer Number	Soil Type	γ_m	At Bottom of Layer Depth		At Center of Layer Depth		σ_o	EQ u	EQ σ'_o	r_d	EQ CSR	N raw	Sampler	N SPT	Fines Content	C_{fines}	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60-cs}$	$CRR^*_{7.5,1tsf}$	Magnitude Scaling Factor NCEER K_m Lower	Upper	Middle	Overburden Correction K_σ	Above GWT?	F.S.	Liquefy ?	F.S=1.0
	(USCS)	pcf	ft	m	ft	m	psf	psf	psf						%							during EQ	Critical						NCEER	NCEER	
1	SM	125	4.0	1.22	2	0.61	250	0	250	0.997	0.441													0.88	0.84	0.86	1.000	Y	2.00	N	1
2	OH/CH	90	12.5	3.81	8.3	2.51	883	234	649	0.983	0.591													0.88	0.84	0.86	1.000	N	2.00	N	1
3	CL	130	16.0	4.88	14.3	4.34	1,493	608	884	0.970	0.724													0.88	0.84	0.86	1.000	N	2.00	N	1
4	SC	135	19.0	5.79	17.5	5.33	1,923	811	1,111	0.963	0.736	10	M	8	20	1.15	1.15	1.72	1.00	0.85	1.00	15	0.167	0.88	0.84	0.86	1.000	N	0.19	Liquef	1
5	ML	125	21.0	6.40	20.0	6.10	2,250	967	1,283	0.957	0.742	3	S	3	55	1.47	1.09	1.72	1.00	0.95	1.00	8	0.087	0.88	0.84	0.86	1.000	N	0.10	Liquef	1
6	CL	120	26.2	7.99	23.6	7.19	2,687	1,192	1,495	0.947	0.752													0.88	0.84	0.86	1.000	N	2.00	N	1
7	SP-SM	120	27.0	8.23	26.6	8.11	3,047	1,379	1,668	0.936	0.756	8	M	6	10	1.09	0.99	1.72	1.00	0.95	1.00	11	0.122	0.88	0.84	0.86	1.000	N	0.14	Liquef	1
8	CH	120	39.0	11.89	33.0	10.06	3,815	1,778	2,037	0.904	0.748													0.88	0.84	0.86	1.000	N	0.00	N	1
9	SC-SM	140	42.0	12.80	40.5	12.34	4,745	2,246	2,499	0.847	0.711	21	M	17	21	1.13	0.84	1.72	1.00	1.00	1.00	27	0.326	0.88	0.84	0.86	0.975	N	0.38	Liquef	1
10	GM	140	44.0	13.41	43.0	13.11	5,095	2,402	2,693	0.823	0.689	24	S	24	20	1.11	0.81	1.72	1.00	1.00	1.00	37	0.459	0.88	0.84	0.86	0.963	N	2.00	N	1
11	CL	120	50.5	15.39	47.3	14.40	5,625	2,668	2,957	0.781	0.656													0.88	0.84	0.86	0.948	N	2.00	N	1

Layer Number	Depth to Bot. Layer	Thickness	σ_o	u	σ'_o	r_d	$(N_1)_{60-cs}$	Liquefy ?	τ_{cyc}	$CSR_{M=7.5}$	CSR_M	Volumetric Strain**	Settl.	
		ft	psf	psf	psf			NCEER	psf	τ_{cyc}/σ'_o	τ_{cyc}/σ'_o	%	in	
1	4.0	4.0	250	0	250	0.997		N	110.2	0.441	0.51			
2	12.5	8.5	883	234	649	0.983		N	383.4	0.591	0.69			
3	16.0	3.5	1,493	608	884	0.970		N	640.0	0.724	0.84			
4	19.0	3.0	1,923	811	1,111	0.963	15.5	Liquef	818.3	0.736	0.86	0.0	0.00	LL=31, PI=16 falls in Zone B, WC(14%)<0.85LL, Non-liquefiable
5	21.0	2.0	2,250	967	1,283	0.957	7.8	Liquef	951.6	0.742	0.86	3.0	0.72	
6	26.2	5.2	2,687	1,192	1,495	0.947		N	1124.2	0.752	0.88			
7	27.0	0.8	3,047	1,379	1,668	0.936	11.2	Liquef	1260.4	0.756	0.88	2.3	0.22	
8	39.0	12.0	3,815	1,778	2,037	0.904		N	1523.9	0.748	0.87			
9	42.0	3.0	4,745	2,246	2,499	0.847	27.3	Liquef	1775.5	0.711	0.83	0.00	0.00	LL=21, PI=4, -#200=21%, Clay=5.1%, WC (13%)<0.85LL, Non-liquefiable
10	44.0	2.0	5,095	2,402	2,693	0.823	37.2	N	1854.1	0.689	0.80			
11	50.5	6.5	5,625	2,668	2,957	0.781		N	1941.4	0.656	0.76			
												Total Settlement (inch) =	**0.94**	

* Note: The equation used to obtain $CRR_{7.5}$ is not valid for corrected $(N_1)_{60}$ higher than 30. According to NCEER 1997, the soil layer with corrected $(N_1)_{60}$ higher than 30 blows per foot is unlikely to be susceptible to liquefaction.

** Note: These values were obtained from a chart for estimation of volumetric strain in saturated sands based on a cyclic stress ratio and standard penetration resistance (Tokimatsu and Seed, 1987).
See figure 9.53 from "Geotechnical Earthquake Engineering" by S. Kramer.

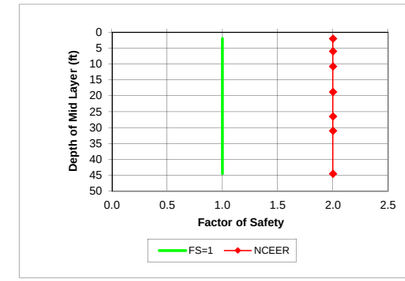
LIQUEFACTION ANALYSIS

Project	Broadway Interchange Reconstruction
Project No.	28645286
Boring No.	R-11-018

PGA =	0.68	
M_w =	7.9	
GWT during EQ	5.0	ft
Sampler:	Symbol	Corr. Factor
SPT	S	1
Mod.Cal	M	0.8
California	C	0.7
Mag. Weighting Factor($CSR_M/CSR_{M=7.5}$)		1.16

Note: Cells in Red must be input

Hammer type :	Type		C_E	Code	C_E
	Donut		0.75	1	3
	Safety		1	2	
	Auto		1.72	3	
Borehole Diameter:	(inch)	(mm)	C_B		C_B
	2.5-4.5	65-115	1	1	1
	6	150	1.05	2	
	8	200	1.15	3	
Rod Length:	(feet)	(m)	C_R		
	Default			999	
Sampling Method:	Type		Cs		
	Stand		1		
	No liners		1.2		



Note: F.S. greater than 2 is set to be equal to 2

Layer Number	Soil Type	γ_m	At Bottom of Layer Depth		At Center of Layer Depth		σ_o	EQ u	EQ σ'_o	r_d	EQ CSR	N raw	Sampler	N SPT	Fines Content	C_{fines}	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60-cs}$	$CRR^*_{7.5,1tsf}$	Magnitude Scaling Factor NCEER K_m Lower	Upper	Middle	Overburden Correction K_σ	Above GWT?	F.S.	Liquefy ?	F.S=1.0
	(USCS)	pcf	ft	m	ft	m	psf	psf	psf						%							during EQ	Critical						NCEER	NCEER	
1	ML	125	4.0	1.22	2	0.61	250	0	250	0.997	0.441													0.88	0.84	0.86	1.000	Y	2.00	N	1
2	CL	135	8.0	2.44	6.0	1.83	770	62	708	0.988	0.475													0.88	0.84	0.86	1.000	N	2.00	N	1
3	OH/CH	90	13.5	4.11	10.8	3.28	1,288	359	929	0.978	0.599													0.88	0.84	0.86	1.000	N	2.00	N	1
4	CL	135	24.0	7.32	18.8	5.72	2,244	858	1,386	0.960	0.687													0.88	0.84	0.86	1.000	N	2.00	N	1
5	SC	125	29.0	8.84	26.5	8.08	3,265	1,342	1,923	0.936	0.702	26	S	26	20	1.11	0.90	1.72	1.00	0.95	1.00	42	0.459	0.88	0.84	0.86	1.000	N	2.00	N	1
6	SP	120	33.0	10.06	31.0	9.45	3,818	1,622	2,195	0.915	0.704	45	M	36	5	1.00	0.86	1.72	1.00	0.95	1.00	50	0.459	0.88	0.84	0.86	0.993	N	2.00	N	1
7	CL	120	56.0	17.07	44.5	13.56	5,438	2,465	2,973	0.809	0.654													0.88	0.84	0.86	0.947	N	2.00	N	1

Layer Number	Depth to Bot. Layer	Thickness	σ_o	u	σ'_o	r_d	$(N_1)_{60-cs}$	Liquefy ?	τ_{cyc}	$CSR_{M=7.5}$	CSR_M	Volumetric Strain**			Settl.
		ft	psf	psf	psf			NCEER	psf	τ_{cyc}/σ'_o	τ_{cyc}/σ'_o		%		in
1	4.0	4.0	250	0	250	0.997		N	110.2	0.441	0.51				
2	8.0	4.0	770	62	708	0.988		N	336.2	0.475	0.55				
3	13.5	5.5	1,288	359	929	0.978		N	556.3	0.599	0.70				
4	24.0	10.5	2,244	858	1,386	0.960		N	952.1	0.687	0.80				
5	29.0	5.0	3,265	1,342	1,923	0.936	42.2	N	1351.1	0.702	0.82				0.00
6	33.0	4.0	3,818	1,622	2,195	0.915	50.3	N	1544.5	0.704	0.82				0.00
7	56.0	23.0	5,438	2,465	2,973	0.809		N	1943.4	0.654	0.76				
8															
9															
10															
11															
												Total Settlement (inch) =			0.00

* Note: The equation used to obtain $CRR_{7.5}$ is not valid for corrected $(N_1)_{60}$ higher than 30. According to NCEER 1997, the soil layer with corrected $(N_1)_{60}$ higher than 30 blows per foot is unlikely to be susceptible to liquefaction.

** Note: These values were obtained from a chart for estimation of volumetric strain in saturated sands based on a cyclic stress ratio and standard penetration resistance (Tokimatsu and Seed, 1987).
See figure 9.53 from "Geotechnical Earthquake Engineering" by S. Kramer.

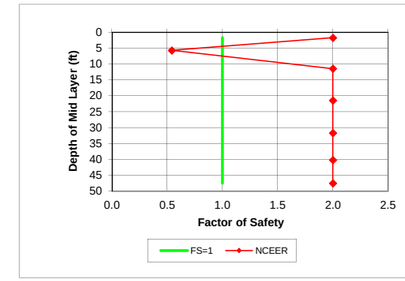
LIQUEFACTION ANALYSIS

Project	Broadway Interchange Reconstruction
Project No.	28645286
Boring No.	R-11-005

PGA =	0.68	
M_w =	7.9	
GWT during EQ	5.0	ft
Sampler:	Symbol	Corr. Factor
SPT	S	1
Mod.Cal	M	0.8
California	C	0.7
Mag. Weighting Factor($CSR_M/CSR_{M=7.5}$)		1.16

Note: Cells in Red must be input

Hammer type :	Type		C_E	Code	C_E
	Donut		0.75	1	3
	Safety		1	2	
	Auto		1.72	3	
Borehole Diameter:	(inch)	(mm)	C_B		C_B
	2.5-4.5	65-115	1	1	1
	6	150	1.05	2	
	8	200	1.15	3	
Rod Length:	(feet)	(m)	C_R		
	Default			999	
Sampling Method:	Type		Cs		
	Stand		1		
	No liners		1.2		



Note: F.S. greater than 2 is set to be equal to 2

Layer Number	Soil Type (USCS)	γ_m pcf	At Bottom of Layer Depth ft	Depth m	At Center of Layer Depth ft	Depth m	σ_o psf	EQ u psf	EQ σ'_o psf	r_d	EQ CSR
1	AC	140	3.5	1.07	1.75	0.53	245	0	245	0.998	0.441
2	SC	125	8.0	2.44	5.8	1.75	771	47	724	0.989	0.465
3	OH/CH	90	15.0	4.57	11.5	3.51	1,368	406	962	0.976	0.613
4	CH	115	28.0	8.53	21.5	6.55	2,430	1,030	1,400	0.953	0.731
5	GC	125	35.5	10.82	31.8	9.68	3,646	1,669	1,977	0.911	0.743
6	CL/CH	120	45.0	13.72	40.3	12.27	4,685	2,200	2,485	0.849	0.707
7	CL/SC	125	50.0	15.24	47.5	14.48	5,568	2,652	2,916	0.778	0.657

Layer Number	N raw	Sampler	N SPT	Fines Content %	C_{fines}	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60-cs}$ during EQ	$CRR^*_{7.5,1tsf}$ Critical	Magnitude Scaling Factor NCEER K_m Lower	Upper	Middle	Overburden Correction K_σ	Above GWT?	F.S. NCEER	Liquefy ? NCEER	F.S=1.0
1													0.88	0.84	0.86	1.000	Y	2.00	N	1
2	13	M	10	25	1.16	1.66	1.72	1.00	0.75	1.00	26	0.294	0.88	0.84	0.86	1.000	N	0.54	Liquef	1
3													0.88	0.84	0.86	1.000	N	2.00	N	1
4													0.88	0.84	0.86	1.000	N	2.00	N	1
5	36	M	29	30	1.15	0.93	1.72	1.00	0.95	1.00	50	0.459	0.88	0.84	0.86	1.000	N	2.00	N	1
6													0.88	0.84	0.86	0.975	N	2.00	N	1
7													0.88	0.84	0.86	0.951	N	2.00	N	1

Layer Number	Depth to Bot. Layer	Thickness ft	σ_o psf	u psf	σ'_o psf	r_d	$(N_1)_{60-cs}$	Liquefy ? NCEER	τ_{cyc} psf	$CSR_{M=7.5}$ τ_{cyc}/σ'_o	CSR_M τ_{cyc}/σ'_o	Volumetric Strain** %	Settl. in
1	3.5	3.5	245	0	245	0.998		N	108.1	0.441	0.51		
2	8.0	4.5	771	47	724	0.989	25.6	Liquef	337.0	0.465	0.54	0.0	0.00
3	15.0	7.0	1,368	406	962	0.976		N	589.9	0.613	0.71		
4	28.0	13.0	2,430	1,030	1,400	0.953		N	1023.4	0.731	0.85		
5	35.5	7.5	3,646	1,669	1,977	0.911	50.4	N	1468.5	0.743	0.86		
6	45.0	9.5	4,685	2,200	2,485	0.849		N	1757.7	0.707	0.82		
7	50.0	5.0	5,568	2,652	2,916	0.778		N	1915.2	0.657	0.76		

Total Settlement (inch) = 0.00

Falls in the borderline of Zone A and Zone B. LL=26, PI=12. WC not available. WC in samples from same depth in Borings R-11-007 and R-11-008 are 13% and 14%, respectively. Asumming similar WC for this layer WC<0.85LL (22%) non-liquefiable. Field description was moist.

* Note: The equation used to obtain $CRR_{7.5}$ is not valid for corrected $(N_1)_{60}$ higher than 30. According to NCEER 1997, the soil layer with corrected $(N_1)_{60}$ higher than 30 blows per foot is unlikely to be susceptible to liquefaction.

** Note: These values were obtained from a chart for estimation of volumetric strain in saturated sands based on a cyclic stress ratio and standard penetration resistance (Tokimatsu and Seed, 1987).
See figure 9.53 from "Geotechnical Earthquake Engineering" by S. Kramer.

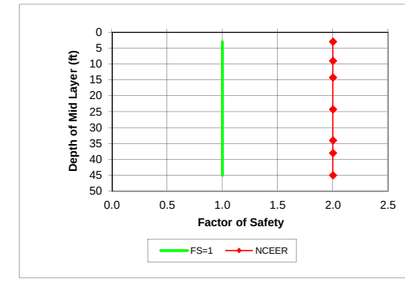
LIQUEFACTION ANALYSIS

Project	Broadway Interchange Reconstruction
Project No.	28645286
Boring No.	R-11-006

PGA =	0.68	
M_w =	7.9	
GWT during EQ	4.5	ft
Sampler:	Symbol	Corr. Factor
SPT	S	1
Mod.Cal	M	0.8
California	C	0.7
Mag. Weighting Factor($CSR_M/CSR_{M=7.5}$)		1.16

Note: Cells in Red must be input

Hammer type :	Type		C_E	Code	C_E
	Donut		0.75	1	3
	Safety		1	2	
	Auto		1.72	3	
Borehole Diameter:	(inch)	(mm)	C_B		C_B
	2.5-4.5	65-115	1	1	1
	6	150	1.05	2	
	8	200	1.15	3	
Rod Length:	(feet)	(m)	C_R		
	Default			999	
Sampling Method:	Type		Cs		
	Stand		1		
	No liners		1.2		



Note: F.S. greater than 2 is set to be equal to 2

Layer Number	Soil Type	γ_m	At Bottom of Layer Depth		At Center of Layer Depth		σ_o	EQ u	EQ σ'_o	r_d	EQ CSR	N raw	Sampler	N SPT	Fines Content	C_{fines}	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60\text{-}cs}$ during EQ	$CRR^*_{7.5,1tsf}$ Critical	Magnitude Scaling Factor NCEER K_m Lower	Upper	Middle	Overburden Correction K_σ	Above GWT?	F.S. NCEER	Liquefy ? NCEER	F.S=1.0
	(USCS)	pcf	ft	m	ft	m	psf	psf	psf						%																
1	CL/SC	140	6.0	1.83	3	0.91	420	0	420	0.995	0.440													0.88	0.84	0.86	1.000	Y	2.00	N	1
2	GC/CL	125	12.0	3.66	9.0	2.74	1,215	281	934	0.981	0.564													0.88	0.84	0.86	1.000	N	2.00	N	1
3	CH	110	16.5	5.03	14.3	4.34	1,838	608	1,229	0.970	0.641													0.88	0.84	0.86	1.000	N	2.00	N	1
4	CL	120	32.0	9.75	24.3	7.39	3,015	1,232	1,783	0.944	0.706													0.88	0.84	0.86	1.000	N	2.00	N	1
5	GC	125	36.0	10.97	34.0	10.36	4,195	1,841	2,354	0.897	0.707	21	S	21	25	1.14	0.84	1.72	1.00	1.00	1.00	35	0.459	0.88	0.84	0.86	0.983	N	2.00	N	1
6	CH	120	40.0	12.19	38.0	11.58	4,685	2,090	2,595	0.868	0.693													0.88	0.84	0.86	0.969	N	2.00	N	1
7	CL/SC	125	50.0	15.24	45.0	13.72	5,550	2,527	3,023	0.804	0.652													0.88	0.84	0.86	0.945	N	2.00	N	1

Layer Number	Depth to Bot. Layer	Thickness ft	σ_o psf	u psf	σ'_o psf	r_d	$(N_1)_{60\text{-}cs}$	Liquefy ? NCEER	τ_{cyc} psf	$CSR_{M=7.5}$ τ_{cyc}/σ'_o	CSR_M τ_{cyc}/σ'_o	Volumetric Strain** %			Settl. in
1	6.0	6.0	420	0	420	0.995		N	184.7	0.440	0.51				
2	12.0	6.0	1,215	281	934	0.981		N	527.0	0.564	0.66				
3	16.5	4.5	1,838	608	1,229	0.970		N	787.9	0.641	0.75				
4	32.0	15.5	3,015	1,232	1,783	0.944		N	1258.6	0.706	0.82				
5	36.0	4.0	4,195	1,841	2,354	0.897	34.7	N	1663.9	0.707	0.82				
6	40.0	4.0	4,685	2,090	2,595	0.868		N	1797.4	0.693	0.81				
7	50.0	10.0	5,550	2,527	3,023	0.804		N	1971.4	0.652	0.76				
												Total Settlement (inch) =			**0.00**

* Note: The equation used to obtain $CRR_{7.5}$ is not valid for corrected $(N_1)_{60}$ higher than 30. According to NCEER 1997, the soil layer with corrected $(N_1)_{60}$ higher than 30 blows per foot is unlikely to be susceptible to liquefaction.

** Note: These values were obtained from a chart for estimation of volumetric strain in saturated sands based on a cyclic stress ratio and standard penetration resistance (Tokimatsu and Seed, 1987).
See figure 9.53 from "Geotechnical Earthquake Engineering" by S. Kramer.

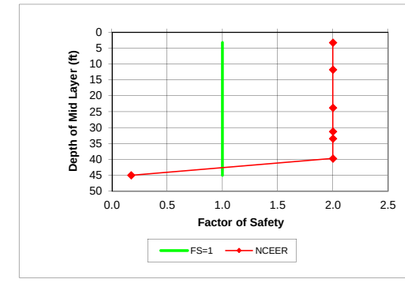
LIQUEFACTION ANALYSIS

Project	Broadway Interchange Reconstruction
Project No.	28645286
Boring No.	R-11-007

PGA =	0.68	
M_w =	7.9	
GWT during EQ	3.5	ft
Sampler:	Symbol	Corr. Factor
SPT	S	1
Mod.Cal	M	0.8
California	C	0.7
Mag. Weighting Factor($CSR_M/CSR_{M=7.5}$)		1.16

Note: Cells in Red must be input

Hammer type :	Type		C_E	Code	C_E
	Donut		0.75	1	3
	Safety		1	2	
	Auto		1.55	3	
Borehole Diameter:	(inch)	(mm)	C_B		C_B
	2.5-4.5	65-115	1	1	1
	6	150	1.05	2	
	8	200	1.15	3	
Rod Length:	(feet)	(m)	C_R		
	Default			999	
Sampling Method:	Type		Cs		
	Stand		1		
	No liners		1.2		



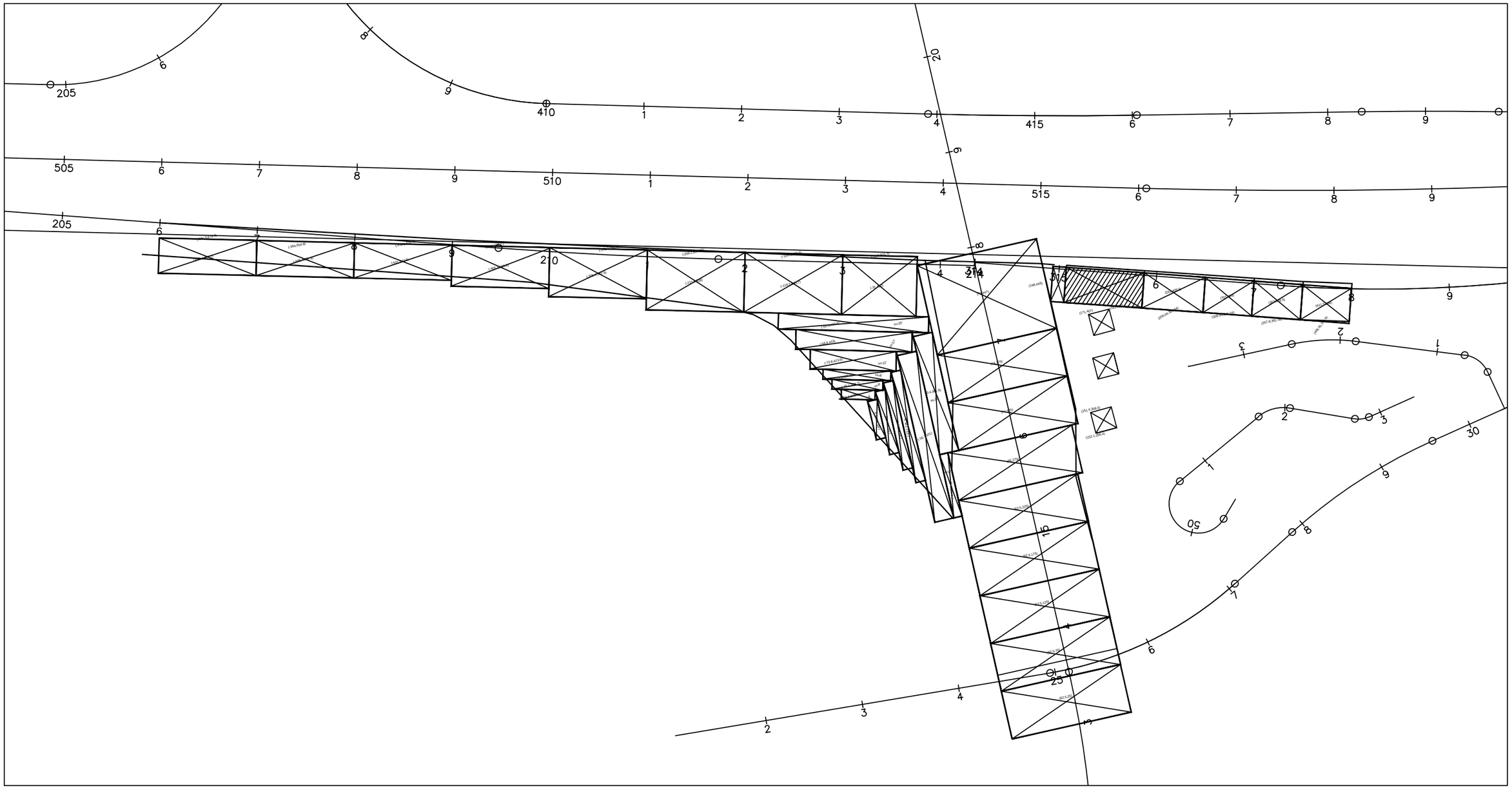
Note: F.S. greater than 2 is set to be equal to 2

Layer Number	Soil Type (USCS)	γ_m pcf	At Bottom of Layer Depth ft	Depth m	At Center of Layer Depth ft	Depth m	σ_o psf	EQ u psf	EQ σ'_o psf	r_d	EQ CSR	N raw	Sampler	N SPT	Fines Content %	C_{fines}	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60-cs}$ during EQ	$CRR^*_{7.5,1tsf}$ Critical	Magnitude Scaling Factor NCEER K_m Lower	Upper	Middle	Overburden Correction K_σ	Above GWT?	F.S. NCEER	Liquefy ? NCEER	F.S=1.0
1	CL	140	6.5	1.98	3.25	0.99	455	0	455	0.994	0.440													0.88	0.84	0.86	1.000	Y	2.00	N	1
2	OH/CH	100	17.0	5.18	11.8	3.58	1,435	515	920	0.975	0.672													0.88	0.84	0.86	1.000	N	2.00	N	1
3	CL	120	30.5	9.30	23.8	7.24	2,770	1,264	1,506	0.946	0.769													0.88	0.84	0.86	1.000	N	2.00	N	1
4	ML/CL	130	32.0	9.75	31.3	9.53	3,678	1,732	1,946	0.914	0.763													0.88	0.84	0.86	1.000	N	2.00	N	1
5	CL	130	35.0	10.67	33.5	10.21	3,970	1,872	2,098	0.901	0.753													0.88	0.84	0.86	1.000	N	2.00	N	1
6	SC/CL	125	44.5	13.56	39.8	12.12	4,759	2,262	2,497	0.853	0.719													0.88	0.84	0.86	0.975	N	2.00	N	1
7	ML	120	45.5	13.87	45.0	13.72	5,413	2,590	2,823	0.804	0.681	10	M	8	90	1.31	0.81	1.55	1.00	1.00	1.00	13	0.143	0.88	0.84	0.86	0.956	N	0.17	Liquef	1
8	CH	110	59.0	17.98	52.3	15.93	6,215	3,042	3,173	0.730	0.632													0.88	0.84	0.86	0.936	N	0.00	N	1

Layer Number	Depth to Bot. Layer	Thickness ft	σ_o psf	u psf	σ'_o psf	r_d	$(N_1)_{60-cs}$	Liquefy ? NCEER	τ_{cyc} psf	$CSR_{M=7.5}$ τ_{cyc}/σ'_o	CSR_M τ_{cyc}/σ'_o	Volumetric Strain** %	Settl. in
1	6.5	6.5	455	0	455	0.994		N	200.0	0.440	0.51		
2	17.0	10.5	1,435	515	920	0.975		N	618.7	0.672	0.78		
3	30.5	13.5	2,770	1,264	1,506	0.946		N	1158.3	0.769	0.90		
4	32.0	1.5	3,678	1,732	1,946	0.914		N	1485.6	0.763	0.89		
5	35.0	3.0	3,970	1,872	2,098	0.901		N	1580.4	0.753	0.88		
6	44.5	9.5	4,759	2,262	2,497	0.853		N	1794.6	0.719	0.84		
7	45.5	1.0	5,413	2,590	2,823	0.804	13.3	Liquef	1922.5	0.681	0.79	2.0	0.24
8	59.0	13.5	6,215	3,042	3,173	0.730		N	2005.4	0.632	0.74		
												Total Settlement (inch) =	**0.24**

* Note: The equation used to obtain $CRR_{7.5}$ is not valid for corrected $(N_1)_{60}$ higher than 30. According to NCEER 1997, the soil layer with corrected $(N_1)_{60}$ higher than 30 blows per foot is unlikely to be susceptible to liquefaction.

** Note: These values were obtained from a chart for estimation of volumetric strain in saturated sands based on a cyclic stress ratio and standard penetration resistance (Tokimatsu and Seed, 1987).
See figure 9.53 from "Geotechnical Earthquake Engineering" by S. Kramer.



Embankment Load Estimates
West Approach Embankment &
Southbound On-/Off-Ramp
101 / Broadway (BWY and B2, B3)

URS

Page ____ of ____

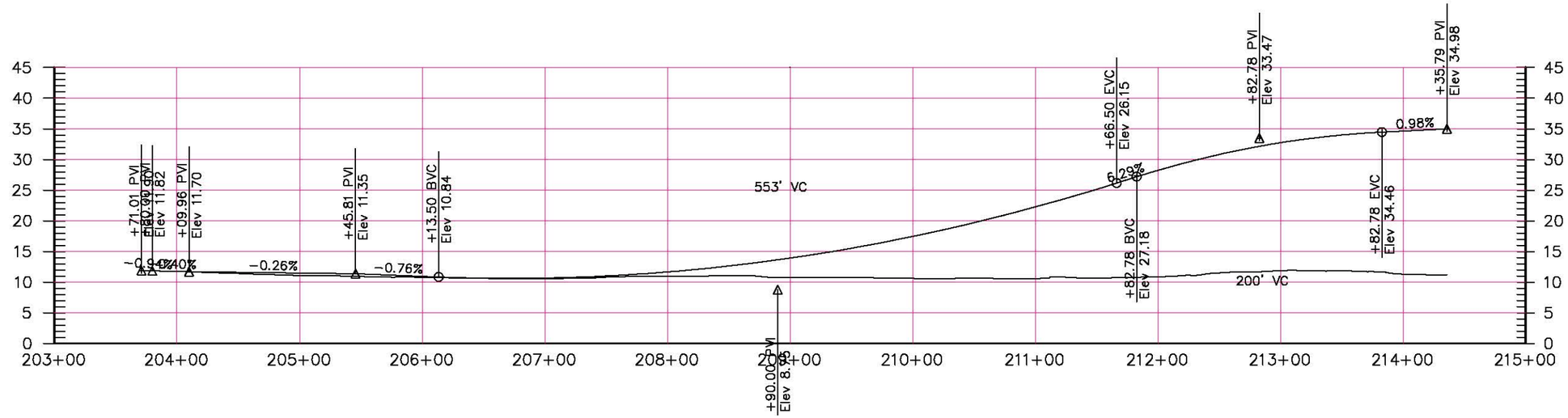
Job BROADWAY INTERCHANGE RECONSTRUCTION Project No. 9864529.86 Sheet ____ of ____

Description RAMP "B2" EMBANKMENT SETTLEMENT Computed by MT Date 12/18/11

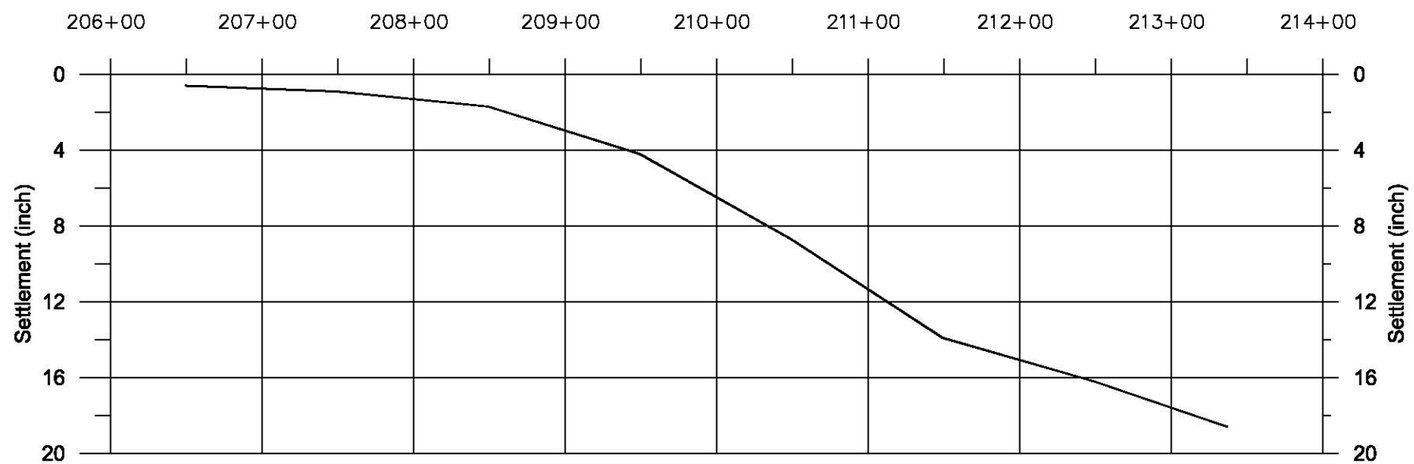
Checked by S. HUANG Date 1/20/12

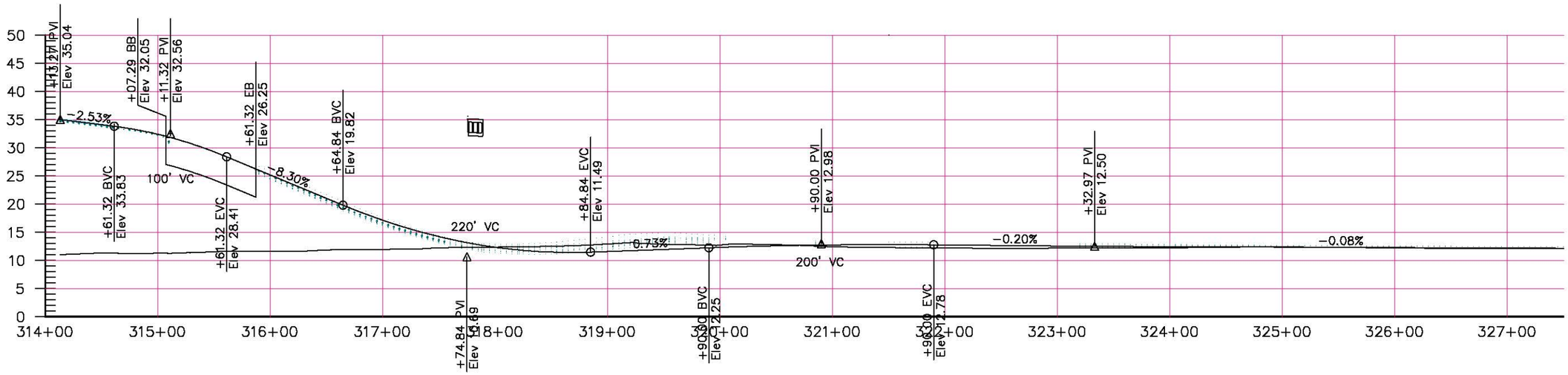
Reference

EL	DEPTH (ft)	STRESS (KSF) 0 5 10	γ' PCF	C_{CE}	$C_{\gamma E}$	P_p (KSF)	E $\times 10^6$ PSF	μ	C_α	A	t_{ZERO}	S_α / σ'_{VO}
EL 11	FILL	EL 3	120	-	-		0.30	0.3	-	1	10	
EL 1	OH	EL -7.5	27.6	0.30	0.03	1.3 1.8	0.03	0.5	0.015	1	10	
EL -9	CL	EL -25.5	57.6	0.12	0.015	4.0	0.78	0.5	-	1	10	
EL -19	CL/SC	EL -36	62.6	-	-	-	0.30	0.3	-	1	10	
EL -29	CH	EL -49.5	52.6	0.19	0.02	5.5	(1000x 300) 0.30	0.5	-	1	10	
EL -39	ML											
EL -49	CL		72.6	0.05	0.005	7.0	(1600x600) ~1.0	0.5	-	1	10	
EL -59	GC											
EL -69	CL											

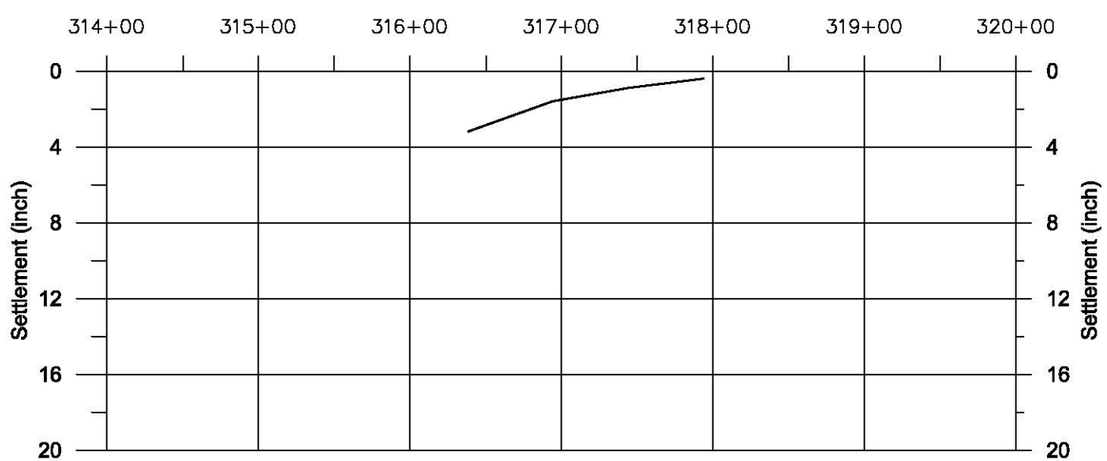

+71.01 PVI
Elev 11.82
+09.96 PVI
Elev 11.70
+45.81 PVI
Elev 11.35
+13.50 BVC
Elev 10.84
553' VC
+66.50 EVC
Elev 26.15
+82.78 BVC
Elev 27.18
+82.78 PVI
Elev 33.47
+82.78 EVC
Elev 34.46
+35.79 PVI
Elev 34.98
+90.00 PVI
Elev 8.45
−0.26%
−0.76%
0.98%
200' VC
203+00
204+00
205+00
206+00
207+00
208+00
209+00
210+00
211+00
212+00
213+00
214+00
215+00

"B2" LINE


206+00
207+00
208+00
209+00
210+00
211+00
212+00
213+00
214+00
Settlement (inch)
0
4
8
12
16
20


+13.27 PVI
Elev 35.04
+07.29 BB
Elev 32.05
+11.32 PVI
Elev 32.56
+61.32 EB
Elev 26.25
+64.84 BVC
Elev 19.82
+84.84 EVC
Elev 11.49
+90.00 PVI
Elev 12.98
+32.97 PVI
Elev 12.50
-2.53%
-8.30%
-0.73%
-0.20%
-0.08%
100' VC
220' VC
200' VC
+61.32 BVC
Elev 33.83
+61.32 EVC
Elev 28.41
+74.84 PVI
Elev 19.69
+90.00 BVC
Elev 12.25
+96.00 EVC
Elev 12.78
50
45
40
35
30
25
20
15
10
5
0
314+00
315+00
316+00
317+00
318+00
319+00
320+00
321+00
322+00
323+00
324+00
325+00
326+00
327+00

"B3" LINE


314+00
315+00
316+00
317+00
318+00
319+00
320+00
Settlement (inch)
0
4
8
12
16
20

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1
FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

b2ramp_2.dat
NUMBER OF SOIL LAYERS: 10

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	11.0	7.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	7.0	3.0	57.6	.000	.000	1200.0	.300	.30	.00000	1.000	5.00
3	3.0	-2.0	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
4	-2.0	-7.5	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
5	-7.5	-25.5	57.6	.120	.015	4000.0	.780	.50	.00000	1.000	5.00
6	-25.5	-36.0	62.6	.000	.000	8000.0	.300	.30	.00000	1.000	5.00
7	-36.0	-49.5	52.6	.190	.020	5500.0	.300	.50	.00000	1.000	5.00
8	-49.5	-69.0	72.6	.050	.005	7000.0	1.000	.50	.00000	1.000	5.00
9	-69.0	-79.0	72.6	.000	.000	9000.0	.300	.30	.00000	1.000	5.00
10	-79.0	-89.0	72.6	.050	.005	10000.0	1.000	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 36

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	62.50	25.00	.00	11.00	125.00	50.00	375.00
2	62.50	75.00	.00	11.00	125.00	50.00	625.00
3	62.50	125.00	.00	11.00	125.00	50.00	938.00
4	62.50	175.00	.00	11.00	125.00	50.00	1375.00
5	62.50	225.00	.00	11.00	125.00	50.00	1750.00
6	65.00	275.00	.00	11.00	130.00	50.00	2000.00
7	74.00	325.00	.00	11.00	125.00	50.00	2375.00
8	74.00	375.00	.00	11.00	125.00	50.00	2625.00
9	74.00	447.00	.00	11.00	125.00	93.80	3000.00
10	148.00	443.00	16.70	11.00	13.50	36.00	3000.00
11	193.00	430.00	16.70	11.00	80.00	36.00	.10
12	261.00	409.50	16.70	11.00	62.70	36.00	1625.00
13	315.00	393.00	16.70	11.00	50.00	36.00	1125.00
14	363.00	378.50	16.70	11.00	50.00	36.00	625.00
15	411.50	364.00	16.70	11.00	50.00	36.00	250.00
16	-31.00	482.00	14.10	11.00	76.40	61.10	3000.00
17	-116.50	503.70	14.10	11.00	100.00	61.10	2625.00
18	-213.50	528.00	14.10	11.00	100.00	61.10	2250.00
19	-309.10	557.60	14.10	11.00	100.00	50.00	1500.00
20	-405.10	585.50	14.10	11.00	100.00	42.00	1000.00
21	-501.50	613.00	14.10	11.00	100.00	36.00	625.00
22	-598.40	637.40	14.10	11.00	100.00	36.00	375.00
23	-695.40	661.70	14.10	11.00	100.00	36.00	250.00
24	-65.30	450.80	14.10	11.00	153.60	16.30	2500.00
25	-68.80	433.00	14.10	11.00	118.90	20.00	2125.00
26	-73.80	413.60	14.10	11.00	88.06	20.00	1500.00

27	-73.50	398.10	14.10	11.00	69.30	10.00	1000.00
28	-75.10	388.20	14.10	11.00	52.06	10.00	750.00
29	-76.60	378.20	14.10	11.00	34.43	10.00	500.00
30	-63.70	349.10	.00	11.00	10.00	40.12	500.00
31	-53.70	344.20	.00	11.00	10.00	66.10	750.00
32	-43.60	338.50	.00	11.00	10.00	91.39	1000.00
33	-33.10	335.20	.00	11.00	10.00	115.70	1500.00
34	-18.70	321.00	.00	11.00	19.98	174.87	2125.00
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TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5
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SETTLEMENT POINT : -31.0, 482.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2999.7	2877.6	2824.2	1.000	.003	.000	.206	.209
2	595.2	2993.5	2637.4	2482.8	1.000	.002	.000	.233	.236
3	779.4	2967.9	2382.4	2132.4	1.000	8.676	.722	1.421	10.819
4	924.3	2906.3	2115.2	1786.5	1.000	7.067	.795	2.102	9.964
5	1518.6	2674.6	1647.4	1255.1	1.000	1.894	.000	.339	2.232
6	2365.6	2353.4	1267.5	906.1	1.000	.000	.000	.715	.715
7	3049.3	2118.5	1043.2	732.9	1.000	.742	.000	.664	1.407
8	4112.3	1859.8	816.8	576.2	1.000	.190	.000	.272	.462
9	5183.1	1676.5	665.9	477.9	1.000	.000	.000	.533	.533
10	5909.1	1570.7	583.1	425.0	1.000	.061	.000	.128	.189
						---	---	---	---
						18.636	1.517	6.614	26.767

SETTLEMENT POINT : -23.5, 511.9

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1239.4	1325.3	1468.3	1.000	.002	.000	.064	.066
2	595.2	1411.5	1326.4	1409.9	1.000	.001	.000	.094	.096
3	779.4	1446.3	1253.1	1343.2	1.000	4.603	.722	.296	5.622
4	924.3	1455.9	1163.1	1267.0	1.000	2.976	.795	.530	4.300
5	1518.6	1439.7	989.3	1106.2	1.000	.938	.000	.109	1.047
6	2365.6	1394.0	829.2	934.6	1.000	.000	.000	.363	.363
7	3049.3	1348.5	721.3	811.2	1.000	.515	.000	.314	.830
8	4112.3	1282.7	598.0	670.3	1.000	.138	.000	.152	.290
9	5183.1	1222.0	506.3	568.2	1.000	.000	.000	.360	.360
10	5909.1	1180.4	452.5	509.5	1.000	.047	.000	.084	.131
						---	---	---	---
						9.221	1.517	2.367	13.105

SETTLEMENT POINT : -116.5, 503.7

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2624.8	2528.9	2447.8	1.000	.003	.000	.181	.184
2	595.2	2619.3	2339.4	2103.2	1.000	.002	.000	.206	.208
3	779.4	2596.9	2136.0	1748.9	1.000	7.861	.722	1.309	9.892
4	924.3	2542.4	1918.2	1398.3	1.000	6.209	.795	1.945	8.949
5	1518.6	2331.7	1520.0	863.5	1.000	1.309	.000	.316	1.625
6	2365.6	2025.3	1180.8	533.4	1.000	.000	.000	.635	.635
7	3049.3	1791.7	979.0	392.1	1.000	.650	.000	.597	1.248

8	4112.3	1530.8	779.1	288.3	1.000	.161	.000	.233	.394
9	5183.1	1349.4	649.0	236.8	1.000	.000	.000	.433	.434
10	5909.1	1248.3	578.4	212.9	1.000	.050	.000	.102	.152
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						16.246	1.517	5.958	23.721

SETTLEMENT POINT : -109.1, 533.3

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1345.2	1303.7	1273.2	1.000	.002	.000	.092	.093
2	595.2	1323.1	1242.6	1195.2	1.000	.001	.000	.095	.096
3	779.4	1317.1	1184.4	1109.2	1.000	4.136	.722	.341	5.199
4	924.3	1311.5	1119.6	1012.9	1.000	2.438	.795	.540	3.772
5	1518.6	1290.6	983.9	819.9	1.000	.866	.000	.108	.973
6	2365.6	1245.0	839.0	635.5	1.000	.000	.000	.337	.337
7	3049.3	1193.0	734.4	520.0	1.000	.465	.000	.306	.770
8	4112.3	1112.0	614.4	407.1	1.000	.122	.000	.141	.262
9	5183.1	1038.5	526.9	337.4	1.000	.000	.000	.312	.312
10	5909.1	990.6	476.4	301.5	1.000	.040	.000	.072	.113
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						8.069	1.517	2.341	11.927

SETTLEMENT POINT : -213.5, 528.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2249.7	2153.9	2064.1	1.000	.003	.000	.157	.160
2	595.2	2243.0	1965.1	1704.6	1.000	.002	.000	.183	.185
3	779.4	2215.6	1764.2	1341.3	1.000	6.924	.722	1.326	8.972
4	924.3	2150.0	1552.8	993.5	1.000	5.176	.795	1.929	7.900
5	1518.6	1906.4	1183.3	503.8	1.000	1.144	.000	.294	1.439
6	2365.6	1574.8	896.2	246.8	1.000	.000	.000	.517	.518
7	3049.3	1339.6	741.7	156.4	1.000	.512	.000	.481	.993
8	4112.3	1095.7	601.1	102.9	1.000	.120	.000	.174	.294
9	5183.1	938.7	514.8	82.7	1.000	.000	.000	.304	.304
10	5909.1	856.0	468.8	75.3	1.000	.035	.000	.070	.105
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						13.917	1.517	5.436	20.870

SETTLEMENT POINT : -206.2, 557.8

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1066.2	1070.2	1079.2	1.000	.001	.000	.067	.069
2	595.2	1104.9	1039.3	988.4	1.000	.001	.000	.079	.080

3	779.4	1111.2	987.9	889.1	1.000	3.328	.722	.345	4.395
4	924.3	1109.0	927.3	779.7	1.000	1.621	.795	.562	2.978
5	1518.6	1082.0	802.5	569.8	1.000	.757	.000	.110	.867
6	2365.6	1017.8	678.3	387.3	1.000	.000	.000	.293	.293
7	3049.3	949.4	595.5	286.2	1.000	.381	.000	.275	.656
8	4112.3	852.5	506.6	200.8	1.000	.096	.000	.117	.212
9	5183.1	773.1	444.7	156.6	1.000	.000	.000	.237	.237
10	5909.1	725.2	409.5	136.8	1.000	.030	.000	.054	.084
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						6.216	1.517	2.140	9.873

SETTLEMENT POINT : -309.1, 557.6

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1499.7	1429.3	1348.8	1.000	.002	.000	.107	.108
2	595.2	1491.9	1291.6	1061.2	1.000	.001	.000	.126	.127
3	779.4	1461.7	1148.6	784.2	1.000	4.657	.722	.991	6.370
4	924.3	1395.2	1003.9	539.5	1.000	2.754	.795	1.372	4.920
5	1518.6	1185.7	767.0	240.3	1.000	.812	.000	.189	1.001
6	2365.6	950.1	592.9	108.6	1.000	.000	.000	.311	.311
7	3049.3	802.0	499.9	66.8	1.000	.329	.000	.280	.609
8	4112.3	657.5	414.4	43.2	1.000	.075	.000	.100	.176
9	5183.1	566.8	361.9	34.7	1.000	.000	.000	.179	.179
10	5909.1	519.1	334.3	31.7	1.000	.022	.000	.040	.062
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						8.652	1.517	3.694	13.863

SETTLEMENT POINT : -303.1, 581.9

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	735.8	727.9	713.1	1.000	.001	.000	.049	.049
2	595.2	744.8	702.6	640.3	1.000	.000	.000	.055	.055
3	779.4	744.8	670.3	561.6	1.000	1.644	.722	.258	2.624
4	924.3	740.2	633.2	477.0	1.000	.506	.795	.407	1.708
5	1518.6	714.3	556.4	323.4	1.000	.542	.000	.076	.618
6	2365.6	661.7	478.4	202.9	1.000	.000	.000	.192	.192
7	3049.3	610.6	425.5	142.3	1.000	.257	.000	.176	.433
8	4112.3	543.2	368.6	94.9	1.000	.063	.000	.073	.136
9	5183.1	490.6	329.3	71.9	1.000	.000	.000	.148	.148
10	5909.1	459.6	307.2	62.1	1.000	.020	.000	.033	.053
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						3.033	1.517	1.467	6.016

SETTLEMENT POINT : -405.1, 585.5

SOIL	INITIAL	VERTICAL STRESS	HORIZ. X STRESS	HORIZ. Y STRESS	SKEMPTON BJERRUM	CONSOL.	SECOND. COMP.	ELASTIC	TOTAL

LAYER	STRESS (PSF)	INCREASE (PSF)	INCREASE (PSF)	INCREASE (PSF)	FACTOR	COMP. (IN.)	20. YR (IN.)	COMP. (IN.)	COMP. (IN.)
1	240.0	999.6	943.4	879.9	1.000	.001	.000	.072	.074
2	595.2	991.0	834.4	655.8	1.000	.001	.000	.087	.088
3	779.4	959.7	724.7	452.2	1.000	2.675	.722	.743	4.140
4	924.3	896.6	619.2	287.7	1.000	.673	.795	.975	2.442
5	1518.6	725.3	460.8	112.8	1.000	.549	.000	.121	.671
6	2365.6	559.7	356.5	47.3	1.000	.000	.000	.184	.184
7	3049.3	464.3	305.1	28.5	1.000	.199	.000	.161	.360
8	4112.3	376.1	260.5	18.6	1.000	.044	.000	.055	.100
9	5183.1	322.9	234.3	15.3	1.000	.000	.000	.099	.099
10	5909.1	295.6	220.8	14.3	1.000	.013	.000	.021	.034
						4.155	1.517	2.519	8.192

SETTLEMENT POINT : -400.0, 606.2

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	400.2	437.8	469.7	1.000	.000	.000	.020	.021
2	595.2	465.7	447.8	412.6	1.000	.000	.000	.033	.033
3	779.4	477.8	429.4	351.1	1.000	.374	.722	.175	1.271
4	924.3	478.3	404.2	286.7	1.000	.359	.795	.292	1.445
5	1518.6	456.8	351.8	177.8	1.000	.370	.000	.053	.423
6	2365.6	412.1	302.3	101.9	1.000	.000	.000	.122	.122
7	3049.3	372.3	271.3	67.7	1.000	.162	.000	.109	.272
8	4112.3	324.2	240.3	43.3	1.000	.039	.000	.043	.081
9	5183.1	289.4	220.0	32.4	1.000	.000	.000	.085	.086
10	5909.1	269.9	208.9	28.0	1.000	.012	.000	.018	.030
						1.315	1.517	.952	3.784

SETTLEMENT POINT : -501.5, 613.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	624.6	584.1	537.5	1.000	.000	.000	.046	.047
2	595.2	616.4	506.2	378.2	1.000	.000	.000	.056	.056
3	779.4	588.2	430.7	242.8	1.000	.796	.722	.503	2.022
4	924.3	536.7	361.9	143.3	1.000	.394	.795	.625	1.814
5	1518.6	415.3	266.7	50.7	1.000	.340	.000	.071	.411
6	2365.6	312.4	209.3	20.5	1.000	.000	.000	.102	.102
7	3049.3	257.1	182.4	12.5	1.000	.114	.000	.086	.200
8	4112.3	207.8	160.1	8.5	1.000	.025	.000	.029	.054
9	5183.1	178.7	147.7	7.3	1.000	.000	.000	.053	.053
10	5909.1	164.0	141.5	7.0	1.000	.007	.000	.011	.018
						1.677	1.517	1.583	4.777

SETTLEMENT POINT : -498.1, 630.7

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	313.5	304.4	290.7	1.000	.000	.000	.022	.022
2	595.2	312.3	287.2	248.3	1.000	.000	.000	.024	.024
3	779.4	309.8	269.0	204.1	1.000	.262	.722	.146	1.131
4	924.3	304.0	249.4	159.7	1.000	.244	.795	.219	1.258
5	1518.6	280.3	213.5	90.4	1.000	.238	.000	.036	.274
6	2365.6	244.0	183.6	47.9	1.000	.000	.000	.073	.073
7	3049.3	215.9	166.4	30.8	1.000	.096	.000	.063	.160
8	4112.3	184.9	150.4	19.5	1.000	.022	.000	.023	.046
9	5183.1	163.9	140.7	14.8	1.000	.000	.000	.047	.047
10	5909.1	152.5	135.6	13.0	1.000	.007	.000	.009	.016
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						.870	1.517	.663	3.050

SETTLEMENT POINT : -598.4, 637.4

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	374.8	350.3	322.5	1.000	.000	.000	.028	.028
2	595.2	369.8	303.4	226.8	1.000	.000	.000	.034	.034
3	779.4	352.9	258.0	145.4	1.000	.292	.722	.302	1.317
4	924.3	322.0	216.5	85.7	1.000	.257	.795	.376	1.428
5	1518.6	249.0	159.3	30.0	1.000	.214	.000	.043	.256
6	2365.6	186.8	125.2	11.8	1.000	.000	.000	.061	.061
7	3049.3	153.2	109.7	7.0	1.000	.069	.000	.051	.120
8	4112.3	123.1	97.7	4.7	1.000	.015	.000	.017	.032
9	5183.1	105.2	91.6	4.0	1.000	.000	.000	.031	.031
10	5909.1	96.2	88.8	3.9	1.000	.004	.000	.006	.010
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						.851	1.517	.948	3.317

SETTLEMENT POINT : -594.0, 654.8

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	193.7	185.6	174.4	1.000	.000	.000	.014	.014
2	595.2	189.2	173.7	148.7	1.000	.000	.000	.015	.015
3	779.4	187.0	162.6	122.1	1.000	.168	.722	.089	.980
4	924.3	183.1	150.9	95.3	1.000	.155	.795	.132	1.082
5	1518.6	168.7	129.6	53.4	1.000	.148	.000	.021	.170
6	2365.6	146.7	111.8	27.8	1.000	.000	.000	.044	.044
7	3049.3	129.6	101.9	17.6	1.000	.059	.000	.038	.096
8	4112.3	110.5	93.2	10.9	1.000	.013	.000	.014	.027
9	5183.1	97.4	88.5	8.1	1.000	.000	.000	.027	.027
10	5909.1	90.3	86.3	7.1	1.000	.004	.000	.005	.009

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						.548	1.517	.399	2.464

SETTLEMENT POINT : -695.4, 661.7

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	249.9	232.3	214.9	1.000	.000	.000	.019	.019
2	595.2	246.5	198.6	151.1	1.000	.000	.000	.023	.023
3	779.4	235.1	165.8	96.8	1.000	.206	.722	.208	1.136
4	924.3	214.2	135.7	56.9	1.000	.179	.795	.259	1.233
5	1518.6	164.1	94.2	19.7	1.000	.144	.000	.030	.174
6	2365.6	120.4	70.8	7.6	1.000	.000	.000	.041	.041
7	3049.3	96.3	61.6	4.4	1.000	.044	.000	.034	.078
8	4112.3	74.6	55.8	2.9	1.000	.009	.000	.011	.020
9	5183.1	61.9	53.9	2.4	1.000	.000	.000	.018	.018
10	5909.1	55.6	53.4	2.4	1.000	.002	.000	.003	.006
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						.585	1.517	.645	2.747

SETTLEMENT POINT : -691.5, 679.2

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	131.1	123.6	116.2	1.000	.000	.000	.009	.010
2	595.2	126.8	112.8	98.9	1.000	.000	.000	.010	.010
3	779.4	124.9	103.0	80.9	1.000	.116	.722	.066	.904
4	924.3	121.9	92.9	62.8	1.000	.107	.795	.097	.998
5	1518.6	110.9	75.5	34.7	1.000	.099	.000	.015	.115
6	2365.6	94.0	62.9	17.6	1.000	.000	.000	.029	.029
7	3049.3	80.9	57.1	10.8	1.000	.037	.000	.025	.062
8	4112.3	66.5	53.4	6.5	1.000	.008	.000	.009	.017
9	5183.1	57.0	52.2	4.8	1.000	.000	.000	.016	.016
10	5909.1	52.0	52.0	4.2	1.000	.002	.000	.003	.005
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						.369	1.517	.280	2.166

SETTLEMENT POINT : -65.3, 450.8

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2500.5	2428.0	2410.3	1.000	.003	.000	.168	.171
2	595.2	2506.6	2281.6	2215.1	1.000	.002	.000	.185	.187
3	779.4	2506.7	2118.2	1988.0	1.000	7.649	.722	.907	9.279
4	924.3	2487.0	1939.1	1743.5	1.000	6.071	.795	1.420	8.286
5	1518.6	2386.7	1596.6	1303.6	1.000	1.329	.000	.259	1.588

6	2365.6	2211.8	1280.8	936.3	1.000	.000	.000	.650	.650
7	3049.3	2051.1	1079.9	727.1	1.000	.724	.000	.620	1.343
8	4112.3	1838.9	869.8	535.3	1.000	.188	.000	.266	.454
9	5183.1	1669.4	725.9	422.6	1.000	.000	.000	.530	.530
10	5909.1	1566.8	645.1	366.1	1.000	.061	.000	.127	.189
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						16.027	1.517	5.133	22.677

SETTLEMENT POINT : -68.8, 433.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2124.6	2057.8	2034.0	1.000	.003	.000	.144	.146
2	595.2	2116.7	1928.4	1866.9	1.000	.002	.000	.157	.158
3	779.4	2097.4	1795.2	1707.2	1.000	6.609	.722	.692	8.024
4	924.3	2069.9	1656.2	1545.0	1.000	4.949	.795	1.033	6.777
5	1518.6	1997.3	1398.7	1238.0	1.000	1.181	.000	.188	1.369
6	2365.6	1887.3	1163.2	951.0	1.000	.000	.000	.526	.527
7	3049.3	1786.4	1009.2	768.4	1.000	.649	.000	.485	1.134
8	4112.3	1648.9	839.1	583.0	1.000	.171	.000	.219	.391
9	5183.1	1532.9	715.0	463.9	1.000	.000	.000	.472	.472
10	5909.1	1459.0	642.3	401.2	1.000	.058	.000	.112	.170
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						13.622	1.517	4.028	19.167

SETTLEMENT POINT : -73.8, 413.6

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1500.1	1468.7	1473.6	1.000	.002	.000	.099	.101
2	595.2	1501.9	1405.9	1416.1	1.000	.001	.000	.105	.106
3	779.4	1503.4	1336.6	1345.4	1.000	4.801	.722	.325	5.848
4	924.3	1499.1	1261.9	1264.0	1.000	3.130	.795	.519	4.444
5	1518.6	1472.0	1125.1	1097.7	1.000	.954	.000	.100	1.053
6	2365.6	1434.1	996.8	915.9	1.000	.000	.000	.361	.362
7	3049.3	1403.1	902.6	778.6	1.000	.533	.000	.304	.836
8	4112.3	1356.6	783.2	618.2	1.000	.145	.000	.153	.298
9	5183.1	1308.3	685.2	502.9	1.000	.000	.000	.381	.381
10	5909.1	1272.1	624.0	438.4	1.000	.051	.000	.089	.140
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						9.617	1.517	2.436	13.570

SETTLEMENT POINT : -73.5, 398.1

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)

1	240.0	1003.1	1014.0	1046.3	1.000	.001	.000	.062	.063
2	595.2	1030.4	1021.1	1072.3	1.000	.001	.000	.064	.065
3	779.4	1051.7	1010.3	1063.4	1.000	3.078	.722	.030	3.830
4	924.3	1061.1	994.8	1047.5	1.000	1.416	.795	.088	2.298
5	1518.6	1078.1	962.0	990.2	1.000	.755	.000	.028	.783
6	2365.6	1113.7	907.5	880.8	1.000	.000	.000	.242	.243
7	3049.3	1141.7	846.9	775.6	1.000	.447	.000	.178	.626
8	4112.3	1161.9	752.5	636.5	1.000	.126	.000	.109	.236
9	5183.1	1159.4	666.7	528.2	1.000	.000	.000	.320	.320
10	5909.1	1148.2	610.8	464.8	1.000	.046	.000	.073	.120
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						5.871	1.517	1.195	8.584

SETTLEMENT POINT : -75.1, 388.2

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	749.9	757.6	774.5	1.000	.001	.000	.046	.047
2	595.2	750.1	774.9	822.2	1.000	.000	.000	.043	.044
3	779.4	754.4	797.2	865.3	1.000	1.693	.722	-.154	2.262
4	924.3	766.6	823.2	897.0	1.000	.519	.795	-.206	1.108
5	1518.6	820.5	858.9	903.3	1.000	.608	.000	-.017	.591
6	2365.6	905.1	848.0	836.0	1.000	.000	.000	.168	.168
7	3049.3	967.4	806.9	752.9	1.000	.388	.000	.101	.489
8	4112.3	1024.9	728.2	632.2	1.000	.113	.000	.081	.194
9	5183.1	1048.8	650.8	532.6	1.000	.000	.000	.277	.278
10	5909.1	1052.4	598.9	472.5	1.000	.043	.000	.062	.105
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						3.365	1.517	.403	5.285

SETTLEMENT POINT : -76.6, 378.2

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	497.2	513.0	508.5	1.000	.000	.000	.031	.031
2	595.2	475.0	557.7	581.2	1.000	.000	.000	.021	.021
3	779.4	469.5	621.6	675.1	1.000	.369	.722	-.358	.733
4	924.3	493.4	688.8	750.4	1.000	.368	.795	-.498	.665
5	1518.6	593.8	779.7	810.8	1.000	.464	.000	-.056	.409
6	2365.6	723.4	799.9	781.0	1.000	.000	.000	.105	.105
7	3049.3	813.3	772.9	719.6	1.000	.333	.000	.036	.369
8	4112.3	900.2	705.9	619.0	1.000	.101	.000	.056	.156
9	5183.1	945.0	635.3	530.2	1.000	.000	.000	.238	.238
10	5909.1	960.9	586.8	474.6	1.000	.039	.000	.052	.091
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						1.674	1.517	-.373	2.818

SETTLEMENT POINT : 148.0, 443.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2972.6	2224.6	2458.5	1.000	.003	.000	.251	.254
2	595.2	2612.1	1423.8	1639.9	1.000	.002	.000	.271	.273
3	779.4	2127.0	1249.3	1149.8	1.000	6.689	.722	1.855	9.267
4	924.3	1768.1	1208.3	880.3	1.000	4.035	.795	1.592	6.422
5	1518.6	1411.3	1107.9	654.0	1.000	.925	.000	.147	1.072
6	2365.6	1250.7	966.8	531.1	1.000	.000	.000	.337	.337
7	3049.3	1176.1	857.4	458.1	1.000	.459	.000	.280	.739
8	4112.3	1099.1	726.7	381.2	1.000	.120	.000	.128	.248
9	5183.1	1040.4	627.8	327.6	1.000	.000	.000	.302	.302
10	5909.1	1003.5	569.1	297.0	1.000	.041	.000	.068	.109
						12.275	1.517	5.230	19.022

SETTLEMENT POINT : 261.0, 409.5

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1624.0	1489.4	1397.4	1.000	.002	.000	.121	.123
2	595.2	1600.9	1232.3	983.2	1.000	.001	.000	.150	.151
3	779.4	1521.2	986.4	631.7	1.000	4.862	.722	1.424	7.009
4	924.3	1372.4	771.2	375.1	1.000	2.669	.795	1.758	5.222
5	1518.6	1009.0	515.6	142.1	1.000	.717	.000	.188	.905
6	2365.6	695.8	420.9	75.0	1.000	.000	.000	.230	.230
7	3049.3	536.7	403.6	62.4	1.000	.228	.000	.164	.392
8	4112.3	413.2	401.3	59.9	1.000	.049	.000	.043	.091
9	5183.1	356.6	399.0	60.7	1.000	.000	.000	.087	.087
10	5909.1	335.0	394.3	61.2	1.000	.014	.000	.013	.027
						8.542	1.517	4.179	14.238

SETTLEMENT POINT : 256.0, 392.1

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	784.9	757.3	754.0	1.000	.001	.000	.053	.054
2	595.2	800.6	686.6	640.2	1.000	.000	.000	.064	.065
3	779.4	793.9	608.6	522.6	1.000	1.892	.722	.457	3.071
4	924.3	769.8	534.8	405.8	1.000	.521	.795	.659	1.975
5	1518.6	673.1	440.7	230.6	1.000	.516	.000	.093	.610
6	2365.6	541.5	410.2	133.3	1.000	.000	.000	.159	.159
7	3049.3	455.0	411.3	99.8	1.000	.196	.000	.108	.303
8	4112.3	379.2	418.1	81.7	1.000	.045	.000	.030	.075
9	5183.1	343.3	417.8	75.4	1.000	.000	.000	.078	.078
10	5909.1	330.4	413.0	72.8	1.000	.014	.000	.010	.025
						3.185	1.517	1.712	6.414

SETTLEMENT POINT : 315.0, 393.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1124.4	1047.4	967.8	1.000	.001	.000	.083	.085
2	595.2	1109.3	899.7	681.7	1.000	.001	.000	.102	.102
3	779.4	1058.1	756.5	438.7	1.000	3.105	.722	.921	4.749
4	924.3	964.1	626.0	260.7	1.000	.985	.795	1.146	2.926
5	1518.6	740.4	447.5	96.6	1.000	.559	.000	.130	.689
6	2365.6	546.6	348.1	45.6	1.000	.000	.000	.180	.180
7	3049.3	440.1	310.3	33.8	1.000	.190	.000	.145	.334
8	4112.3	344.7	288.8	29.7	1.000	.041	.000	.043	.084
9	5183.1	290.6	282.5	29.5	1.000	.000	.000	.079	.079
10	5909.1	265.1	280.5	29.8	1.000	.011	.000	.013	.025
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						4.894	1.517	2.841	9.252

SETTLEMENT POINT : 310.0, 375.7

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	568.5	547.8	523.4	1.000	.000	.000	.040	.040
2	595.2	563.3	511.0	447.2	1.000	.000	.000	.044	.044
3	779.4	557.8	473.8	368.0	1.000	.621	.722	.274	1.617
4	924.3	545.9	435.2	288.6	1.000	.399	.795	.405	1.599
5	1518.6	499.0	369.0	165.7	1.000	.400	.000	.064	.464
6	2365.6	427.1	322.1	92.2	1.000	.000	.000	.127	.127
7	3049.3	371.1	302.6	64.0	1.000	.162	.000	.101	.263
8	4112.3	310.2	292.4	46.9	1.000	.037	.000	.033	.070
9	5183.1	271.7	290.2	40.7	1.000	.000	.000	.069	.069
10	5909.1	252.8	289.7	38.5	1.000	.011	.000	.011	.022
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						1.630	1.517	1.168	4.314

SETTLEMENT POINT : 363.0, 378.5

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	624.6	587.1	537.8	1.000	.000	.000	.046	.046
2	595.2	616.5	514.9	379.1	1.000	.000	.000	.056	.056
3	779.4	588.8	445.1	244.3	1.000	.800	.722	.488	2.010
4	924.3	538.2	381.7	145.5	1.000	.395	.795	.604	1.793
5	1518.6	418.9	295.3	54.1	1.000	.343	.000	.068	.410
6	2365.6	316.9	247.4	25.4	1.000	.000	.000	.099	.099
7	3049.3	261.5	229.3	18.6	1.000	.116	.000	.074	.190
8	4112.3	212.2	219.1	16.1	1.000	.026	.000	.022	.048

9	5183.1	184.0	216.5	16.1	1.000	.000	.000	.046	.046
10	5909.1	170.5	216.2	16.4	1.000	.007	.000	.007	.014
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						1.686	1.517	1.509	4.712

SETTLEMENT POINT : 357.8, 361.2

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	295.8	298.8	291.2	1.000	.000	.000	.019	.019
2	595.2	306.5	293.7	249.6	1.000	.000	.000	.023	.023
3	779.4	306.9	283.2	206.3	1.000	.260	.722	.124	1.106
4	924.3	302.9	270.7	162.7	1.000	.244	.795	.190	1.228
5	1518.6	282.4	247.1	94.5	1.000	.240	.000	.031	.271
6	2365.6	248.4	229.3	53.1	1.000	.000	.000	.069	.069
7	3049.3	221.2	222.1	36.9	1.000	.099	.000	.049	.148
8	4112.3	191.2	219.1	26.9	1.000	.023	.000	.016	.039
9	5183.1	171.7	219.7	23.2	1.000	.000	.000	.040	.040
10	5909.1	161.9	220.7	22.0	1.000	.007	.000	.005	.012
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						.872	1.517	.565	2.955

SETTLEMENT POINT : 411.5, 364.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	249.9	238.8	215.3	1.000	.000	.000	.018	.018
2	595.2	246.7	217.8	152.0	1.000	.000	.000	.022	.022
3	779.4	235.9	198.1	98.3	1.000	.207	.722	.175	1.105
4	924.3	216.5	181.3	59.1	1.000	.181	.795	.212	1.188
5	1518.6	171.5	161.4	22.9	1.000	.151	.000	.022	.173
6	2365.6	134.5	154.6	11.7	1.000	.000	.000	.036	.036
7	3049.3	115.3	154.9	9.2	1.000	.052	.000	.018	.070
8	4112.3	99.4	158.4	8.5	1.000	.012	.000	.004	.016
9	5183.1	91.2	162.3	8.8	1.000	.000	.000	.016	.016
10	5909.1	87.6	164.9	9.1	1.000	.004	.000	.000	.004
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						.607	1.517	.522	2.646

SETTLEMENT POINT : 405.6, 346.6

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	97.0	112.9	116.6	1.000	.000	.000	.005	.005
2	595.2	115.4	126.0	101.0	1.000	.000	.000	.008	.008
3	779.4	119.2	131.5	84.4	1.000	.111	.722	.022	.856

4	924.3	120.0	135.6	67.6	1.000	.105	.795	.041	.940
5	1518.6	116.1	141.1	40.9	1.000	.104	.000	.007	.111
6	2365.6	106.9	146.8	24.4	1.000	.000	.000	.023	.023
7	3049.3	99.2	151.9	17.9	1.000	.045	.000	.008	.053
8	4112.3	91.0	158.8	14.0	1.000	.011	.000	.001	.012
9	5183.1	86.3	164.4	12.6	1.000	.000	.000	.013	.013
10	5909.1	84.3	167.7	12.3	1.000	.004	.000	-.001	.003
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						.380	1.517	.127	2.024

SETTLEMENT POINT : 171.0, 407.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.2	102.3	34.5	1.000	.000	.000	-.007	-.007
2	595.2	4.5	299.0	101.2	1.000	.000	.000	-.018	-.018
3	779.4	22.0	494.3	168.8	1.000	.022	.722	-.619	.125
4	924.3	63.7	673.4	233.3	1.000	.057	.795	-.857	-.005
5	1518.6	216.4	887.3	318.7	1.000	.187	.000	-.107	.080
6	2365.6	415.3	926.2	344.3	1.000	.000	.000	.014	.014
7	3049.3	545.2	880.0	332.8	1.000	.231	.000	-.033	.198
8	4112.3	661.3	781.5	299.1	1.000	.076	.000	.028	.104
9	5183.1	718.2	689.4	264.8	1.000	.000	.000	.173	.173
10	5909.1	738.9	630.4	242.4	1.000	.031	.000	.036	.067
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						.605	1.517	-1.390	.732

SETTLEMENT POINT : 193.0, 407.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.1	65.0	14.8	1.000	.000	.000	-.004	-.004
2	595.2	1.6	192.1	43.7	1.000	.000	.000	-.011	-.011
3	779.4	8.0	324.8	74.4	1.000	.008	.722	-.383	.347
4	924.3	24.4	458.7	106.2	1.000	.022	.795	-.568	.249
5	1518.6	95.3	663.0	159.0	1.000	.086	.000	-.087	-.002
6	2365.6	214.3	760.9	191.4	1.000	.000	.000	-.030	-.030
7	3049.3	312.3	765.3	200.0	1.000	.137	.000	-.092	.045
8	4112.3	421.3	716.8	195.7	1.000	.050	.000	-.008	.041
9	5183.1	489.9	653.1	184.0	1.000	.000	.000	.096	.096
10	5909.1	522.7	607.4	174.1	1.000	.022	.000	.016	.038
						---	---	---	---
						.325	1.517	-1.072	.770

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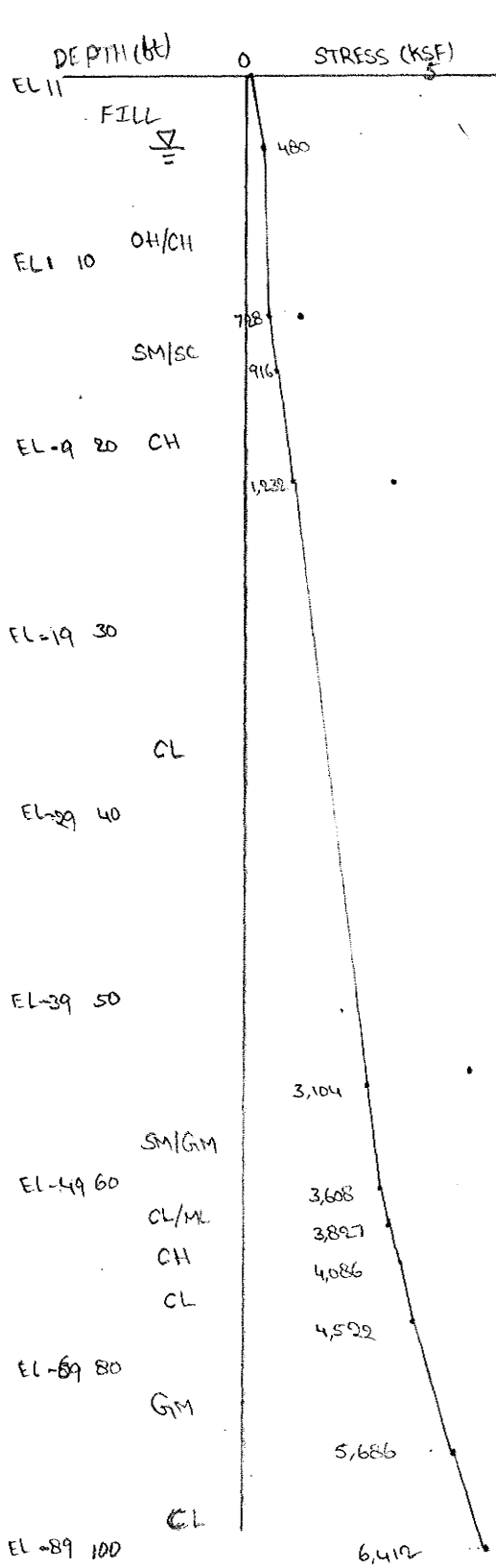
Page ____ of ____

Job BROADWAY INTERCHANGE RECONSTRUCTION Project No. 28645286 Sheet ____ of ____

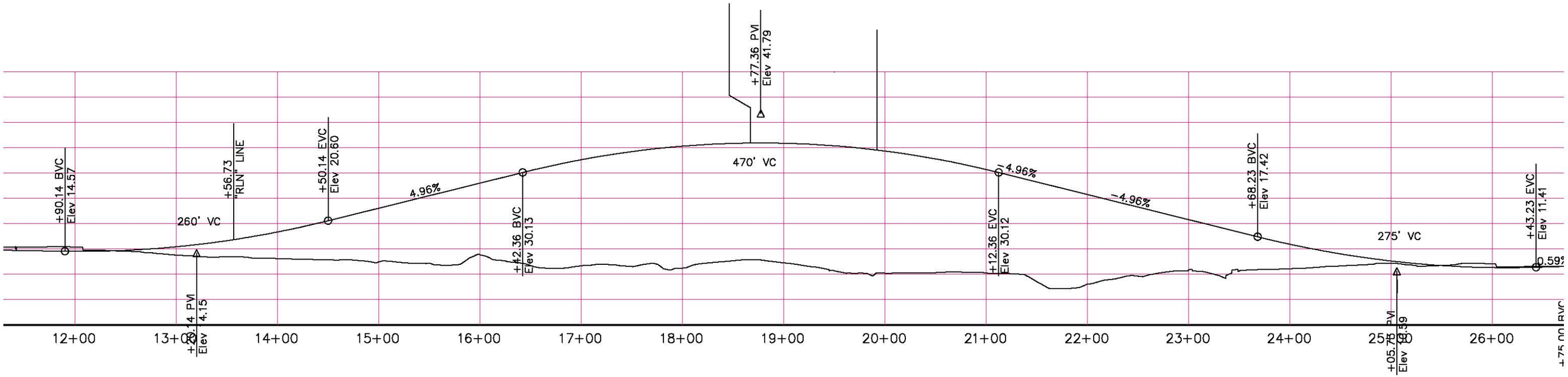
Description BROADWAY WEST APPROACH EMBANKMENT SETTLEMENT Computed by MT Date 12/8/11

Checked by SHUANG Date 1/20/12

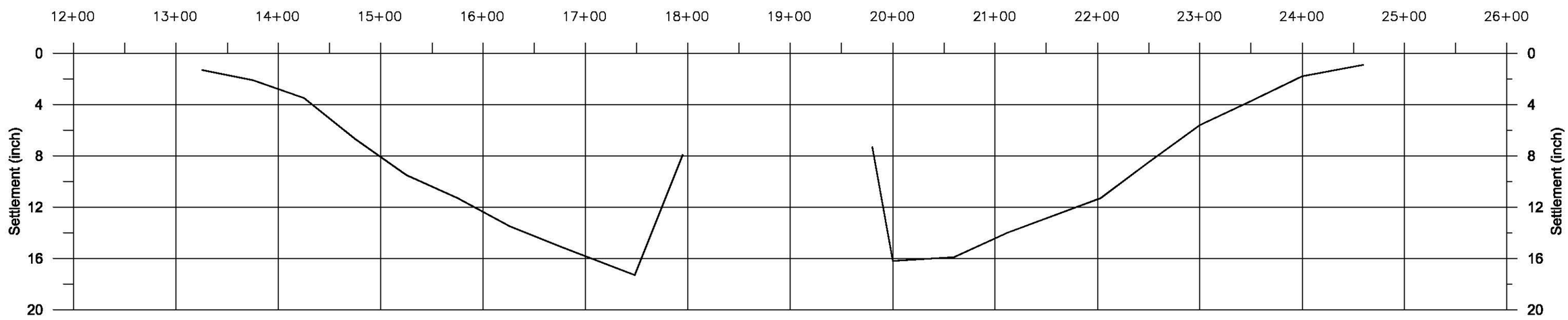
Reference



	γ' PCF	C_{CE}	$C_{\gamma E}$	P_p (KSF)	E $\times 10^6$ PSF	μ	C_α	A	t_{ZERO}	S_u/σ_{vo}
FILL	120	-	-		0.30	0.3	-	1	10	
OH/CH	27.6	0.30	0.03	1.3 / 1.8	0.03	0.5	0.015	1	10	
SM/SC	62.6	-	-	-	0.23	0.3	-	1	10	
CH	52.6	0.19	0.02	3.5	0.26	0.5	-	1	10	
CL	57.6	0.12	0.015	4.5 / 5.5	0.78	0.5	-	1	10	
SM/GM	77.6	-	-		0.80	0.4	-	1	10	
CL/ML	62.6	0.12	0.015	7.0	0.70	0.5	-	1	10	
CH	57.6	0.19	0.02		1.00	0.5	-	1	10	
CL	72.6	0.05	0.005		1.00	0.5	-	1	10	
GM	77.6	-	-		1.65	0.4	-	1	10	
CL	72.6	0.05	0.005		1.00	0.5	-	1	10	


+77.36 PVI
Elev 41.79
+90.14 BVC
Elev 14.57
+56.73
"RLN" LINE
+50.14 EVC
Elev 20.60
470' VC
4.96%
-4.96%
+68.23 BVC
Elev 17.42
+43.23 EVC
Elev 11.41
260' VC
275' VC
+42.36 BVC
Elev 30.13
+12.36 EVC
Elev 30.12
+29.14 PVI
Elev 4.15
+05.75 PVI
Elev 19.59
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00

"BWY" LINE


12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00
Settlement (inch)
0
4
8
12
16
20

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1
FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

bwy_2.dat
NUMBER OF SOIL LAYERS: 13

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	11.0	7.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	7.0	3.0	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
3	3.0	-2.0	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
4	-2.0	-5.0	62.6	.000	.000	3000.0	.230	.30	.00000	1.000	5.00
5	-5.0	-11.0	52.6	.190	.020	3500.0	.260	.50	.00000	1.000	5.00
6	-11.0	-27.0	57.6	.120	.015	4500.0	.780	.50	.00000	1.000	5.00
7	-27.0	-43.5	57.6	.120	.015	5500.0	.780	.50	.00000	1.000	5.00
8	-43.5	-50.0	77.6	.000	.000	6500.0	.800	.40	.00000	1.000	5.00
9	-50.0	-53.5	62.6	.120	.015	7000.0	.700	.50	.00000	1.000	5.00
10	-53.5	-58.0	57.6	.190	.020	7500.0	1.000	.50	.00000	1.000	5.00
11	-58.0	-64.0	72.6	.050	.005	8000.0	1.000	.50	.00000	1.000	5.00
12	-64.0	-79.0	77.6	.000	.000	9000.0	1.700	.40	.00000	1.000	5.00
13	-79.0	-89.0	72.6	.050	.005	10000.0	1.000	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 36

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	62.50	25.00	.00	11.00	125.00	50.00	375.00
2	62.50	75.00	.00	11.00	125.00	50.00	625.00
3	62.50	125.00	.00	11.00	125.00	50.00	938.00
4	62.50	175.00	.00	11.00	125.00	50.00	1375.00
5	62.50	225.00	.00	11.00	125.00	50.00	1750.00
6	65.00	275.00	.00	11.00	130.00	50.00	2000.00
7	74.00	325.00	.00	11.00	125.00	50.00	2375.00
8	74.00	375.00	.00	11.00	125.00	50.00	2625.00
9	74.00	447.00	.00	11.00	125.00	93.80	3000.00
10	148.00	443.00	16.70	11.00	13.50	36.00	3000.00
11	193.00	430.00	16.70	11.00	80.00	36.00	.10
12	261.00	409.50	16.70	11.00	62.70	36.00	1625.00
13	315.00	393.00	16.70	11.00	50.00	36.00	1125.00
14	363.00	378.50	16.70	11.00	50.00	36.00	625.00
15	411.50	364.00	16.70	11.00	50.00	36.00	250.00
16	-31.00	482.00	14.10	11.00	76.40	61.10	3000.00
17	-116.50	503.70	14.10	11.00	100.00	61.10	2625.00
18	-213.50	528.00	14.10	11.00	100.00	61.10	2250.00
19	-309.10	557.60	14.10	11.00	100.00	50.00	1500.00
20	-405.10	585.50	14.10	11.00	100.00	42.00	1000.00
21	-501.50	613.00	14.10	11.00	100.00	36.00	625.00
22	-598.40	637.40	14.10	11.00	100.00	36.00	375.00
23	-695.40	661.70	14.10	11.00	100.00	36.00	250.00

24	-65.30	450.80	14.10	11.00	153.60	16.30	2500.00
25	-68.80	433.00	14.10	11.00	118.90	20.00	2125.00
26	-73.80	413.60	14.10	11.00	88.06	20.00	1500.00
27	-73.50	398.10	14.10	11.00	69.30	10.00	1000.00
28	-75.10	388.20	14.10	11.00	52.06	10.00	750.00
29	-76.60	378.20	14.10	11.00	34.43	10.00	500.00
30	-63.70	349.10	.00	11.00	10.00	40.12	500.00
31	-53.70	344.20	.00	11.00	10.00	66.10	750.00
32	-43.60	338.50	.00	11.00	10.00	91.39	1000.00
33	-33.10	335.20	.00	11.00	10.00	115.70	1500.00
34	-18.70	321.00	.00	11.00	19.98	174.87	2125.00
35	-4.40	266.90	.00	11.00	8.62	66.38	2125.00
36	.40	361.90	.00	11.00	20.00	123.84	2500.00

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TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5
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SETTLEMENT POINT : 74.0, 493.8

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1595.3	1507.8	1472.5	1.000	.002	.000	.112	.114
2	535.2	1531.5	1396.8	1417.5	1.000	3.454	.578	.199	4.231
3	659.4	1516.7	1302.5	1356.2	1.000	2.268	.722	.375	3.365
4	822.3	1509.3	1224.8	1302.5	1.000	.000	.000	.118	.118
5	1074.0	1501.8	1142.4	1243.2	1.000	.547	.000	.086	.633
6	1692.6	1477.7	963.0	1105.2	1.000	.785	.000	.109	.894
7	2628.6	1422.6	755.0	923.3	1.000	.558	.000	.148	.706
8	3356.0	1373.0	642.6	811.8	1.000	.000	.000	.077	.077
9	3717.7	1349.8	601.0	767.7	1.000	.085	.000	.040	.125
10	3956.9	1330.8	570.3	734.3	1.000	.136	.000	.037	.173
11	4304.3	1305.6	533.3	692.7	1.000	.041	.000	.050	.091
12	5104.1	1254.4	468.7	617.1	1.000	.000	.000	.087	.087
13	6049.1	1193.9	405.0	538.9	1.000	.047	.000	.087	.134
						7.924	1.300	1.523	10.748

SETTLEMENT POINT : 74.0, 447.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2999.9	2898.5	2881.3	1.000	.003	.000	.203	.206
2	535.2	2998.0	2697.0	2646.6	1.000	6.808	.578	.522	7.908
3	659.4	2989.7	2476.2	2392.6	1.000	6.309	.722	1.111	8.142
4	822.3	2974.0	2288.1	2180.4	1.000	.000	.000	.256	.256
5	1074.0	2945.4	2088.3	1960.8	1.000	1.561	.000	.255	1.816
6	1692.6	2826.0	1663.3	1517.7	1.000	1.264	.000	.304	1.568
7	2628.6	2565.0	1200.8	1075.9	1.000	.878	.000	.362	1.240
8	3356.0	2362.4	970.4	869.5	1.000	.000	.000	.159	.159
9	3717.7	2276.2	889.1	798.2	1.000	.131	.000	.086	.217
10	3956.9	2209.0	830.8	747.3	1.000	.208	.000	.077	.285
11	4304.3	2123.8	762.2	687.7	1.000	.063	.000	.101	.163
12	5104.1	1964.4	647.3	587.8	1.000	.000	.000	.156	.156
13	6049.1	1794.7	540.1	494.1	1.000	.068	.000	.153	.221
						17.294	1.300	3.743	22.337

SETTLEMENT POINT : 74.0, 375.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2625.0	2545.6	2565.1	1.000	.003	.000	.175	.178

2	535.2	2624.6	2387.9	2445.2	1.000	6.109	.578	.333	7.020
3	659.4	2622.6	2214.0	2310.6	1.000	5.480	.722	.721	6.924
4	822.3	2618.4	2064.4	2191.6	1.000	.000	.000	.210	.210
5	1074.0	2610.0	1903.6	2059.6	1.000	1.043	.000	.174	1.217
6	1692.6	2567.7	1552.4	1751.9	1.000	1.155	.000	.225	1.380
7	2628.6	2447.3	1151.1	1357.3	1.000	.849	.000	.303	1.152
8	3356.0	2332.1	941.5	1127.4	1.000	.000	.000	.147	.147
9	3717.7	2277.5	865.8	1039.8	1.000	.131	.000	.079	.210
10	3956.9	2232.7	811.0	974.8	1.000	.210	.000	.072	.282
11	4304.3	2172.8	745.9	895.8	1.000	.064	.000	.097	.161
12	5104.1	2052.1	635.5	757.8	1.000	.000	.000	.158	.159
13	6049.1	1910.9	531.2	623.5	1.000	.072	.000	.160	.232
						---	---	---	---
						15.116	1.300	2.855	19.271

SETTLEMENT POINT : 136.5, 375.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1312.5	1295.3	1293.0	1.000	.002	.000	.086	.087
2	535.2	1312.7	1260.8	1253.5	1.000	2.754	.578	.089	3.421
3	659.4	1313.4	1222.0	1207.9	1.000	1.501	.722	.197	2.421
4	822.3	1314.5	1187.3	1165.9	1.000	.000	.000	.095	.095
5	1074.0	1316.1	1148.3	1117.0	1.000	.500	.000	.051	.551
6	1692.6	1319.8	1053.4	992.8	1.000	.721	.000	.073	.794
7	2628.6	1315.1	917.6	812.9	1.000	.523	.000	.114	.637
8	3356.0	1300.6	827.3	698.4	1.000	.000	.000	.067	.067
9	3717.7	1291.5	789.9	652.9	1.000	.082	.000	.034	.116
10	3956.9	1282.9	760.9	618.6	1.000	.132	.000	.032	.164
11	4304.3	1270.3	724.1	576.1	1.000	.040	.000	.045	.085
12	5104.1	1240.9	654.8	499.9	1.000	.000	.000	.082	.083
13	6049.1	1200.1	580.1	422.9	1.000	.047	.000	.084	.131
						---	---	---	---
						6.303	1.300	1.049	8.653

SETTLEMENT POINT : .4, 361.9

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2499.5	2380.7	2414.5	1.000	.003	.000	.170	.173
2	535.2	2487.5	2164.2	2250.3	1.000	5.832	.578	.448	6.858
3	659.4	2455.0	1969.8	2084.3	1.000	5.071	.722	.856	6.649
4	822.3	2420.6	1827.1	1952.8	1.000	.000	.000	.201	.202
5	1074.0	2381.0	1687.6	1819.2	1.000	.731	.000	.174	.904
6	1692.6	2281.6	1411.8	1540.5	1.000	1.068	.000	.198	1.266
7	2628.6	2133.9	1112.5	1218.3	1.000	.767	.000	.246	1.012
8	3356.0	2033.6	947.8	1036.6	1.000	.000	.000	.121	.121
9	3717.7	1991.1	885.0	967.0	1.000	.117	.000	.064	.181
10	3956.9	1957.6	838.0	914.9	1.000	.189	.000	.058	.247
11	4304.3	1914.1	780.3	851.0	1.000	.058	.000	.079	.137
12	5104.1	1828.5	677.4	736.9	1.000	.000	.000	.134	.134
13	6049.1	1729.0	573.7	622.1	1.000	.066	.000	.136	.201

13.900	1.300	2.885	18.085

SETTLEMENT POINT : 74.0, 325.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2375.0	2299.0	2319.5	1.000	.003	.000	.158	.161
2	535.2	2374.1	2148.0	2209.4	1.000	5.593	.578	.313	6.483
3	659.4	2370.4	1982.3	2088.6	1.000	4.856	.722	.670	6.248
4	822.3	2363.7	1840.5	1985.0	1.000	.000	.000	.190	.190
5	1074.0	2351.7	1689.1	1873.2	1.000	.725	.000	.158	.883
6	1692.6	2302.3	1362.0	1621.4	1.000	1.074	.000	.200	1.274
7	2628.6	2185.8	994.1	1302.9	1.000	.781	.000	.263	1.044
8	3356.0	2083.3	804.9	1113.6	1.000	.000	.000	.128	.128
9	3717.7	2036.1	737.2	1039.8	1.000	.119	.000	.069	.188
10	3956.9	1997.6	688.4	984.3	1.000	.192	.000	.063	.254
11	4304.3	1946.7	630.8	916.0	1.000	.058	.000	.084	.143
12	5104.1	1844.8	534.2	793.7	1.000	.000	.000	.139	.139
13	6049.1	1726.3	444.2	670.1	1.000	.065	.000	.140	.206
						13.467	1.300	2.576	17.343

SETTLEMENT POINT : 136.5, 325.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1187.5	1170.0	1158.4	1.000	.001	.000	.078	.080
2	535.2	1186.5	1135.0	1102.1	1.000	2.312	.578	.109	2.999
3	659.4	1183.2	1096.2	1045.0	1.000	.968	.722	.225	1.915
4	822.3	1178.1	1062.2	1000.7	1.000	.000	.000	.088	.088
5	1074.0	1171.1	1024.7	957.1	1.000	.461	.000	.050	.511
6	1692.6	1153.7	936.2	867.5	1.000	.650	.000	.062	.712
7	2628.6	1133.6	814.3	751.2	1.000	.462	.000	.089	.552
8	3356.0	1120.4	734.7	674.1	1.000	.000	.000	.054	.054
9	3717.7	1114.1	701.9	641.8	1.000	.072	.000	.027	.098
10	3956.9	1108.8	676.6	616.7	1.000	.116	.000	.025	.141
11	4304.3	1101.2	644.4	584.6	1.000	.036	.000	.035	.071
12	5104.1	1083.9	583.9	523.9	1.000	.000	.000	.068	.068
13	6049.1	1059.6	518.7	457.9	1.000	.042	.000	.069	.111
						5.121	1.300	.978	7.399

SETTLEMENT POINT : 65.0, 275.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)

1	240.0	2000.0	1937.7	1964.8	1.000	.002	.000	.133	.135
2	535.2	1999.9	1813.8	1894.1	1.000	4.732	.578	.233	5.543
3	659.4	1999.2	1676.6	1813.6	1.000	3.834	.722	.508	5.064
4	822.3	1997.3	1558.1	1741.1	1.000	.000	.000	.158	.158
5	1074.0	1993.0	1430.0	1659.4	1.000	.656	.000	.124	.780
6	1692.6	1967.2	1147.5	1464.3	1.000	.965	.000	.163	1.127
7	2628.6	1886.3	821.3	1204.9	1.000	.698	.000	.222	.919
8	3356.0	1805.6	652.1	1047.6	1.000	.000	.000	.110	.110
9	3717.7	1766.9	591.9	985.9	1.000	.106	.000	.059	.165
10	3956.9	1734.9	548.7	939.3	1.000	.171	.000	.054	.224
11	4304.3	1692.1	498.2	881.7	1.000	.052	.000	.072	.124
12	5104.1	1605.4	414.6	777.8	1.000	.000	.000	.119	.120
13	6049.1	1503.8	339.0	671.3	1.000	.058	.000	.120	.178
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						11.273	1.300	2.074	14.648

SETTLEMENT POINT : 130.0, 275.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1000.0	986.0	994.5	1.000	.001	.000	.065	.066
2	535.2	1000.5	958.0	982.3	1.000	1.597	.578	.049	2.224
3	659.4	1002.4	926.4	965.1	1.000	.723	.722	.113	1.558
4	822.3	1005.1	898.1	946.3	1.000	.000	.000	.071	.071
5	1074.0	1008.7	866.2	921.6	1.000	.414	.000	.032	.446
6	1692.6	1015.9	788.8	852.9	1.000	.588	.000	.048	.636
7	2628.6	1016.3	679.9	748.3	1.000	.422	.000	.077	.498
8	3356.0	1009.3	608.9	678.1	1.000	.000	.000	.048	.048
9	3717.7	1004.6	579.9	649.0	1.000	.065	.000	.023	.089
10	3956.9	1000.3	557.5	626.3	1.000	.106	.000	.022	.128
11	4304.3	993.8	529.3	597.5	1.000	.032	.000	.031	.063
12	5104.1	978.4	476.9	542.8	1.000	.000	.000	.060	.061
13	6049.1	956.4	421.3	483.1	1.000	.038	.000	.061	.099
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						3.987	1.300	.700	5.987

SETTLEMENT POINT : 62.5, 225.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1750.0	1685.6	1711.9	1.000	.002	.000	.117	.119
2	535.2	1749.2	1558.0	1636.4	1.000	4.080	.578	.243	4.902
3	659.4	1745.8	1418.2	1554.2	1.000	3.051	.722	.519	4.292
4	822.3	1739.6	1299.2	1484.4	1.000	.000	.000	.142	.142
5	1074.0	1728.8	1173.0	1409.8	1.000	.600	.000	.121	.721
6	1692.6	1685.0	904.9	1244.2	1.000	.864	.000	.150	1.014
7	2628.6	1584.7	615.8	1037.5	1.000	.609	.000	.192	.801
8	3356.0	1499.5	475.7	914.9	1.000	.000	.000	.092	.092
9	3717.7	1461.1	427.6	866.9	1.000	.091	.000	.049	.140
10	3956.9	1430.4	393.7	830.7	1.000	.145	.000	.044	.189
11	4304.3	1390.2	354.7	785.9	1.000	.044	.000	.059	.103

12	5104.1	1311.7	291.8	704.6	1.000	.000	.000	.097	.097
13	6049.1	1223.7	236.7	620.6	1.000	.048	.000	.095	.143
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						9.533	1.300	1.921	12.754

SETTLEMENT POINT : 125.0, 225.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	875.0	859.2	870.7	1.000	.001	.000	.057	.058
2	535.2	875.4	827.8	861.1	1.000	1.066	.578	.050	1.693
3	659.4	876.7	792.8	847.2	1.000	.661	.722	.114	1.497
4	822.3	878.6	762.2	831.8	1.000	.000	.000	.063	.063
5	1074.0	880.7	728.6	811.7	1.000	.375	.000	.031	.405
6	1692.6	883.1	650.6	756.9	1.000	.525	.000	.044	.569
7	2628.6	876.8	547.0	675.3	1.000	.371	.000	.067	.439
8	3356.0	866.9	482.7	620.7	1.000	.000	.000	.041	.042
9	3717.7	861.5	457.0	598.0	1.000	.057	.000	.020	.077
10	3956.9	856.6	437.4	580.2	1.000	.092	.000	.019	.111
11	4304.3	849.8	413.1	557.4	1.000	.028	.000	.026	.054
12	5104.1	834.4	368.7	513.9	1.000	.000	.000	.051	.051
13	6049.1	813.8	322.8	465.8	1.000	.033	.000	.050	.083
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						3.209	1.300	.633	5.142

SETTLEMENT POINT : 62.5, 175.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1375.0	1320.6	1347.1	1.000	.002	.000	.092	.094
2	535.2	1374.4	1212.8	1291.8	1.000	2.960	.578	.195	3.733
3	659.4	1371.7	1095.0	1231.2	1.000	1.729	.722	.417	2.869
4	822.3	1366.8	994.9	1179.3	1.000	.000	.000	.112	.112
5	1074.0	1358.0	889.3	1123.7	1.000	.511	.000	.097	.608
6	1692.6	1320.9	667.6	999.7	1.000	.722	.000	.120	.841
7	2628.6	1234.5	436.3	845.9	1.000	.497	.000	.151	.647
8	3356.0	1161.8	328.9	755.7	1.000	.000	.000	.071	.071
9	3717.7	1129.5	293.1	720.5	1.000	.073	.000	.037	.110
10	3956.9	1103.9	268.2	694.1	1.000	.115	.000	.034	.149
11	4304.3	1070.8	240.0	661.3	1.000	.035	.000	.045	.079
12	5104.1	1007.2	195.5	601.8	1.000	.000	.000	.073	.073
13	6049.1	937.7	157.8	540.0	1.000	.038	.000	.071	.108
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						6.680	1.300	1.514	9.495

SETTLEMENT POINT : 125.0, 175.0

SOIL	INITIAL	VERTICAL STRESS	HORIZ. X STRESS	HORIZ. Y STRESS	SKEMPTON BJERRUM	CONSOL.	SECOND. COMP.	ELASTIC	TOTAL

LAYER	STRESS (PSF)	INCREASE (PSF)	INCREASE (PSF)	INCREASE (PSF)	FACTOR	COMP. (IN.)	20. YR (IN.)	COMP. (IN.)	COMP. (IN.)
1	240.0	687.5	674.6	680.4	1.000	.001	.000	.045	.046
2	535.2	687.4	648.9	666.3	1.000	.517	.578	.048	1.142
3	659.4	687.0	620.3	650.9	1.000	.558	.722	.103	1.383
4	822.3	686.3	595.3	637.7	1.000	.000	.000	.050	.050
5	1074.0	685.3	567.7	623.4	1.000	.309	.000	.025	.333
6	1692.6	681.5	503.6	589.9	1.000	.423	.000	.033	.456
7	2628.6	673.3	418.9	542.1	1.000	.294	.000	.049	.343
8	3356.0	665.3	366.9	509.0	1.000	.000	.000	.031	.031
9	3717.7	661.2	346.3	494.8	1.000	.045	.000	.014	.059
10	3956.9	657.7	330.7	483.5	1.000	.072	.000	.014	.086
11	4304.3	652.7	311.5	469.0	1.000	.022	.000	.019	.041
12	5104.1	641.7	276.7	440.5	1.000	.000	.000	.038	.038
13	6049.1	627.0	241.3	407.9	1.000	.026	.000	.036	.062
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						2.266	1.300	.503	4.070

SETTLEMENT POINT : 62.5, 125.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	938.0	902.0	927.1	1.000	.001	.000	.062	.063
2	535.2	938.0	830.6	904.8	1.000	1.337	.578	.112	2.028
3	659.4	937.8	752.0	878.2	1.000	.692	.722	.245	1.659
4	822.3	937.0	684.8	853.2	1.000	.000	.000	.074	.074
5	1074.0	934.7	613.1	823.7	1.000	.392	.000	.060	.451
6	1692.6	919.4	460.4	750.3	1.000	.543	.000	.077	.620
7	2628.6	870.7	298.6	650.9	1.000	.369	.000	.101	.470
8	3356.0	824.9	223.2	590.8	1.000	.000	.000	.049	.049
9	3717.7	803.8	198.0	567.3	1.000	.054	.000	.025	.079
10	3956.9	786.8	180.6	549.6	1.000	.085	.000	.023	.108
11	4304.3	764.7	161.0	527.6	1.000	.026	.000	.030	.056
12	5104.1	721.8	130.2	487.6	1.000	.000	.000	.050	.050
13	6049.1	674.5	104.5	446.0	1.000	.028	.000	.048	.075
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						3.525	1.300	.957	5.783

SETTLEMENT POINT : 125.0, 125.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	469.0	461.5	469.1	1.000	.000	.000	.030	.031
2	535.2	469.2	446.5	468.9	1.000	.394	.578	.018	.990
3	659.4	469.7	429.4	467.7	1.000	.420	.722	.042	1.185
4	822.3	470.6	414.1	465.5	1.000	.000	.000	.032	.032
5	1074.0	471.9	396.9	461.8	1.000	.228	.000	.012	.240
6	1692.6	475.0	355.0	448.8	1.000	.309	.000	.018	.327
7	2628.6	476.6	297.0	424.4	1.000	.215	.000	.029	.244
8	3356.0	474.7	260.4	405.6	1.000	.000	.000	.020	.020
9	3717.7	473.2	245.9	397.3	1.000	.033	.000	.009	.042

10	3956.9	471.7	234.8	390.6	1.000	.053	.000	.009	.061
11	4304.3	469.4	221.2	381.9	1.000	.016	.000	.012	.028
12	5104.1	463.7	196.5	364.4	1.000	.000	.000	.025	.025
13	6049.1	455.4	171.5	343.9	1.000	.019	.000	.024	.043
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						1.687	1.300	.282	3.270

SETTLEMENT POINT : 62.5, 75.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	625.0	600.7	618.5	1.000	.000	.000	.041	.042
2	535.2	624.9	552.5	605.4	1.000	.484	.578	.074	1.135
3	659.4	624.6	499.6	589.9	1.000	.521	.722	.160	1.403
4	822.3	623.8	454.3	575.4	1.000	.000	.000	.049	.049
5	1074.0	621.9	406.1	558.6	1.000	.286	.000	.039	.324
6	1692.6	610.6	303.9	517.5	1.000	.385	.000	.049	.434
7	2628.6	577.5	195.9	462.9	1.000	.256	.000	.063	.319
8	3356.0	547.2	145.8	430.3	1.000	.000	.000	.031	.031
9	3717.7	533.4	129.2	417.6	1.000	.037	.000	.016	.052
10	3956.9	522.4	117.7	407.9	1.000	.058	.000	.014	.072
11	4304.3	508.1	104.7	396.0	1.000	.017	.000	.019	.036
12	5104.1	480.8	84.5	374.1	1.000	.000	.000	.031	.032
13	6049.1	451.1	67.8	350.8	1.000	.019	.000	.029	.048
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						2.063	1.300	.615	3.978

SETTLEMENT POINT : 125.0, 75.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	312.5	307.4	313.6	1.000	.000	.000	.020	.020
2	535.2	312.6	297.1	315.6	1.000	.288	.578	.010	.876
3	659.4	312.9	285.5	317.3	1.000	.304	.722	.023	1.049
4	822.3	313.3	275.1	318.2	1.000	.000	.000	.021	.021
5	1074.0	314.0	263.5	318.6	1.000	.160	.000	.006	.167
6	1692.6	315.6	235.5	317.1	1.000	.214	.000	.010	.224
7	2628.6	316.5	197.2	311.0	1.000	.147	.000	.016	.163
8	3356.0	315.8	173.2	304.9	1.000	.000	.000	.012	.012
9	3717.7	315.1	163.7	301.9	1.000	.022	.000	.005	.027
10	3956.9	314.4	156.5	299.3	1.000	.036	.000	.005	.041
11	4304.3	313.3	147.5	295.8	1.000	.011	.000	.007	.018
12	5104.1	310.7	131.5	288.3	1.000	.000	.000	.015	.015
13	6049.1	306.9	115.3	278.6	1.000	.013	.000	.013	.026
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						1.194	1.300	.163	2.658

SETTLEMENT POINT : 62.5, 25.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	375.0	358.9	368.3	1.000	.000	.000	.025	.025
2	535.2	374.6	327.1	355.4	1.000	.332	.578	.053	.963
3	659.4	372.9	292.6	342.9	1.000	.350	.722	.110	1.183
4	822.3	370.1	263.8	333.8	1.000	.000	.000	.030	.030
5	1074.0	365.6	233.7	325.9	1.000	.183	.000	.024	.207
6	1692.6	350.7	172.2	313.2	1.000	.236	.000	.027	.262
7	2628.6	324.9	110.4	301.7	1.000	.150	.000	.030	.180
8	3356.0	307.0	82.5	294.6	1.000	.000	.000	.015	.015
9	3717.7	299.7	73.4	291.5	1.000	.021	.000	.007	.028
10	3956.9	294.1	67.2	288.9	1.000	.034	.000	.006	.040
11	4304.3	287.1	60.1	285.5	1.000	.010	.000	.008	.018
12	5104.1	274.4	49.2	278.5	1.000	.000	.000	.015	.015
13	6049.1	261.5	40.3	269.7	1.000	.011	.000	.013	.024
						1.328	1.300	.364	2.992

SETTLEMENT POINT : 125.0, 25.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	187.5	183.5	187.4	1.000	.000	.000	.012	.012
2	535.2	187.3	175.5	187.4	1.000	.188	.578	.009	.775
3	659.4	186.8	166.9	188.2	1.000	.195	.722	.018	.936
4	822.3	185.9	159.5	189.8	1.000	.000	.000	.013	.013
5	1074.0	184.6	151.7	192.5	1.000	.099	.000	.003	.103
6	1692.6	181.3	134.6	201.1	1.000	.127	.000	.003	.131
7	2628.6	178.5	113.3	212.8	1.000	.085	.000	.004	.089
8	3356.0	178.1	100.6	218.3	1.000	.000	.000	.005	.005
9	3717.7	178.2	95.7	219.9	1.000	.013	.000	.001	.014
10	3956.9	178.4	91.9	220.9	1.000	.021	.000	.001	.022
11	4304.3	178.7	87.3	221.8	1.000	.006	.000	.002	.008
12	5104.1	179.4	78.9	222.2	1.000	.000	.000	.006	.006
13	6049.1	180.3	70.5	220.8	1.000	.008	.000	.004	.012
						.742	1.300	.083	2.125

SETTLEMENT POINT : 148.0, 443.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2972.6	2224.6	2458.5	1.000	.003	.000	.251	.254
2	535.2	2612.1	1423.8	1639.9	1.000	6.085	.578	1.728	8.391
3	659.4	2127.0	1249.3	1149.8	1.000	4.201	.722	1.855	6.778
4	822.3	1836.1	1216.5	927.1	1.000	.000	.000	.187	.187
5	1074.0	1627.4	1184.9	788.8	1.000	.577	.000	.177	.754
6	1692.6	1371.7	1083.1	627.3	1.000	.742	.000	.127	.870
7	2628.6	1219.5	924.4	501.6	1.000	.492	.000	.129	.620

8	3356.0	1155.7	823.6	437.4	1.000	.000	.000	.064	.064
9	3717.7	1132.0	783.3	413.5	1.000	.073	.000	.032	.105
10	3956.9	1114.1	752.5	395.8	1.000	.116	.000	.029	.146
11	4304.3	1091.8	714.1	374.2	1.000	.035	.000	.039	.075
12	5104.1	1049.9	643.4	335.9	1.000	.000	.000	.070	.070
13	6049.1	1003.5	569.1	297.0	1.000	.040	.000	.068	.108
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						12.364	1.300	4.756	18.421

SETTLEMENT POINT : -31.0, 482.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2999.7	2877.6	2824.2	1.000	.003	.000	.206	.209
2	535.2	2993.5	2637.4	2482.8	1.000	6.800	.578	.693	8.071
3	659.4	2967.9	2382.4	2132.4	1.000	6.263	.722	1.421	8.406
4	822.3	2924.0	2175.5	1862.2	1.000	.000	.000	.268	.268
5	1074.0	2852.3	1968.2	1608.3	1.000	1.422	.000	.295	1.716
6	1692.6	2617.4	1568.4	1176.4	1.000	1.169	.000	.306	1.476
7	2628.6	2260.4	1175.7	832.6	1.000	.800	.000	.319	1.119
8	3356.0	2049.4	981.2	688.5	1.000	.000	.000	.135	.135
9	3717.7	1969.1	910.6	639.4	1.000	.116	.000	.072	.188
10	3956.9	1909.3	858.9	604.3	1.000	.185	.000	.064	.248
11	4304.3	1836.1	796.8	562.9	1.000	.056	.000	.083	.139
12	5104.1	1705.1	688.8	492.7	1.000	.000	.000	.130	.131
13	6049.1	1570.7	583.1	425.0	1.000	.060	.000	.128	.188
						---	---	---	---
						16.874	1.300	4.121	22.295

SETTLEMENT POINT : -23.5, 511.9

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1239.4	1325.3	1468.3	1.000	.002	.000	.064	.066
2	535.2	1411.5	1326.4	1409.9	1.000	3.080	.578	.069	3.727
3	659.4	1446.3	1253.1	1343.2	1.000	2.011	.722	.296	3.030
4	822.3	1455.1	1184.1	1284.9	1.000	.000	.000	.112	.112
5	1074.0	1455.0	1110.6	1221.0	1.000	.536	.000	.080	.616
6	1692.6	1432.9	957.8	1074.1	1.000	.767	.000	.103	.870
7	2628.6	1377.3	786.5	886.1	1.000	.543	.000	.137	.681
8	3356.0	1332.8	689.1	774.2	1.000	.000	.000	.073	.073
9	3717.7	1313.0	651.0	730.6	1.000	.083	.000	.037	.120
10	3956.9	1296.9	622.1	697.7	1.000	.133	.000	.034	.167
11	4304.3	1275.6	586.3	657.1	1.000	.041	.000	.047	.088
12	5104.1	1232.4	520.7	584.1	1.000	.000	.000	.084	.084
13	6049.1	1180.4	452.5	509.5	1.000	.046	.000	.084	.130
						---	---	---	---
						7.242	1.300	1.221	9.764

SETTLEMENT POINT : 151.4, 308.3

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1.0	166.8	68.4	1.000	.000	.000	-.011	-.011
2	535.2	23.4	455.5	195.9	1.000	.027	.578	-.484	.121
3	659.4	91.5	668.9	312.7	1.000	.102	.722	-.799	.025
4	822.3	173.5	772.6	390.3	1.000	.000	.000	-.027	-.027
5	1074.0	268.1	828.6	452.4	1.000	.139	.000	-.103	.036
6	1692.6	457.9	844.2	528.6	1.000	.299	.000	-.056	.243
7	2628.6	630.2	773.8	540.3	1.000	.277	.000	-.007	.270
8	3356.0	702.9	710.5	517.3	1.000	.000	.000	.021	.021
9	3717.7	726.1	682.7	503.4	1.000	.049	.000	.008	.057
10	3956.9	741.7	660.7	491.3	1.000	.081	.000	.009	.090
11	4304.3	758.9	632.4	474.3	1.000	.025	.000	.015	.040
12	5104.1	783.6	577.9	438.6	1.000	.000	.000	.040	.040
13	6049.1	799.8	517.7	395.2	1.000	.032	.000	.041	.074
						---	---	---	---
						1.032	1.300	-1.354	.978

SETTLEMENT POINT : 152.1, 286.4

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.4	111.2	58.0	1.000	.000	.000	-.008	-.008
2	535.2	9.7	317.5	168.2	1.000	.011	.578	-.373	.216
3	659.4	43.9	501.0	273.8	1.000	.050	.722	-.687	.086
4	822.3	94.7	613.9	347.4	1.000	.000	.000	-.030	-.030
5	1074.0	165.2	692.4	408.8	1.000	.089	.000	-.107	-.017
6	1692.6	339.7	752.4	488.5	1.000	.229	.000	-.069	.160
7	2628.6	524.1	710.0	509.7	1.000	.235	.000	-.022	.213
8	3356.0	605.9	656.1	494.1	1.000	.000	.000	.014	.014
9	3717.7	632.5	631.5	483.4	1.000	.043	.000	.005	.047
10	3956.9	650.7	611.7	473.6	1.000	.071	.000	.006	.077
11	4304.3	670.9	586.0	459.7	1.000	.023	.000	.011	.033
12	5104.1	701.0	536.2	429.5	1.000	.000	.000	.033	.033
13	6049.1	722.8	480.9	391.8	1.000	.029	.000	.034	.064
						---	---	---	---
						.781	1.300	-1.193	.888

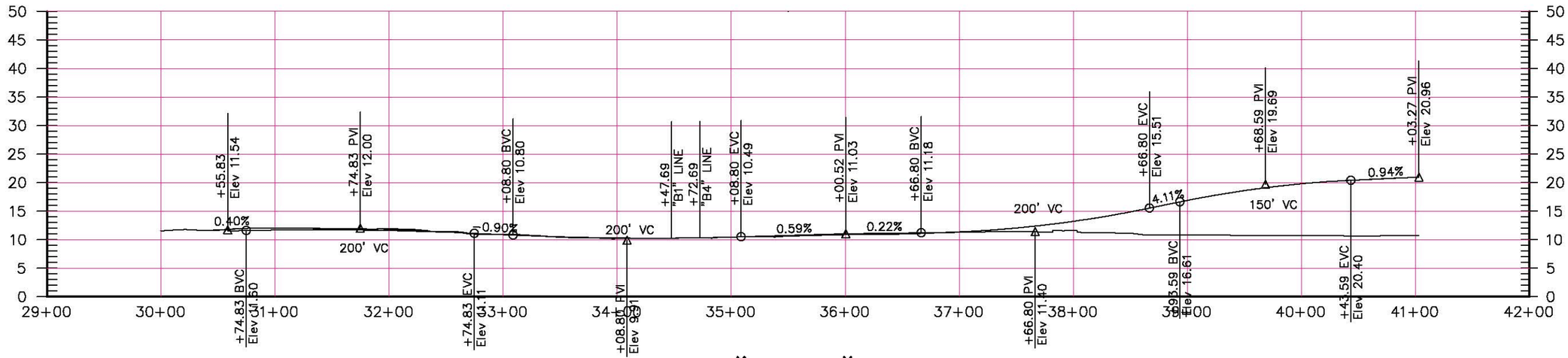
SETTLEMENT POINT : 171.0, 407.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.2	102.3	34.5	1.000	.000	.000	-.007	-.007
2	535.2	4.5	299.0	101.2	1.000	.005	.578	-.313	.270
3	659.4	22.0	494.3	168.8	1.000	.026	.722	-.619	.129
4	822.3	51.7	635.9	219.5	1.000	.000	.000	-.032	-.032
5	1074.0	99.8	756.5	264.7	1.000	.056	.000	-.114	-.058

6	1692.6	253.1	906.7	328.0	1.000	.174	.000	-.090	.085
7	2628.6	468.8	913.6	342.2	1.000	.212	.000	-.040	.171
8	3356.0	579.5	858.0	325.8	1.000	.000	.000	.010	.010
9	3717.7	616.6	828.3	315.7	1.000	.042	.000	.003	.045
10	3956.9	641.9	803.5	307.0	1.000	.071	.000	.005	.075
11	4304.3	670.0	770.4	295.1	1.000	.023	.000	.010	.033
12	5104.1	711.0	704.7	270.6	1.000	.000	.000	.034	.034
13	6049.1	738.9	630.4	242.4	1.000	.030	.000	.036	.066
						---	---	---	---
						.638	1.300	-1.117	.821

SETTLEMENT POINT : 193.0, 407.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.1	65.0	14.8	1.000	.000	.000	-.004	-.004
2	535.2	1.6	192.1	43.7	1.000	.002	.578	-.186	.394
3	659.4	8.0	324.8	74.4	1.000	.009	.722	-.383	.349
4	822.3	19.5	429.1	99.1	1.000	.000	.000	-.022	-.022
5	1074.0	39.6	528.5	123.5	1.000	.023	.000	-.079	-.057
6	1692.6	114.8	690.4	166.9	1.000	.082	.000	-.077	.005
7	2628.6	252.4	768.5	196.2	1.000	.118	.000	-.058	.060
8	3356.0	341.9	757.5	200.3	1.000	.000	.000	-.004	-.004
9	3717.7	376.1	743.6	199.3	1.000	.026	.000	-.006	.021
10	3956.9	401.1	730.0	197.7	1.000	.045	.000	-.003	.042
11	4304.3	430.8	709.8	194.6	1.000	.015	.000	-.002	.013
12	5104.1	480.0	664.4	186.3	1.000	.000	.000	.015	.015
13	6049.1	522.7	607.4	174.1	1.000	.022	.000	.016	.037
						---	---	---	---
						.343	1.300	-.794	.849


+55.83
Elev 11.54
+74.83 PVI
Elev 12.00
+08.80 BVC
Elev 10.80
+47.69
"B1" LINE
+72.69
"B4" LINE
+08.80 EVC
Elev 10.49
+00.52 PVI
Elev 11.03
+66.80 BVC
Elev 11.18
+66.80 EVC
Elev 15.51
+68.59 PVI
Elev 19.69
+03.27 PVI
Elev 20.96
0.40%
0.90%
0.59%
0.22%
4.11%
0.94%
200' VC
200' VC
200' VC
150' VC
+74.83 BVC
Elev 11.60
+74.83 EVC
Elev 11.11
+08.80 PVI
Elev 9.91
+66.80 PVI
Elev 11.40
+93.59 BVC
Elev 16.61
+43.59 EVC
Elev 20.40
29+00
30+00
31+00
32+00
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37+00
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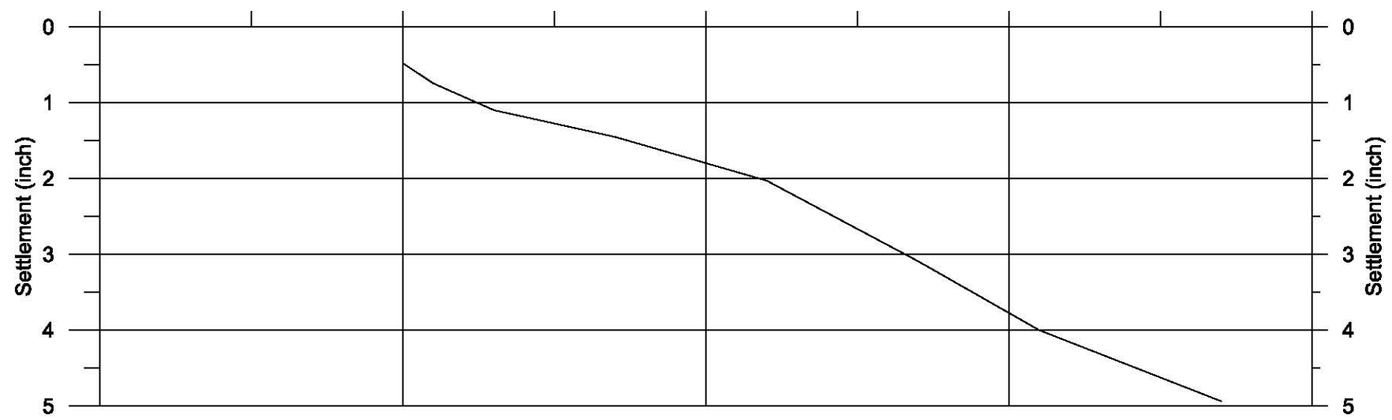
40+00
41+00
42+00

"BYSH" LINE


Settlement (inch)
0
1
2
3
4
5

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1
FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

bysh_2.dat
NUMBER OF SOIL LAYERS: 12

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	10.0	6.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	6.0	4.0	57.6	.000	.000	800.0	.300	.30	.00000	1.000	5.00
3	4.0	.5	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
4	.5	-3.5	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
5	-3.5	-24.0	57.6	.120	.015	5000.0	1.500	.50	.00000	1.000	5.00
6	-24.0	-30.0	47.6	.190	.020	5500.0	.300	.50	.00000	1.000	5.00
7	-30.0	-39.0	57.6	.000	.000	6000.0	.400	.40	.00000	1.000	5.00
8	-39.0	-50.0	62.6	.120	.015	6800.0	.400	.50	.00000	1.000	5.00
9	-50.0	-60.0	67.6	.000	.000	7000.0	.550	.40	.00000	1.000	5.00
10	-60.0	-81.0	62.6	.120	.015	8000.0	1.000	.50	.00000	1.000	5.00
11	-81.0	-85.0	67.6	.000	.000	9000.0	.650	.40	.00000	1.000	5.00
12	-85.0	-90.0	67.6	.120	.015	9500.0	1.400	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 13

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	.00	10.00	.00	10.00	100.00	20.00	250.00
2	.00	30.00	.00	10.00	100.00	20.00	375.00
3	.00	70.00	.00	10.00	90.00	60.00	500.00
4	.00	120.00	.00	10.00	90.00	40.00	688.00
5	-7.50	170.00	.00	10.00	75.00	60.00	875.00
6	45.00	170.00	.00	10.00	30.00	60.00	1250.00
7	75.00	170.00	.00	10.00	30.00	60.00	625.00
8	-7.50	210.00	.00	10.00	75.00	20.00	1063.00
9	45.00	210.00	.00	10.00	30.00	20.00	1375.00
10	75.00	210.00	.00	10.00	30.00	20.00	1250.00
11	-7.50	270.00	.00	10.00	75.00	100.00	1188.00
12	50.00	270.00	.00	10.00	40.00	100.00	1625.00
13	85.00	270.00	.00	10.00	30.00	100.00	1875.00

TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1

FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

bysh_2.dat
NUMBER OF SOIL LAYERS: 12

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	10.0	6.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	6.0	4.0	57.6	.000	.000	800.0	.300	.30	.00000	1.000	5.00
3	4.0	.5	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
4	.5	-3.5	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
5	-3.5	-24.0	57.6	.120	.015	5000.0	1.500	.50	.00000	1.000	5.00
6	-24.0	-30.0	47.6	.190	.020	5500.0	.300	.50	.00000	1.000	5.00
7	-30.0	-39.0	57.6	.000	.000	6000.0	.400	.40	.00000	1.000	5.00
8	-39.0	-50.0	62.6	.120	.015	6800.0	.400	.50	.00000	1.000	5.00
9	-50.0	-60.0	67.6	.000	.000	7000.0	.550	.40	.00000	1.000	5.00
10	-60.0	-81.0	62.6	.120	.015	8000.0	1.000	.50	.00000	1.000	5.00
11	-81.0	-85.0	67.6	.000	.000	9000.0	.650	.40	.00000	1.000	5.00
12	-85.0	-90.0	67.6	.120	.015	9500.0	1.400	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 13

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	.00	10.00	.00	10.00	100.00	20.00	500.00
2	.00	30.00	.00	10.00	100.00	20.00	375.00
3	.00	70.00	.00	10.00	90.00	60.00	500.00
4	.00	120.00	.00	10.00	90.00	40.00	688.00
5	-7.50	170.00	.00	10.00	75.00	60.00	875.00
6	45.00	170.00	.00	10.00	30.00	60.00	1250.00
7	75.00	170.00	.00	10.00	30.00	60.00	625.00
8	-7.50	210.00	.00	10.00	75.00	20.00	1063.00
9	45.00	210.00	.00	10.00	30.00	20.00	1375.00
10	75.00	210.00	.00	10.00	30.00	20.00	1250.00
11	-7.50	270.00	.00	10.00	75.00	100.00	1188.00
12	50.00	270.00	.00	10.00	40.00	100.00	1625.00
13	85.00	270.00	.00	10.00	30.00	100.00	1875.00

TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5

SETTLEMENT POINT : .0, .0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	250.0	235.8	241.2	1.000	.000	.000	.017	.017
2	537.6	249.6	214.9	228.6	1.000	.000	.000	.009	.009
3	643.5	248.5	196.4	218.1	1.000	.179	.506	.058	.742
4	747.0	245.9	172.7	206.2	1.000	.178	.578	.090	.846
5	1392.6	230.4	110.1	181.0	1.000	.245	.000	.014	.259
6	2125.8	210.0	67.0	164.2	1.000	.059	.000	.023	.082
7	2527.8	198.7	51.2	156.4	1.000	.000	.000	.031	.031
8	3131.3	184.4	36.5	147.2	1.000	.049	.000	.031	.080
9	3813.6	171.0	26.5	138.6	1.000	.000	.000	.023	.023
10	4808.9	154.7	17.7	127.2	1.000	.052	.000	.021	.073
11	5601.4	144.2	13.4	118.8	1.000	.000	.000	.007	.007
12	5905.6	141.0	12.3	115.9	1.000	.009	.000	.003	.013
						---	---	---	---
						.771	1.084	.326	2.182

SETTLEMENT POINT : .0, 10.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	499.0	449.4	423.1	1.000	.000	.000	.038	.038
2	537.6	487.3	379.5	329.5	1.000	.000	.000	.022	.022
3	643.5	465.1	325.4	274.2	1.000	.298	.506	.231	1.035
4	747.0	428.2	266.7	232.9	1.000	.283	.578	.285	1.147
5	1392.6	335.0	149.7	190.6	1.000	.345	.000	.027	.372
6	2125.8	277.9	85.5	172.6	1.000	.077	.000	.036	.113
7	2527.8	254.5	63.7	164.3	1.000	.000	.000	.044	.044
8	3131.3	228.8	44.4	154.6	1.000	.061	.000	.043	.103
9	3813.6	207.1	31.7	145.4	1.000	.000	.000	.030	.030
10	4808.9	182.4	20.7	133.1	1.000	.061	.000	.027	.088
11	5601.4	167.4	15.6	124.0	1.000	.000	.000	.008	.008
12	5905.6	162.9	14.2	120.8	1.000	.011	.000	.004	.015
						---	---	---	---
						1.136	1.084	.795	3.015

SETTLEMENT POINT : -50.0, 10.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	249.5	228.6	212.5	1.000	.000	.000	.019	.019
2	537.6	243.7	199.5	167.2	1.000	.000	.000	.011	.011
3	643.5	232.6	177.6	141.0	1.000	.169	.506	.103	.777

4	747.0	214.4	154.8	122.6	1.000	.158	.578	.121	.857
5	1392.6	170.1	111.7	110.5	1.000	.185	.000	.010	.194
6	2125.8	148.0	85.9	110.7	1.000	.042	.000	.012	.054
7	2527.8	141.0	75.1	110.5	1.000	.000	.000	.018	.018
8	3131.3	134.4	63.4	109.5	1.000	.036	.000	.016	.052
9	3813.6	129.4	53.4	107.4	1.000	.000	.000	.014	.014
10	4808.9	123.8	42.2	102.8	1.000	.042	.000	.013	.055
11	5601.4	120.1	35.3	98.3	1.000	.000	.000	.005	.005
12	5905.6	118.9	33.3	96.5	1.000	.008	.000	.002	.010
						---	---	---	---
						.639	1.084	.343	2.066

SETTLEMENT POINT : .0, 30.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	375.4	362.6	380.8	1.000	.000	.000	.024	.025
2	537.6	379.4	342.2	381.5	1.000	.000	.000	.013	.013
3	643.5	386.6	320.7	371.6	1.000	.257	.506	.057	.820
4	747.0	396.7	288.4	348.2	1.000	.266	.578	.125	.970
5	1392.6	397.3	186.1	268.8	1.000	.402	.000	.028	.430
6	2125.8	359.4	110.2	217.4	1.000	.098	.000	.047	.145
7	2527.8	333.4	82.5	199.1	1.000	.000	.000	.060	.060
8	3131.3	300.4	57.6	181.1	1.000	.079	.000	.060	.139
9	3813.6	270.2	41.0	166.5	1.000	.000	.000	.041	.041
10	4808.9	234.9	26.7	149.0	1.000	.078	.000	.037	.115
11	5601.4	213.2	20.0	136.7	1.000	.000	.000	.011	.011
12	5905.6	206.6	18.3	132.6	1.000	.013	.000	.006	.019
						---	---	---	---
						1.195	1.084	.508	2.787

SETTLEMENT POINT : -50.0, 30.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	187.5	186.3	182.5	1.000	.000	.000	.012	.012
2	537.6	187.5	183.8	175.9	1.000	.000	.000	.006	.006
3	643.5	187.8	180.0	170.8	1.000	.140	.506	.017	.663
4	747.0	189.0	172.8	164.1	1.000	.141	.578	.033	.752
5	1392.6	190.6	142.6	144.8	1.000	.206	.000	.008	.213
6	2125.8	184.1	112.4	133.1	1.000	.052	.000	.015	.067
7	2527.8	179.0	98.2	128.9	1.000	.000	.000	.024	.024
8	3131.3	172.2	82.4	124.2	1.000	.046	.000	.023	.069
9	3813.6	165.6	69.0	119.6	1.000	.000	.000	.020	.020
10	4808.9	156.9	53.9	112.3	1.000	.053	.000	.019	.071
11	5601.4	150.8	44.8	105.9	1.000	.000	.000	.007	.007
12	5905.6	148.7	42.0	103.6	1.000	.010	.000	.003	.013
						---	---	---	---
						.647	1.084	.186	1.917

SETTLEMENT POINT : .0, 70.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	500.0	473.0	489.6	1.000	.000	.000	.034	.034
2	537.6	499.8	433.1	474.0	1.000	.000	.000	.018	.019
3	643.5	499.2	397.4	459.7	1.000	.314	.506	.099	.919
4	747.0	497.6	351.0	440.2	1.000	.319	.578	.163	1.060
5	1392.6	481.9	226.2	378.4	1.000	.476	.000	.029	.506
6	2125.8	448.9	139.6	319.5	1.000	.120	.000	.053	.172
7	2527.8	426.5	107.9	291.0	1.000	.000	.000	.072	.072
8	3131.3	396.0	78.7	258.2	1.000	.102	.000	.075	.178
9	3813.6	365.9	58.5	229.2	1.000	.000	.000	.055	.055
10	4808.9	326.9	40.1	194.1	1.000	.108	.000	.053	.161
11	5601.4	300.3	30.9	170.7	1.000	.000	.000	.016	.016
12	5905.6	291.8	28.3	163.2	1.000	.019	.000	.008	.027
						---	---	---	---
						1.459	1.084	.676	3.219

SETTLEMENT POINT : -45.0, 70.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	250.0	244.1	248.8	1.000	.000	.000	.016	.016
2	537.6	250.1	235.2	246.8	1.000	.000	.000	.008	.008
3	643.5	250.2	227.1	244.8	1.000	.180	.506	.020	.705
4	747.0	250.5	216.1	241.5	1.000	.181	.578	.035	.794
5	1392.6	252.2	181.5	226.4	1.000	.267	.000	.008	.275
6	2125.8	252.1	147.7	205.9	1.000	.070	.000	.018	.088
7	2527.8	250.5	131.0	194.2	1.000	.000	.000	.033	.033
8	3131.3	246.6	111.4	179.3	1.000	.065	.000	.033	.099
9	3813.6	240.8	94.1	164.8	1.000	.000	.000	.030	.030
10	4808.9	230.5	74.0	145.4	1.000	.077	.000	.030	.107
11	5601.4	221.5	61.5	131.4	1.000	.000	.000	.011	.011
12	5905.6	218.3	57.7	126.6	1.000	.014	.000	.005	.020
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						.854	1.084	.248	2.185

SETTLEMENT POINT : .0, 120.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	688.0	653.9	672.3	1.000	.001	.000	.046	.047
2	537.6	687.7	603.3	648.9	1.000	.000	.000	.025	.025
3	643.5	687.0	558.0	627.7	1.000	.512	.506	.132	1.149
4	747.0	684.7	499.0	599.0	1.000	.407	.578	.217	1.202
5	1392.6	664.6	337.7	510.7	1.000	.625	.000	.039	.665
6	2125.8	623.5	221.2	427.3	1.000	.161	.000	.072	.233

7	2527.8	595.9	176.5	386.1	1.000	.000	.000	.100	.100
8	3131.3	558.1	133.4	337.5	1.000	.141	.000	.106	.248
9	3813.6	519.9	101.9	293.4	1.000	.000	.000	.079	.079
10	4808.9	468.7	71.3	239.0	1.000	.153	.000	.079	.232
11	5601.4	432.1	55.0	202.8	1.000	.000	.000	.024	.024
12	5905.6	419.9	50.3	191.2	1.000	.027	.000	.013	.040
						---	---	---	---
						2.026	1.084	.933	4.043

SETTLEMENT POINT : -45.0, 120.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	344.0	336.5	339.4	1.000	.000	.000	.023	.023
2	537.6	344.0	325.3	332.4	1.000	.000	.000	.012	.012
3	643.5	344.0	315.1	326.1	1.000	.234	.506	.033	.773
4	747.0	343.9	301.3	317.4	1.000	.237	.578	.055	.870
5	1392.6	342.9	257.9	289.2	1.000	.353	.000	.011	.364
6	2125.8	340.0	215.2	259.2	1.000	.093	.000	.025	.117
7	2527.8	337.4	193.5	242.5	1.000	.000	.000	.044	.044
8	3131.3	332.7	167.4	221.0	1.000	.087	.000	.046	.133
9	3813.6	326.4	143.6	199.5	1.000	.000	.000	.041	.041
10	4808.9	314.7	114.5	170.1	1.000	.104	.000	.043	.147
11	5601.4	303.7	95.6	148.9	1.000	.000	.000	.015	.015
12	5905.6	299.5	89.6	141.8	1.000	.019	.000	.008	.027
						---	---	---	---
						1.127	1.084	.356	2.567

SETTLEMENT POINT : -7.5, 170.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	875.0	837.4	851.6	1.000	.001	.000	.059	.060
2	537.6	874.7	781.5	816.7	1.000	.001	.000	.032	.032
3	643.5	873.8	731.4	785.0	1.000	1.231	.506	.162	1.898
4	747.0	871.2	666.1	742.5	1.000	.483	.578	.267	1.328
5	1392.6	848.4	484.2	613.7	1.000	.762	.000	.049	.812
6	2125.8	803.0	343.9	495.4	1.000	.200	.000	.092	.292
7	2527.8	772.0	285.4	438.3	1.000	.000	.000	.130	.130
8	3131.3	728.2	224.5	372.2	1.000	.180	.000	.142	.322
9	3813.6	681.9	176.5	313.6	1.000	.000	.000	.106	.106
10	4808.9	616.0	125.9	243.8	1.000	.198	.000	.109	.306
11	5601.4	566.3	97.3	199.4	1.000	.000	.000	.033	.033
12	5905.6	549.3	88.9	185.6	1.000	.035	.000	.018	.052
						---	---	---	---
						3.091	1.084	1.198	5.372

SETTLEMENT POINT : -45.0, 170.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	437.5	429.9	430.1	1.000	.000	.000	.029	.029
2	537.6	437.5	418.4	418.9	1.000	.000	.000	.015	.015
3	643.5	437.5	407.9	408.7	1.000	.284	.506	.041	.830
4	747.0	437.5	393.6	394.8	1.000	.288	.578	.069	.936
5	1392.6	437.2	347.1	349.5	1.000	.438	.000	.015	.452
6	2125.8	435.5	298.0	302.1	1.000	.117	.000	.033	.149
7	2527.8	433.3	271.4	276.5	1.000	.000	.000	.058	.058
8	3131.3	428.5	238.0	244.6	1.000	.110	.000	.062	.172
9	3813.6	421.1	205.9	213.9	1.000	.000	.000	.055	.055
10	4808.9	405.8	164.9	174.2	1.000	.133	.000	.060	.193
11	5601.4	390.5	137.2	147.1	1.000	.000	.000	.020	.020
12	5905.6	384.5	128.4	138.3	1.000	.025	.000	.011	.035
						---	---	---	---
						1.395	1.084	.466	2.945

SETTLEMENT POINT : -7.5, 210.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1062.9	1016.7	1024.2	1.000	.001	.000	.072	.073
2	537.6	1061.3	948.5	968.4	1.000	.001	.000	.039	.040
3	643.5	1058.0	888.3	920.8	1.000	1.858	.506	.215	2.578
4	747.0	1051.2	811.0	860.6	1.000	.549	.578	.345	1.472
5	1392.6	1015.0	600.0	687.7	1.000	.877	.000	.061	.938
6	2125.8	956.9	436.8	534.3	1.000	.232	.000	.113	.346
7	2527.8	918.8	366.9	461.9	1.000	.000	.000	.159	.159
8	3131.3	865.4	292.2	380.0	1.000	.210	.000	.175	.384
9	3813.6	808.3	231.2	309.7	1.000	.000	.000	.129	.129
10	4808.9	725.6	165.0	229.8	1.000	.231	.000	.133	.364
11	5601.4	662.4	126.6	181.5	1.000	.000	.000	.040	.040
12	5905.6	640.6	115.3	167.0	1.000	.040	.000	.021	.062
						---	---	---	---
						4.000	1.084	1.501	6.584

SETTLEMENT POINT : -45.0, 210.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	531.4	520.9	516.0	1.000	.000	.000	.035	.036
2	537.6	530.8	505.4	493.9	1.000	.000	.000	.018	.019
3	643.5	529.7	491.6	475.3	1.000	.329	.506	.065	.899
4	747.0	527.7	473.5	451.9	1.000	.334	.578	.104	1.016
5	1392.6	521.7	417.5	382.8	1.000	.510	.000	.020	.530
6	2125.8	514.9	359.6	316.5	1.000	.136	.000	.042	.178
7	2527.8	509.8	328.1	282.8	1.000	.000	.000	.072	.072
8	3131.3	500.9	288.1	242.4	1.000	.128	.000	.078	.205
9	3813.6	488.9	249.3	205.6	1.000	.000	.000	.067	.067

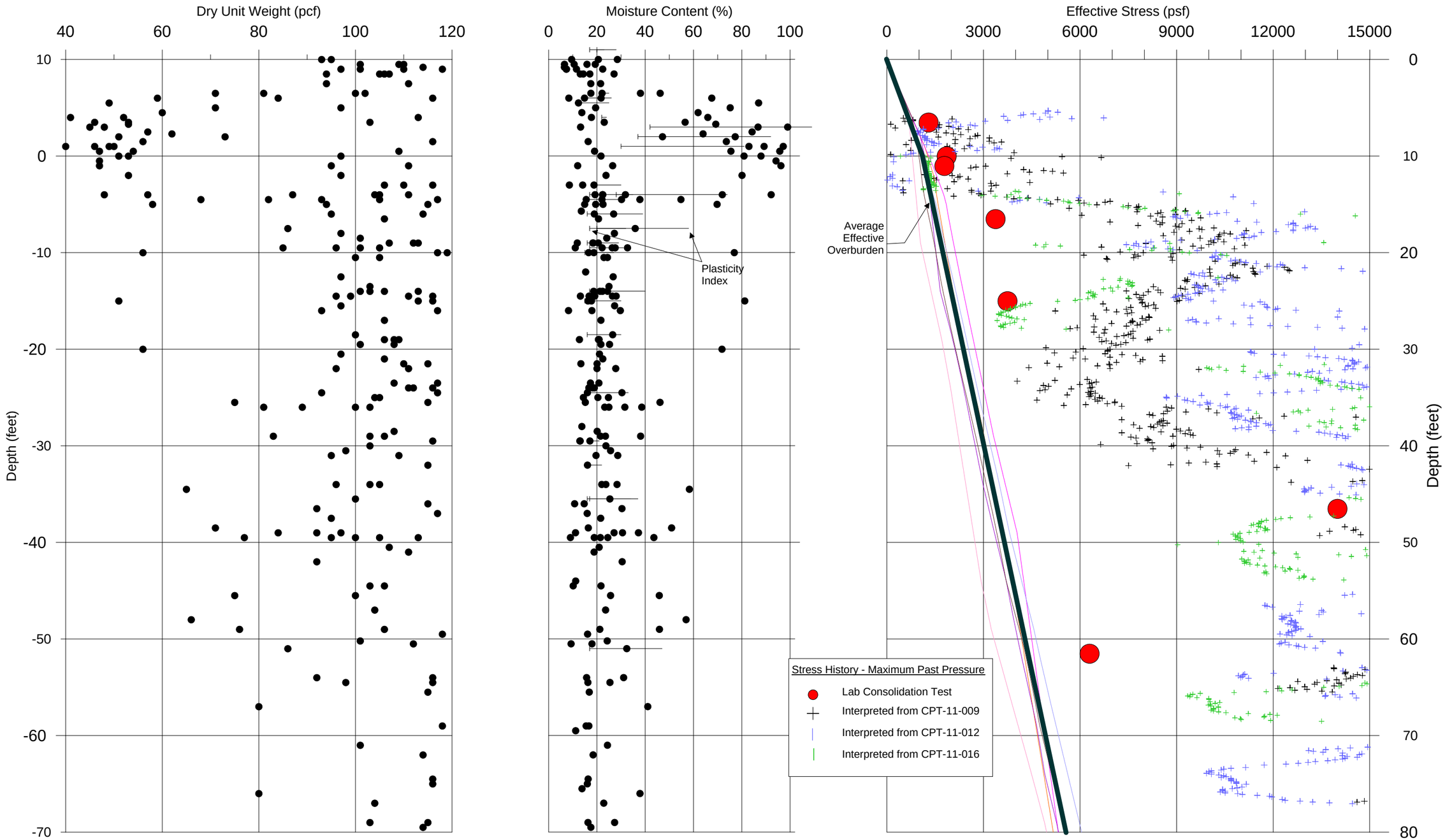
10	4808.9	466.5	199.1	160.8	1.000	.152	.000	.072	.224
11	5601.4	445.1	165.0	131.9	1.000	.000	.000	.024	.024
12	5905.6	437.0	154.0	122.8	1.000	.028	.000	.013	.041
						---	---	---	---
						1.617	1.084	.610	3.311

SETTLEMENT POINT : -7.5, 270.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1188.0	1138.4	1138.3	1.000	.001	.000	.081	.082
2	537.6	1187.3	1064.8	1064.3	1.000	.001	.000	.044	.045
3	643.5	1185.6	999.0	997.9	1.000	2.253	.506	.262	3.021
4	747.0	1180.6	913.0	910.6	1.000	.978	.578	.430	1.986
5	1392.6	1136.8	673.6	663.6	1.000	.956	.000	.077	1.033
6	2125.8	1051.0	486.8	471.3	1.000	.251	.000	.137	.388
7	2527.8	994.2	407.1	392.0	1.000	.000	.000	.182	.182
8	3131.3	917.0	322.3	311.0	1.000	.221	.000	.198	.419
9	3813.6	838.9	253.5	248.0	1.000	.000	.000	.139	.139
10	4808.9	733.8	179.2	182.7	1.000	.233	.000	.139	.372
11	5601.4	658.9	136.5	145.5	1.000	.000	.000	.040	.040
12	5905.6	634.0	124.0	134.6	1.000	.040	.000	.022	.061
						---	---	---	---
						4.935	1.084	1.752	7.771

SETTLEMENT POINT : -45.0, 270.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	594.0	581.6	572.3	1.000	.000	.000	.040	.040
2	537.6	593.9	563.1	540.1	1.000	.000	.000	.021	.021
3	643.5	593.5	546.2	511.0	1.000	.358	.506	.091	.954
4	747.0	592.4	523.4	472.7	1.000	.365	.578	.151	1.094
5	1392.6	582.4	451.6	362.9	1.000	.560	.000	.029	.589
6	2125.8	560.7	380.4	274.7	1.000	.146	.000	.056	.202
7	2527.8	545.1	343.5	237.0	1.000	.000	.000	.084	.084
8	3131.3	522.5	298.4	197.1	1.000	.133	.000	.091	.223
9	3813.6	498.0	256.1	164.8	1.000	.000	.000	.072	.072
10	4808.9	461.9	202.7	129.0	1.000	.151	.000	.075	.225
11	5601.4	433.6	167.2	107.3	1.000	.000	.000	.024	.024
12	5905.6	423.6	155.9	100.6	1.000	.027	.000	.013	.040
						---	---	---	---
						1.740	1.084	.745	3.569



Index Properties and Stress History
U.S. 101 / Broadway Interchange Reconstruction
Burlingame, California
URS Project 28645286

Summary of Laboratory Consolidation Parameters
US 101/Broadway Interchange Reconstruction
Burlingame, California

Boring	Sample Depth (ft)	Elev (ft)	N_{60}	Water Content (%)	Dry Density (pcf)	Liquid Limit	Platicity Index	Liquidity Index	Soil Classification	C_{ce}	C_{re}	Existing Overburden Pressure (psf)	Max Past Pressure (psf)	OCR	C_v (ft^2/day)	C_v from PI (ft2/day)	e_0	Cc	Cr
B-31	14.5	-3	3	90	49	99	63	0.86	OH	0.31	0.040	1100	1100	1.0	0.22	0.01 to 0.04	na	na	na
BRO-1	9.5	0.5	1	89	51	110	72	0.71	OH	0.26	0.040	600	700	1.2	0.032	0.007 to 0.03	na	na	na
BRO-2	14.5	-3	3	82	55	98	63	0.75	OH	0.27	0.035	1200	1400	1.2	0.033	0.01 to 0.04	na	na	na
R-11-005	10	1	300 psi	83	50	81	51	1.04	OH/CH	0.30	0.020	1200	1860	1.6	0.03	0.04	2.34	1.00	0.067
											0.044					0.1			0.147
											0.053								0.177
R-11-011	6.5	3	250 psi	87	48	109	67	0.67	OH/CH	0.29	0.026	700	1,300	1.9	0.03	0.015	2.88	1.11	0.101
											-					0.025			
											0.059								0.229
R-11-013	11	2	200 psi	77	51	92	55	0.73	OH/CH	0.34	0.029	1300	1790	1.4	0.05	0.025	2.92	1.33	0.114
											-					0.05			
											0.057								0.223
R-11-015	61.5	-51	350 psi	32	86	47	30	0.50	CL/CH	0.19	0.017	4417	6300	1.4	0.05	0.18	0.86	0.34	0.032
											0.035					0.8			0.065
											0.035								0.065
R-11-014	25	-14	350 psi	22	103	40	23	0.22	CL	0.12	0.01	1813	3750	2.1	0.05	0.26	0.72	0.21	0.02
											-					1.5			
											0.04								0.07
R-11-006	16.5	-5.5	120 psi	27	95	39	23	0.48	CL	0.12	0.02	1814	3380	1.9	0.06	0.26	0.68	0.20	0.03
											0.02					1.5			0.04
											0.03								0.04
R-11-017	46.5	-35.5	250 psi	25	100	37	20	0.40	CL	0.17	0.02	3691	14000	3.8	0.4	0.3	0.73	0.29	0.03
											-					2			
											0.03								0.05

US 101/BROADWAY
INTERCHANGE RECONSTRUCTION PROJECT

PROPOSED RETAINING WALLS

CORROSION ASSESSMENT FOR THE BROADWAY INTERCHANGE PROJECT

FOUNDATION REPORT

Prepared for

URS

Prepared by

V&A

January 2012

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APPENDICES

Appendix A: Soil Sample Laboratory Chemical Analysis Results

EXECUTIVE SUMMARY

V&A was retained by URS Corporation to perform a soil corrosivity investigation for the proposed US 101/Broadway Interchange Replacement Project in the City of Burlingame, San Mateo County. This project extends from Toyon Drive at the south to Mills Creek at the north, along US 101 from Post Mile 16.30 to Post Mile 17.06. The project objectives include reconstruction improvements to US 101 on-ramps and off-ramps at Rollins Road, the Bayshore Highway, Airport Boulevard, and the Crowne Plaza Hotel access road. Retaining walls, concrete barriers, a new Broadway overcrossing bridge, a single-span box girder structure over PG&E high-voltage tower foundations, and modifications to the existing US 101 pedestrian overcrossing approach structures will be constructed to accommodate the proposed US 101 mainline and Broadway interchange improvements.

This report provides recommendations for corrosion control of structural foundation materials under consideration for retaining walls and concrete barriers along the on ramps, off ramps, and frontage roads in the immediate vicinity of the Broadway interchange. The structures being considered as part of this investigation are buried reinforced concrete. The investigation was conducted in accordance with California Department of Transportation's Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch *Corrosion Guidelines*, Version 1.0, dated September 2003. These Guidelines consider representative soil or water samples to be corrosive to metallic or reinforced concrete structural elements if one or more of the following conditions exist:

- **The chloride concentration is 500 ppm or greater**
- **The sulfate concentration is 2,000 ppm or greater**
- **The pH is 5.5 or less**

Evaluation of the soil environment was made in terms of potential corrosion damage to buried reinforced concrete structures. Soil resistivity measurements were conducted by V&A in the field during the initial stages of the work. Soil corrosivity was determined for the proposed project structures' materials to a depth of 15 feet at proposed retaining wall locations and to 100 feet below grade at the proposed Broadway overcrossing bridge abutment sites. In addition, 14 soil samples taken during a geotechnical investigation by URS were sent to Cooper Testing Laboratory in Palo Alto, California, for chemical analysis. The soil samples were analyzed for as-received and minimum (saturated) resistivity, for pH, and for water-soluble chloride and sulfate ion concentrations. All of these chemical properties affect the corrosion rate of buried reinforced concrete structures. A previously reported soil sample from Rajappan & Meyers for Job No. 201191.GDR, December 22, 2005, page 72, is included with the current analyses to provide information along a portion of the northbound US 101 on-ramp. A water sample from Easton Creek was sent to XENCO Laboratories in Houston, Texas, to be analyzed for specific conductance (conductivity), pH, and chloride, sulfate, and bicarbonate ion concentration. The water sample analysis is pertinent to the proposed box culvert widening at Easton Creek. The water analysis and its impact on this structure is discussed in the "US

101/Broadway Interchange Reconstruction Project – Materials Report, Corrosion Assessment," prepared by V&A.

Fourteen soil samples from selected points along the proposed retaining walls and concrete barriers at the Broadway interchange site had minimum (saturated) resistivities that ranged from 61 to 3,566 ohm-cm. The soil pH values varied from 7.6 to 8.8. Water-soluble chlorides ranged from less than 2 to 8,325 mg/kg (ppm), and the water-soluble sulfate concentrations were from 6 to 5,391 mg/kg (ppm). Six borehole soil samples (A-11-004, A-11-023, A-11-030-2-4, A-11-031-2-3, R-11-018-2-2, and B-31) are considered *corrosive* based on their chloride contents. Two borehole sites (A-11-030-2-4 and R-11-010-1-3) are *corrosive* based on their sulfate ion concentrations as defined by the Caltrans *Corrosion Guidelines*. The other soil samples are *non-corrosive* based on the Caltrans *Corrosion Guidelines*.

Conclusions

- Six soil boring sample chemical analyses had soluble chloride concentrations greater than 500 mg/kg. Two soil boring samples had soluble sulfate concentrations greater than 2,000 mg/kg. According to the Caltrans *Corrosion Guidelines*, these soils are corrosive to buried reinforced concrete structures.
- The project site is within 1,000 feet of salt water or brackish water.

Recommendations

General

- Corrosion protection against a marine atmosphere is required by the *Corrosion Guidelines* for above-ground reinforced concrete structures at the proposed retaining walls and concrete barriers.
- Design of structures installed in these locations should include corrosion mitigation measures as detailed below.

Buried Reinforced Concrete Structures

Buried concrete structures should be constructed of durable concrete as described in ACI Standards 201.2R and 222R and Chapter 850.3, "Corrosion," of the Caltrans *Highway Design Manual* (last updated September 28, 2011). Criteria for protecting reinforced concrete structures under corrosive conditions discussed in Caltrans Standard Special Provision (SSP) S8-C04, "Corrosion Control for Portland Cement Concrete" (a modification of Bridge Design Specifications, Section 8, "Reinforced Concrete"), should be followed. These recommendations include, but are not limited to, the following for reinforced concrete in corrosive soil:

- Based on a worst-case corrosive soil with water-soluble sulfate content greater than 2,000 mg/kg (ppm) or water-soluble chloride content greater than 5,000 mg/kg (ppm), the following

concrete compositional requirements are recommended per the Caltrans Standard Specifications updated July 28, 2011, Section 90-1.02H, “Concrete in Corrosive Environments”:

- The cementitious material used in the concrete must be a combination of Type II or Type V Portland cement and SCM (supplementary cementitious materials).
- The concrete must contain at least 675 pounds of cementitious material per cubic yard.
- The reduction of cementitious material content specified in Section 90-1.02E(2) is not allowed.
- The specifications for SCM content in Section 90-1.02B(3) do not apply.
- The cementitious material must be composed of one of the following by weight:
  - 25% natural pozzolan or fly ash with a CaO content of up to 10%, and 75% Portland cement.
  - 20% natural pozzolan or fly ash with a CaO content of up to 10%, 5% silica fume, and 75% Portland cement.
  - 12% silica fume, metakaolin, or UFFA (ultra-fine fly ash) and 88% Portland cement.
  - 50% GGBFS (ground granular blast furnace slag) and 50% Portland cement.
- A maximum water-to-cementitious material ratio of 0.40 shall be used in the concrete.

- Type II modified or Type V cement shall be used since some soils at the project site have water-soluble sulfate contents greater than 2,000 mg/kg (ppm).
- The water/cement ratio in Type II modified and Type V cement shall not exceed 0.45, and should be kept to a maximum of 0.40. Supplementary cementitious materials per Standard Special Provision S8-C04 should be considered for optimum sulfate corrosion resistance.
- A minimum concrete cover of at least 2.5 inches and preferably 3 inches should be applied over all steel reinforcement. Local soil chloride and sulfate concentrations exceed 5,000 mg/kg (ppm) and 2,000 mg/kg (ppm), respectively.
- Sand and water used in concrete mixtures should contain a maximum of 100 mg/kg (ppm) of water-soluble chloride ions and water-soluble sulfate ions. Sand and water pH shall be between 6.5 to 8.0. Potable water should be used in all concrete mixtures.
- Above-ground reinforced concrete structures within 1,000 feet of brackish or salt water are exposed to a corrosive marine atmosphere. A 3-inch concrete cover over unprotected reinforcing steel is recommended for all concrete structures exposed to this environment.

Cast-in-Drilled-Hole (CIDH) Piles

- Cast-in-drilled-hole (CIDH) concrete piling shall conform to the provisions in Section 49-3, "Cast-In-Place Concrete Piles," of the Caltrans Standard Specifications.
- The concrete used in CIDH piles should be dense and homogeneous throughout the length and cross-section of the pile per California Test 233.
- Concrete for portions of CIDH concrete piling to be formed shall contain not less than 675 pounds of cementitious material per cubic yard and shall contain 6.0±1.5 percent air entrainment in the freshly mixed concrete.
- Concrete shall conform to the requirements in "Corrosion Control for Portland Cement Concrete" of Standard Special Provision S8-04C, August 5, 2011.

Reinforced Concrete Exposed to Marine Atmosphere

- Above-ground reinforced concrete structures within 1,000 feet of brackish or salt water are exposed to a corrosive marine atmosphere. The following minimum concrete cover over unprotected reinforcing steel is recommended for the concrete structures listed below:
  - 3 inches concrete cover for the following:
    - Footings and pile caps
    - Walls, columns, and cast-in-place piles
  - 2 inches concrete cover for precast piles and pile extensions
- This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete Cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.

TESTING OVERVIEW

Figures 1 and 2 show the overall project location.

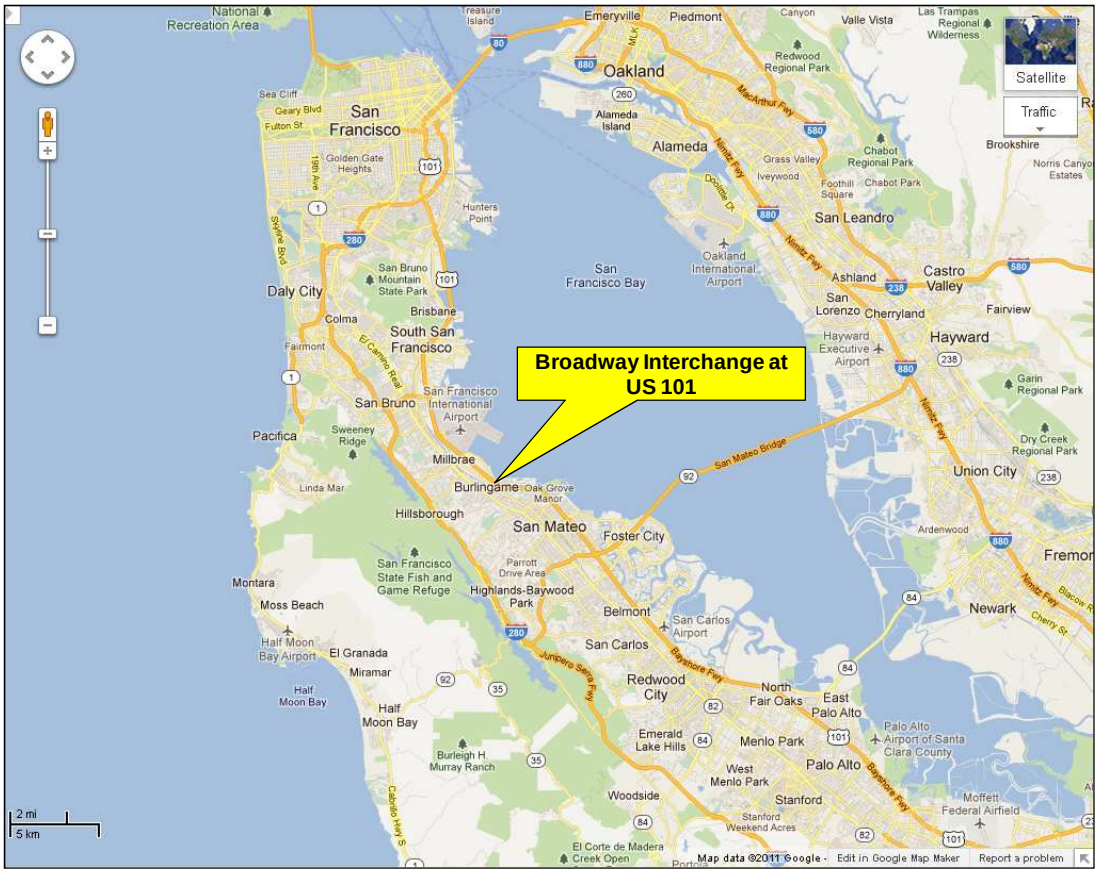

Figure 1. Vicinity and Project Site Map

Figure 2. Aerial View of Project Site (Red Box)

Proposed retaining wall and concrete barrier locations are shown in Figure 3.

Figure 3. Proposed Retaining Wall and Concrete Barrier Locations

To predict corrosion problems associated with a particular type of structure prior to installation, it is necessary to investigate the soil conditions the structure will encounter. Since corrosion is an electrochemical process accompanied by current flow, the electrochemical characteristics of a soil are of primary importance when evaluating corrosivity. Test methods utilized during this investigation reflect the most practical methods of determining soil corrosivity. This investigation was based on field measurements of soil resistivity and laboratory analysis of soil samples from the project site. The field resistivity tests have been conducted for comparison with laboratory soil boring sample analyses.

Resistivity is a measure of the ability of a soil to conduct an electric current. Soil resistivity is primarily dependent on the chemical and moisture content of the soil. As the concentrations of soluble chemical constituents increases, the soil resistivity will decrease. Lower soil resistivity is associated with higher corrosivity to buried metal and reinforced concrete structures.

At ten sites the soil resistivity was measured to a depth of 15 feet below grade. Soil resistivities at four sites located near the abutments for the proposed Broadway overcrossing bridge were measured to a depth of 100 feet below grade. Figure 4 shows the soil resistivity test sites at the US 101/Broadway interchange project site.

Legend

1 Northbound (NB) soil resistivity test location

1 Southbound (SB) soil resistivity test location

Figure 4. Soil Resistivity Test Sites

A wide variety of water-soluble salts is typically found in soils. Two soils having the same resistivity may have significantly different corrosion characteristics, depending on the specific ions available. The major constituents that accelerate corrosion are chlorides, sulfates, and the acidity (pH) of the soil. Also, concentrations of bicarbonates tend to decrease soil resistivities. Bicarbonates are not

directly aggressive to buried metallic or concrete structures, but the lower soil resistivity can promote corrosion activity.

Chloride ions break down otherwise protective surface deposits and can facilitate corrosion of buried metallic structures. Sulfates in soil can be highly aggressive to Portland cement by combining chemically with certain constituents of the concrete, principally tricalcium aluminate. This reaction is accompanied by expansion and eventual disruption of the concrete matrix. Sulfate ions reduce the soil resistivity, which also promotes corrosion activity on buried metallic structures.

Acidity, as indicated by the pH value, is another important factor of soil with respect to corrosivity. Lower pH (more acidic) will result in a greater degree of corrosivity with respect to buried metallic structures. When pH increases above 7.0 (the neutral value) the conditions become increasingly more alkaline. In alkaline environments, iron forms a protective layer on its surface. This is referred to as passivation. When the soil pH drops below about 9.0, the passive layer may break down.

Figure 5 shows the URS soil boring sites that provided soil samples for laboratory analysis.

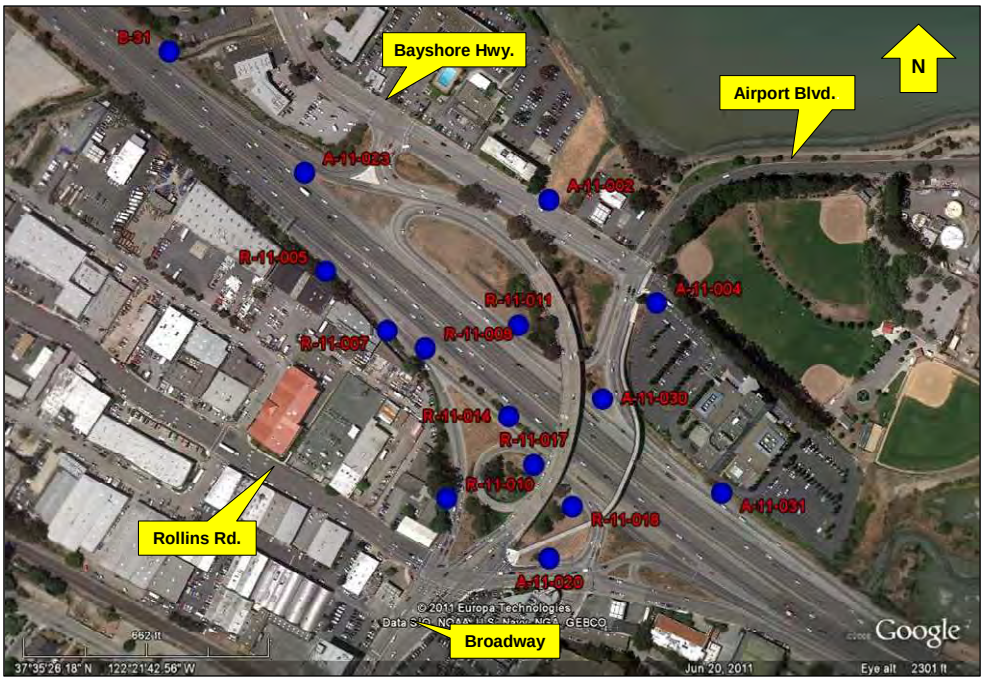

Figure 5. Soil Borehole Locations

TESTING METHODS

Field Soil Resistivity

Field soil resistivity measurements were taken using the Wenner Four Electrode Method (ASTM G57), utilizing an AEMC Instruments Model 4500 soil resistance meter. The Wenner method uses

four metal pins or electrodes, driven into the ground along a straight line, equidistant from each other, as shown in Figure 6. Soil resistivity measurements were conducted at electrode spacings of 2.5, 5, 7.5, 10, and 15 feet; and where applicable 25, 50, 75, and 100 feet.

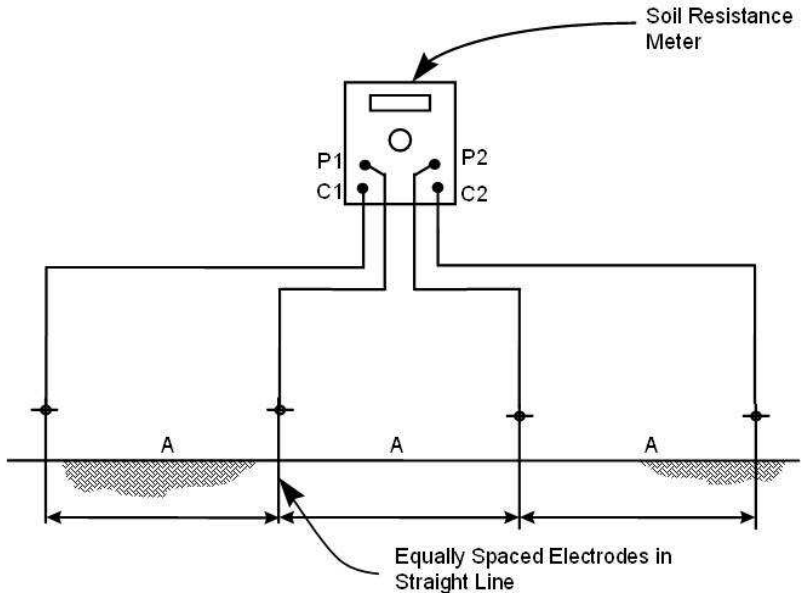

Figure 6. Soil Resistivity Measurement

An alternating current from the soil resistance meter causes a current to flow through the soil between the outer electrodes, C1 and C2. The current creates a voltage gradient in the soil, which is proportional to the average resistance of the soil mass to a depth equal to the electrode spacing. The voltage drop is then measured across pins P1 and P2. Resistivity of the soil is then computed from the instrument reading according to the formula

$$\rho = 2\pi AR$$

where ρ = soil resistivity (ohm-cm)
A = distance between electrodes (cm)
R = soil resistance, instrument reading (ohms)
π = 3.14 (approximate).

To calculate the resistivity of a soil layer, the Barnes layer method is used based on the results of the Wenner four-electrode tests. The Wenner Method measures soil resistivity from the surface to various depths below grade. The Barnes layer method is used to calculate the resistivity of a soil layer between two depths below grade from the surface-to-depth resistivity measurements. The Barnes layer method assumes the soil layers are a uniform thickness and that the upper and lower boundaries are parallel to the surface.

The Barnes layer resistivity of each layer of soil was calculated using the equations

$$\rho_{b-a} = KR_{(b-a)}$$

and

$$\frac{1}{R_{b-a}} = \frac{1}{R_a} - \frac{1}{R_b}$$

where

ρ_{b-a}	=	resistivity of soil layer from depth *a* to *b* (ohm-cm)
a	=	soil depth to top of layer (cm)
b	=	soil depth to bottom of layer (cm)
R_a	=	soil resistance read at depth *a* (ohms)
R_b	=	soil resistance read at depth *b* (ohms)
R_{b-a}	=	resistance of soil layer from depth *a* to *b* (ohms)
K	=	layer constant (cm)
	=	$2\pi(b–a)$.

Laboratory Soil Analysis

For the purposes of this analysis, 14 soil samples were obtained from 14 URS soil boreholes (Figure 5) for laboratory soil resistivity analysis. A soil box was used in accordance with California Test Method 643. The test apparatus is shown in Figure 7. It consists of a small plastic box with metal end plates for passing current through a tightly packed soil sample. Electric current flowing through the sample causes a voltage drop between pins P1 and P2. The soil resistivity is measured with a soil resistance meter. The soil box is designed so that the meter resistance reading is also the sample resistivity in ohm-cm. The soil resistivity is first measured in the "as-received" state. Distilled water is then added in increments to the soil sample. The soil resistivity is measured after each water addition. As the soil sample becomes more saturated, the resistivity decreases until the minimum soil resistivity is reached. Adding more water increases the resistivity as the soil electrolyte solution is diluted. The minimum observed resistivity is recorded.

The soil samples from the URS boreholes were forwarded to Cooper Testing Laboratory in Palo Alto, California, for minimum resistivity measurement, pH analysis, and analysis of water-soluble chloride and sulfate ion concentrations. The analytical procedures followed California Test Methods 417, 422, 643, and 644.

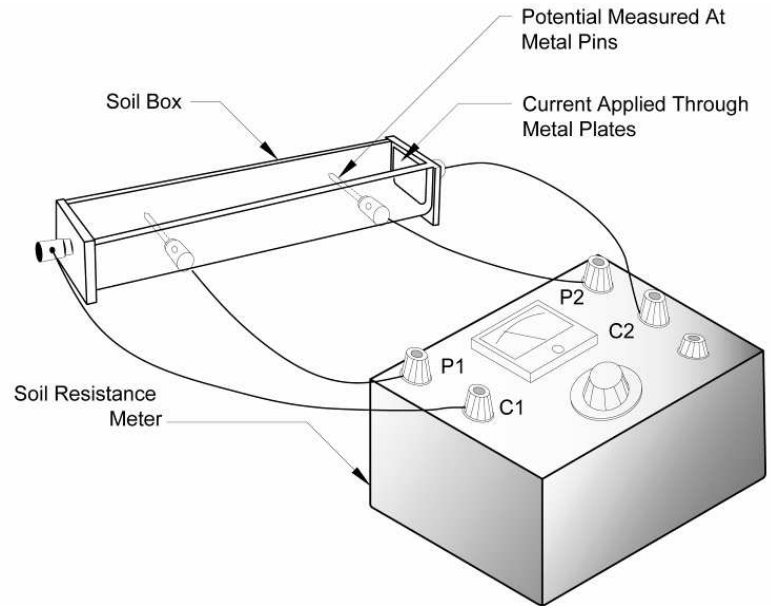

Figure 7. Soil Resistivity Measurement Using the Soil Box Method

TEST RESULTS

Field Soil Resistivity Results

Data obtained during this investigation has been tabulated for analysis and presentation. Table 1 lists the results of the Wenner soil resistivity measurements and Barnes layer calculations conducted at the US 101/Broadway interchange project site.

Table 1. Field Soil Resistivity Measurements

Site	Depth (feet)	Resistivity (Ohm-cm)	Layer Depth (feet)	Layer Resistivity (ohm-cm)	Site	Depth (feet)	Resistivity (Ohm-cm)	Layer Depth (feet)	Layer Resistivity (ohm-cm)
NB-1	2.5	2,298	0 - 2.5	2,298	SB-1	2.5	2,557	0 - 2.5	2,557
	5	852	2.5 - 5	523		5	1,274	2.5 - 5	848
	7.5	417	5 - 7.5	206		7.5	603	5 - 7.5	294
	10	402	7.5 - 10	364		10	306	7.5 - 10	124
	15	259	10 - 15	151		15	259	10 - 15	197
NB-2	2.5	1,197	0 - 2.5	1,197	SB-2	2.5	2,427	0 - 2.5	2,427
	5	259	2.5 - 5	145		5	1,455	2.5 - 5	1,039
	7.5	172	5 - 7.5	103		7.5	1,508	5 - 7.5	1,626
	10	96	7.5 - 10	41		10	1,111	7.5 - 10	620
	15	29	10 - 15	12		15	1,207	10 - 15	1,458
NB-3	2.5	1,647	0 - 2.5	1,647	SB-3	2.5	5,042	0 - 2.5	5,042
	5	929	2.5 - 5	647		5	3,074	2.5 - 5	2,211
	7.5	632	5 - 7.5	386		7.5	1,566	5 - 7.5	790
	10	249	7.5 - 10	88		10	900	7.5 - 10	396
	15	172	10 - 15	107		15	373	10 - 15	172
NB-4	2.5	1,666	0 - 2.5	1,666	SB-4	2.5	1,628	0 - 2.5	1,628
	5	1,676	2.5 - 5	1,685		5	1,302	2.5 - 5	1,085
	7.5	632	5 - 7.5	281		7.5	747	5 - 7.5	403
	10	345	7.5 - 10	146		10	594	7.5 - 10	368
	15	201	10 - 15	110		15	402	10 - 15	244
NB-5	2.5	6,334	0 - 2.5	6,334	SB-5	2.5	6,195	0 - 2.5	6,195
	5	3,447	2.5 - 5	2,368		5	3,371	2.5 - 5	2,315
	7.5	4,252	5 - 7.5	7,972		7.5	1,566	5 - 7.5	756
	10	1,666	7.5 - 10	590		10	900	7.5 - 10	396
	15	431	10 - 15	174		15	718	10 - 15	511
NB-6	2.5	12,448	0 - 2.5	12,448	SB-6	2.5	3,332	0 - 2.5	3,332
	5	1,609	2.5 - 5	860		5	3,074	2.5 - 5	2,852
	7.5	862	5 - 7.5	447		7.5	1,566	5 - 7.5	790
	10	218	7.5 - 10	67		10	1,072	7.5 - 10	551
	15	204	10 - 15	180		15	172	10 - 15	64
	25	321	15 - 25	2,278		25	48	15 - 25	23
	50	278	25 - 50	245		50	**ND**	25 - 50	**ND**
	75	373	50 - 75	1,203		75	**ND**	50 - 75	**ND**
	100	315,036	75 - 100	11,031		100	**ND**	75 - 100	**ND**
NB-7	2.5	1,254	0 - 2.5	1,254	SB-7	2.5	6,464	0 - 2.5	6,464
	5	1,072	2.5 - 5	937		5	4,376	2.5 - 5	3,308
	7.5	282	5 - 7.5	114		7.5	975	5 - 7.5	382
	10	170	7.5 - 10	78		10	515	7.5 - 10	213
	15	359	10 - 15	296		15	290	10 - 15	155
	25	737	15 - 25	1,271		25	326	15 - 25	399
	50	517	25 - 50	398		50	354	25 - 50	389
	75	876	50 - 75	2,253		75	733	50 - 75	645
	100	102,267	75 - 100	1,093		100	**ND**	75 - 100	**ND**

ND: not determined. Insufficient space to set up the Wenner four-electrode test array for the indicated soil depth.

Laboratory Soil Analysis Results

Table 2 lists the minimum soil resistivity and chemical analyses of the 14 soil samples retrieved from URS soil borings taken at the project site and analyzed at the Cooper Testing Laboratory.

An additional sample from a previous soil boring (B-31) was included to provide additional information along the proposed northbound US 101 on-ramp concrete barrier alignment. The results for B-31 were reported in Rajappan & Meyer Job No. 201191.GDR (GDMR for US 101 Auxiliary Lane Project), December 22, 2005, Table 8B, page 72.

Table 2. Laboratory Soil Resistivity and Chemical Data

Boring No.	Depth (feet)	Minimum Resistivity (ohm-cm)	Chemical Data		
			pH	Chloride (mg/kg)	Sulfate (mg/kg)
A-11-002	2.5 - 5	1,236	8.8	92	434
A-11-004	2.5 - 5	622	8.3	528	900
A-11-020-2-3	5 - 6.5	3,566	8.3	<2	6
A-11-023	2 - 5	198	8.2	2,034	447
A-11-030-2-4	3 - 6.5	114	7.8	6,739	2,606
A-11-031-2-3	3 - 6.5	90	7.7	3,284	425
R-11-005	3.5 - 5	1,151	7.9	90	542
R-11-007-1-3	5 - 7	1,952	7.9	13	6
R-11-008-1-3	5 - 7	2,517	8.0	<2	132
R-11-010-1-3	5 - 7	1,768	7.7	24	5,391
R-11-011	0 - 6	1,252	8.0	246	9
R-11-014-1	5 - 6.5	1,328	7.6	181	8
R-11-017-1-2	5 - 7	561	7.7	451	272
R-11-018-2-2	10 - 11.5	131	8.0	4,965	786
B-31*	9.5 - 19.5	61	8.1	8,325	1,094

* Soil sample B-31 was previously reported in Rajappan & Meyer Job No. 201191.GDR, 12/22/05, page 72
mg/kg – milligrams per kilogram (ppm)
Minimum resistivity by Caltrans Method 643
pH by Caltrans Method 644
Chloride by Caltrans Method 422-modified
Sulfate by Caltrans Method 417-modified

Based on the Caltrans *Corrosion Guidelines*, six of the analyzed soil samples and Rajappan & Meyer soil sample B-31 are considered corrosive to buried metallic objects and reinforced concrete structures with regards to chloride or sulfate contents. These samples are color-highlighted in Table 2 above.

APPENDIX A: SOIL SAMPLE LABORATORY CHEMICAL ANALYSIS RESULTS

Corrosivity Test Summary

CTL #	632-011		**Date:**	12/19/2011		**Tested By:**	PJ		**Checked:**	PJ		
Client:	V&A Consulting Engineers		**Project:**	URS Hwy 101 Broadway Interchange					**Proj. No:**	11-0149		
Remarks:												
Sample Location or ID			**Resistivity @ 15.5 °C (Ohm-cm)**			**Chloride**	**Sulfate**		**pH**	**ORP**	**Moisture**	
Boring	**Sample, No.**	**Depth, ft.**	**As Rec.**	**Minimum**	**Saturated**	**mg/kg**	**mg/kg**	**%**		(Redox)	At Test	**Soil Visual Description**
						Dry Wt.	Dry Wt.	Dry Wt.		mV	%	
			ASTM G57	Cal 643	ASTM G57	Cal 422-mod.	Cal 417-mod.	Cal 417-mod.	Cal 643	SM 2580B	ASTM D2216	
A-11-002	-	2.5-5	29,118	1,236	-	92	434	0.0434	8.8	-	8.3	Olive Silty SAND (Slightly Plastic)
A-11-004	-	2.5-5	1,308	622	-	528	900	0.0900	8.3	-	16.8	Dark Olive Gray Clayey SAND w/ Gravel
A-11-020-2-3	-	5-6.5	3,566	3,566	-	<2	6	0.0006	8.3	-	20.4	Olive Brown Silty SAND
A-11-023	-	2-5	5,591	198	-	2,034	447	0.0447	8.2	-	7.8	Olive Gray Clayey SAND w/ Gravel
A-11-030-2-4	-	3-6.5	129	114	-	6,739	2,606	0.2606	7.8	-	95.7	Olive Gray CLAY w/ Organics
A-11-031-2-3	-	3-6.5	104	90	-	3,284	425	0.0425	7.7	-	77.0	Dark Greenish Gray CLAY
R-11-005	-	3.5-5	149,040	1,151	-	90	542	0.0542	7.9	-	4.8	Olive Brown Clayey SAND w/ Gravel
R-11-007-1-3	-	5-7	6,381	1,952	-	13	6	0.0006	7.9	-	12.5	Gray Clayey SAND changing to Sandy CLAY
R-11-008-1-3	-	5-7	2,904	2,517	-	<2	132	0.0132	8.0	-	7.4	Gray Clayey SAND w/ Gravel
R-11-010-1-3	-	5-7	5,515	1,768	-	24	5,391	0.5391	7.7	-	20.8	Olive Brown Clayey SAND
R-11-011	-	0-6	600,080	1,252	-	246	9	0.0009	8.0	-	3.9	Olive Brown Clayey SAND w/ Gravel
R-11-011-13-3	-	55-60	821	719	-	341	9	0.0009	7.7	-	23.6	Olive Brown Clayey SAND
R-11-014-1	-	5-6.5	1,605	1,328	-	181	8	0.0008	7.6	-	24.9	Brown Clayey SAND w/ Gravel
R-11-014-13-4	-	57-58	3,214	2,829	-	43	<5	<0.0005	8.0	-	16.1	Olive Brown Clayey SAND
R-11-017-1-2	-	5-7	561	561	-	451	272	0.0272	7.7	-	15.4	Olive Brown Sandy CLAY w/ Gravel
R-11-018-2-2	-	10-11.5	146	131	-	4965	786	0.0786	8.0	-	80.3	Gray CLAY

US101/BROADWAY INTERCHANGE RECONSTRUCTION PROJECT

PS&E Phase

Geotechnical Design and Materials Report

April 19, 2013

URS

April 19, 2013
URS Project 28645286

File No.04-SM-101-PM 16.3/17.1
EA 04-235844

Mr. Jim McKim
Project Manager
San Mateo County Transportation Authority
1250 San Carlos Avenue
San Carlos, CA 94070-1306

Subject: **Geotechnical Design Report and Materials Report (GDMR)**
US 101/Broadway Interchange Reconstruction
Burlingame, California

Dear Mr. McKim:

URS has completed a geotechnical investigation and the Geotechnical Design Report/Materials Report (GDMR) for the proposed reconstruction of Broadway Interchange on US 101 in Burlingame, California. The accompanying report has been prepared in accordance with Caltrans GDR Guidelines, dated December 2006 and Corrosion Guidelines, dated September 2003.

The report presents our engineering opinions and recommendations regarding the geotechnical factors influencing the design and construction of the proposed roadways and road signs. The opinions and recommendations have been based upon the results of our field investigation, laboratory testing, engineering judgment and local experience. Mr. Madhu Thummaluru, P.E., Mr. Allen Moore, Project Geotechnical Engineer, and Ms. Anne-Marie Moore, Geotechnical Engineer, assisted in preparation of this report. Mr. Mark Schmoll, Certified Engineering Geologist, contributed to the seismic source characterization and the evaluation of geologic conditions along the project alignment. Messrs. Jose Landazuri, G.E. and Paul Boddie, G.E. provided technical review and guidance to the URS project team over the course of the investigation.

If any questions should arise, or if we can be of further service, please contact the undersigned at (408) 297-9585.

Sincerely,

S. Stephen Huang
Geotechnical Task Leader, G.E. 2150

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1.1 DESCRIPTION OF PROJECT

1.1.1 Location and Route Description

The proposed project will replace the existing Broadway overcrossing with a wider structure, and reconfigure all northbound and southbound ramp connections to US 101. The total length of the project is 0.75 mile. The purpose of the project is to reduce congestion, enhance safety, and improve performance of the interchange. It is also intended to relieve the weaving problems at the interchange by eliminating the collector-distributor roads and thus improving the traffic safety and operations. The pedestrian overcrossing located approximately 50 feet south of the existing Broadway overcrossing will be removed to accommodate the new southbound on-ramp. Eight (8) retaining walls are planned at different locations to minimize the right-of-way impacts to existing business properties and to support the ramp approaches and roadway embankments. The existing 6 x 6 feet double barrel box culvert at Easton Creek on the east side of northbound US 101 will be extended by approximately 50 feet to accommodate the construction of the new northbound US 101 on-ramps. The approximate location of project site is shown on the Project Location Map, Figure 1. The new interchange will be constructed in several stages in order to keep traffic flowing.

Below is a summary of features for the proposed design option:

- Replace or reconstruct all existing on- and off-ramps to accommodate additional lanes and additional storage;
- Replace the Broadway overcrossing with a wider structure allowing seven lanes to accommodate projected traffic growth;
- Update all intersections to operate at acceptable levels of service (LOS D or better), and where possible, show an improvement in the 2035 Build Condition compared to the 2035 No-Build Condition; and
- Correct and/or improve the existing nonstandard vertical clearance between US 101 and the Broadway overcrossing, and the existing five-legged intersection of Broadway, Rollins Road, and the US 101 southbound off-ramp.

Adjoining driveways will be reconstructed to match proposed grades.

1.1.2 Retaining Walls

Table 1-1 presents a summary of the retaining walls planned to minimize the right-of-way impacts to existing business properties and to support the ramp approaches and roadway embankments.

Table 1-1 Planned Retaining Walls

Retaining Wall No.	Control Line	Station Reference		Length of Wall (feet)	Design Height (feet)
		From	To		
205	B2 and BWY	"B2" 208+16	"BWY" 15+01	727	9 to 27
209	B2	208+85	213+65	480	12 to 27
315	B3	316+17	317+48	130	7 to 17
316	B3	316+17	317+55	138	7 to 17
314	B3	314+62	315+07	46	27
15	BWY	15+46	16+78	133	19 to 24
38	BYSH	38+24	39+21	97	6 to 8
39	BYSH	39+21	40+13	92	10 to 12

The geotechnical design parameters and aspects of these walls are presented in the "Foundation Report, Retaining Wall Nos. 15, 38, 39, 205, 209, 314, 315 and 316," dated November 16, 2012.

1.1.3 Overhead Sign

One new overhead sign is planned on the shoulder of US 101 southbound, Station "US101" 501+80. This sign is to replace the existing sign near Station "US 101" 506+50 to accommodate the lengthened southbound off-ramp.

1.2 EXISTING STRUCTURE

The existing Broadway Overcrossing consists of four lanes and spans across US 101. The bridge has a 2¾-foot-wide walkway on each side with metal railing and was constructed in 1947. There is also a newer one-lane structure, constructed around 1970, attached to the original structure on the northwest side of the intersection.

Based on as-built plans provided by Caltrans dated September 1947, the existing bridge is a 12-span structure supported on an abutment at each end and 11 bents in between. The overall length of the structure is approximately 761 feet. The superstructure was constructed with a concrete slab supported on steel I-beams. According to the as-built drawings, the abutments are supported on driven steel H-piles (12BP53), vertical and batter, and bents are supported on three rows of vertical untreated timber piles. Steel piles at the abutments are estimated to be approximately 50 to 55 feet in length with a specified capacity of 24 tons, and the timber piles at bents are estimated to be approximately 40 feet in length with a specified capacity of 20 tons. Based on our review of the available as-built and soil boring information, it appears that the existing pile foundations at the Broadway overcrossing derive support through a combination of skin friction in the upper 40 to 50 feet of the alluvial soil profile, and potentially through end-

bearing resistance in the dense sands and gravels encountered below approximately Elevation -40 feet. Bottom of pile cap at the abutments of the original structure ranges from Elevation 9.5 to 11.5 feet at Abutment 1 and from Elevation 13.7 to 14.5 feet at Abutment 13; the bottom of pile cap at all bents is Elevation 1 foot.

The interchange was modified in 1970 with the addition of an on-ramp from Broadway to southbound US 101. The on-ramp is a four span cast-in-place slab bridge on pile extensions consisting of corrosion resistant Class XI concrete piles (45-ton capacity). The specified tip elevation for these concrete piles was Elevation -40 feet. All available as-built plans are attached to this report in Appendix A.

1.3 PHYSICAL SETTING

1.3.1 Climate

Climatologically, the area is classified as Mediterranean with dry summers and mild winters. The following discussion includes records at the San Francisco International Airport (SFIA) weather station (Western Regional Climate Center). The mean annual temperature is 59.2° F. Extremes of temperatures expected range from an average daily maximum of 78.8° F in July to average daily lows of 33.0° F in December. The highest and lowest temperatures on record at SFIA are 107° F and 15° F. Freezing temperatures should only be expected to occur on an average of 16 days per year, so freeze-thaw conditions should not be a factor.

Precipitation at SFIA averages 15.24 inches per year, primarily confined to the months of October through May. November through March usually have the most precipitation accumulation, averaging 1.78, 2.73, 3.25, 2.87, and 2.23 inches per month, respectively. Thunderstorms are rare.

1.3.2 Terrain

The topography along the existing roadways connecting to the Broadway Overcrossing structure ranges in elevation from approximately 8½ to 15 feet, based on datum NAVD 88.

Development within the project limits is primarily commercial and industrial.

1.3.3 Surface Drainage

The project is split between the Easton Creek and Sanchez Creek watersheds, with Broadway dividing the watersheds. Most of the creeks in the area originate from the eastern side of the Santa Cruz Mountains and form a series of small parallel basins that drain northeasterly to San Francisco Bay. Easton Creek is 2.4 miles long and drains an area of 1.2 square miles; Sanchez Creek is 1.9 miles long and drains an area of 2.1 square miles (Wreco, 2012).

1.3.4 Regional Geology

The US 101/Broadway interchange is located on the western margin of the San Francisco Bay block within the central portion of the Coast Ranges geomorphic province of California.

Northwest-southeast-trending valleys and ridges characterize the regional morphology of the Coast Ranges province. These topographic features are controlled by folds and faults that resulted from the collision of the Farallon and North American plates and subsequent predominantly strike-slip faulting along the San Andreas fault system between the Pacific and North American plates. The San Francisco Bay block is a relatively stable, seismic block bounded by the San Andreas and Hayward faults to the west and east, respectively.

The project site is located just east and northeast of the historic San Francisco bay margin. The historic tidal flats have been covered with artificial fill to create the present day topography. The artificial fill covers the majority of the project area and is mapped from about Rollins Road extending north to the edge of the bay (Witter, et al, 2006; Brabb, et al, 1998). A portion of the geologic map covering the project area prepared by Brabb is included as Figure 2. Witter (2006) shows the artificial fill as being underlain by estuarine deposits (Bay Mud). South and southwest of Rollins Road, Quaternary deposits exposed at the surface are mapped by Witter (2006) as Holocene (less than 10,000 years old) alluvial fan deposits consisting of sand, silt and clayey silt, underlain by older Pleistocene alluvial fan and fluvial deposits consisting of gravel, sand and silt. Mapping by Brabb (1998) classifies the deposits south of Rollins Road as the Pleistocene age Colma Formation consisting of fine to medium-grained sand with silt and clay. Bedrock consisting of Franciscan Complex sandstone outcrops are mapped approximately 1 mile south of the site. The depth to bedrock at the site is unknown; however bedrock was encountered at a depth of 270 feet at the west end of the San Mateo Bridge (Goldman, 1969) and is estimated to be in the range of 150 to 200 feet deep at the project site.

1.4 PREVIOUS INVESTIGATIONS NEAR SITE

Log of Test Borings (as-built LOTBs in Appendix B) completed for the improvements to the existing Broadway Overcrossing (Bridge No. 35-0096) in 1970, and for the pedestrian bridge in 2002 were reviewed. The 1970 investigation included two rotary wash borings (B-1 and B-3) and one soil tube boring (B-2). These borings were drilled into the alluvial fan deposits, fine grained facies as mapped by Witter et al, (2006), and extended to depths ranging from 20 to 88 feet (to about Elevation -8 feet to -75 feet).

Borings drilled for the pedestrian bridge by Parikh Consultants, Inc. in January 2002 included two hollow-stem auger borings (02-BRO-1 and 02-BRO-2) extending to a maximum depth of 90 feet (about Elevation -80 feet). Several other borings drilled for the US101 Auxiliary Lane project by Parikh Consultants, Inc. in December 2001 and January 2002 included eleven hollow-stem auger borings (R-44, B-31, RW-65, B-32, R-45, OS-79, R-46, SW-1, SW-2, SW-3, and SW-4) extending to a maximum depth of 50 feet (about Elevation -40 feet). The approximate locations of 1970 Caltrans borings, pedestrian bridge borings, and all other known borings in the project vicinity are shown on Figures 3a through 3e as reference.

Log of Test Borings for the original construction of the existing overcrossing in 1949 were not available.

1.5 CALTRANS REVIEW COMMENTS

We received comments prepared by Caltrans for the Geotechnical Design and Materials Report dated January 17, 2013. Our responses to the comments are incorporated into this report. Copies of the review comments and our responses for previous versions of the report are presented in Appendix C.

2.1 ORIGINAL CONSTRUCTION

Information on existing roadway structural pavement sections is based on the following as-built plans:

- State of California, Highway Transportation Agency, Department of Public Works, Division of Highways, "Plans for Construction on State Highway in San Mateo County, between Whipple Avenue in Redwood City and Broadway in Burlingame," January 19, 1966, Contract No. 04-161534
- State of California, Department of Public Works, Division of Highways, "Plan and Profile of State Highway in San Mateo County, between Colma Creek in South San Francisco and Broadway in Burlingame," August 2, 1946, Contract No. 4TC30-F
- State of California, Department of Public Works, Division of Highways, "Plan and Profile of State Highway in San Mateo County, Burlingame and 5th Avenue, San Mateo," February 14, 1931, Contract No. 24CT7
- State of California, Department of Public Works, Division of Highways, "Plan of State Highway in San Mateo County, between South San Francisco and Broadway in Burlingame," March 14, 1947, Contract No. Unknown
- State of California, Department of Public Works, Division of Highways, "Plan of State Highway Projects in San Francisco, San Mateo and Santa Clara Counties, at Various Locations," December 10, 1956, Contract No. 58-4TC6
- State of California, Department of Public Works, Division of Highways, "Project Plans for Construction on State Highway in San Mateo County in Burlingame at Broadway Interchange," August 23, 1971, Contract No. 04-337204
- State of California, Department of Public Works, Division of Highways, "Project Plans for Construction on State Highway in San Mateo County in Burlingame on Route 101 from 0.2 Mile North of Broadway Overcrossing to 0.7 Mile South of Millbrae Avenue Overcrossing," April 8, 1978, Contract No. 04-400554
- State of California, Department of Transportation, "Project Plans for Construction on State Highway in San Mateo County in Burlingame, Millbrae and South San Francisco from 0.2 Mile South of Broadway Overcrossing to South San Francisco Overhead," March 25, 1994, Contract No. 04-108424
- State of California, Department of Transportation, "Project Plans for Construction on State Highway in San Mateo County in San Mateo, Burlingame, and Millbrae on Route 101 from Millbrae Avenue Overcrossing in Millbrae to 3rd Avenue Overcrossing in San," August 21, 2006
- City of Burlingame, "Improvement Plan for Reconstruction of Bayshore Highway, Burlingame, California," March 26, 1985
- Mobil Oil Corporation, "Street Improvement Plan, N. W. Corner, Bayshore Hwy & Broadway (Exit), Burlingame, California," June 30, 1968

Available information on existing structural sections within the project limits are summarized on the typical cross section drawings of the project plans. Copies of Typical Cross Section plan sheets are presented in Appendix A as reference.

Consistent with Caltrans terminology, for the remainder of this report, the following definitions, abbreviations, and acronyms are used:

- Asphalt concrete, Type A is AC(A)
- Asphalt treated permeable material is ATPB
- Asphalt concrete base, Type A is ACB(A)
- Cement treated base, Class A is Cl. A CTB
- Cement treated base, Class B is C1. B CTB
- Cement treated subbase is CTS
- Cement treated subgrade is CTSR
- Class 2 aggregate base is CL2 AB
- Class 3 aggregate base is CL3 AB
- Class 4 aggregate subbase is CL4 AS
- Hot mix asphalt is HMA
- Lean concrete base is LCB
- Open graded asphalt concrete is OGAC
- Open graded friction course is OGFC
- Pavement reinforcing fabric is PRF
- Pervious subbase material is PSM
- Permeable material is Perm.
- Perforated metal pipe is PMP
- Plant-Mixed Surfacing is PMS; 1954 terminology for asphalt concrete
- Portland cement concrete is PCC
- Rubberized asphalt concrete, gap graded is RAC-G
- Rubberized Hot Mix Asphalt – Type G is RHMA-G
- Selected material is SM
- Subgrade enhancement geotextile is SEG

2.2 STRUCTURAL PAVEMENT SECTION

According to Typical Cross Sections presented in the record drawings discussed in Section 2.1, the existing pavement sections for Broadway, US 101 mainline and interchange ramps are summarized in the following table. The delineation of the various pavement sections are presented in more detail on the Typical Cross Sections, Sheets X-1 to X-23, of the Project Plans.

Table 2-1 Existing Typical Structural Sections

Component	Control Line	Traveled Way Section (feet)	
US 101	"US101"	OGAC	0 - 0.10
		AC	0.31 - 0.64
		CL3 AB	0.89 - 1.08
		CL4 AS	0.44 - 0.69
	"US101"	OGAC	0.10
		AC	0 – 0.25
		PRF	
		Varying AC leveling course	
		Crusher Run Base	0 – 0.67
		Imported Borrow	0 – 3.00
	"US101"	OGAC	0.10
		AC	0.15
		PRF	
		Varying AC leveling course	
		CTB	0 – 0.67
		AS	0 – 0.70
On-Ramp Broadway to SB US 101	"B2" and "B3"	AC	0.10 - 0.70
		CTB	0 - 0.67
		AS	0 - 0.70
		Plant Mix Surfacing	0 - 0.08
		Varying AC leveling course	
		Crusher Run Base	0 – 0.50
Off-Ramp Nouthbound (NB) US 101 to Bayshore Highway	"B4"	AC	0.10 - 0.70
		CTB	0 - 0.67
		AS	0 - 0.70
		Plant Mix Surfacing	0 - 0.08
		Varying AC leveling course	
		Crusher Run Base	0 – 0.50
Broadway	"BWY"	AC	0.10 - 0.70
		CTB	0 - 0.67
		AS	0 - 0.70
		Plant Mix Surfacing	0 - 0.08
		Varying AC leveling course	
		Crusher Run Base	0 – 0.50

2.2.1 Measured Structural Pavement Section

The existing pavement structural sections were measured where 2011 URS boring locations coincided with the existing pavement. Approximate measurements of the existing sections were made in exploratory boreholes at the time of drilling and are summarized in Table 2-2.

Table 2-2 Pavement Section Measurements

Boring/ Pavement Core Number	Approximate Station	Offset (feet)	Thickness (inches)			
			AC	AB	CTB	AS
A-11-022	"BYSH" 30+99.6	Lt 24	6	12	NA	NA
R-11-002	"BYSH" 39+26.4	Lt 12.5	12	18	NA	NA
R-11-004	"HTL" 52+44.0	Rt 47	8	12	NA	NA
R-11-005	"B2" 208+21.1	Rt 7	16	26	NA	NA
R-11-006	"B2" 209+47.2	Rt 6	9	2	NA	NA
R-11-010	"BWY" 15+60.6	Lt 58	6	18	NA	18
R-11-013	"US101" 514+12.6	Lt 1	12	12	NA	NA
R-11-040	"BWY" 12+42.4	Rt 5	6	12	NA	NA
PC-1	“RLN” 23+04	Rt 31	11	5	NA	NA
PC-2	“BWY” 10+27	Rt 10	7.5	10.5	NA	NA
PC-3	“B3” 323+77	Rt 8	10	18	NA	NA
PC-4	“RLN” 30+08	Rt 21	10	6	NA	NA
PC-5	“BYSH” 31+98	Rt 16	5	15	NA	NA
PC-6	“BWY” 28+13	0 ±	13.5	9	NA	NA
PC-7	“B4” 409+25	Rt 21	7	NA	9	23
PC-8	“US 101” 524+00	Lt 83	7.5	7	NA	NA

3.1 FIELD EXPLORATION

To supplement available data, URS advanced 15 borings and four cone penetration tests (CPT) for bridge structures, retaining walls, culvert extension and approach embankments. One CPT were advanced to investigate subsurface conditions at the planned overhead sign structures and 15 shallow borings were drilled at strategic location to investigation pavement subgrade conditions. Eight pavement cores were retrieved at existing on- and off-ramps and local streets to confirm as-built plan information. Approximate locations of the borings, CPTs and pavement cores are presented in Figures 3a through 3e.

Eighteen borings were drilled with a truck-mounted drill rig using rotary wash methods, and one boring near existing Easton Creek culvert with a track-mounted rig. A solid flight auger (6-inch diameter) was used for the shallow borings.

A representative of URS observed the drilling operations and soil sampling. Visual classifications of the soils encountered were made from cuttings and soil samples. The soil samples collected from the borings were sealed and labeled immediately to preserve their natural moisture content. At completion of the exploration, samples were delivered to the laboratory for further examination and testing. The CPTs and borings were then backfilled with a mixture of cement and bentonite in accordance with the requirements of the San Mateo County Health Services Division (EHSD).

The Unified Soil Classification System, as well as guidelines summarizing soil consistency and relative density, are presented on the LOTB legend (Sheets A10F and A10G of the 2010 Standard Plan). The logging method is consistent with guidelines presented in Caltrans Soil & Rock Logging, Classification, and Presentation Manual, 2010 Edition.

Comprehensive descriptions of the soils encountered at each boring and CPT, together with field and laboratory test data, are presented on the Boring Records (Appendix D). Detailed results of the laboratory tests, including corrosion, are presented in Appendix E.

3.2 SUBSURFACE CONDITIONS

3.2.1 General

All explorations (auger and rotary wash borings) were located in the paved shoulder, the paved mainline areas, in the future traveled way (ramps and median), within new bridge abutments footprints, or near future retaining walls. The pavement sections encountered in the explorations were presented previously in Section 2 “Existing Structural Pavement Sections.”

3.2.2 Subsurface Conditions

Below the pavement sections as discussed in Section 2, fill material was encountered to between about 3 and 11½ feet below ground surface (bgs). The fill materials gernerally consist of medium stiff lean clay with gravel, and sandy lean clay with gravel, and medium dense to dense sandy silt with gravel and silty gravel with sand.

Soft to medium stiff organic elastic silt/fat clay was encountered below the fill. This material is more commonly known as Bay Mud. The Bay Mud extends to depths of 12 to 19 feet bgs. However, in the northern end of the project limits, Bay Mud was encountered to a depth of 34 feet bgs in Boring R-11-036. The Bay Mud deposits have high moisture contents (ranging from above 50 percent to exceeding 100 percent) and low dry unit weights (between 40 and 60 lb/ft^3). The plasticity indices range from 12 to more than 50.

Below the Bay Mud, alluvial deposits consisting loose to dense silty sand and clayey sand interbedded with stiff to very stiff lean clay layers were encountered to a depth of 70 feet bgs. Below the stiff to very stiff lean clay layer, alternating layers of stiff to hard lean clay as well as medium dense to dense silt sand to clayey sand and sandy clay were encountered to between 100 and 101½ feet below the ground surface, or the terminal depth of the borings.

3.2.3 Groundwater

Groundwater was encountered at depths from 4½ to 15 feet bgs during drilling. For CPTs, the groundwater depths are estimated from the results of pore pressure dissipation tests; tests were conducted at a depth of 30 feet bgs. A summary of the groundwater level measurements are presented in Table 3-1.

Table 3-1 Summary of Groundwater Level Measurements

Boring	Groundwater Depth (feet)	Approximate Groundwater Elevation (feet)
A-11-021	Dry	Not Applicable (NA)
A-11-022	Dry	NA
A-11-023	5	4.5
A-11-024	4.5	5
A-11-025	6.1	4.9
A-11-026	Dry	NA
A-11-027	Dry	NA
A-11-028	Dry	NA
A-11-029	Dry	NA
A-11-030	5.5	3
A-11-031	Dry	NA
A-11-032	Dry	NA
A-11-033	Not measured	NA
A-11-034	Dry	NA
A-11-035	Dry	NA
CPT-11-009	1.7	8.3
CPT-11-012	3.4	6.6
CPT-11-016	0.5	10.5
CPT-11-019	4.6	7.4

Table 3-1 Summary of Groundwater Level Measurements (continued)

Boring	Groundwater Depth (feet)	Approximate Groundwater Elevation (feet)
CPT-11-039	5.6	6.4
R-11-001	15	-4
R-11-002	6	4.5
R-11-003	5	4
R-11-004	5	5
R-11-005	12.5	-1.5
R-11-006	14.5	-4
R-11-007	9.5	0
R-11-008	5	5.5
R-11-010	12.5	-1
R-11-011	5	4.5
R-11-013	8	5
R-11-014	6	5
R-11-015	12.5	-2
R-11-017	14.5	-3.5
R-11-018	16	-5
R-11-020	Not measured	NA
R-11-036	13.5	-3.5
R-11-037	7.5	1.5
R-11-038	4.5	6
R-11-040	11	4

4.1 PROJECT SITE SEISMICITY

The seismic design methodology adopted for this project is based on Caltrans Seismic Design Criteria (SDC), v 1.6, November 2010.

The project site lies between known active and potentially active geologic faults; a regional fault map is presented on Figure 4. The closest active fault to this section of US 101 is the San Andreas Fault (SAN). This fault is designated with a Maximum Magnitude (M_{Max}) of 7.9 in the Caltrans 2007 fault database. The horizontal distance from the site to the San Andreas fault is about 2.5 miles. The location of this fault is based on Caltrans ARS Online (2009).

Table 4-1 Seismic Source Parameters

Fault	Type	M_{Max}	Distance* (miles)	Near Field Effects?
San Andreas (north coast segment)	strike-slip	7.9	2.5	Yes
San Gregario-Palo Colorado	strike-slip	7.2	9.5	No
Hayward (northern section)	strike-slip	7.3	16.0	No
Monte Vista-Shannon	reverse	6.7	14.0	No

For design, a site peak ground acceleration (PGA) of 0.68 g was estimated using Caltrans ARS Online tool; this value of PGA corresponds to a site specific average shear wave velocity of 820 feet per second (fps).

4.1.1 Design Acceleraton Response Spectra

The design response spectrum for the site is estimated with spectral acceleration values generated using Caltrans ARS Online (2009). This method was developed by Caltrans Geo Research Group in partnership with United States Geological Survey (USGS), Pacific Earthquake Engineering Research (PEER) and California Department of Conservation. This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in Appendix B of the Caltrans SDC.

The deterministic spectrum is determined as the average of median response spectra calculated using the Campbell-Bozorgnia (2008) and Chiou-Youngs (2008) ground motion prediction equations developed under the “Next Generation Attenuation” project coordinated through the PEER-Lifelines program. These equations are applied to all faults considered to be active in the last 750,000 years (late-Quaternary age) that are capable of producing a moment magnitude earthquake of 6.0 or greater. The probabilistic spectrum is obtained from the USGS (2008) National Hazard Map for 5% probability of exceedance in 50 years. Caltrans design spectrum is based on the larger of the deterministic and probabilistic spectral values. Both the deterministic and probabilistic spectra account for soil effects through incorporation of the parameter V_{s30}, the average shear wave velocity in the upper 100 feet of the soil profile.

The input values selected for the Caltrans ARS Online included:

- V_{s30} of 820 fps
- Maximum Moment Magnitude ($M_{W,Max}$) 7.9 (San Andreas fault)
- No ARS increase for fault-type or long period structure
- ARS increase for near-field effects

The calculated spectra using the Caltrans ARS Online tool for both deterministic and probabilistic methods are presented as the blue curve on Figure 5A. Since the average shear wave velocity at the site is less than 1,000 feet per second, Caltrans requires that the calculated spectra be determined using the USGS deaggregation tool; this curve is plotted in red on Figure 5A. In cases where the calculated spectra for the two curves (Caltrans and USGS) differ by 10 percent or more for periods of less than 0.5 second, Caltrans requires that the USGS calculated spectra be used for design.

As shown on Figure 5A, the calculated spectral value for the 0.5 second period is about 1.3g based on Caltrans ARS and just over 1.4g based on the USGS deaggregation. Therefore, in accordance with Caltrans requirements, the USGS calculated spectra should be used for design (Figure 5B). Appendix F presents the results of ground motion evaluation based on the Caltrans ARS Online tool.

4.2 POTENTIAL GEOLOGIC HAZARDS

4.2.1 Surface Fault Displacement and Ground Shaking

Surface fault rupture tends to recur along existing fault traces. The highest potential for surface faulting is along existing fault traces that have had Holocene fault displacement. The California Geological Survey (formerly Division of Mines and Geology) has produced maps showing Alquist-Priolo Earthquake Fault Zones along faults with known Holocene activity that pose a potential surface faulting hazard. There are no Alquist-Priolo zones mapped in the vicinity of the project site. The closest active fault to the site is the San Andreas fault, approximately 2.5 miles to the west as shown on Figure 4. The potential for surface fault rupture at the site is considered remote.

4.2.2 Liquefaction

Soil liquefaction is a phenomenon in which saturated cohesionless soils are subject to a temporary but essentially total loss of shear strength under the reversing, cyclic shear stresses associated with earthquake shaking. In extreme cases, the soil particles can be suspended in groundwater, resulting in the deposit becoming mobile and fluid-like. Three conditions are generally required for liquefaction to occur: 1) a cohesionless soil of loose to medium dense relative density; 2) a saturated condition; and 3) rapid, large strain cyclic loading normally induced by earthquake ground shaking. Liquefaction can result in loss of foundation bearing capacity, differential settlements, and lateral spreading. Traditionally, a depth of 50 feet has been used as the terminal depth of analysis for the evaluation of liquefaction.

Based on a liquefaction susceptibility map generated from the Association of Bay Area Governments (ABAG) geographic information systems (GIS) and reproduced in this report as

Figure 6 (primarily based on Knudsen, et al, 2000 data, and Witter & others, 2006), the project alignment at the US 101/Broadway Interchange is mapped as an area of "very high" liquefaction susceptibility.

Based on evaluation of subsurface soils susceptible to liquefaction, in our opinion, the likely consequence of a strong earthquake will be post-liquefaction settlement. For site specific analysis of boring data and CPT soundings, we estimated post-liquefaction settlement for a PGA of 0.68g and design earthquake of M_w 7.9. Table 4-2 presents a summary of the estimated post-liquefaction ground surface settlement of borings and CPTs that encountered liquefaction susceptible soils.

Table 4-2 Estimated Post Liquefaction Ground Surface Settlement

Boring / CPT Number	Depth Ranges of Liquefiable Layers (feet)	Estimated Ground Surface Settlement (inch)
R-11-011	40 to 41½	< ¼
CPT-11-012	13½ to 16½	½
R-11-013	5 to 9½	1½
R-11-014	14½ to 16	½
CPT-11-016	29½ to 31	¾
R-11-015	19 to 21; 26 to 27	1¼
CPT-11-009	7½ to 8½; 44 to 46½	¾
R-11-008	40½ to 42½	½
R-11-007	44½ to 45½	¼
CPT-11-039	7½ to 8½; 24 to 30	¾
R-11-020	40½ to 41½	< ¼
R-11-002	6 to 8; 31 to 34	1¼
R-11-003	25½ to 29	1
R-11-036	34½ to 36	¼
R-11-037	4 to 7; 10 to 13½; 28½ to 31½	1¼
R-11-038	30½ to 41	1½
R-11-040	47½ to 50	½

4.2.3 Subsidence and Seismic Compaction

Subsidence typically occurs as a result of subsurface fluid extraction (e.g. groundwater, petroleum) or compression of soft, geologically young sediments. Groundwater extraction for high volume municipal and agricultural use has the potential to cause future ground subsidence in the region. However, we are not aware of subsidence in the area. No active petroleum wells

are present within many miles of the site (California Division of Oil, Gas and Geothermal Resources, 2001).

Compaction settlement, or seismic densification, occurs when loose granular soils above the water table increase in density as a result of earthquake shaking. The soil densification can result in differential settlement because of variations in soil composition, thickness, and initial density. Occasional layers of granular soils were encountered within the unsaturated fills. These granular layers may be subject to cyclic densification during strong ground shaking, resulting in compaction settlement. Use of cement deep soil mixing (CDSM) or equivalent ground improvement methods would reduce potential for seismic compaction to adversely affect new structures, pavement and underground utilities at the site.

4.2.4 Consolidation Settlement

Settlement occurs when soil is loaded by a structure or embankment fill. This settlement can occur quickly in unsaturated and free-draining soils, and it can occur gradually when pore pressures in saturated, low permeability soils, increased by vertical loading, gradually dissipate over time.

The Bay Mud and fat clays that underlie the site are very soft to medium stiff, have moderate to high compressibility, and are normally to slightly overconsolidated. We estimate that these clays will settle up to 17 inches under the weight of the proposed embankment fills (up to 22 feet high) beneath the tallest portions of the retaining walls and west approach embankment. Up to about 7 inches of settlement is estimated at the proposed Broadway Overcrossing abutments. Based on results of laboratory consolidation testing, we estimate that the settlement period to reach 90 to 95% consolidation of the Bay Mud and underlying fat clays would be about 3 to 4 years, well beyond the anticipated construction period of 180 days.

We anticipate that this settlement period could be shortened to 8 to 12 months with surcharging and wickdrains; however, the potential adverse effects of surcharge loads and resulting settlement on existing nearby structures and underground utilities which are to remain, should be considered.

Alternatively, the strength and compressibility characteristics of these underlying clays could be improved using cement deep soil mixing (CDSM) or equivalent. The magnitudes of the estimated settlements could also be reduced to tolerable amounts by using a lightweight embankment fill alternative such as expanded polystyrene (EPS) blocks.

4.2.5 Landslides and Lateral Spreading

Based on the relatively flat topography at the site, landsliding is not considered a hazard.

Liquefaction induced lateral spreading occurs on gentle slopes underlain by loose sands and shallow groundwater. When liquefaction occurs, the unsaturated overburden can slide as intact blocks over the lower liquefied deposit. Surface displacements proceed downslope or toward a steep free face, such as a stream bank, with the formation of fissures and scarps. The geologic conditions conducive to lateral spreading are frequently found along streams and other waterfronts in recent alluvial or deltaic deposits as well as in loosely placed, saturated sandy fills (Youd and Hoose, 1976).

As discussed in the liquefaction section of this report, pockets of potentially liquefiable fill were encountered at several of the exploration locations; in addition, potentially liquefiable native sands were identified below the Bay Mud at several exploration locations. Therefore, in our opinion, liquefaction induced lateral spreading is a potential hazard at the site.

The U.S. Geological Survey published a map with digitized locations of historic post-earthquake ground effects (Youd and Hoose, 1978, and Tinsley and others, 1998); this data is shown on the geologic map in USGS Open File Report 00-444 by Knudsen et al (2000). Based on review of these digitized locations, no historic failures have been documented at the project site, but sand boils were noted at a location about one mile east of the site following the Loma Prieta earthquake in 1989. In addition, settlement and ground cracking were noted about one mile northwest of the site following the 1906 earthquake.

Use of CDSM or equivalent extending through the potentially liquefiable soils across the project area would, in our opinion, reduce the potential for lateral spreading to affect new structures, pavements and underground utilities at the site.

4.3 FLOOD

The project site is located within the FEMA 100-year flood zone (Zone A) as shown on the ABAG Flood Hazard Map (2007). A copy of the ABAG flood hazard map is included as Figure 7.

Floodplain information on the project area is discussed in more detail in the Project Location Hydraulic Study Report (WRECO, 2011). The study identifies three areas of flooding potential as discussed below and as shown in Appendix G, an excerpt of the City of Burlingame Flood Insurance Rating Map.

The first problematic flooding area is in the vicinity of the northeastern landing of the Broadway Overcrossing. The source of this flooding is the relatively high tailwater elevation in the unlined channel northeast of the corner of Airport Boulevard and Bayshore Highway. The outfall from the storm drain system draining the flooded area is buried under the channel bottom. The combination of the high tailwater elevation in the channel relative to the storm drain system and the buried outfall prevents adequate conveyance, which results in water frequently ponding in the vicinity of the intersection of Bayshore Highway and Airport Boulevard.

Another area believed to experience flooding due to high tides is between the Crowne Plaza Hotel parking lot and the northbound US101 off-ramp to Airport Boulevard.

A third area subject to flooding is where overbank flow from Easton Creek has historically flooded an area between Bayshore Highway and the on-ramp from Bayshore Highway to northbound US101. However, the current interchange reconstruction project is expected to have no impacts on the existing floodplains.

4.4 SCOUR

The closest channel is Easton Creek which is more than 1,200 feet north of the interchange. Therefore, channel scour is unlikely to pose any risk to the interchange improvements.

5.1 STRUCTURAL SECTION DESIGN PARAMETERS

Structural pavement section designs described in the following paragraphs are based on the Caltrans Highway Design Manual (HDM), Chapters 600-670 "Pavement Engineering", last updated on May 7, 2012, and in particular Chapter 630 "Flexible Pavement".

Acronyms used in this section are defined in Section 2.1 "Original Construction".

5.1.1 Traffic Data

The projected traffic loading for the US 101/Broadway Interchange design is given in terms of traffic index (TI). The TI for a 20-year design life for the on- and off-ramps and local streets was determined by URS in agreement with Caltrans as discussed in the approved pavement selection review committee checklist, dated December 28, 2010 for the US 101/Broadway project. For US 101, the agreed upon TI was for a 40-year design life. The following TI values for the various segments of the project were established:

Table 5-1 Summary of Design TIs

Interchange Segment	Design TI
US 101 mainline	15
Broadway Interchange On-Ramps and Off-Ramps	11
Broadway and other local streets	11

5.2 SUBGRADE CONDITIONS

The existing fill and native subgrade conditions beneath the areas of the proposed roadway and ramp modifications were revealed by the exploratory borings listed previously in Section 3. Three bulk samples of the existing fill materials were selected for R-value testing; the test results are summarized in the table below and in Appendix E.

Table 5-2 R-Value Test Results

Boring	R-Value	Soil Description	Depth Interval (feet)	Control Line Designation	Stationing (feet)	Offset (feet)
A-11-021	48	Clayey Sand	2 to 5	"B1"	196+18	Left 9
A-11-028	24	Clayey Sand	2 to 5	"BWY"	25+19	Left 3

Caltrans defines an "expansive subgrade" as soil with a plasticity index (PI) greater than 12 and California R-value less than 10. On this basis, the majority of the upper 4 to 9 feet of native Bay Mud is considered highly expansive. Based on HDM, an expansive subgrade should be compensated with one of the following:

(a) Treating expansive soil with lime or other additives to reduce expansion in the presence of moisture. Lime is often used with highly plastic, fine-grained soils. When mixed and compacted, the plasticity and swelling potential of clay soils are reduced and workability increased, as lime combines with the clay particles. It also increases the California R-value of the subgrade. Soil treated with lime is considered to be lime stabilized subgrade.
(b) Replacing the expansive material with a non-expansive material to a depth where the seasonal moisture content that would remain nearly constant.
(c) Providing a pavement structure of sufficient thickness to counteract the expansion pressure, such as the existing fill sections below the US 101 travel ways and shoulders.

Further discussions of expansive subgrade are presented in Section 5.2.1.

Based on review of subsurface data in the upper 5 feet of exploratory borings, we developed the following subgrade design R-values for the various roadway alignments:

Table 5-3 Subgrade Design R-values

Alignment	Design R-value	Anticipated Subgrade Condition
US 101 Mainline (Fill thicker than or equal to 4 feet)	15	Fill of stiff to very stiff lean clay, sandy lean clay with gravel and clayey gravel
US 101 Mainline (Fill thinner than 4 feet)	5	Fill of stiff to very stiff lean clay, sandy lean clay with gravel and clayey gravel
On- and Off-ramps connecting Broadway (Fill thicker than or equal to 4 feet)	15	Fill of clayey sand and gravel to native highly plastic organic silt to fat clay
On- and Off-ramps connecting Broadway (Fill thinner than 4 feet)	5	Fill of clayey sand and gravel to native highly plastic organic silt to fat clay

5.2.1 Expansive Subgrade

Lime Stabilization

Representative samples of the Bay Mud were selected for a laboratory testing program to evaluate if subgrade improvements by lime treatment can be achieved in the soft, expansive native subgrade. Bulk samples from Borings A-11-030 and A-11-031 were combined with an additive of varying percentages of lime and tested in general accordance with California Test 373, “Unconfined Compressive Strength of Lime Treated Soils and Aggregates.” Five batches of the Bay Mud sample were mixed with lime, then, two specimens of each batch were remolded and cured prior to subjecting to unconfined compressive strength tests. The laboratory test results are summarized in Table 5-4.

Table 5-4 Bulk Sample California Test 373 (Modified) Results

Batch No.	Lime Percentage		Compaction Pressure (psi)	Average Unconfined Compressive Strength (psf)
	Incremental	Final		
1	3% 3%	6%	60	5802
2	5% 4%	9%	105	9504
3	9%	9%	70	6868
4	7% 5%	12%	130	12658
5	9% 6%	15%	270	16633

Four batches (Batch No. 1, 2, 4 and 5) were initially mixed with 3, 5, 7 and 9 percent of lime, and then cured for 24 hours. Then, additional lime was added to create the final percentage of 6, 9, 12 and 15 percent of lime. One batch (Batch No. 3) was mixed with 9 percent of lime once and then cured. The resulting unconfined compressive strengths vary from about 5,800 to 16,600 psf (40.3 to 115.5 psi).

One common approach in pavement design to substitute lime treated soils for a portion of aggregate subbase (AS) in flexible (HMA) pavement design. The actual thickness of AS to be substituted should be obtained by dividing the calculated gravel equivalent (GE) by the appropriate gravel factor (G_f) determined as follows, based on the unconfined compressive strength (UCS) in units of psi.

$$G_f = 0.9 + \frac{UCS}{1000}$$

According to HDM, the minimum G_f should be 1.2; this is equivalent to a UCS of 300 psi. Based on the above laboratory test results, the substitute for AS strategy is not feasible. However, the expansive potential of the Bay Mud should be reduced with a reasonable amount of lime additive, say about 3 percent lime.

Expansion Pressure Counteracting Pavement Structure

Another feasible option to address the expansive subgrade is to thicken the pavement structure section to counteract the expansion pressure of the Bay Mud. It is our experience that a minimum 4-foot thick pavement structural section underlain by non-expansive engineered fill should be capable of counteracting the expansion pressure.

Replacement of Bay Mud with Non Expansive Fill

Since Bay Mud is highly plastic, soft, and has a high moisture content, removal with standard excavation equipment will likely be problematic due to instability at the base. Some form of

stabilization would be required to provide a working platform for construction equipment. This will then be similar to the lime stabilization option.

Recommendations

For a majority of the new pavement section, the existing subgrade consists of 4 or more feet of shoulder structural pavement section plus engineered fill. For locations where the fill section is less than 4 feet, the option of lime stabilization should be employed. Therefore, we recommend the following 2 options to address the expansive subgrade issue:

1. For fill greater than or equal to 4 feet, structural pavement sections should be based on HDM using a design R-value of 15;
2. For fill less than 4 feet, the subgrade should be lime stabilized for a minimum depth of 18 inches, and then determine the minimum structural pavement section based on a design R-value of 5.

5.3 NEW STRUCTURAL PAVEMENT SECTIONS

5.3.1 Fill Greater Than or Equal to 4 feet over Bay Mud

Recommended Mainline Sections for US 101

Design Factors for SPCS 1, TI_{40} = 15.0, R-value = 15, GE (required) = 4.08 feet

Recommended Structural Section		
Structural Section (feet)		**Gravel Equivalent (feet)**
OGFC	0.10	N.A.
RHMA-G*	0.15	
HMA	1.75	4.25
CL2 AB	0.50	0.55
	Total	**4.80**

*According to HDM, RHMA or a PG-PM binder should be used for the top of the surface layer. Although, no RHMA is planned for the US 101 Auxiliary lane project from 3rd Avenue to Millbrae Avenue, the quantity anticipated for the interchange reconstruction should be enough for consideration. In addition, a performance graded-polymer modified (PG-PM) binder should be specified for OGFC layer. For Burlingame, the PG 64-28 PM should be used as shown in Table 632.1, HDM. This recommended section should be considered only when the pavement width is at least 4 feet, because of difficulty to achieve specified degree of compaction. For sliver widening less than 4 feet, the following alternative section of RHMA-G/HMA/LCB is recommended:

Recommended Structural Section Alternative		
Structural Section (feet)		**Gravel Equivalent (feet)**
OGFC	0.10	N.A.
RHMA-G	0.15	
HMA	0.85	1.81
LCB	1.30	2.47
	Total	**4.28**

Recommended Sections for On-Ramps and Off-Ramps

Design Factors for SPCS 2, TI_{20} = 11.0, R-value = 15, GE (required) = 2.99 feet

Recommended Structural Section		
Structural Section (feet)		**Gravel Equivalent (feet)**
RHMA-G	0.15	
HMA	0.40	0.95
CL2 AB	0.95	1.05
CL4 AS	1.00	1.00
	Total	**3.00**

Recommended Section for Broadway and Local Roads

Design Factors for SPCS 3, TI_{20} = 11.0, R-value = 15, GE (required) = 2.99 feet

Recommended Structural Section		
Structural Section (feet)		**Gravel Equivalent (feet)**
HMA	0.55	0.95
CL2 AB	0.95	1.05
CL4 AS	1.00	1.00
	Total	**3.00**

5.3.2 Fill Less Than 4 Feet Thick over Bay Mud

Recommended Mainline Sections for US 101

Design Factors for SPCS 4, TI_{40} = 15.0, R-value = 5, GE (required) = 4.56 feet

Recommended Structural Section		
Structural Section (feet)		**Gravel Equivalent (feet)**
OGFC	0.10	NA
RHMA-G*	0.15	
HMA	1.85	4.55
CL2 AB	0.50	0.55
SEG Class B2		NA
Lime Stabilized Soil Subgrade (LSS)	1.50	Assume no contribution
	Total	**5.10**

*Refer to Section 5.3.1.

For sliver widening less than 4 feet, the following alternative section of HMA over LCB is recommended:

Recommended Structural Section Alternative		
Structural Section (feet)		**Gravel Equivalent (feet)**
OGFC	0.10	N.A.
RHMA-G	0.15	
HMA	0.95	2.05
LCB	1.45	2.76
SEG Class B2		N.A.
Lime Stabilized Soil Subgrade (LSS)	1.50	Assume no contribution
	Total	**4.81**

Recommended Sections for On-Ramps and Off-Ramps

Design Factors for SPCS 5, TI_{20} = 11.0, R-value = 5, GE (required) = 3.34 feet

Recommended Structural Section		
Structural Section (feet)		**Gravel Equivalent (feet)**
RHMA-G	0.15	
HMA	0.40	0.95
CL2 AB	0.95	1.05
CL4 AS	1.35	1.35
SEG Class B2		N.A.
LSS	1.50	Assume no contribution
	Total	**3.35**

Recommended Section for Broadway and Local Roads

Design Factors for SPCS 6, TI_{20} = 11.0, R-value = 5, GE (required) = 3.34 feet

Recommended Structural Section		
Structural Section (feet)		**Gravel Equivalent (feet)**
HMA	0.55	0.95
CL2 AB	0.95	1.05
CL4 AS	1.35	1.35
SEG Class B2		N.A.
LSS	1.50	Assume no contribution
	Total	**3.35**

6.1 FOUNDATION TREATMENT

6.1.1 Clearing and Grubbing

Before any grading begins, all locations to be filled should be cleared of existing improvements (rails, posts, curbs, pavements, etc.), all debris, vegetation, and any soils containing roots or other vegetative matter in accordance with Section 16 of Caltrans Standard Specifications. A stripping depth of 4 to 6 inches is estimated in unpaved areas. The entire root ball of large shrubs should be removed, including all roots greater than 1 inch in diameter.

6.1.2 Subgrade Preparation

Immediately after existing guardrail posts have been removed, the resulting voids should be backfilled with slurry cement up to present ground surface in accordance with Caltrans Standard Specifications Section 19-3.02D "Slurry Cement Backfill".

All subgrades should be prepared in accordance with Caltrans Standard Specifications Section 25-1.03B "Subgrade" and 26-1.03B "Subgrade", except where Bay Mud is encountered. After the areas to receive fill have been cleared and stripped, the exposed subgrade soil should be scarified, moisture conditioned to near the optimum moisture content, and compacted to the requirements of fill to a minimum depth of 6 inches. When the subgrade has been compacted and approved by the Engineer, fill can be placed to provide the desired finished grades. When Bay Mud is exposed during subgrade preparation, the upper 18 inches of the Bay Mud should be stabilized with lime in accordance with Caltrans Standard Specifications Section 24-2 "Lime Stabilized Soil." Laboratory test results or samples of lime treated Bay Mud are presented in Table 5-4.

6.1.3 Fill Material

In general, material intended for use as fill should be a soil or soil/rock mixture that is free of organic matter and other deleterious substances in accordance with Section 19 of Caltrans Standard Specifications. In addition, these materials should have an R-value greater than 15 to be consistent with the design R-value used in pavement structural design. All import material should meet these requirements and should be approved by the Engineer prior to construction. Asphalt concrete and aggregate base that are pulverized to meet the size requirements for fill material detailed above, could be reused as fill. In our opinion, the Bay Mud and fat clays excavated from the project site should not be reused as engineered fill due to their expansive nature, i.e. potential to shrink and swell with moisture changes and difficult workability. A detailed discussion about the reuse of onsite soils is provided in Section 6.5 "Cuts and Excavations".

6.1.4 Fill Placement

All fill should be constructed in accordance with Caltrans Standard Specifications Section 19, entitled "Earthwork." Relative compaction of not less than 90 percent should be achieved in all fill materials, except where 95 percent is required.

6.2 ESTIMATED SETTLEMENT

6.2.1 Consolidation

Settlement occurs when soil is loaded by a structure or embankment fill placed on top of the soil. This settlement can occur quickly in unsaturated and free-draining soils, and it can occur gradually when pore pressures in saturated soils, increased by vertical loading, gradually dissipate over time.

The Bay Mud and fat clays that underlie the site are very soft to medium stiff, have moderate to high compressibility, and are normally to slightly overconsolidated. We estimate that these clays will settle up to 17 inches under the weight of the proposed embankment fills (up to 22 feet high) beneath the tallest portions of the retaining walls and west approach embankment. Up to about 7 inches of settlement are estimated at the proposed Broadway Overcrossing abutments. Based on results of laboratory consolidation testing, we estimate that the settlement period to reach 90 to 95% consolidation of the Bay Mud and underlying fat clays would be about 3 to 4 years, well beyond the anticipated construction period of 180 days during advanced planning study. Appendix H presents the settlement calculations along proposed Broadway Overcrossing and modifications along Bayshore Highway.

6.3 GROUND IMPROVEMENT METHODS

In order to shorten settlement periods where new embankment fill will be placed, we have considered two ground improvement methods, use of light weight fill or cement deep soil mix as discussed below. The goal is to expedite construction and to open the interchange for traffic as soon as possible.

6.3.1 Light Weight Fill

In this method, most of the proposed embankment soil fill is replaced with much lighter weight cellular concrete or Expanded Polystyrene Foam (EPS) blocks. For example, the moist unit weight of soil fill is on the order of 125 pounds per cubic foot (lb/ft^3), whereas cellular concrete (a commonly used light weight fill) is about 36 lb/ft^3 and EPS is about 2 lb/ft^3. In our estimate of embankment settlement using cellular concrete, we assumed a 2-foot thick HMA/AB/AS pavement section with an average moist unit weight of 145 lb/ft^3. In this method a lower moist unit weight is used for the fill, so the ultimate consolidation of the underlying Bay Mud, fat clay and lean clay layers results in a lower ground surface settlement.

Our estimates indicate maximum ultimate settlement for cellular concrete (single stage) (abbreviated as “cell conc” on plans) is about 7 inches beneath the tallest portions of the retaining walls and west approach embankment. Time to reach 90 percent degree of consolidation exceeds 24 months. Therefore, using cellular concrete exclusively is not a feasible option. However, at locations where the total load of cellular concrete could be compensated by excavating existing fill and native soils and replacing them with cellular concrete at a reasonable depth (5± feet), this is a viable alternative.

Because of the low unit weight of EPS blocks, the strategy to implement this option is to compensate the weight of the embankment by over-excavating the subgrade soils and replace

them with EPS blocks. For example, an embankment of 22 feet high should be compensated by about 2 feet of subgrade soil/fill over-excavation. Therefore, EPS block is a feasible settlement mitigation option from a geotechnical point of view. To minimize the potential damage from petroleum by-products on the EPS blocks, the top surface of the EPS blocks and exposed side slopes should be covered by a petroleum resistant geomembrane.

6.3.2 Cement Deep Soil Mix Method

Cement deep soil mixing (CDSM) is a process whereby soil is improved by injecting cement grout through one or more augers that simultaneously mix the soil, forming in-place soil-cement columns. CDSM is performed in a grid layout typically consisting of blocks of CDSM columns that are placed in rows (treatment zones) aligned parallel to the longitudinal axis of an embankment. The blocks consist of exterior and interior walls formed by adjacent CDSM columns. The matrix of treated soil should exhibit higher bearing capacity, lower compressibility (reduced settlement), and be less susceptible to liquefaction than untreated soil. Analysis of settlement and stability of CDSM improved soil is based on a composite material strength of soil and soil/cement mixture that is generally proportional to the ratio of treated to untreated soil.

The CDSM mix is designed by a specialty contractor. The improved properties of the CDSM treated soil is governed by a number of factors including soil type, slurry properties, mixing procedures and curing conditions. High strengths can be attained in the final soil-cement product, typically greater than 100 psi.

To minimize post-construction differential embankment settlement between adjacent CDSM treated elements (columns or panels), we recommend the following guidelines:

- For areas where fill loads are greater than or equal to 14 feet of normal weight fill, the spacing between CDSM columns should not exceed 7 feet;
- For locations where panels of overlapping CDSM columns are required, each column should overlap at least 20 percent of the adjacent column width;
- For areas where fill loads are less than 14 feet of normal weight fill, the spacing between CDSM columns should not exceed 4 feet.

The challenges associated with CDSM construction included space limitations for construction staging and rig operations, coordination during excavation and embankment reconstruction, assessing the effectiveness of the soil improvement, and evaluating the depth of penetration. Close coordination between the design team and the specialty CDSM contractor is important to avoid cost overruns and/or schedule impacts to the project.

To assess the effectiveness the CDSM improvement, a detailed monitoring and testing program should be established. The program, pre-production program (PPC), should include test sections utilizing several different mix designs with varied cement contents and water-cement ratios, varying improvement (soil/CDSM elements) ratios, monitoring of various parameters during CDSM construction, sampling and testing of recently mixed CDSM columns, unconfined compressive strength testing of selected CDSM cured samples, test borings prior to CDSM construction and/or adjacent to completed CDSM columns, and test of full-depth core samples of CDSM treated soil.

Specifications for CDSM construction are presented in Appendix J, Non-Standard Special Provisions.

6.4 MONITORING SETTLEMENT

To assist the Resident Engineer in determining the effectiveness of the CDSM construction, we recommend the embankment construction at the interchange be monitored in accordance with California Test 112, "Method for Installation and Use of Embankment Settlement Devices." As a minimum, two settlement monitoring devices should be installed at each abutment at "BWY" Stations 17+50 and 20+10. One device should be installed near the center of embankment, and the second one close to hinge point of the proposed embankment slope. Similarly, settlement monitoring should be conducted along control line "B2" for the longer walls RW 205 and RW 209. As a minimum, we recommend two settlement monitoring devices be installed along the wall alignment where fill height exceeds 10 feet. The approximate locations of these devices are summarized in Table 6-1.

Table 6-1 Proposed Locations of Embankment Settlement Devices

Control Line	Station	Offset (feet)
"BWY"	17+50	0
"BWY"	17+50	50 Lt
"BWY"	20+10	0
"BWY"	20+10	50 Lt
"RW 205 LOL"	11+50	5 Rt
"RW 209 LOL"	13+50	30 Rt

In addition, the potential impact of the embankment construction on the existing PG&E towers and buildings along the US 101 southbound off-ramp to Broadway should be monitored. Because of the critical nature of the PG&E towers, we recommend that all four footings supporting each of the three PG&E towers be surveyed prior to fill placement and wall construction, and then surveyed periodically during construction. The elevations should be measured daily during active placement of fill. Measurements should be conducted weekly after the completion of each stage of fill placement for a minimum of 3 months. A minimum of two locations, on the wall footings supporting each existing building along the US 101 southbound off-ramp be monitored in a similar manner to the PG&E tower footings, prior to fill placement and wall construction, and periodically during construction.

6.5 BOX CULVERT AT EASTON CREEK

The existing Easton Creek undercrossing (a twin box culvert, each with dimensions of 5 feet x 6 feet each) will be extended approximately 35 feet on the downstream end to accommodate new fill for roadway widening. Based on as-built plans for the original construction in 1946, the bottom of the extended box culvert was placed on imported fill that replaced soft Bay Mud. In

1995, the City of Burlingame implemented an Easton Creek improvement project by deepening the channel east of the box culvert to Bayshore Highway. The transition structure from the box culvert to the improved channel consists of a curtain wall along the southern bank of the channel; the wall is reportedly supported on 24-inch diameter drilled piers with tip at Elevation -12 feet.

To investigate the subsurface condition of the planned extension, Boring R-11-001 (located south of planned culvert extension) was drilled to a terminal depth of 50 feet. Five feet of silty sand fill was encountered overlying soft Bay Mud that extends to a depth of 19 feet bgs. The lean clay deposit below the Bay Mud ranges from soft to stiff, extending to about 29 feet bgs. Granular deposits consisting of medium dense to dense clayey sand with gravel underlie the lean clays extending to about 48-½ feet bgs. The granular deposits are underlain by stiff to very stiff lean clay that extends to the terminal depth of the boring at 50 feet bgs. Free groundwater was observed at about 15 feet bgs at the time of drilling. It is our opinion that the soils encountered in Boring R-11-001 are not susceptible to liquefaction.

Soft Bay Mud was encountered at the invert elevation (Elevation 5 feet) in Boring R-11-001. To bridge the soft subgrade, a layer of geotextile bridging fabric such as Mirafi 600X covered with a 2-foot thick section of ¾ -inch to 6-inch bridging material should be provided. Bridging material conforming to the following grading requirements has been successfully used on a number of projects on the Peninsula and in the South Bay:

Sieve Size (U.S. Standard)	Percentage Passing
6 inches	100
2 inches	0-50
¾ inch	0-10

Durability Index = 40 minimum

Based on our calculations and field exploration, we estimate a total settlement of 1 inch for the new box culvert extension, and estimate differential settlement of about 1 inch at the connection between the existing and new box culvert. These estimates are based on the assumption that two feet of bridging fabric and rock will be provided over the Bay Mud as discussed above.

The base of the excavation (about Elevation 3 feet) is expected to be soft and unable to support construction traffic. Disturbances of the subgrade during construction could lead to substantially larger settlements than those tolerable for design. To minimize disturbance, we recommend that the last 2 feet of excavation be made by equipment supported above the base of the excavation. This might be accomplished with a backhoe excavating from locations at least 2 feet above final subgrade or with a dragline from outside the excavation. All dewatering should be installed before the final 2 feet of soil is excavated.

The Geotechnical Engineer should be retained to observe the excavation and box culvert foundation construction. If any undesirable conditions are encountered, additional recommendations could be provided.

The culvert should be designed for the load factors recommended in Caltrans Standard Plans D82. The load factors include earth pressures for two conditions: (1) 140 lb/ft^3 vertical with 42 lb/ft^3 horizontal; and (2) 140 lb/ft^3 vertical with 140 lb/ft^3 horizontal. The structure should be designed to resist each earth loading condition, as well as HS 20-44 truck loading, including impact. These load values were developed by Caltrans based on extensive studies including

strain gauge measurements on culvert walls and load cells on the soil outside of the culverts. The two conditions represent the range of horizontal pressures, long term as well as immediately after construction.

6.6 CUTS AND EXCAVATIONS

In all on-ramp and off-ramp areas, fill heights of more than 7 feet are currently planned. Near the bridge abutments, an approach fill height up to 25 feet is expected.

Other than the Easton Creek box culvert extension, no significant cuts are anticipated to accommodate the on- and off-ramp modifications at the interchange. Because of their high moisture and organic contents, and expansive nature, i.e. potential to shrink and swell with moisture changes, the native fat clays and Bay Mud do not meet the expansion index and sand equivalent requirements for embankment fill. For that reason, they are considered to be unsuitable material pursuant to Standard Specification Section 19-1.01B.

It should be noted where 2011 borings encountered fill, the fill materials generally consisted of clayey sand (with gravel), sandy lean clay (with gravel), clayey gravel, lean clay (with gravel); therefore onsite fat clays were not reused in the existing roadway subgrade fill.

It is also likely that free ground water would be encountered in the bottom of the proposed box culvert invert excavation.

6.7 EMBANKMENTS

The planned fills should be constructed in accordance with Caltrans Standard Specifications Section 19, entitled “Earthwork”. The undesirable materials should be removed in accordance with Caltrans Standard Specifications Section 16, “Clearing and Grubbing”.

Consistent with Caltrans standards, the proposed slope inclinations of new embankments throughout the project are 4H:1V. However, in constrained locations, embankment slopes as steep as 2H:1V are proposed. In our opinion, the existing embankment and foundation soils are capable of being inclined at these proposed slope inclinations provided that the new embankment fills are constructed in accordance with the recommendations of this report and Caltrans Standard Specifications.

6.8 EARTHWORK FACTORS

Relatively shallow excavations (less than 6 feet) and fill heights up to 25 feet are anticipated. A majority of the cut materials will be generated by excavating the basins as well as removal of existing shoulder and median to allow for placement of the new traveled way pavement structural sections.

In general, no apparent distress was observed in median shoulder pavements. Assuming that the existing pavement structural sections were constructed in accordance with Caltrans Standard Specifications, it is likely that the pavement structural sections were constructed on well compacted subgrade. Based on unit weight tests performed in our laboratory on samples recovered from our borings, the subgrade materials appear to exhibit moderate to high in place density. Based on our field observations, laboratory testing, and our engineering judgment and experience, an earthwork factor of 1.0 should be used for existing asphalt concrete, aggregate

base materials and granular soil fill used for fill material compacted to a relative compaction of 95 percent.

6.9 DRAINAGE PIPELINES AND SANITARY SEWERS

6.9.1 Drainage System 7 and Sanitary Sewer Systems 1, 2, 3, 4 and 5

Drainage System 7

The location of proposed Drainage System 7 (24-inch reinforced concrete pipe) is shown on Drainage Plan Sheets D-2 and D-3. As shown, System 7 is parallel to retaining wall RW 205, along the toe of the wall. The distance between the wall face of RW 205 and the centerline of System 7 ranges from less than 5 to about 25 feet. The portion of System 7 that is less than 5 feet from the wall face is offset from B2 Line, between approximately Stations 208+50 and 212+50. Based on Drainage Profile Sheets DP-7 and DP-8, the invert of System 7 is about 3 to 6 feet below existing ground surface and future finish grade. Because of the shallow depth to pipe invert, we anticipate this pipeline to be installed by the open cut and cover method.

Sanitary Sewer Systems 1, 2, 3, 4 and 5

The location of proposed Sanitary Sewer (SS) System 1 along Nerli Lane and Rollins Road is presented on Sanitary Sewer Plan Sheet SS-6. The locations of proposed Sanitary Sewer Systems 2, 3, 4 and 5 are along the southeastern edge of Bayshore Highway and are shown on Sanitary Sewer Plan Sheets SS-7. The proposed SS Systems 1, 2, 3, 4 and 5 are 24-inch, 30-inch, 6-inch, 16-inch and 8-inch diameter pipes, respectively. Based on Sanitary Sewer Profile Sheet SSP-1, the new System 1 will follow Rollins Road and cross Broadway; the embedment depths range from 12 to 20 feet. Based on Sanitary Sewer Profile Sheets SSP-1 and SSP-2, the new pipelines for Systems 2 to 5 will cross under Airport Boulevard and be embedded underneath the new eastern approach embankment to the reconstructed Broadway Overcrossing. The invert of the new sanitary sewer systems will be about 5 to 10 feet below existing ground surface. Across the new approach embankment, the height of new fill above original ground surface will be about 7 feet. Therefore, SS Systems 2 to 5 would be 12 to 17 feet below future finish grade.

Since SS System 1 crosses underneath Broadway Avenue with invert depth of about 20 feet, and assuming construction staging for cut and cover method would be challenging, we anticipate that the bore and jack method could be a cost effective installation alternative for this pipeline as discussed in Section 6.9.4. For the invert depth of 20 feet, soil conditions revealed in Boring R-11-020 consist of clayey sand fill from ground surface to 7 feet, underlain by lean clay from 7½ to 8½ feet, organic fat clay (Bay Mud) from 8½ to 14½ feet, lean clay from 14½ feet to 20 feet, and clayey sand from 20 to 28 feet. At nearby borings R-11-010 and R-11-040, groundwater was encountered at depths of 12½ and 11 feet during drilling.

Because of the shallow invert depths of SS Systems 2 through 5, we anticipate the pipelines to be installed by the open cut and cover method.

6.9.2 Soil Loading on Pipe (Marston Coefficient)

The structural design of a rigid pipeline requires that the supporting strength of the conduit, as installed, be divided by a suitable factor of safety that must equal or exceed the loads imposed on it by the weight of the earth above it and the weight of any superimposed loads. Recommended soil loading criteria are summarized in this section of the report.

The earth load is the weight of the earth on the pipe and varies depending on the soil characteristics and the installation conditions. The geometric configuration of the buried pipeline, with respect to the surrounding natural ground surface, is used to determine whether the soil loading parameters for either a "trench condition", "embankment condition", or a combination of the two might apply.

A trench condition typically applies when a pipeline is constructed in a ditch or trench that is excavated in natural or undisturbed soil, and then covered by refilling the trench to the original ground surface. This construction procedure is often referred to as "cut and cover" or "cut and fill".

An embankment condition will apply when the trench wall friction does not affect the load on the pipe, for example, if the pipe is covered with fill above the original ground surface, or if the trench in undisturbed ground is very wide. The embankment classification is further subdivided into two major sub-classifications: positive projecting and negative projecting. Detailed definitions of the various loading conditions may be found in the ASCE Manual of Practice on "Design and Construction of Sanitary and Storm Sewers" (1986).

Trench Conditions

We anticipate that a trench condition as discussed above will apply to this project. For a trench condition, the recommended Marston coefficient curve and applicable pipe loading equations for rigid or flexible pipe are presented in Figure 8. In preparation of Figure 8, a kμ value of 0.110 was assumed, which corresponds to a saturated clay material (where k= Rankine's ratio of lateral pressure to vertical pressure, and μ= the coefficient of internal friction of backfill material). In our engineering judgment, this represents the soil type for most of the pipeline alignments and should therefore be used for all of the project design. We estimated the kμ based on a saturated condition, assuming conservatively that the groundwater level could rise above the pipe invert. There are some areas where granular materials exist, and the pipe load would therefore be less in these areas. However, it would be impractical to locate and design for these areas. Therefore, we recommend that the entire pipeline be designed for a kμ value of 0.110.

Embankment Conditions

For reference, the recommended Marston coefficient curve for embankment conditions, positive projecting conduit, is presented in Figure 9. In preparation of Figure 9, kμ values of 0.19 (for a positive settlement ratio) and 0.13 (for a negative settlement ratio) and $r_{sd}p$ values ranging from less than -1.0 to more than +2.0 were assumed. The projection ratio, p, is defined as the ratio of the distance that the top of the conduit projects above 1) the adjacent natural ground surface, 2) the top of thoroughly compacted fill, or 3) the bottom of a wide trench, to the vertical outside height of the pipe. It is a physical factor that can be determined in final design when the size of the pipe and the invert elevation has been established. The projection ratio, p, should be selected

by the designer. Recommended design values of r_{sd}, based on measured settlements of a number of actual conduits (ASCE, 1986) are presented in Table 6-2.

Table 6-2 Design Value of Settlement Ratio, r_{sd}

Type of Conduit	Soil Conditions	Settlement Ratio, r_{sd}
Rigid	Rock or unyielding foundation	+1.0
Rigid	Ordinary foundation	+0.5 to +0.8
Rigid	Yielding foundation	0 to +0.5
Rigid	Negative projecting installations	-0.3 to -0.5
Flexible	Poorly-compacted side fills	-0.4 to 0
Flexible	Well-compacted side fills	0

For estimation of loads on the pipe (for conceivably raising the existing grade), the recommended Marston coefficient curve and applicable pipe loading equation for embankment conditions, negative projecting conduit, are presented in Figure 10. In developing Figure 10, a settlement ratio of -0.3 and projection ratios of 0.5, 1.0, 1.5 and 2.0 were used to develop the family of curves shown on the figure. The basis for selecting a settlement ratio (r_{sd}) of -0.3 is as follows. According to ASCE Manual of Practice on "Design and Construction of Sanitary and Storm Sewers" (1986), "Present knowledge of the value of the settlement ratio which may develop in these special cases is very meager. A design value of -0.3 is recommended temporarily." We recommend that a total unit weight of 140 pounds per cubic foot be assumed for the native soil or imported backfill when calculating earth loads on the entire length of the pipeline.

Surcharge Loading on Pipeline

The pipeline will be subject to temporary surcharge loads during construction, as well as permanent surcharge loads over time. Permanent surcharge loads are considered to be those imposed by the adjacent off-ramp embankment and vehicular traffic. Upon completion of the project, vertical loads will be transmitted through the soil to the pipe. Figure 11 presents anticipated vertical surcharge pressure versus height of cover over top of pipe due to various AASHTO HS-20 and alternate highway live load configurations, with a 50 percent provision for impact. To obtain the load per lineal foot of pipe, multiply the vertical pressure obtained from Figure 11 by the outside diameter (width) of the pipe, B_c. This load should be added to the earth loads determined from Figures 8, 9 and 10. If other surcharge loads are anticipated, the Geotechnical Engineer should be contacted for supplemental recommendations.

Temporary surcharge loads refer to those applied only during construction and include spoil piles, construction equipment, men and materials. The pipe should also be designed for the expected loads to be incurred during construction.

6.9.3 Settlement Due to Embankment Fill

As discussed in Section 6.2, loads due to new embankment fill along the US101 southbound off ramp and Airport Boulevard could induce long term ground settlement affecting the performance

of underground drainage and sanitary sewers such as Drainage System 7 and SS Systems 2, 3, 4 and 5. To minimize adverse effects of ground settlement, we recommend that CDSM ground improvement techniques, as discussed in Section 6.3, be employed prior to installation of the drainage and sanitary sewer pipelines.

Based on preliminary evaluation, we recommended the general depths of CDSM to be about 25 feet below existing ground surface where new loads are proposed. Deeper depths of improvement are proposed at bridge abutments and adjacent to existing PG&E towers; more detailed discussions regarding CDSM improvement are presented in the companion structures foundation reports. If the underground drainage and sanitary sewer lines are within the improved zones (within a depth of 25 feet from existing ground surface), then the CDSM improvement could be implemented in one of two ways:

1. Improve with CDSM from a depth of 25 feet to existing ground surface, and then excavate trenches with cut and cover method within the improved zone to install the drainage and sanitary sewer lines.
2. Within the trench limits of planned drainage and sanitary sewer lines, improve with CDSM from a depth of 25 feet to the invert level of the pipelines. Then, install the pipeline utilizing cut and cover method within the proposed trench limits. Outside the utility trenches, CDSM improvements should be from the recommended depth of 25 feet to the existing ground surface.

With proper implementation of the CDSM improvements, we estimate post-construction settlement along Drainage System 7 would range from ¼ to ½ inch. For the SS Systems 2, 3, 4 and 5, we estimate post-construction settlement would be on the order of ½ to ¾ inch.

6.9.4 Trenchless Construction Method

Since open cut trenching could be problematic along SS System 1 at the Broadway crossing, the Contractor should submit a trenchless construction method based on soil and groundwater conditions, buried existing utilities and surface constraints at the pits and along the alignment. Potential trenchless construction methods considered include pipe ramming, pipe jacking, microtunneling, and horizontal directional drilling, as discussed below.

Such systems are available to install almost any size pipe from about 1 to 10 feet in diameter. It should be noted that in North America the definition of microtunneling has been expanded to include all remote-controlled pipe jacking operations, while in Europe, the definition of microtunneling is limited to non-person entry pipe sizes, which are typically less than about 3 feet in diameter, as discussed below.

Pipe Ramming

Pipe ramming is a trenchless construction method that uses pneumatic percussive blows to advance an open-ended pipe that allows the soil to enter the pipe interior as it advances through the ground. Spoil removal from inside the pipe may be performed by auger, compressed air, or water jetting, and may be done after the entire pipe length is in place, or spoil may be removed before installation is complete to reduce the ramming force required. Pipe ramming is "not-steerable," meaning that subsurface obstruction or improperly aligned pipes may result in significant deviations from the desired line and grade.

Bore and Jack

Bore and jack method involves installing a pipeline by pushing pipe sections through the ground with hydraulic jacks assembled in a jacking frame located in a shaft excavation called the jacking pit. This involves constructing the tunnel in a one-pass method by which the casing pipe is pushed directly behind the wheel cutter. The spoils fall into a drum located behind the cutter head and are transported from the tunnel via a conveyor system. These machines are steerable in any direction and use laser guided sights to maintain line and grade. If needed, following the installation of an initial casing for ground support, the final carrier pipe can be constructed safely within the casing.

Microtunneling

Microtunneling is distinguished from pipe ramming and pipe jacking in several ways: 1) microtunneling utilizes remotely controlled equipment that does not require personnel to work underground, 2) microtunneling machines have sophisticated computer controlled guidance systems which are capable of more accurate control of line and grade, and 3) microtunneling machines have the capability to control groundwater inflows and minimize loss of ground without the need for dewatering or ground improvement. The pipe is then installed using pipe jacking techniques similar to those described above.

Microtunneling machines can generally be divided into two categories: slurry machines and auger machines. In a slurry machine, soil excavated by the cutterhead of the machine passes through slots or ports where it is mixed with slurry in a chamber at the front of the machine. The spoil-slurry mixture is pumped to the jacking pit through slurry discharge pipes, installed inside the jacking pipe string and is discharged to a surface separation plant to remove spoil.

Conversely, an auger machine relies on a continuous flight auger to convey the excavated soil from the face to the jacking pit. The tunnel face is supported by an earth pressure that results from holding the excavated spoil under pressure in a chamber between the cutterhead and bulkhead. A plug is formed in the chamber by forcing the excavated spoil into the chamber and compacting it.

One advantage to using microtunneling methods is the ability to complete successful pipeline installations where other methods might not be successful. In unstable soil conditions, such as saturated sand and gravel deposits, special microtunneling equipment can be used to safely install the pipeline without the need for dewatering and without excessive loss of ground and surface settlement.

In general, slurry machines are more appropriate for clean, saturated sand and gravel deposits because they can handle higher groundwater pressures and also provide more precise pressure regulation at the cutterhead that is needed to control loss of ground in these deposits. Auger systems are used mainly for cohesive silts and clays because these materials are capable of forming an impervious plug in the chamber that can resist the hydrostatic pressure.

Mixed face conditions consist of soil and rock in the heading at the same time or, in some cases, two soils with extremely different physical properties in the heading at the same time. A mixed face of soil and rock can result in steering difficulties because the machine will tend to ride up the rock contact following the path of least resistance. The best approach to dealing with these potential problems is to avoid a mixed face of soil and rock if at all possible.

Horizontal Directional Drilling

Another trenchless construction method that is commonly used is horizontal directional drilling (HDD). HDD methods utilize a guided drilling bit to drill a pilot hole which is subsequently enlarged with various reaming tools. After the hole has been enlarged to the required size, the pipeline is pulled back into the hole in a single operation. Both microtunneling and HDD methods have advantages and limitations that need to be recognized. For example, HDD methods are not generally feasible in soils having a gravel content more than about 50 percent, soils with cobbles and boulders, and in hard rock, stronger than about 12,000 psi. HDD is feasible along SS System 1 as the encountered gravel content is less than 10 percent at pipe depth in Borings R-11-010, R-11-020 and R-11-040.

Geotechnical Engineering Considerations

Selection of the right equipment for the project depends on determining equipment requirements that are compatible with the subsurface conditions that will be encountered during construction. Because of this, it is extremely important to have a thorough understanding of the subsurface conditions and the physical properties of the soils that will be encountered. There are various types of cutterheads that can be used to adapt these machines to a wide range of ground conditions including sand and gravel, stiff clay, cobbles and boulders, and rock. For these reasons, we recommend that additional field exploration be performed near/on the proposed SS System 1 alignment. At present, Borings R-11-020, R-11-010 and R-11-040 are located about 120 to 200 feet from the pipeline crossing. Therefore, we recommend that two additional borings, each 25 feet deep, be drilled on/near the outside edge of each shoulder. Continuous sampling is recommended.

Evaluation of Trenchless Construction Methods

Key issues that should be considered when developing a preliminary construction cost estimate are as follows:

- Soil and groundwater conditions
- Potential for excavation to encounter cobbles, rock, timber debris, tree roots, old foundations, or other obstructions
- Potential presence of contaminated soils and/or groundwater
- Casing requirements
- Pipe/casing sizes and materials
- Total length of project, number of drives, and maximum drive lengths
- Line and grade tolerances
- Required jacking loads
- Shaft sizes, depths, and groundwater control requirements
- Site layout, staging area, site access, and traffic control
- Equipment requirements and production rates
- Slurry separation requirements; spoil and slurry disposal sites

In addition, the following items should be considered in the planning of the project in order to develop a realistic cost estimate:

- Project set up
- Power supply

- Water supply
- Existing utilities
- Staging areas
- Traffic control and site access

The pipeline invert for SS System 1 will be positioned at a depth of about 20 feet below finished ground surface, or about Elevation -2 to -5 feet. At these depths, medium stiff to stiff lean clay and lean clay with sand were encountered in Borings R-11-010, R-11-020 and R-11-040. Groundwater was encountered at Elevation -0.5 to 4 feet, and is about 6 feet above the assumed pipe invert Elevation -2 feet.

Based on the site surface and subsurface conditions, we offer the following comments:

- Construction dewatering will be required at invert depth of 20 feet bgs.
- Pipe ramming is not advisable for this site because significant deviations from desired line and grade may result.
- HDD, pipe jacking or microtunneling are feasible methods from a geotechnical point of view; cost may then be a key consideration.

After the additional exploration is completed, the boring records should be included in this document and the discussion in Section 6.9.4 should be modified to include our findings.

Jacking and Receiving Pits

This crossing will also require construction of two access shafts (jacking and receiving) or pits to provide an area to mobilize equipment for this trenchless operation, remove spoils and install the pipeline. These access shafts should be located in accordance with applicable right-of-way requirements.

The design of the shoring system at jacking and receiving pits, as well as design of the jacking system, should be performed by a California Registered Civil or Structural Engineer, retained by the Contractor, and submitted to the Engineer prior to its implementation. Furthermore, the Contractor should retain a California Registered Civil Engineer to provide shoring design parameters.

Where shaft or pit excavations are supported with temporary shoring, some settlement of the adjacent ground surface should be anticipated. If these shored excavations are placed in a paved street or highway, cracking and settlement of the adjacent pavements should be anticipated. The project specifications should require restoration of these damaged pavements, curbs and gutters to their preconstruction condition.

At the base of the jacking and receiving pits, the Contractor should consider installing a working platform to stabilize the subgrade. Based on the logs of R-11-010, R-11-020 and R-11-040, the pit subgrade soils are anticipated to be medium stiff to stiff lean clay. The subgrade could become disturbed and weakened when exposed. Therefore, the subgrade should be stabilized by placement of a minimum thickness of 12 inches of ¾ inch drain rock encapsulated in a layer of high strength geofabric such as TC Mirafi 600X or equivalent. As an alternative, a lean concrete rat slab (seal course) could be placed on the subgrade.

Pipe Jacking Considerations

The pipe should be designed to accommodate the axial jacking stresses, as well as the earth loads imposed due to the full overburden pressure. The use of the full overburden pressure is recommended since the depth of the pipe is too shallow to result in a pressure reduction due to soil arching. The excavation method should be selected by the Contractor.

6.10 NEW OVERHEAD SIGN

6.10.1 Subsurface Conditions and Geotechnical Design Parameters

One new overhead sign is planned on the shoulder of US 101 southbound Station 501+80 (Sign SS2-A). CPT-11-039 was advanced near the planned location of the new sign. Based on the CPT sounding, the upper 9 feet of sandy silt to clayey silt was underlain by very soft organic clays (most likely Bay Mud) to a depth of 19 feet. Below this depth, to the terminal depth of the CPT, are deposits of medium stiff clay embedded with layers of sandy silt from a depth of 22 feet to 33 feet. Based on the pore pressure dissipation test, groundwater was measured at a depth of 5½ feet (Elevation 6.5 feet). We estimate the liquefaction induced settlement in the sandy silt deposit to be about ¾ inch.

Based on as-built information on an existing overhead sign (Station 154+00) constructed in 2011 for the US 101 Auxiliary Lanes project, it is our opinion that the Standard Plan CIDH pile foundation is feasible. However, the relatively low shear strength of the Bay Mud from about Elevation -4 to -14 feet, the length of the Standard Plan 60-inch diameter CIDH pile should be extended longer than the tabulated pile depth of 25 feet. For pile analysis, we assume the following loads at the top of the pile:

Table 6-3 Overhead Sign Structure Foundation Design Loads

Sign Number	Approximate "C" Station Location	Axial Compression (kips)	Shear at Base of Sign Post (kips)	Moment at Base of Sign Post (kip-ft)	Estimated Liquefaction Settlement Induced Downdrag (kips)
SS2-A	501+80 Rt. (Facing SB Traffic)	25	30	600	65

For friction piles, negative skin friction due to downdrag resulting from earthquake induced liquefaction settlement should be incorporated to the ultimate frictional resistance. As discussed in Section 4.2.2, "Liquefaction," CPT-11-039 revealed potentially liquefiable layers at depths from 7½ to 8½ feet and from 24 to 30 feet. Based on our analysis of lateral pile capacities, assuming the shear and moment presented above, we recommend the CIDH pile extend to a minimum embedment depth of 35 feet.

6.10.2 Construction Considerations

The subsurface conditions encountered in the overhead sign CPT consists primarily of clay with granular seams. Groundwater was encountered at about Elevation 6.5 feet. In cohesive soils as generally encountered, a fairly long time would be required for the groundwater to seep into the bore hole and attain an equilibrium position with long-term hydrostatic groundwater table. Thus, the immediate readings obtained may or may not be representative of the actual groundwater table level. Furthermore, seasonal fluctuations in groundwater levels should be anticipated throughout the year. To minimize the potential for sloughing due to yielding in the the soft Bay Mud between a depth of 9 and 19 feet, we recommend that the Contractor use temporary casing during installation of CIDH piles at Sign SS2_A to minimize the risk of caving. The casing should be withdrawn from the hole slowly as the concrete is being placed; a minimum head of concrete of 3 feet should be maintained in the casing at all times. The CIDH pile should be installed under the direct observation of the Geotechnical Engineer. Temporary casing should have a diameter at least 8 inches larger than the specified diameter of the CIDH piles; for example, a 68-inch diameter temporary casing should be used for a standard plan (Sheet S7) 60-inch diameter CIDH pile.

7.1 CORROSION INVESTIGATION

V&A was retained by URS to perform a soil corrosivity evaluation within the project limits with regards to the construction materials to be selected. V&A performed in-situ soil resistivity testing and interpreted the field data collected. In addition, V&A interpreted the corrosivity test results on selected boring samples from the analytical lab analysis performed by Cooper Testing Laboratory in Palo Alto, CA. Appendix I presents a copy of the report that includes the field data collected, the test methods used to perform the in-situ soil resistivity testing, laboratory analysis and lab test results, and the analysis of the tests performed.

The investigation was conducted in accordance with California Department of Transportation's Division of Engineering Services, Materials Engineering and Testing Services Corrosion Technology Branch "Corrosion Guidelines" (Guidelines) dated September 2003, and CALTRANS Memo to Designers 3-1, July 2008 (Memo). Based on the results obtained, and according to the Guidelines and Memo, the soil samples tested are considered to be corrosive to reinforced concrete structures and steel piles. This conclusion is based on the values of minimum soil resistivity, pH, sulfates and chlorides.

The results of the minimum soil resistivity, pH, sulfate and chloride concentration of 14 soil samples and Easton Creek water sample are presented in Table 7-1.

Table 7-1 Soil and Water Corrosion Test Results Summary

Boring No.	Depth (ft)	Minimum Resistivity[2] (ohm-cm)	pH[3]	Chloride Content [1,4] (mg/kg)	Sulfate Content [1,5] (mg/kg)
A-11-002	2.5-5	1,236	8.8	92	434
A-11-004	2.5-5	622	8.3	528	900
A-11-020	5-6.5	3,566	8.3	<2	6
A-11-023	2-5	198	8.2	2,034	447
A-11-030	3-6.5	114	7.8	6,739	2,606
A-11-031	3-6.5	90	7.7	3,284	425
R-11-005	3.5-5	1,151	7.9	90	542
R-11-007	5-7	1,952	7.9	13	6
R-11-008	5-7	2,517	8	<2	132
R-11-010	5-7	1,768	7.7	24	5,391
R-11-011	0-6	1,252	8	246	9
R-11-011	55-60	719	7.7	341	9
R-11-014	5-6.5	1,328	7.6	181	8
R-11-014	57-58	2,829	8	43	<5
R-11-017	5-7	561	7.7	451	272
R-11-018	10-11.5	131	8	4965	786

The following information is provided as reference for the preceding Table 7-1:

1. mg/kg – milligrams per kilogram (ppm)
2. Minimum resistivity by Caltrans Method 643
3. pH by Caltrans Method 644
4. Chloride by Caltrans Method 422-modified
5. Sulfate by Caltrans Method 417-modified

7.1.1 Conclusions

- Six soil boring samples (A-11-004, A-11-023, A-11-030-2-4, A-11-031-2-3, R-11-018-2-2, and B-31) had soluble chloride concentrations greater than 500 mg/kg. Two soil boring samples (A-11-030-2-4 and R-11-010-1-3) had soluble sulfate concentrations greater than 2,000 mg/kg. According to the Caltrans Corrosion Guidelines, these soils are *corrosive* to buried reinforced concrete structures.
- The Easton Creek water has a chloride content of 11,600 mg/kg (ppm) and a sulfate concentration of 2,030 mg/kg (ppm). This water is considered to be corrosive to buried reinforced concrete structures according to the Caltrans Corrosion Guidelines.
- Three soil samples were taken within about 75 feet of the proposed box girder structure over the PG&E high-voltage tower foundations at the US 101 southbound on-ramp. Of these three, one (R-11-018-2-2) had a water-soluble chloride content of 4,965 mg/kg (ppm), which is considered *corrosive* to buried reinforced concrete structures per the Caltrans Corrosion Guidelines.
- The project site is within 1,000 feet of salt water or brackish water.

7.1.2 Recommendations

General

- Corrosion protection against a marine atmosphere is required by the *Corrosion Guidelines* for above-ground reinforced concrete structures at the proposed box culvert and box girder locations.
- Design of structures installed in these locations should include corrosion mitigation measures as detailed below.

Buried Reinforced Concrete Structures and Driven Concrete Piles

Buried concrete structures and driven reinforced concrete piles should be constructed of durable concrete as described in ACI Standards 201.2R and 222R and Chapter 850.3, “Corrosion,” of the Caltrans Highway Design Manual (last updated September 28, 2011). Criteria for protecting reinforced concrete structures under corrosive conditions discussed in Caltrans Standard Special Provision (SSP) S8-C04, “Corrosion Control for Portland Cement Concrete” (a modification of Bridge Design Specifications, Section 8, “Reinforced Concrete”), should be followed for the Easton Creek box culvert and the box girder structure at the proposed US 101 southbound on-ramp. These recommendations include, but are not limited to, the following for reinforced concrete in corrosive soil or exposed to corrosive water:

- The following concrete compositional requirements are recommended per the Caltrans Standard Specifications updated July 28, 2011, Section 90-1.02H, “Concrete in Corrosive Environments”:
  - The cementitious material used in the concrete must be a combination of Type II or Type V Portland cement and SCM (supplementary cementitious materials).
  - The concrete must contain at least 675 pounds of cementitious material per cubic yard.

  - The reduction of cementitious material content specified in Section 90-1.02E(2) is not allowed.
  - The specifications for SCM content in Section 90-1.02B(3) do not apply.
  - The cementitious material must be composed of one of the following by weight:
    - 25% natural pozzolan or fly ash with a CaO content of up to 10%, and 75% Portlandcement.
    - 20% natural pozzolan or fly ash with a CaO content of up to 10%, 5% silica fume, and 75% Portland cement.
    - 12% silica fume, metakaolin, or UFFA (ultra-fine fly ash) and 88% Portland cement.
    - 50% GGBFS (ground granular blast furnace slag) and 50% Portland cement.
  - A maximum water-to-cementitious material ratio of 0.40 shall be used in the concrete.
- Concrete sealant (silane) shall not be allowed as an option for concrete in a corrosive environment.
- A minimum concrete cover of 3 inches for a 50-year design life, and 4 inches for a 75-year design life, shall be applied over all steel reinforcement. This is based on a soil water-soluble chloride concentration of 5,000 to 10,000 mg/kg (ppm) for buried reinforced concrete above the groundwater table.

  This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete Cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.

- Sand and water used in concrete mixtures should contain a maximum of 100 mg/kg (ppm) of water-soluble chloride ions and water-soluble sulfate ions. Sand and water pH shall be between 6.5 and 8.0. Potable water should be used in all concrete mixtures.

Reinforced Concrete Exposed to Marine Atmosphere

- Above-ground reinforced concrete structures within 1,000 feet of brackish or salt water are exposed to a corrosive marine atmosphere. The following minimum concrete cover over unprotected reinforcing steel is recommended for the concrete structures listed below:
  - 3 inches concrete cover for the following:
    - Footings and pile caps
    - Walls, columns, and cast-in-place piles
    - Cast-in-place "I" and "T" girders, box-girder webs, bent caps, diaphragms, and hinged joints
  - 2.5 inches concrete cover for the top surface of deck slabs
  - 2 inches concrete cover for precast piles and pile extensions
  - 1.5 inches concrete cover for the following:
    - Bottom surface of deck slab
    - Box-girder bottom slabs
- This recommendation is taken from California Amendments to AASHTO LRFD Bridge Design Specifications, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete Cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, pages 850-35, August 1, 2011.

Culvert, Mechanically Stabilized Embankment, and Metallic Soil Reinforcement Backfill

Non-corrosive backfill for mechanically stabilized embankments with metallic soil reinforcement, such as tieback and tiedown anchors or soil nails, and reinforced concrete structures, shall meet the following requirements, in accordance with the *Corrosion Guidelines*:

- Minimum resistivity greater than 2,000 ohm-cm as determined by California Test Method (CTM) 643
- Chloride concentration less than 250 ppm as determined by CTM 422
- Sulfate concentration less than 500 ppm as determined by CTM 417
- A pH value between 5.5 and 10.0 as determined by CTM 643
- Slag aggregate should not be used as a backfill due to high water-soluble sulfate concentrations

Fast-setting concrete backfill may need to be used when placing culverts in existing roadways. When using an admixture to decrease concrete curing times, only non-chloride admixtures should be considered.

If soil nails, tieback anchors, or tiedown anchors are used for any of the reinforced concrete structures proposed for the project, the following specifications should apply:

- Corrosion mitigation is required for soil nails, tieback anchors, and tiedown anchors due to the critical nature of their application.
  - Soil nails
    - Soil nails shall be either a reinforcing bar encapsulated for its full length in a grouted corrugated plastic sheathing or an epoxy-coated reinforcing bar partially encapsulated in a grouted corrugated plastic sheathing.
    - Soil nails shall be constructed in conformance with Structure Reference Specification 19-660, section 10-1.
    - The bar shall be centered in the sheathing and the space between the sheathing and the bar shall be filled with grout
    - The epoxy coating shall have a minimum thickness of 12 mils.
- Tieback anchors
  - Tieback anchors shall be constructed in conformance with Structure Reference Specification 50-560, section 10-1.
  - Grouting procedures shall follow guidelines discussed in Section 50, “Prestressing Concrete,” in the Caltrans Standard Specifications.
  - The tieback anchorage assembly and anchor steel shall be protected against rust, corrosion, and physical damage prior to completing enclosure grouting or concrete encasement per Section 50 of the Caltrans Standard Specifications.
  - Strand-type tendons shall be encapsulated in corrosion-inhibiting grease per Structure Reference Specification 50-560.
- Tiedown anchors
  - Tiedown anchors shall be constructed in conformance with Structure Reference Specification 50-570, Section 10-1.
  - Grouting procedures shall follow guidelines discussed in Section 50, “Prestressing Concrete,” in the Caltrans Standard Specifications.

- Tieback anchor steel shall be protected prior to completion of all grouting against rust, corrosion, and physical damage per Section 50 of the Caltrans Standard Specifications.
- Strand-type tendons shall be encapsulated in corrosion-inhibiting grease per Structure Reference Specification 50-560.

Alternative Pipe Material Selection

Culvert materials were selected for the 22 selected drainage systems using Caltrans AltPipe webbased software, version 6.08. Alternative pipe material recommendations for each of the 22 drainage systems under consideration are presented in Appendix B of V&A Report (Appendix I) and summarized as follows:

- Refer to the table in Appendix B for permissible steel pipe types, coatings, and minimum thicknesses for each drainage system.
- Use of aluminum pipe (corrugated and spiral-rib) and Type 2 aluminized steel pipe is highly restricted at the project site. Aluminum pipe and aluminum-coated steel pipe can only be used where the soil pH range is 5.5 to 8.5, the minimum soil resistivity is greater than 1,500 ohm-cm, and the abrasion level is 1 to 3 (non-abrasive).
- Corrugated PVC pipe can be used in all of the drainage systems at the specified pipe diameters. Other PVC and HDPE (high-density polyethylene) pipes are permissible with size restrictions.
- Reinforced concrete pipes can be used in all of the drainage systems with the specified minimum concrete cover over the reinforcing steel.

Materials available for the project construction are summarized below in Table 8-1.

Table 8-1 Materials Available

Source:		Stevens Creek Quarry Cupertino	Harbor Sand and Gravel Inc Redwood City	Granite Rock Redwood City	Cemex Santa Clara	Granite Santa Clara	Maccon Masonry Materials San Francisco
		408-253-2512	650-369-9189	650-482-3850	408-969-4933	408-210-9862 408-988-4551	415- 285-5025
Haul Distance (one way) Miles:		12	10	9	9	10	29
Product:	Unit						
Portland Cement	Cubic Yard			$117-$138	$100		$145
Lean Concrete	Cubic Yard				$93		
Asphalt Concrete: Type A Open Graded	Ton			$90		$70	
Rubberized Hot Mix Asphalt Concrete (RHMA-G)	Ton			$100		$100	
Aggregate Base Rock, Class 2	Ton	$9.50	$7.50	$6.50	$6.50		
Aggregate Sub-Base rock Class 4	Ton	$9.25		$14			
Structural Backfill	Ton		$15.50				

9.1 RECOMMENDATIONS

The specifications for this project shall be Caltrans Standard Specifications dated 2010 or later, as applicable.

9.2 SPECIFICATIONS

9.2.1 Earthwork

Earthwork shall conform to the applicable portions of Section 19 of the Standard Specifications and to current Special Provisions.

Expansive fat clay (OH, CH and MH) was encountered in all 2009 and 2011 borings. Where these OH, CH and MH soils are excavated, these soils are classified as unsuitable material pursuant to Section 19-1.01B of Standard Specifications.

Structure Backfill

Structure backfill shall conform to the provisions in Section 19-3 of the Standard Specifications.

Embankment Construction

Embankment material for at least 4 feet below the grading plane shall conform to the requirements noted in the Special Provisions. All imported borrow shall conform to the provisions of Section 19-7.02 of the Standard Specifications and to current Special Provisions.

9.2.2 Structural Pavement Sections

Hot Mix Asphalt (HMA)

Hot mix asphalt shall be Type A, ¾-inch maximum coarse graded and shall conform to the provisions in Section 39 of the Standard Specifications and to the requirements noted in the Standard Special Provisions.

Open Graded Friction Course (OGFC)

Open graded friction course shall be ½-inch maximum and shall conform to the provisions in Section 39 of the Standard Specifications.

Rubberized Hot Mix Asphalt, Gap-Graded (RHMA-G)

Rubberized hot mix asphalt shall conform to the provisions in Section 39 of the Standard Specifications.

Aggregate Base (AB)

Aggregate base shall be Class 2, 1½-inch or ¾-inch maximum grading and shall conform to the provisions in Section 26 of the Standard Specifications and to the -#200 sieverequirements noted in the Standard Special Provisions.

Aggregate Subbase (AS)

Aggregate subbase shall be Class 4 and shall conform to the provisions in Section 25 of the Standard Specifications and to the requirements noted in the Standard Special Provisions.

9.2.3 Culverts and Drains

Edge Drains

Edge drains shall conform to the provisions in Section 68-3 of the Standard Specifications.

Filter Fabric

Filter fabric shall conform to the provisions in Section 88-1.03 of the Standard Specifications.

9.2.4 Standard Special Provisions

Aggregate Base (AB)

Aggregate base shall be Class 2, 1½-inch or ¾-inch maximum grading and shall conform to the provisions in Section 26 of the Standard Specifications and to the following Special Provisions.

The quality requirements shall conform to the quality requirements shown on the following table.

Tests	California Test Method Number	Requirements	
		Operating Range	Contract Compliance
Sand Equivalent	217	25 Min.	22 Min.
Resistance (R-value)	301	-	78 Min.
Durability Index	229	-	35 Min.

Aggregate Subbase (AS)

Aggregate subbase shall be Class 4 and shall conform to the provisions in Section 25 of the Caltrans Standard Specifications and to the following Special Provisions.

Class 4 aggregate subbase shall be clean and free from vegetable matter and other deleterious substances.

The percentage composition by weight of Class 4 aggregate subbase shall conform to the following grading as determined by California Test Method No. 202.

Sieve Size	Percentage Passing Moving Range	Individual Test Results
2½-inches	100	100
No. 4	30-65	25-70
No. 200	0-15	0-18

Class 4 aggregate subbase shall also conform to the quality requirements shown on the following table.

Tests	California Test Method Number	Requirements Operating Range	Contract Compliance
Sand Equivalent	217	21 Min.	18 Min.
Resistance (R-value)	301	--	50 Min.

The opinions, conclusions and recommendations contained in this Geotechnical Design Report and Materials Report are based upon the information obtained from explorations made at widely separated locations, geologic reconnaissance, review of available geologic and topographic information and historic data, and upon local experience and engineering judgment.

The recommendations presented in this report are based on the assumption that the soil and geologic conditions do not deviate substantially from those encountered in the exploratory borings and CPTs. If any variations are encountered during construction, URS should be consulted so that supplementary recommendations can be made.

If the planned construction is changed from that presently conceived, URS should be retained to review the changes and make modifications to the original recommendations presented in this report in order to meet the project needs.

Geotechnical issues may arise during construction which are not apparent at this time. We should be retained during construction to review the soil conditions encountered and the construction procedures. All testing should be done under the direct observation of a representative of our firm.

The elevations shown on the logs of new borings are based on interpolation from spot and contour elevations shown on available topographic maps.

A specific review related to environmental and hazardous waste issues and an investigation for subsurface environmental contamination is being performed by URS and will be presented in a separate report.

As-built drawings pertinent only to the geotechnical investigation are included.

The recommendations presented in this Geotechnical Design Report and Materials Report were developed with the standard of care commonly used as state of the practice in the profession. No other warranties are included, either express or implied, as to the professional advice presented in this report.

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INDEX OF PLANS

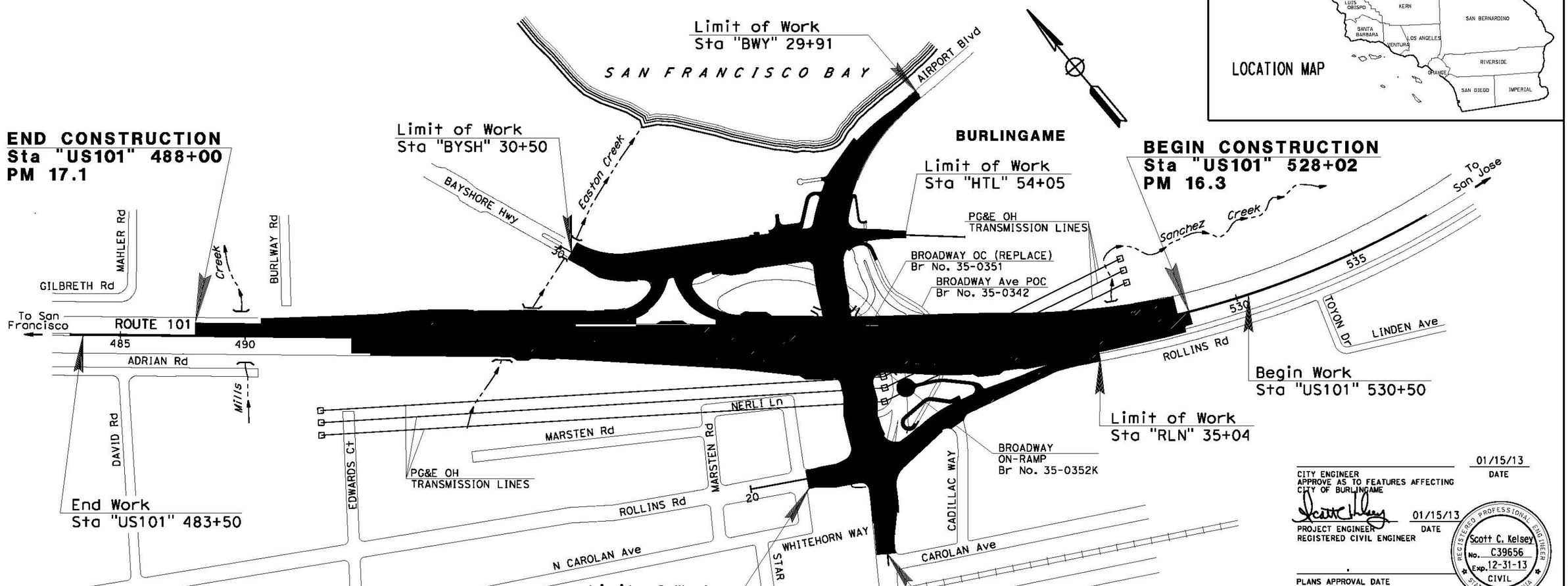
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ON
STATE HIGHWAY

IN SAN MATEO COUNTY
IN BURLINGAME
FROM 0.3 MILE NORTH OF ANZA BOULEVARD
TO 0.9 MILE SOUTH OF MILLBRAE AVENUE OVERCROSSING

TO BE SUPPLEMENTED BY STANDARD PLANS DATED 2010

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.



PROJECT VICINITY MAP
FIGURE 1

NO SCALE

100% PS&E SUBMITTAL
JANUARY 17, 2013

CITY ENGINEER
APPROVE AS TO FEATURES AFFECTING
CITY OF BURLINGAME — DATE 01/15/13

PROJECT ENGINEER
REGISTERED CIVIL ENGINEER — DATE 01/15/13

REGISTERED PROFESSIONAL ENGINEER
Scott C. Kelsey
No. C39656
Exp. 12-31-13
CIVIL
STATE OF CALIFORNIA

PLANS APPROVAL DATE .

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

URS CORPORATION
100 W. SAN FERNANDO St, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

CONTRACT No.	04-235844
PROJECT ID	0400000684

THE CONTRACTOR SHALL POSSESS THE CLASS (OR CLASSES) OF LICENSE AS SPECIFIED IN THE "NOTICE TO BIDDERS."

APPROVED AS TO IMPACT ON STATE FACILITIES AND CONFORMANCE WITH APPLICABLE STATE STANDARDS AND PRACTICES AND THAT TECHNICAL OVERSIGHT WAS PERFORMED.

CONSULTANT DESIGN ENGINEER: SCOTT C. KELSEY
CALTRANS DESIGN OVERSIGHT APPROVAL: AMIR SANATKAR
REGISTRATION No. . LICENSE Exp DATE . DATE SIGNED .

LAST REVISION 12-27-12 DATE PLOTTED => 4/3/2013 TIME PLOTTED => 4:44:41 PM

URS	US 101/Broadway Interchange Reconstruction Project	GEOLOGY MAP	Not to Scale Figure 2 April 2009

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

URS CORPORATION
100 W. SAN FERNANDO St
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTES:

1. FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.
2. COORDINATES, DISTANCES AND BEARINGS SHOWN ARE BASED ON CALIFORNIA COORDINATE SYSTEM ZONE 3. THE HORIZONTAL DATUM IS NAD 1983. THE VERTICAL DATUM IS NAVD 1988.
3. FOR LOCATIONS AND TYPES OF HMA DIKES, MBGR, FENCES, BARRIERS, AND REMOVAL ITEMS, REFER TO LAYOUT AND QUANTITY SHEETS.
4. TEMPORARY FENCE SHALL BE PLACED ALONG TEMPORARY CONSTRUCTION EASEMENTS. SEE QUANTITY SHEETS FOR LOCATIONS.
5. FOR ADDITIONAL GEOMETRICAL DESIGN INFORMATION ON LOCAL ROADS, SEE CONSTRUCTION DETAIL SHEETS.

ABBREVIATIONS:

AMA	ARCHEOLOGICAL MONITORING AREA LIMIT
VEG CTRL	VEGETATION CONTROL (MINOR CONCRETE)
TCE	TEMPORARY CONSTRUCTION EASEMENT
MVP	MAINTENANCE VEHICLE PULLOUT

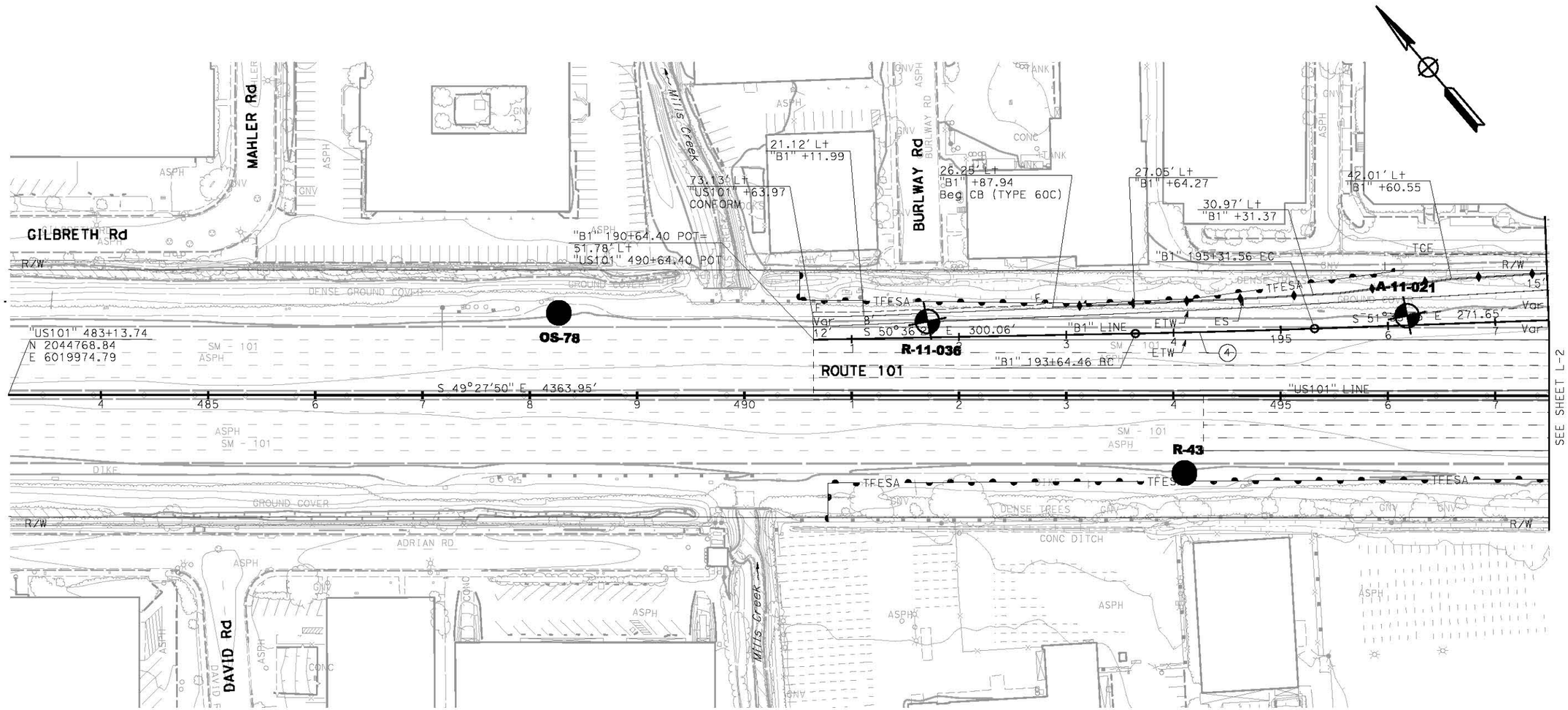
LEGEND:

—AMA— ARCHEOLOGICAL MONITORING AREA

(No.) CURVE ALIGNMENT DATA

MINOR CONCRETE (TEXTURED PAVING)

TEMPORARY FENCE ENVIRONMENTALLY SENSITIVE AREA (TFESA)



CURVE DATA

No.	R	△	T	L	N-COORDINATE	E-COORDINATE
(4)	10000.00'	0°57'27"	83.55'	167.10'	2051858.025	6027157.157

LEGEND

As-Built Boring

Boring for this study

CPT for this study

SITE and BORING LOCATION PLAN
FIGURE 3a

LAYOUT
SCALE 1" = 50'

L-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR

CALCULATED-DESIGNED BY

CHECKED BY

REVISED BY

DATE REVISED

LAST REVISION 12-23-11

DATE PLOTTED => $DATE
TIME PLOTTED => $TIME

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

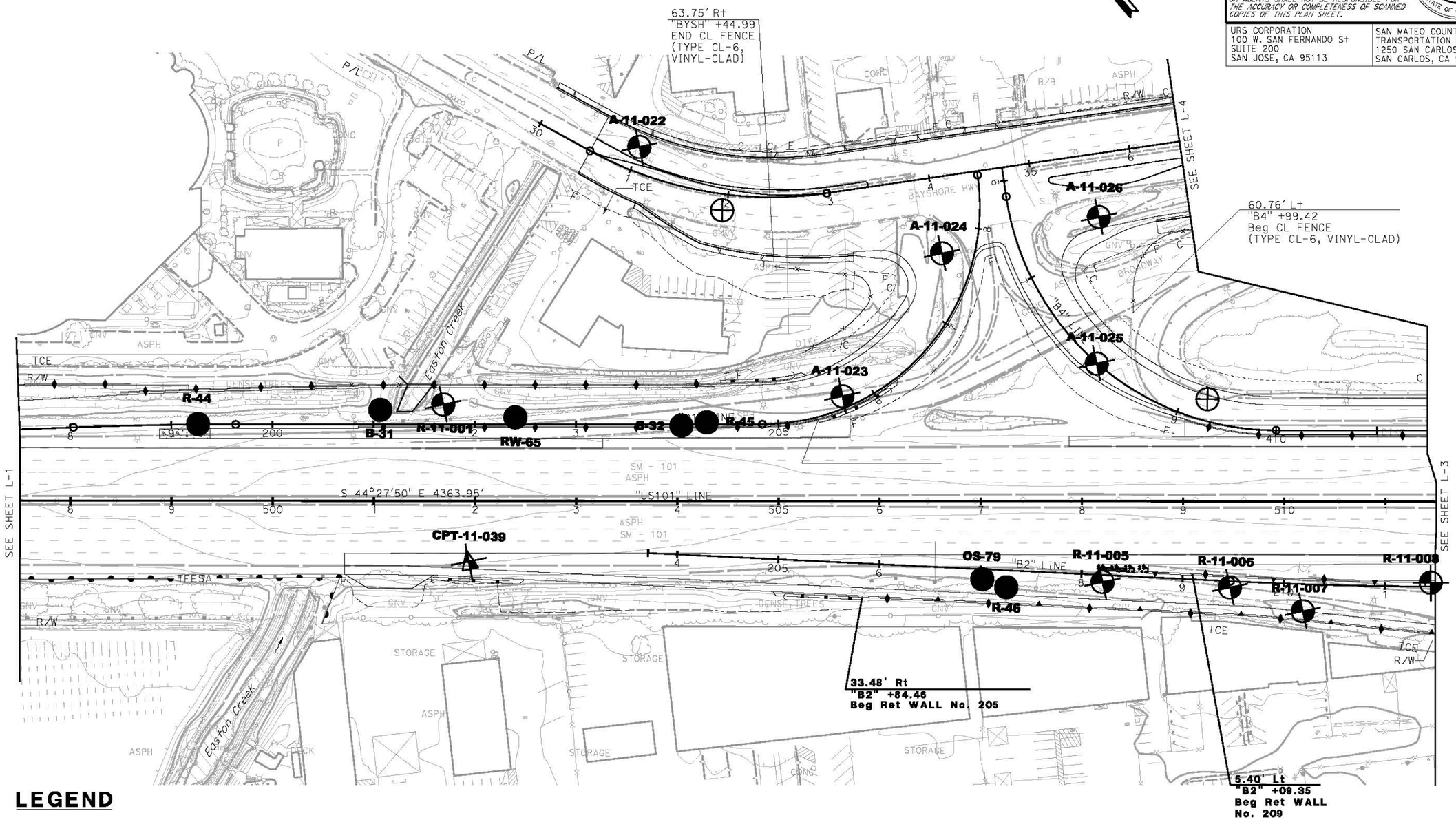
REGISTERED PROFESSIONAL ENGINEER No. EXP. CIVIL STATE OF CALIFORNIA

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

URS CORPORATION
100 W. SAN FERNANDO St
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



LEGEND

- As-Built Boring
- Boring for this study
- CPT for this study
- Pavement coring for this study

SITE and BORING LOCATION PLAN
FIGURE 3b

LAYOUT
SCALE 1" = 50'

L-2

REVISED BY	DATE REVISED
.	.

CALCULATED-DESIGNED BY . CHECKED BY .

CONSULTANT FUNCTIONAL SUPERVISOR

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 12-23-11 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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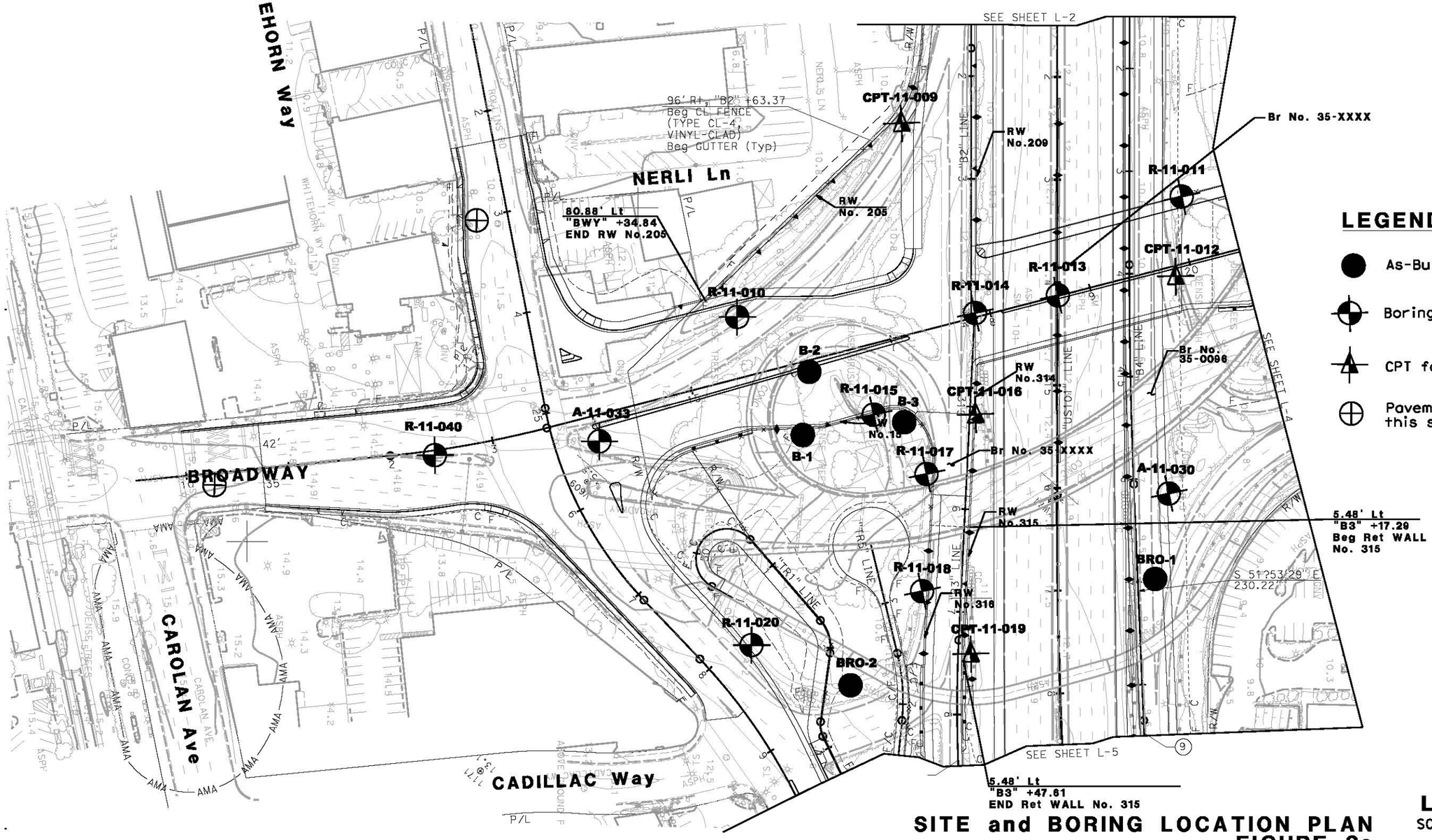
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



LEGEND

- As-Built Boring
- Boring for this study
- CPT for this study
- Pavement coring for this study

SITE and BORING LOCATION PLAN
FIGURE 3c

LAYOUT
SCALE 1" = 50'

L-3

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR | CALCULATED-DESIGNED BY | CHECKED BY | REVISED BY | DATE REVISED

LAST REVISION 12-23-11 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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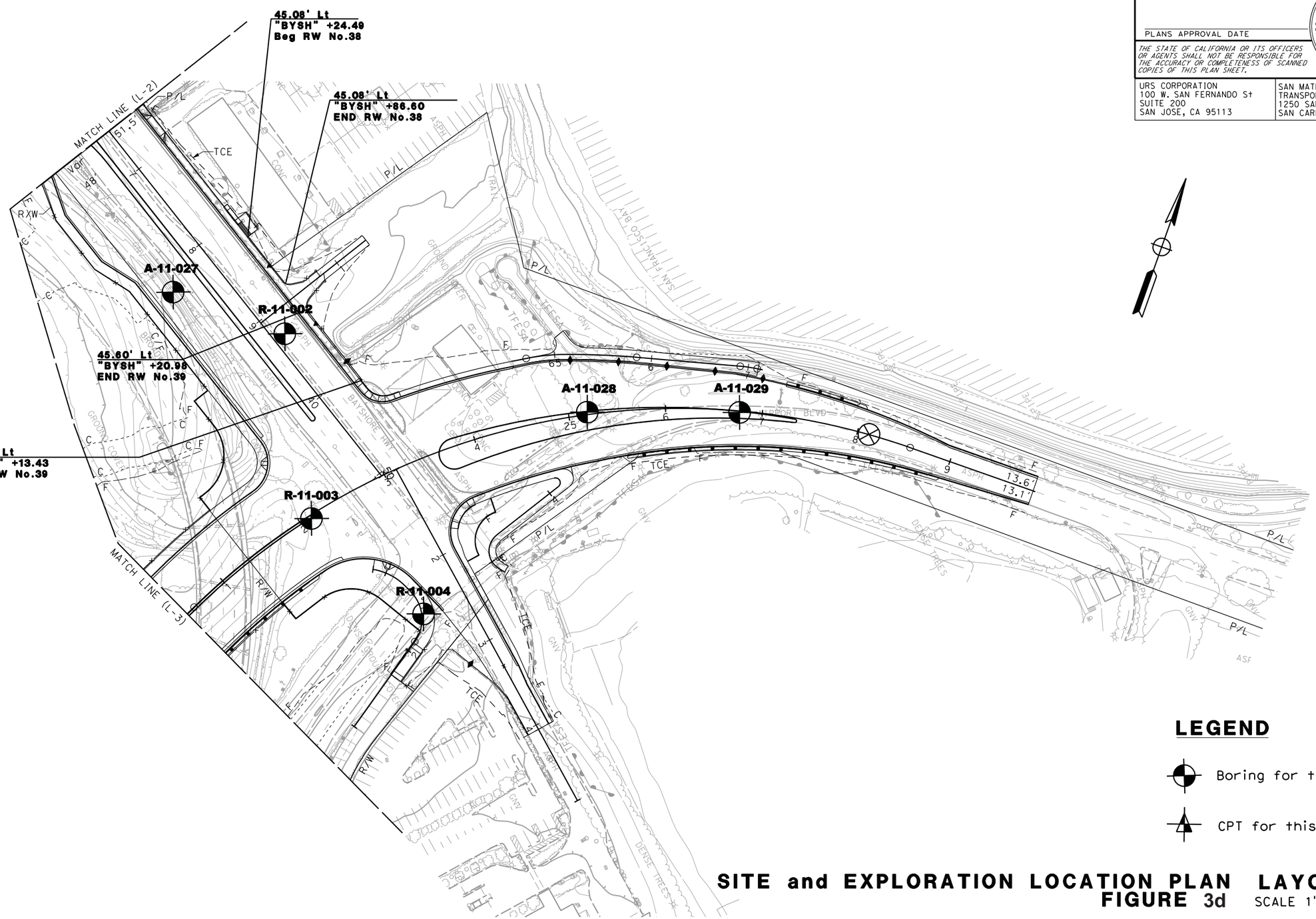
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



LEGEND

Boring for this study

CPT for this study

SITE and EXPLORATION LOCATION PLAN LAYOUT
FIGURE 3d

SCALE 1" = 50'

L-4

APPROVED FOR LAYOUT WORK ONLY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

CONSULTANT FUNCTIONAL SUPERVISOR

CALCULATED-DESIGNED BY

CHECKED BY

REVISED BY

DATE REVISED

LAST REVISION 12-23-11

DATE PLOTTED => 6/19/2012
TIME PLOTTED => 4:39:49 PM

BORDER LAST REVISED 7/2/2010

USERNAME => madhu_thummaluru
DGN FILE => RW_Figure 2c.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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URS CORPORATION
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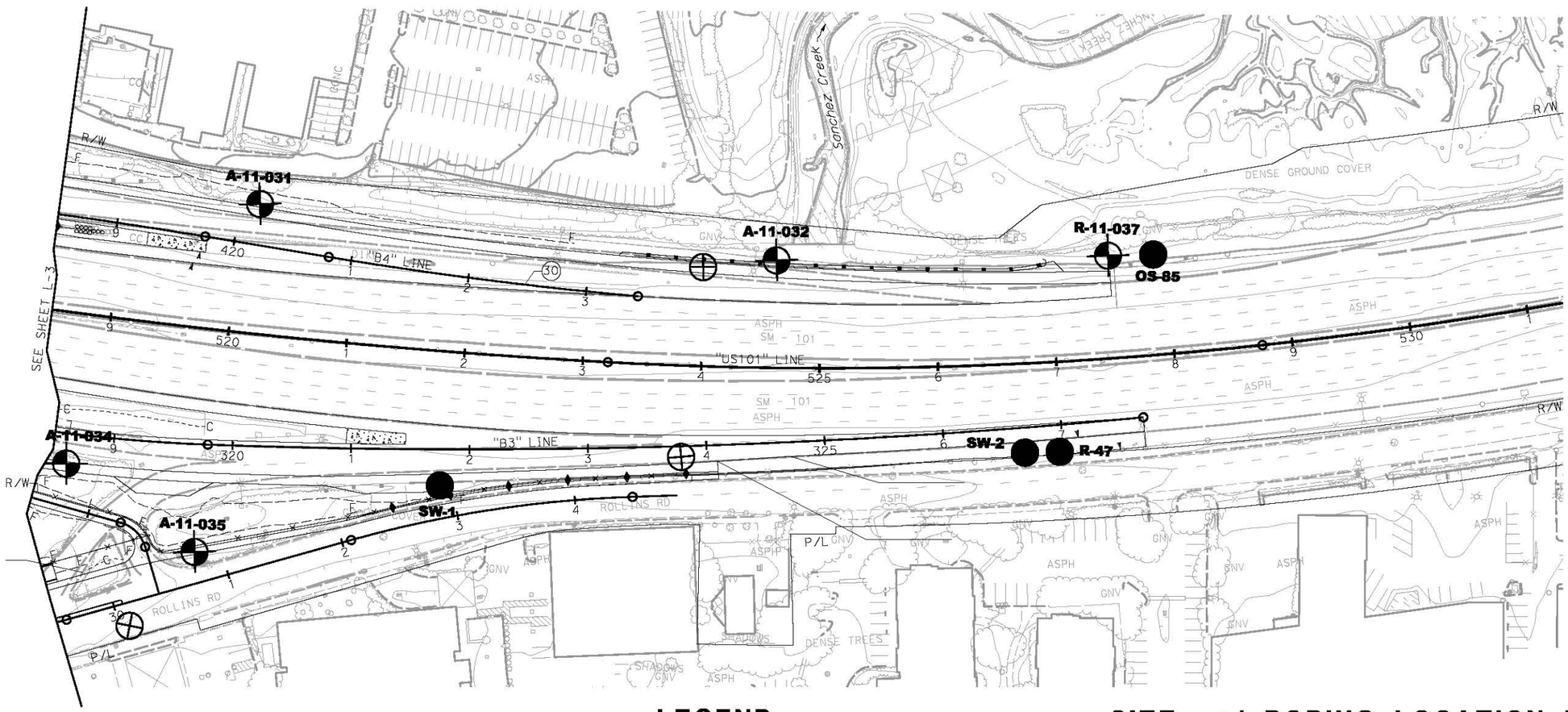
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:
FOR ACCURATE RIGHT OF WAY DATA, CONTACT
RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.



LEGEND

- As-Built Boring
- Boring for this study
- Pavement coring for this study
- CPT for this study

SITE and BORING LOCATION PLAN
FIGURE 3e

LAYOUT
SCALE 1" = 50'

L-5

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR
CALCULATED-DESIGNED BY
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REVISED BY
DATE REVISED

LAST REVISION 12-23-11
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TIME PLOTTED => $TIME

BORDER LAST REVISED 7/2/2010
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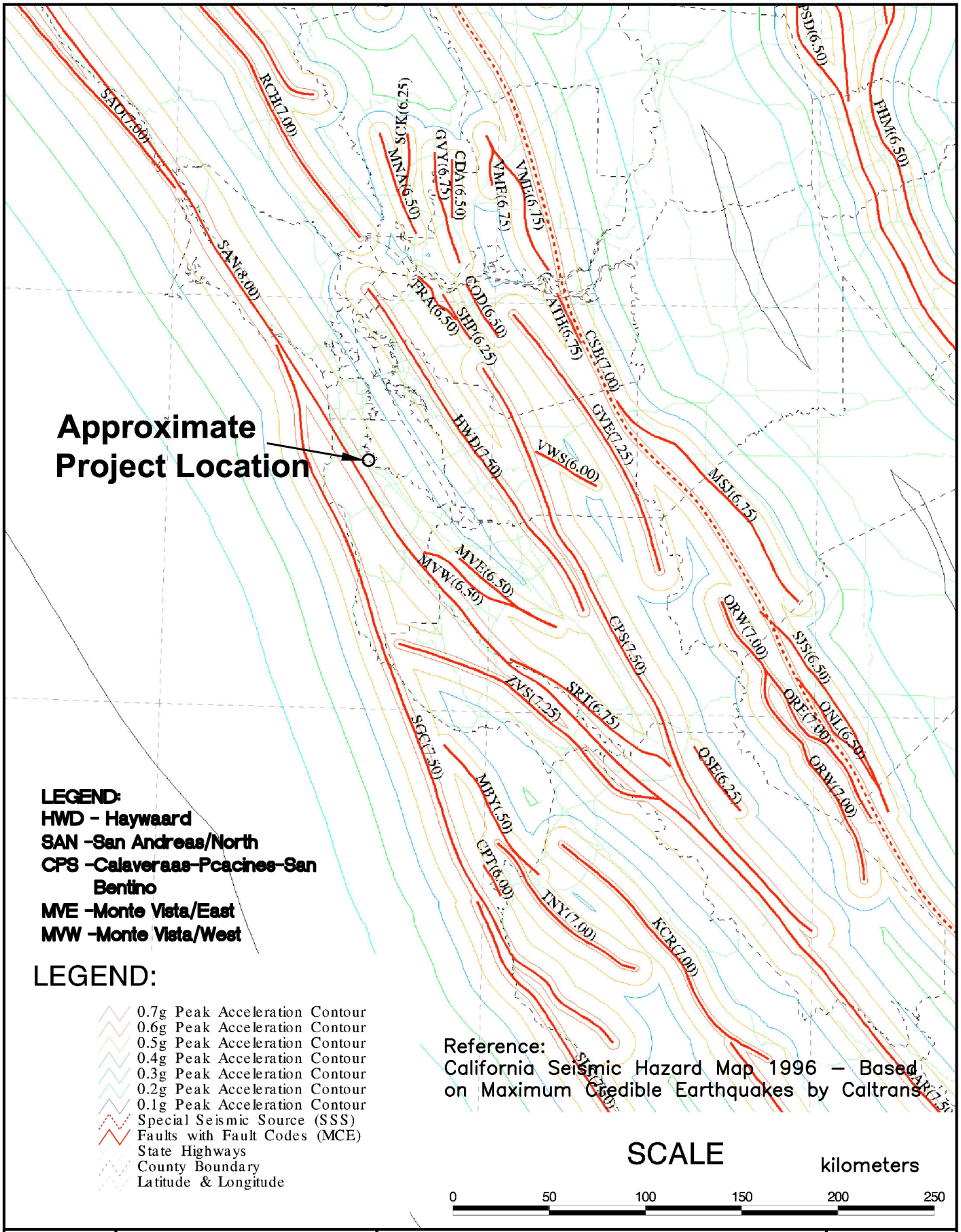
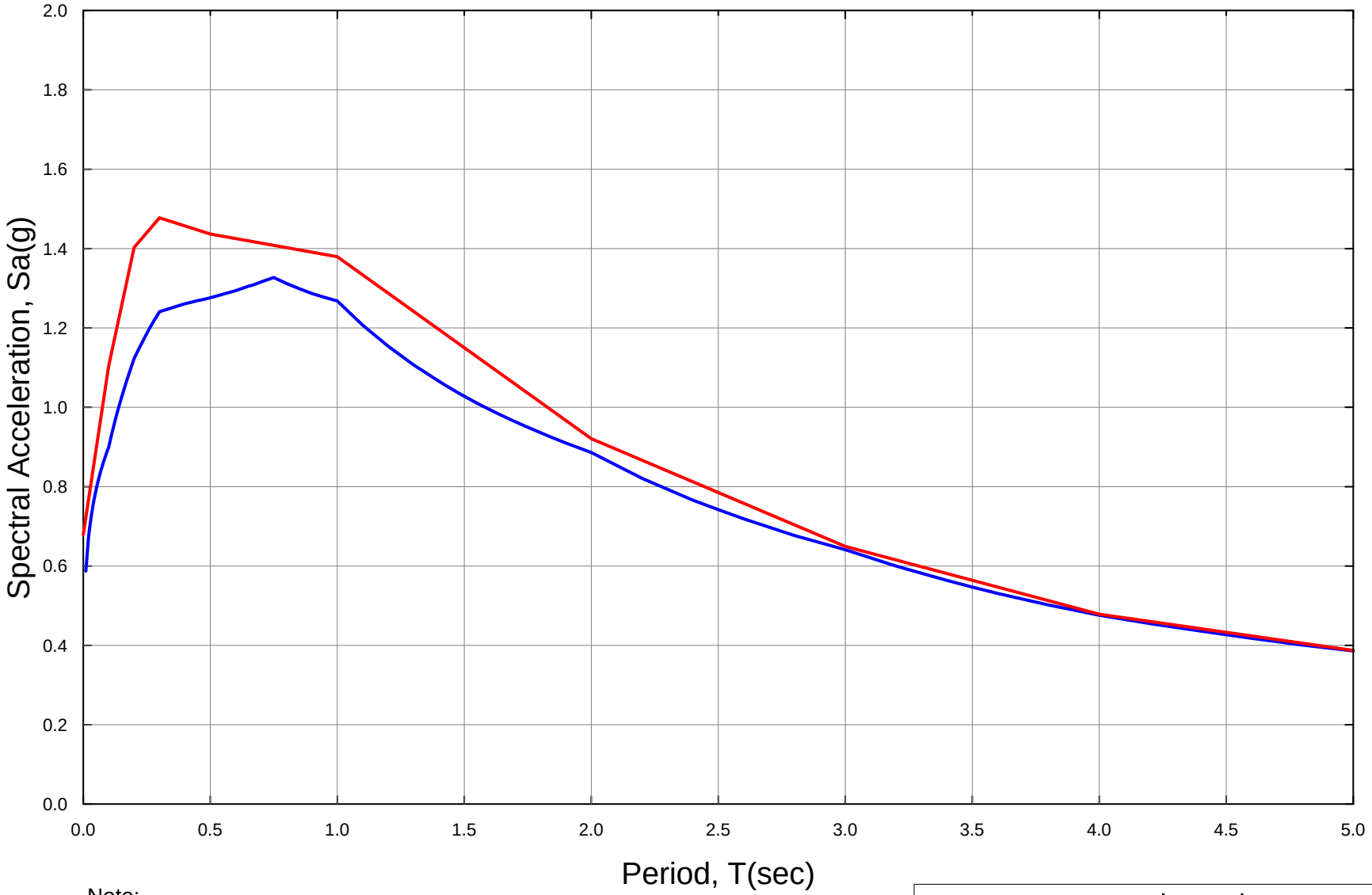
DGN FILE => $REQUEST
RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3
UNIT 0703
PROJECT NUMBER & PHASE 04000006841



URS	US 101/Broadway Interchange Reconstruction Project	REGIONAL FAULT MAP SAN MATEO COUNTY	Not to Scale Figure 4 April 2009



Note:
1. Site Location: LAT = 37.590061 LONG = -122.361241
2. V_{s30} = 820 feet per second

Legend
Caltrans ARS Online
USGS Deaggregation/Design Curve

Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**Acceleration Response Spectra Comparisons**	Figure 5A
URS			

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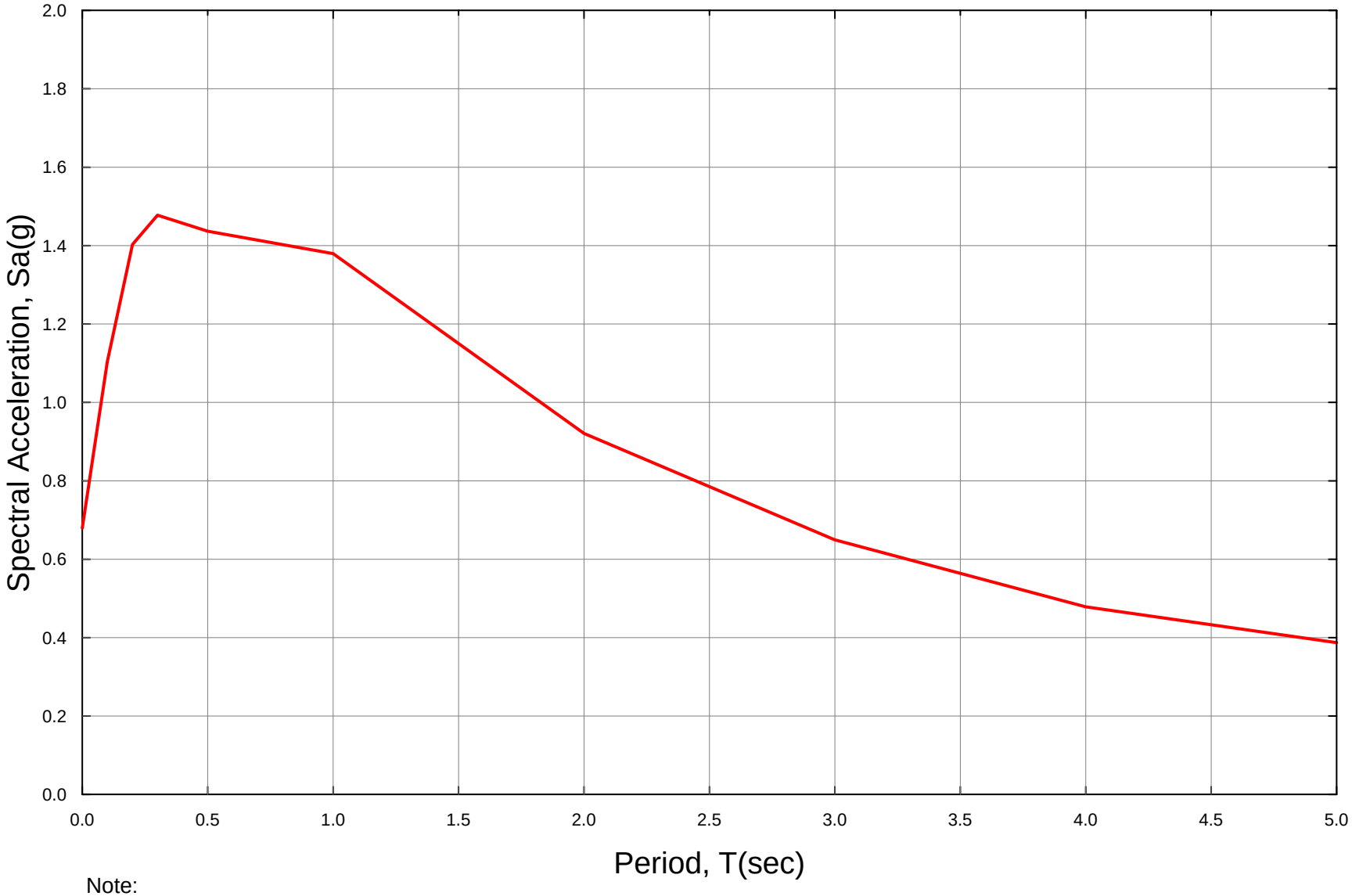


Note:
1. Site Location: LAT = 37.590061 LONG = -122.361241
2. V_{s30} = 820 feet per second

Project No. 28645286	Broadway Interchange Reconstruction Burlingame, California	**Recommended Acceleration Response Spectra**	Figure 5B
URS			

W:\101BdwyPSE_28645286\450_Geotech\Analysis\ARS Online\Broadway OC (Replace)_ARS Design.grf

Susceptibility Level

- Very High
- High
- Moderate
- Low
- Very Low

Major Roads

Local Roads

N

Scale: 1 inch equals 0.33 miles

This map is intended for planning use only and is not intended to be site-specific. Rather, it depicts the general risk within neighborhoods and the relative risk from community to community. More detailed maps are needed for site development decisions.

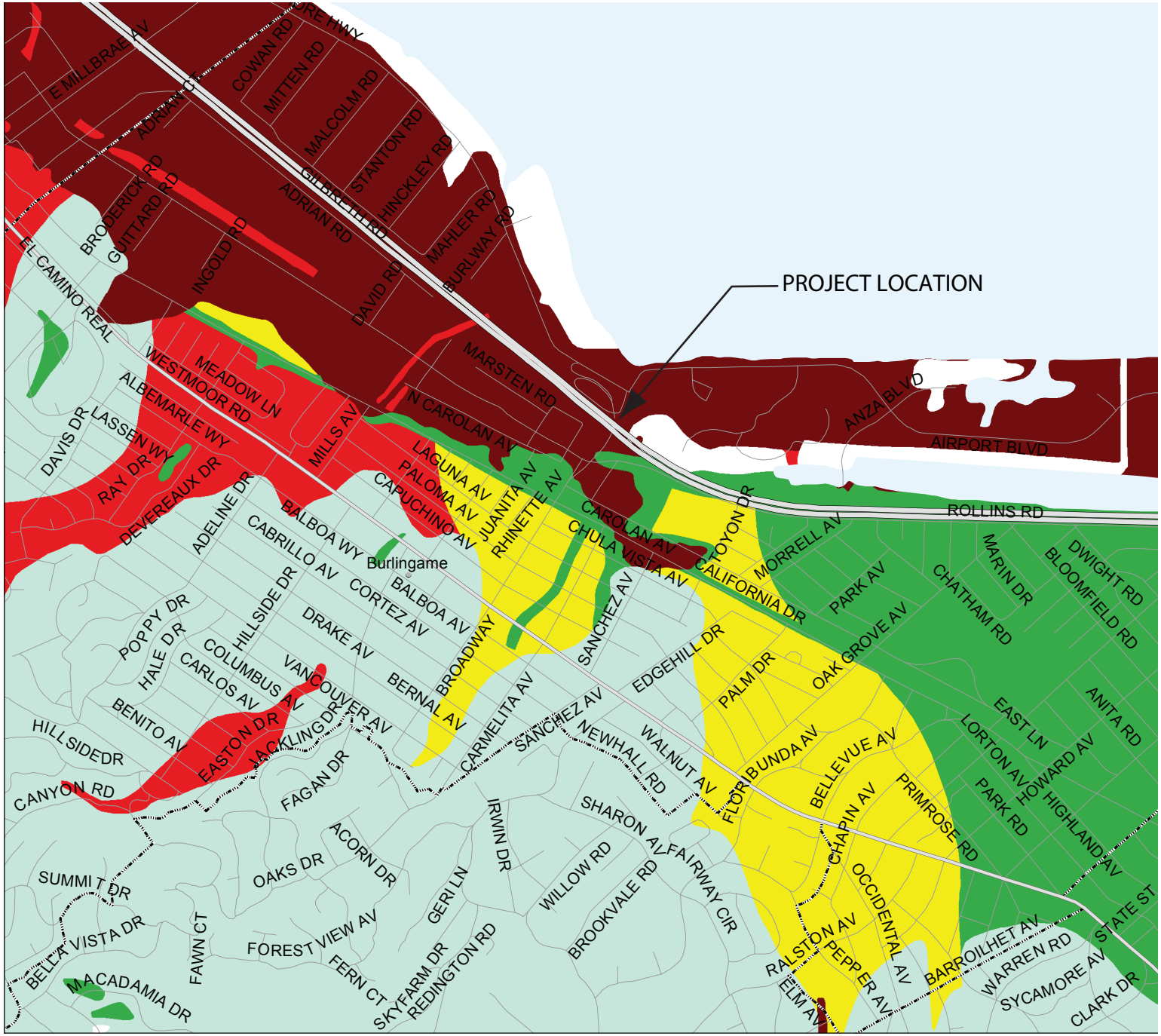
This map is available at http://quake.abag.ca.gov

Source:
This map is based on work by William Lettis & Associates, Inc. and USGS. USGS Open-File Report 00-444, Knudsen & others, 2000

For more information visit: http://geopubs.wr.usgs.gov/open-file/of00-444/

Map Prepared by the ABAG Earthquake Program. April 2004.

ABAG Geographic Information Systems



Project No. 28645286	Broadway Interchange Reconstruction U. S. 101 Burlingame, California	LIQUEFACTION SUSCEPTIBILITY MAP	Figure 6
URS			February 2012

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Flood Hazard Areas

- Zone V- (100 yr. Flood Zone)
- Zone A- (100 yr. Flood Zone)
- Zone X500- (500 yr. Flood Zone or other concerns)
- Urbanized Area

Shaded to show topographical relief

Detailed FEMA Explanation

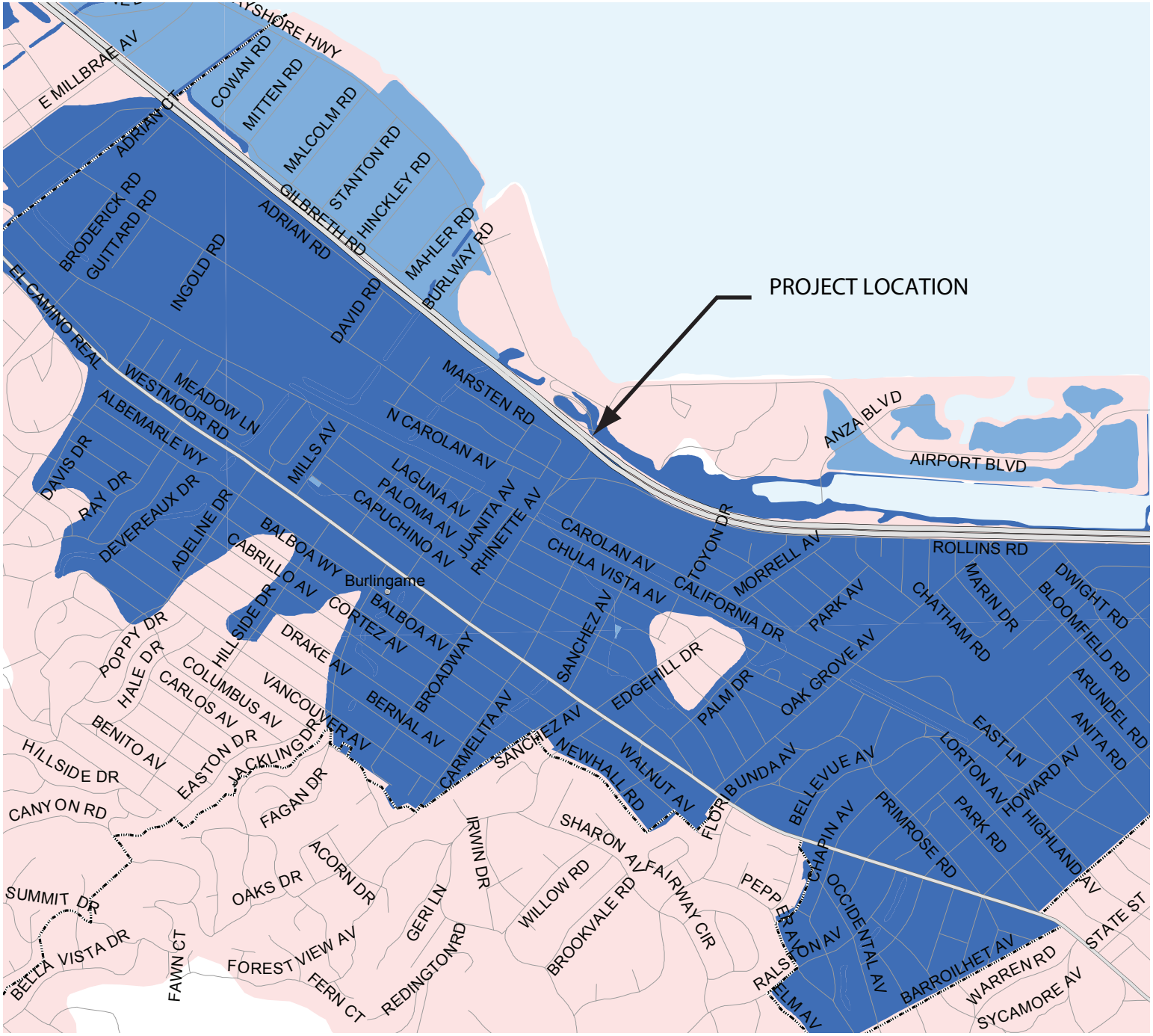
Flood Zone	Description
Zone V	This code identifies an area inundated by 1% annual chance flooding with velocity hazard (wave action).
Zone A	This code identifies an area inundated by 1% annual chance flooding.
Zone X500	This code identifies an area inundated by 0.2% annual chance flooding; an area inundated by 1% annual chance flooding with average depths of less than 1 foot or with drainage areas less than 1 square mile; or an area protected by levees from 1% annual chance flooding.

N

Scale: 1 inch equals 0.32 miles

Source: FEMA Q3 Flood Data and ABAG.
The Q3 Flood Data do not replace the existing hardcopy FIRM, or, if one exists, Digital FIRM product.
The product has been designed to support planning activities.
A more detailed version of this map is available at http://quake.abag.ca.gov

ABAG Geographic Information Systems



Project No. 28645286	Broadway Interchange Reconstruction U. S. 101 Burlingame, California	FEMA FLOOD HAZARD AREAS MAP	Figure 7 February 2012

URS

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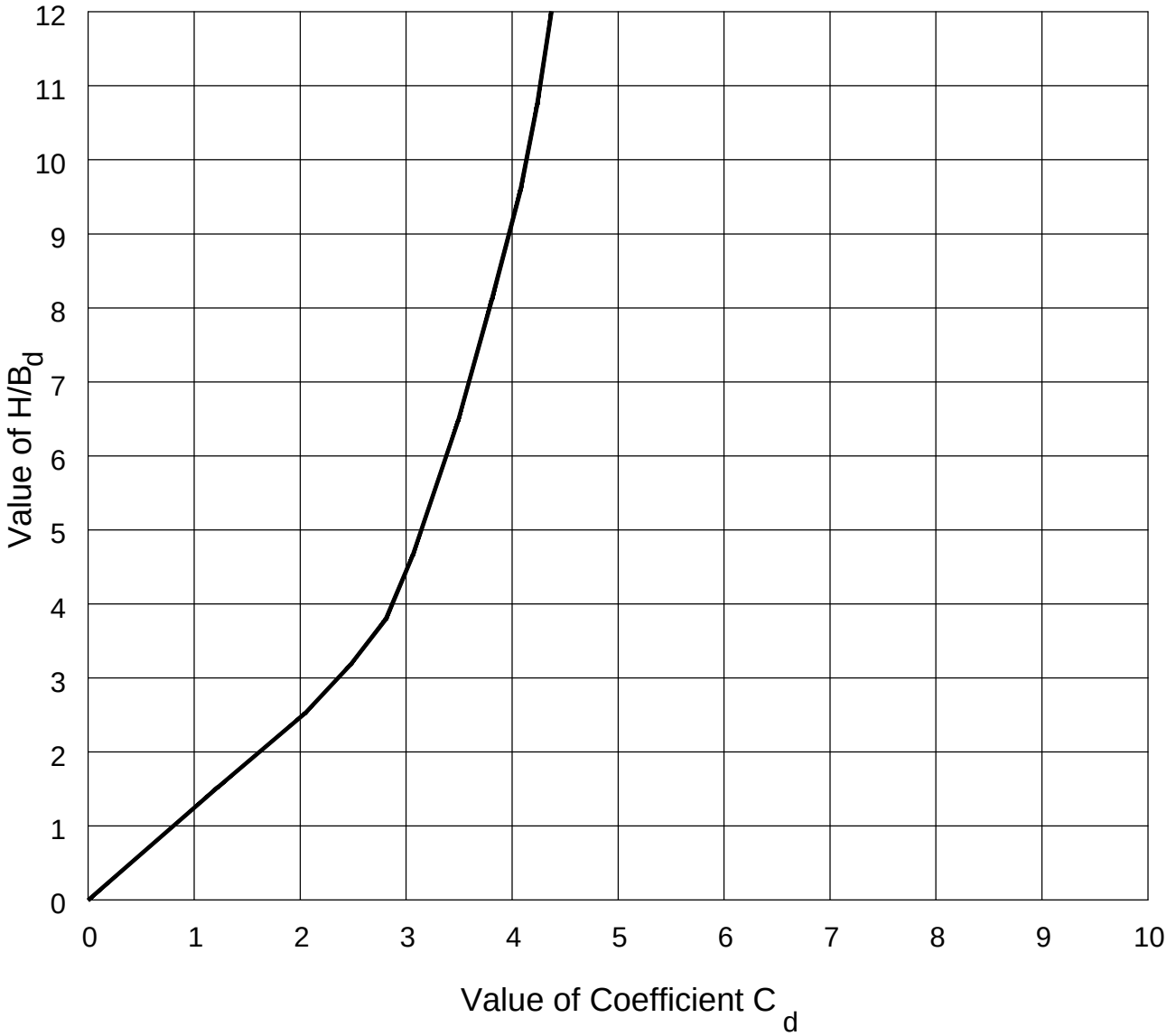


RIGID PIPE

$W_C = Y_t \; C_d \; B_d^2$

Where

W_c = Load on pipe due to backfill (lb/lineal ft)

B_d = Width of trench at the top of the pipe (ft)

C_d = Marston coeefficient for trench condition

H = Height of fill over top of pipe (ft)

Y_t = Total unit weight of backfill = 140lb/cu. ft

FLEXIBLE PIPE

$W_C = Y_t \; C_d \; B_c \; B_d$

Where

W_c = Load on pipe due to backfill (lb/lineal ft)

B_c = Outside width of pipe (ft)

B_d = Width of trench at the top of the pipe (ft)

C_d = Marston coefficient for trench condition

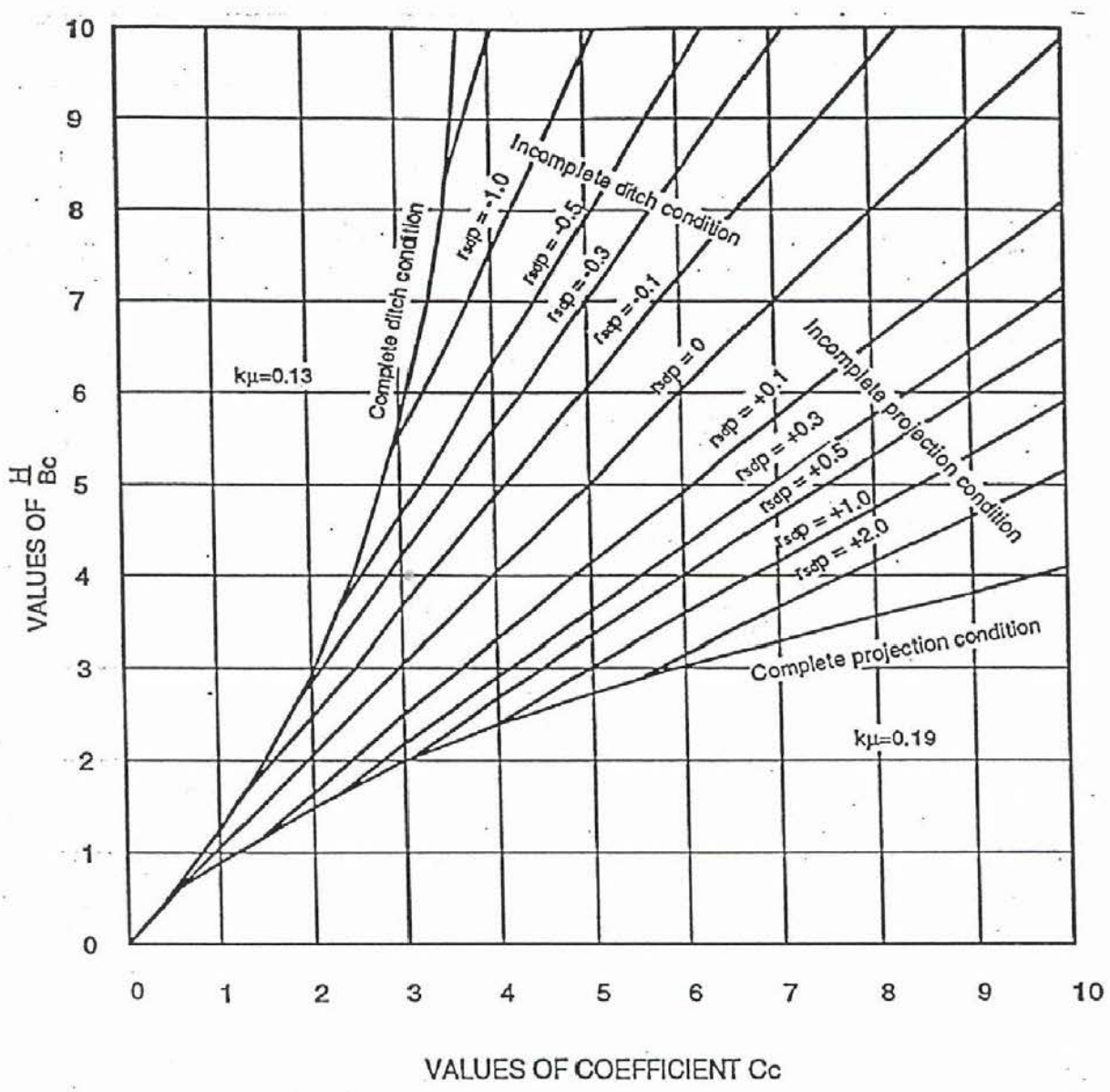
H = Height of fill over top of pipe (ft)

Y_t = Total unit weight of backfill = 140lb/cu. ft

W:\101BdwyPSE_28645286\000-CAD\Sheets\QC-Geotech\DWG\Pipe_soilLoad_trench.dwg

Project No. 28645286	US101 Broadway Interchange Reconstruction Burlingame, California	DESIGN CRITERIA FOR EARTH LOADS ON RIGID OR FLEXIBLE PIPE FOR TRENCH CONDITION	Figure 8
June 2012	URS		

TEMP002



MARSTON'S FORMULA FOR LOADS ON RIGID OR FLEXIBLE PIPE
(Postive projecting embankment condition)

$$Wc = \gamma_t \; Cc \; Bc^2$$

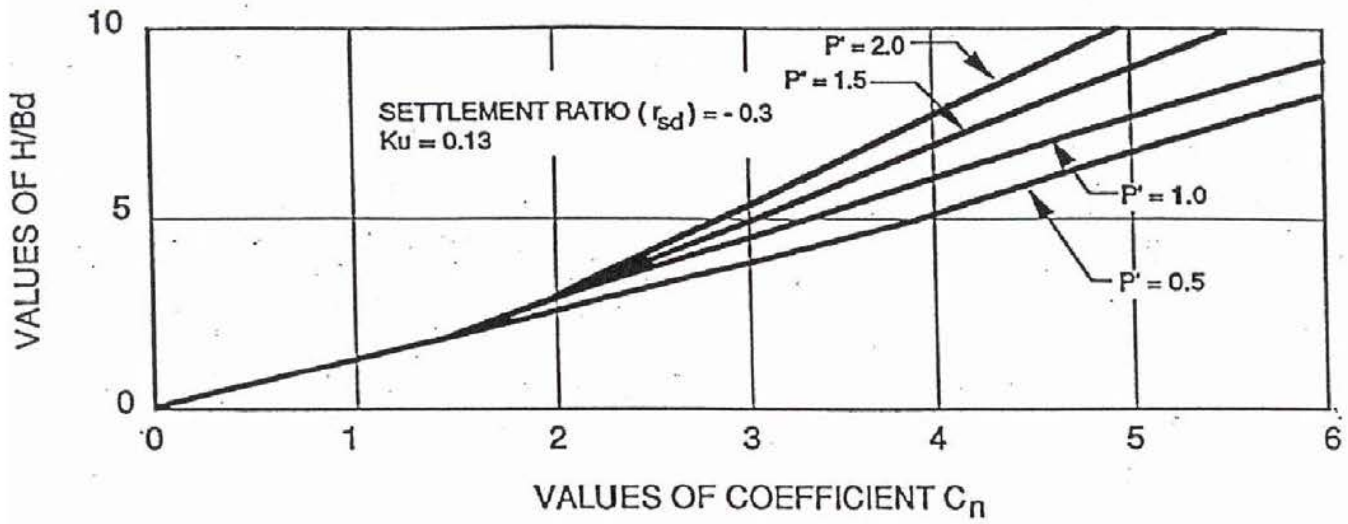
Where

Wc = Load on pipe due to backfill (lb/lineal ft)
Bc = Outside width of pipe (ft)
Cc = Marston coefficient for embankment condition
H = Height of fill over top of pipe (ft)
γ_t = Total unit weight of backfill = 140 lb/cu. ft

W:\101BdwyPSE_28645286\000-CAD\Sheets\DC-Geotech\DWG\Pipe_soilLoad_embankment.dwg

Project No. 28645286	US101 Broadway Interchange Reconstruction Burlingame, California	DESIGN CRITERIA FOR EARTH LOADS ON RIGID OR FLEXIBLE PIPE FOR EMBANKMENT CONDITION POSTIVE PROJECTING CONDUIT	Figure 9
June 2012			
URS			

TEMP002



P'= PROJECTION RATIO. (VERTICAL DISTANCE FROM THE FIRM GROUND SURFACE TO THE TOP OF CONDUIT, DIVIDED BY THE WIDTH OF TRENCH).

MARSTON'S FORMULA FOR LOADS ON RIGID OR FLEXIBLE PIPE

(Negative Projecting Conduit)

$$Wc = \gamma_t \, Cn \, Bd^2$$

Where

Wc = Load on pipe due to backfill (lb/lineal ft)

Bd = Width of trench at the top of the pipe (ft)

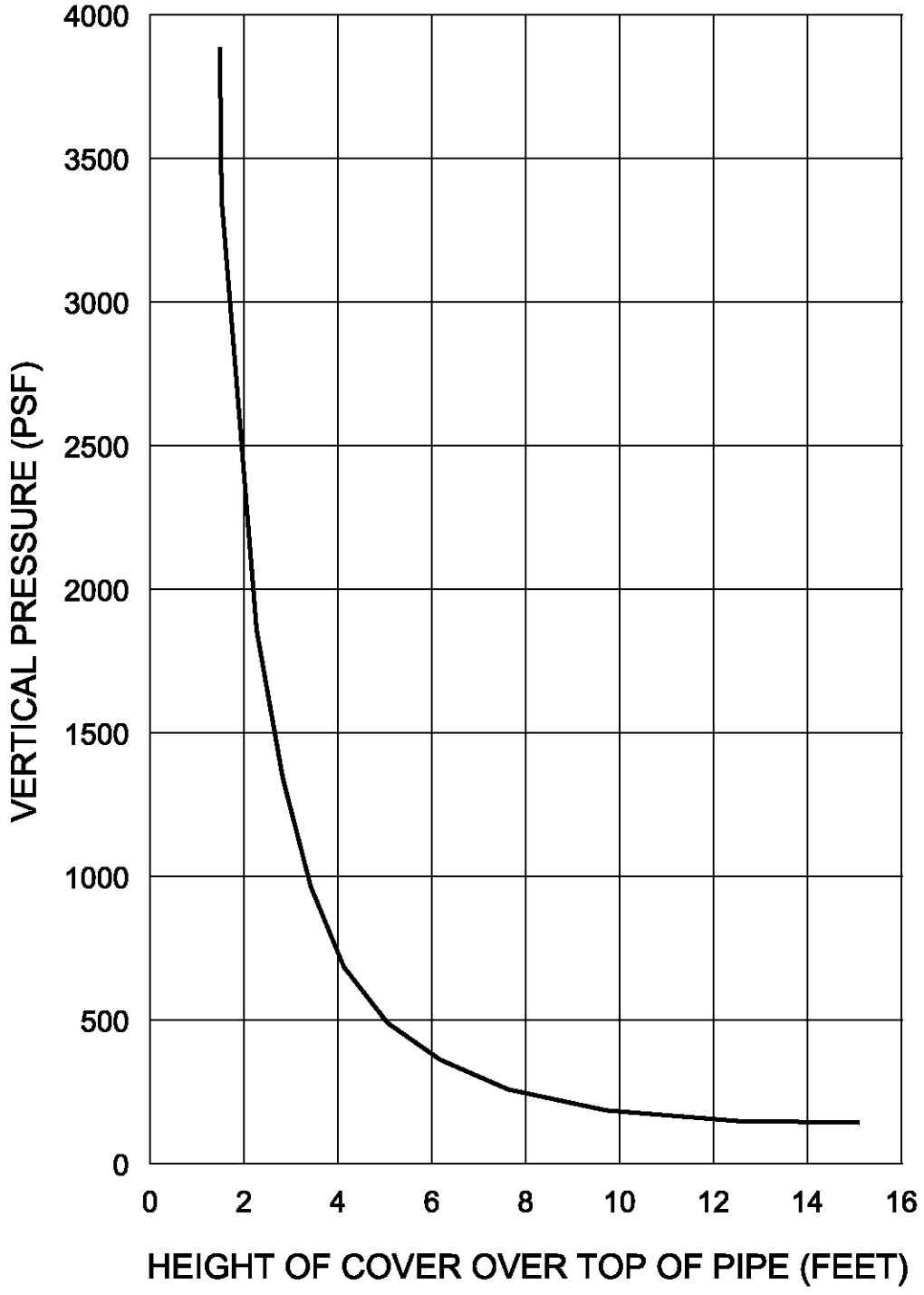
Cn = Marston coefficient for embankment condition

γ_t = Total unit weight of backfill = 140 lb/cu. ft.

W:\101BdwyPSE_28645286\000-CAD\Sheets\QC-Geotech\DWG\Pipe_SoilLoad_negativeProject.dwg

Project No. 28645286 June 2012	US101 Broadway Interchange Reconstruction Burlingame, California	DESIGN CRITERIA FOR EARTH LOADS ON RIGID OR FLEXIBLE PIPE FOR NEGATIVE PROJECTING CONDUIT	Figure 10
URS			

TEMP002



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Project No. 28645286	US101 Broadway Interchange Reconstruction Burlingame, California	VERTICAL SURFACE PRESSURE VERSUS HEIGHT OF COVER OVER TOP OF PIPE DUE TO AASHTO H20 LOADING	Figure 11
June 2012			
URS			

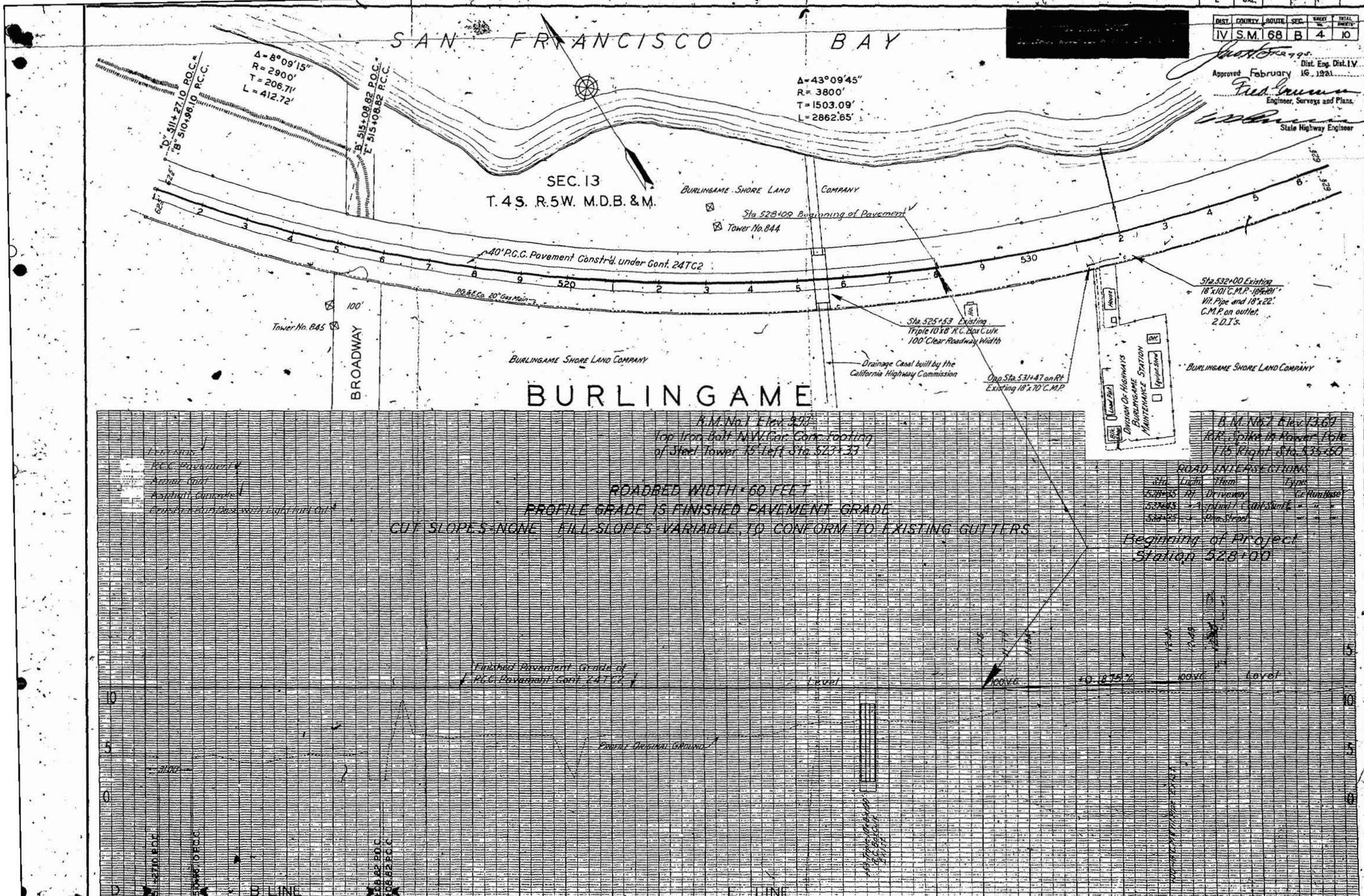
TEMP002

DIST.	COUNTY	ROUTE	SEC.	SHEET No.	TOTAL SHEETS
IV	S.M.	68	B	4	10

DIST. No.	STATE	FED. AID PROJ. No.	YEAR	SHEET No.	TOTAL SHEETS
2	CAL.				

[redacted]

Dist. Eng. Dist. IV.
Approved February 16, 1921.
Engineer, Surveys and Plans.
State Highway Engineer



FED. ROAD DIST. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
2	CAL.		48 49	54	

DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
IV	S M	82	Burl	2	18

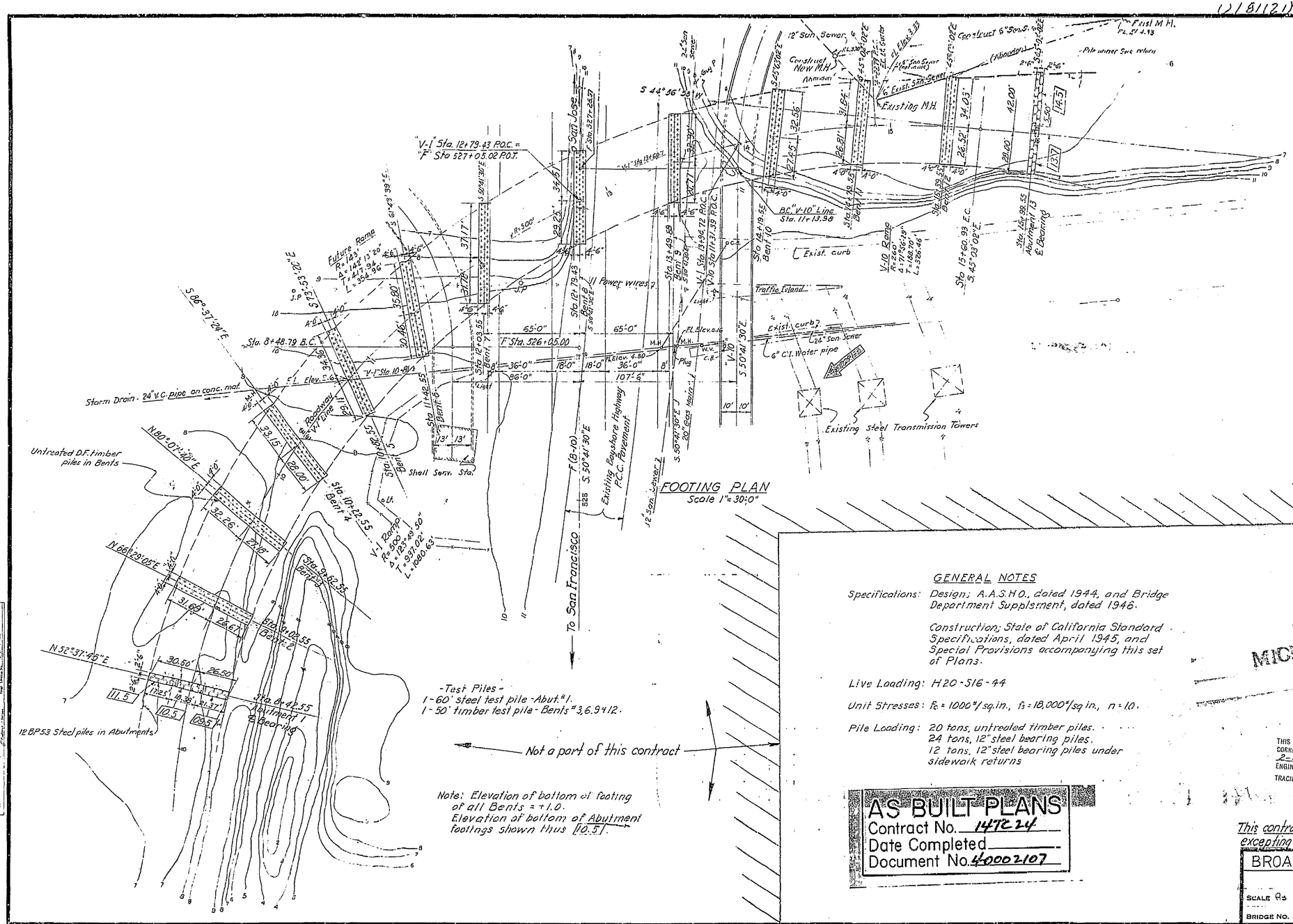
Bridge Engineer

Date approved March 11, 1941

121 B1(21)

DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS
STATE OF CALIFORNIA

BRIDGE DEPARTMENT



FOOTING PLAN
Scale 1" = 30'-0"

-Test Piles-
1-60' steel test pile - Abut. #1.
1-50' timber test pile - Bents #3, 6, 9 & 12.

Note: Elevation of bottom of footing of all Bents = +1.0.
Elevation of bottom of Abutment footings shown thus [10.5].

GENERAL NOTES

Specifications: Design; A.A.S.H.O., dated 1944, and Bridge Department Supplement, dated 1948.

Construction; State of California Standard Specifications, dated April 1945, and Special Provisions accompanying this set of Plans.

Live Loading: H20-S16-44

Unit Stresses: $f_c = 1000^{\#}/sq.in.$, $f_s = 18{,}000^{\#}/sq.in.$, $n = 10$.

Pile Loading: 20 tons, untreated timber piles.
24 tons, 12" steel bearing piles.
12 tons, 12" steel bearing piles under sidewalk returns

MICROFILMED

THIS SET OF PLANS HAS BEEN CORRECTED TO CORRESPOND TO THE "AS BUILT" PRINTS, DATED 2-4-49, AS SUBMITTED BY RESIDENT ENGINEER W.N.S.
TRACINGS CORRECTED BY SDM DATE 9-2-49.

AS BUILT PLANS
Contract No. 147224
Date Completed
Document No. 40002107

This contract is for superstructure only, excepting anchor bolts.

Submitted by: Edward R. Bergman
DESIGN — Chief Bridge Engineer
DETAILS — Bridge Engineer
QUANTITIES — Bridge Engineer
SPECIFICATIONS — Bridge Engineer
Approval Recommended by: W. H. Wheeler, Chief Engineer

DESIGN	R. J.	R. E.	11-46
DETAILS	W. C.	R. E.	11-46
QUANTITIES		R. E.	11-46
SPECIFICATIONS		R. E.	11-46

Scale: 1" = 30'-0"
Checked by: J. T. Hoffman
Approved by: W. H. Wheeler, Chief Engineer

BROADWAY OVERCROSSING
FOOTING PLAN

SCALE As shown	FILE NO.
BRIDGE NO. 35-96	DRAWING NO. C-1908-75

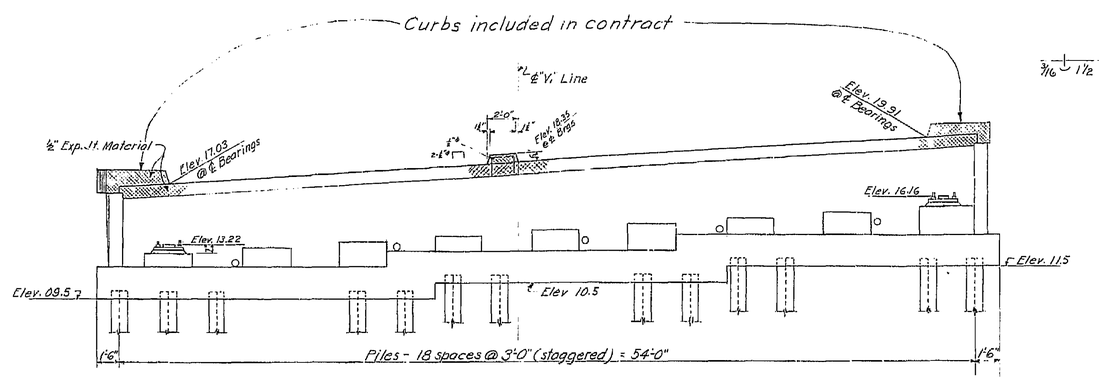
ClibPDF - www.fastio.com

FED. AID PROJ. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
2	CAL.		48	114	54

(1181(21))

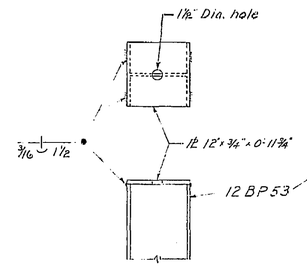
DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
11	M	60	Bur	9	13

March 12, 1947



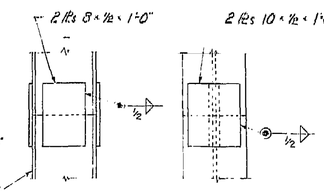
Note:- Top of Bearings are on straight grade between end bearings.

ELEVATION
Scale: ¼" = 1'-0"

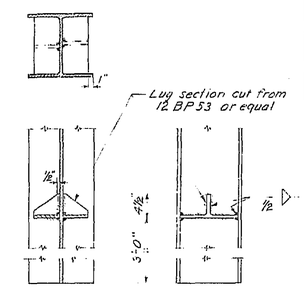


PILE CAP
Scale: 1" = 1'-0"

Pile caps to be placed on all piles after cutoff.



PILE FIELD SPLICE
Scale: 1" = 1'-0"

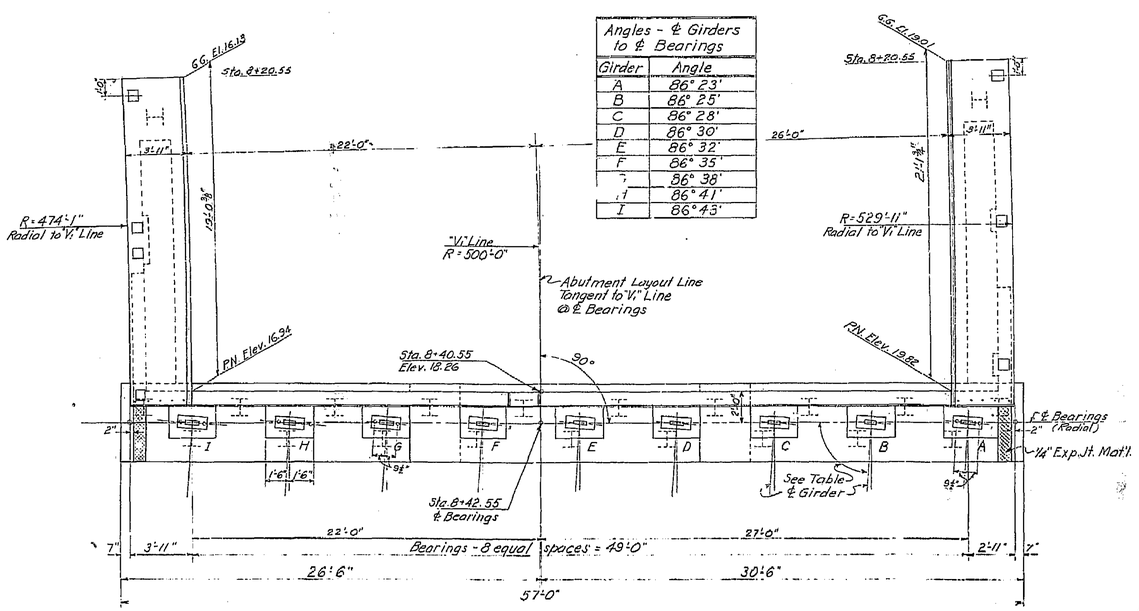


PILE LUG
Scale: 1" = 1'-0"

Notes:
1. Weld splice plates to top pile before placing top pile in position.
2. Place top pile in position and hammer sufficiently to secure good bearing on bottom pile.
3. Weld splice plate to bottom pile and butt weld any opening remaining between piles.
4. All piles to be flame cut, using steel yoke to secure square and even cut.
5. Lug to be used when ordered by the Engineer.

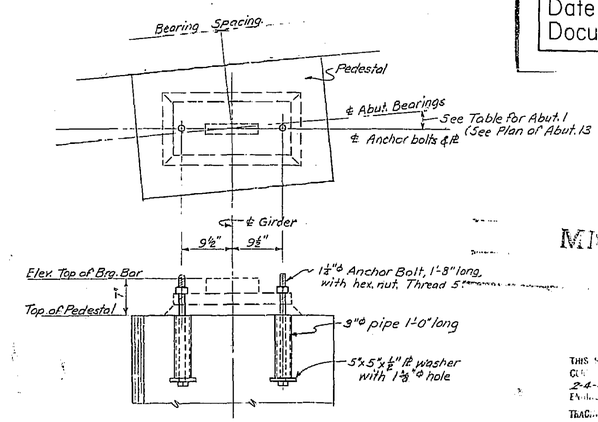
AS BUILT PLANS
Contract No. 14TC24
Date Completed
Document No. 40002107

Angles - ℄ Girders to ℄ Bearings	
Girder	Angle
A	86° 23'
B	86° 25'
C	86° 28'
D	86° 30'
E	86° 32'
F	86° 35'
G	86° 38'
H	86° 41'
I	86° 43'



Note: For details not shown see Sheet 4.
Railing not shown. For details & rail post spacing see Sh. 11.

PLAN
Scale: ¼" = 1'-0"



ANCHOR BOLT DETAILS
Scale: 1" = 1'-0"
Anchor bolts to be placed by others.

Abutments, excepting curb and railing, not a part of this contract.

MICROFILMED

THIS SET OF PLANS [illegible] FROM ORIGINAL TO 1-0 [illegible] PLANS, DATED 2-4-49 [illegible] SUBMITTED BY RESIDENT ENGINEER [illegible] H.N.S. TRACED BY: S.O.M. DATE: 9-2-49

This contract is for superstructure only, excepting anchor bolts.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING

ABUTMENT NO. 1

SCALE	BRIDGE	FILE	DRAWING
As Shown	35-96		C-1909-176

BRIDGE DEPARTMENT

Submitted by: Charles R. Hansen

DESIGN	By R.C.F.	10-46	Checked	R.S.B. 11-46
DETAILS	By R.W.K.	10-46	Checked	R.S.B. 11-46
QUANTITIES	By [illegible]	11-46	Checked	R.S.B. 11-46
SPECIFICATIONS	By [illegible]		Date Last Mod.	
Approx. Recommended by: C.F. Hansen			Bridge Engr.	R.S.B. 11-46
			Bridge Engr.	

ClibPDF - www.fastio.com

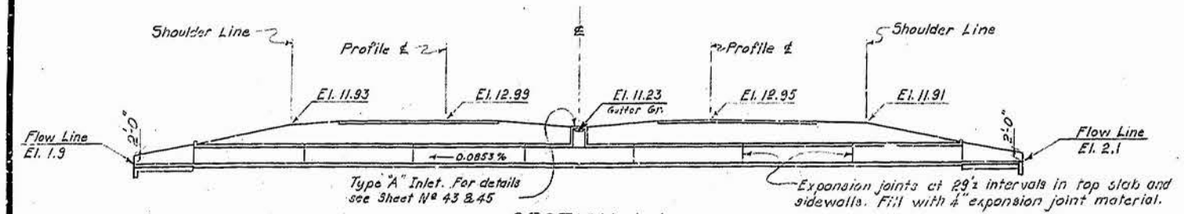
V 181 (17)

FED. ROAD S.B.I. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
2	CAL.		47	59	62

DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
IV	S.M.	68	F	59	62

BRIDGE ENGINEER — STRUCTURAL ENGINEER — LICENSE EXPIRES 30/10

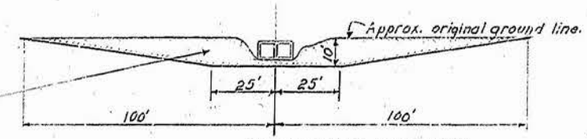
APPROVED August 5, 1946



SECTION A-A

Scale: 1" = 20'

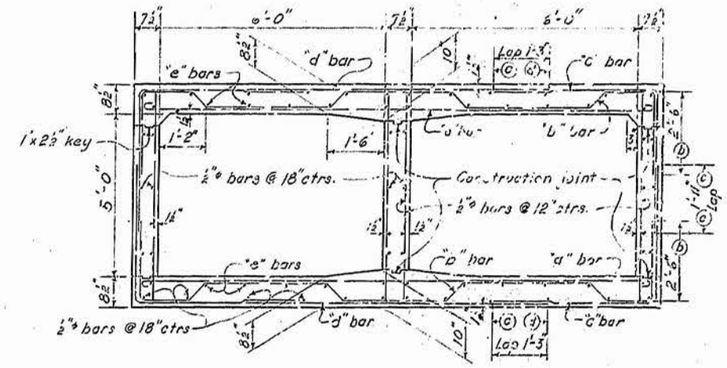
Note:
Unsuitable material shall be removed from the culvert site and the area filled with imported material. The embankment shall be built to grade and overloaded. After a sufficient resting period, the structure site shall be excavated and the culvert built upon imported material.



STRIPPING SECTION

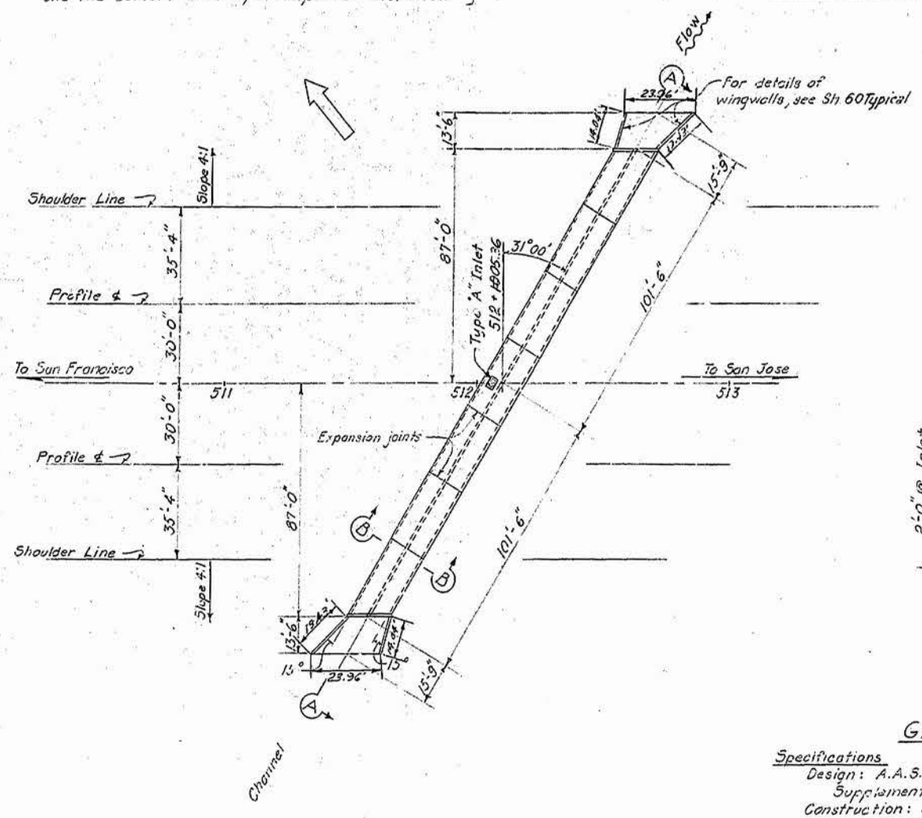
Bar Schedule

"a" bar	¼"φ @ 16" ctrs., 1'-3" lg.
"b" bar	¾"φ @ 16" ctrs., 19'-1" lg.
"c" bar	¾"φ @ 16" ctrs., 8'-1" lg.
"d" bar	¾"φ @ 8" ctrs., 3'-1" lg.
"e" bar	½"φ (total 16) distribution bars.
Spacer bars	½"φ (total 30)



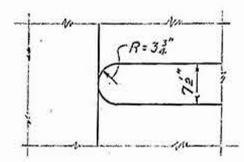
SECTION B-B

Scale: ½" = 1'-0"



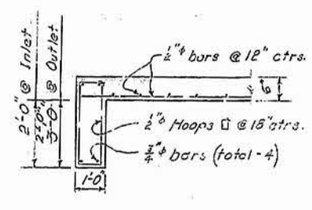
PLAN

Scale: 1" = 30'



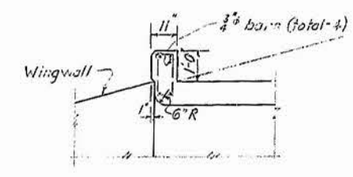
CENTER WALL END DETAIL

Scale: ¾" = 1'-0"

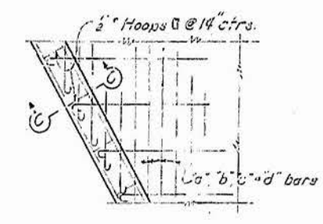


CUT-OFF WALL

Scale: ⅜" = 1'-0"



SECTION C-C



PART PLAN

HEADWALL DETAILS

Scale: ⅜" = 1'-0"

GENERAL NOTES

Specifications
Design: A.A.S.H.O. dated 1944 and Bridge Department Supplement dated 1946.
Construction: Standard Specifications dated April, 1945 and Special Provisions accompanying these plans.

Design Data
Live Load: H20-S16-44
Unit Stresses: fc = 1700 p.s.i., fs = 18000 p.s.i., n = 10
Earth Load: Vertical = 120 p.cu.ft. Equivalent fluid pressure = 36 p.cu.ft.

AS BUILT PLANS
Contract No. 4TC30-F
Date Completed
Document No. 40001181

Contr. 4TC30-F

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BOX CULVERT - STA. 512 +10 = +C5.36

GENERAL PLAN & DETAILS

SCALE As Shown	BRIDGE —	FILE	DRAWING

C-1899-6

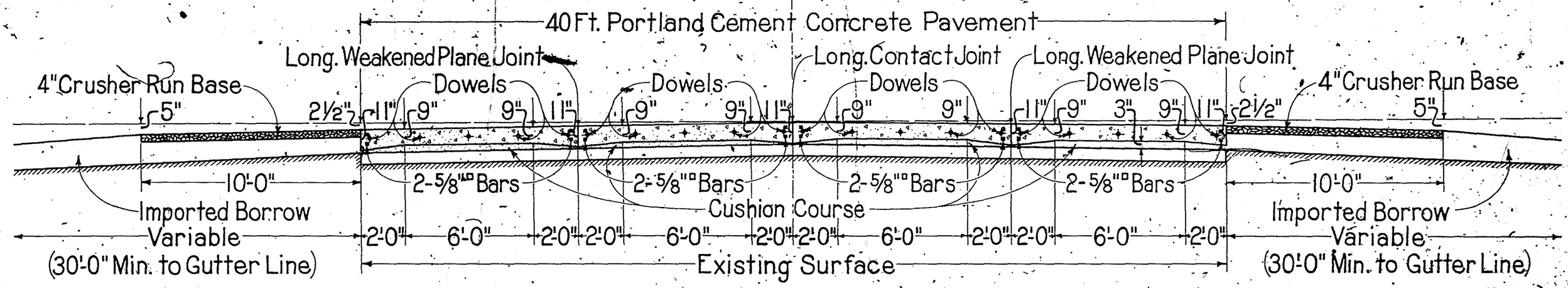
BRIDGE DEPARTMENT

Submitted by: Charles L. Taylor, Engineer					
DESIGN	By R.F.T.	5-46	Checked RWR	5-46	
DETAILS	By A.J.L.	5-46	Checked RWR	5-46	
QUANTITIES	By U.P.L.	6-46	Checked C.C.B.	6-46	
SPECIFICATIONS	By C.L.T.		Checked		
Approved Recommended by: C. L. Taylor, Chief Bridge Engineer			Director of Public Works		

DIST.	COUNTY	ROUTE	SEC.	SHEET NO.	TOTAL SHEETS
IV	S.M.	68	B&C	2	10

APPROVED Feb. 16 1931

STATE HIGHWAY ENGINEER



For Paving Details, See Sheet 3

STA. 528+09 to STA. 679+04
STA. 679+35.8 to STA. 683+57.2

Standard Superelevation to be used

TYPICAL CROSS SECTION

SCALE: 3/8 IN. = 1 FT.

RECOMMENDED February 14, 1931

Fred Hansen

C. S. Pope

AS BUILT PLANS
Contract No. 24707
Date Completed
Document No. 4000638

TPH 2-18-31

5/24/79

P.M. 11.5/16.5
New 04-S.M-101

D.S.	CO.	ROUTE	SECT.	SHEET	TOTAL SHEETS
IV	S.M.	101	[illegible]		62

INDEX OF SHEETS

- 2-3 [illegible]
- 4-21 Plan and Profile
- 22-29 Construction Details
- 30-37 Grading Contours and Pavement Elevations
- 38-42 Vertical Sand Drain Treatment
- 43-45 Miscellaneous Structures
- 46-53 Electrical Installation Details
- 54-59 R.C. Box Culvert Details
- 60-62 Standard Structures
- 1-144 Cross Sections

ADDED SHEETS 32 A,B,C,D,E

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

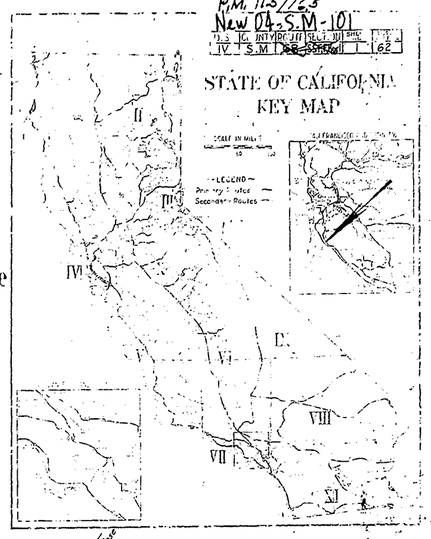
PLAN AND PROFILE OF
STATE HIGHWAY

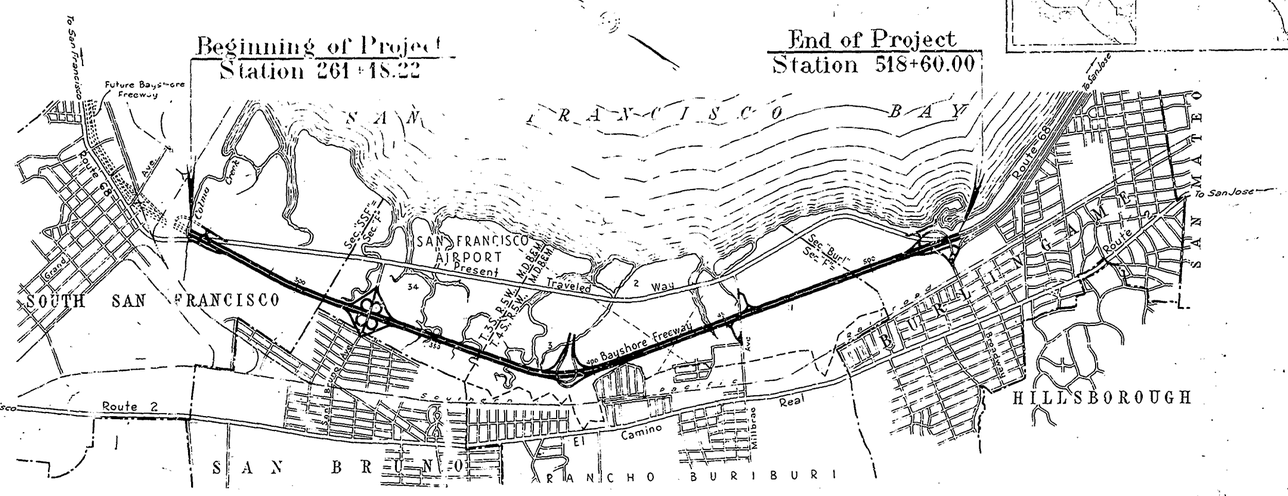
In San Mateo County, between Colma Creek in South San Francisco and Broadway in Burlingame

Scales (Plan: 1 In. = 100 Ft.
(Profile: Hor. 1 In. = 100 Ft. Vert. 1 In. = 5 Ft.

Being the detailed plans of a portion of the route for the State highway adopted by the California Highway Commission February 28, 1941 and January 17, 1946, and declared
FREEWAY
by resolution of the California Highway Commission October 17, 1946

STATE OF CALIFORNIA
KEY MAP





CONVENTIONAL SIGNS

- Quarry
- City or Town Limits
- Township Line
- Section Line
- Grant Line
- Fence
- Orchard
- Underground Property
- Right of Way Line
- Easement Line
- Railroad
- Foot Bridge
- Bank or Revetment
- Levee
- Culvert
- Bridge
- Power Pole
- Power Tower
- Telephone or Telegraph Pole
- Well

Scale in Feet
0 2000 4000 6000

Length of project - 26,909.86 feet - 5.097 miles

AS BUILT PLANS
Contract No. 4TC 30-F
Date Completed
Document No. 40001181

Con. 4TC30-F

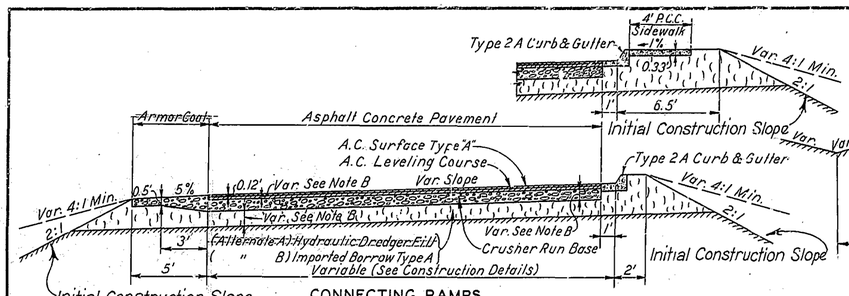
August 2, 1946
District Engineer
Approval recommended
Engineer Surveys and Plans
Approved August 5, 1946
State Highway Engineer
Civil Engineer License 2084
C.H. PURCELL
Director of Public Works

FED. DIV. NO.	STATE	FEDERAL PROJECT NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
	CALIF.	[illegible]	19	2	62

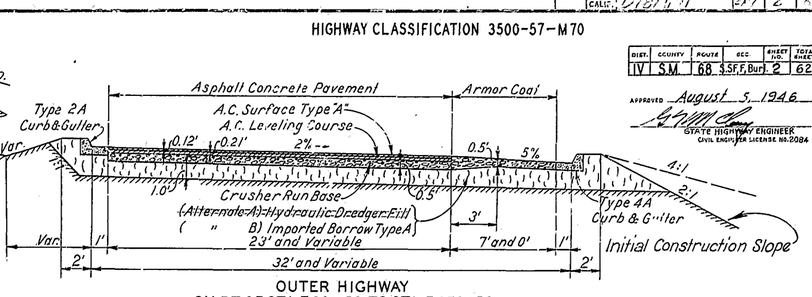
HIGHWAY CLASSIFICATION 3500-57-M70

DIST.	COUNTY	ROUTE	SEC.	SHEET NO.	TOTAL SHEETS
IV	S.M.	68	S.SF.F.Bur.	2	62

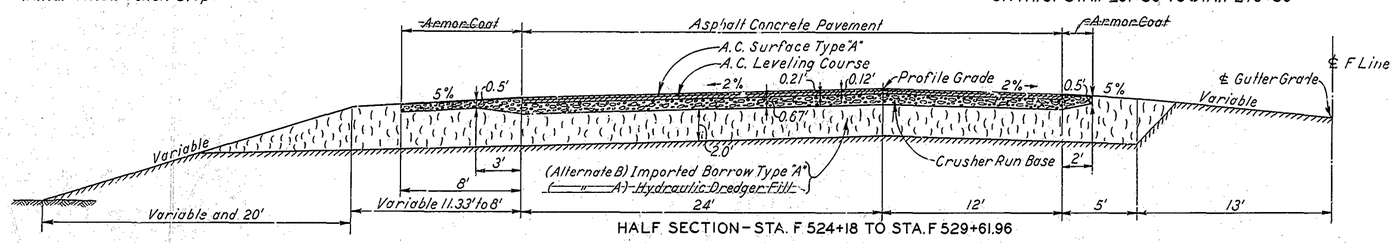
APPROVED August 5, 1946
STATE HIGHWAY ENGINEER
CIVIL ENGINEER LICENSE No. 2084



CONNECTING RAMPS



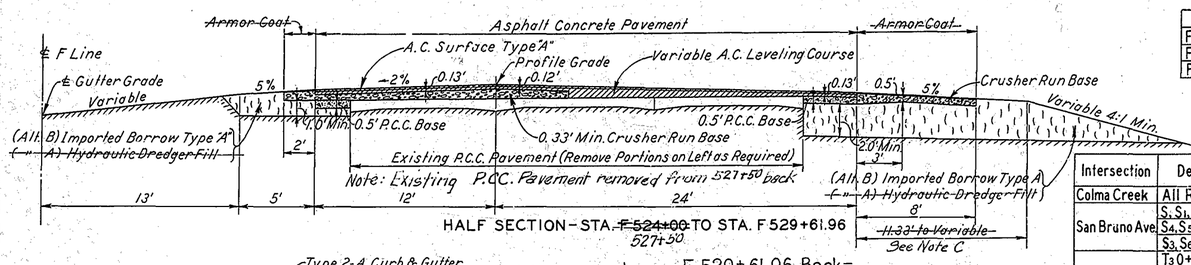
OUTER HIGHWAY
ON RT. OF STA. F 261+50 TO STA. F 270+50



HALF SECTION - STA. F 524+18 TO STA. F 529+61.96

NOTE A

Station	Distance
F 265+75 TO F 295+21±	10'
F 295+21± TO F 304+87±	Var. 10'-13'
F 304+87± TO F 529+61.96	13'



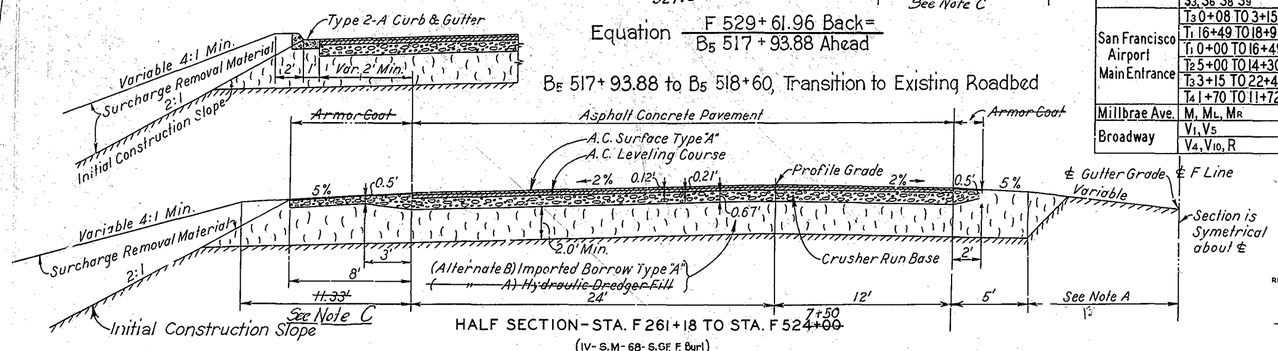
HALF SECTION - STA. ~~F 524+00~~ 527+50 TO STA. F 529+61.96

NOTE B

Intersection	Description	Thickness		
		Imp. Borr.	C.R. Base	A.C. Lev.
Colma Creek	All Ramps	1.0'	0.5'	0.21'
San Bruno Ave.	S_1, S_2, S_7	1.0'	0.5'	0.21'
	S_4, S_5	1.0'	0.5'	0.13'
	S_3, S_6, S_8, S_9	0.75'	0.5'	0.13'
San Francisco Airport Main Entrance	T_3 0+08 TO 3+15	1.0'	0.67'	0.21'
	T_1 16+49 TO 18+91			
	T_1 0+00 TO 16+49	1.0'	0.5'	0.21'
	T_2 5+00 TO 14+30			
	T_3 3+15 TO 22+40			
	T_4 1+70 TO 11+72			
Millbrae Ave.	M, M_L, M_R	0.75'	0.5'	0.13'
Broadway	V_1, V_5	1.0'	0.5'	0.21'
	V_4, V_{10}, R	0.75'	0.5'	0.13'

Equation $\frac{F\ 529+61.96\ \text{Back}=}{B_5\ 517+93.88\ \text{Ahead}}$

B_E 517+93.88 to B_5 518+60, Transition to Existing Roadbed



HALF SECTION - STA. F 261+18 TO STA. F 524~~+00~~ 7+50

(IV-S.M.-68-S.SF.F.Bur.)
Colma Creek to Broadway in Burlingame

TYPICAL CROSS-SECTIONS

SCALE 1" = 4'

Note:- See Sheets No's. 38 and 40 for Typical Cross-Section of Vertical Sand Drain Construction

Contr. 4TC30-F

RECOMMENDED August 2, 1946

T.H. Dennis
MAINTENANCE ENGINEER

A.W. Aasch
ENGINEER SURVEYS AND PLANS

R.R. Rollis
CONSTRUCTION ENGINEER

AS BUILT PLANS
Contract No. 4TC30-F
Date Completed
Document No. 4000(18)

Ⓐ

U181(21)

FED. ROAD DIST. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
2	CAL		48	1	54

P.M. 16.5
New 04-S.M-101

DIST	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
IV	S.M.	101		1	8

INDEX OF SHEETS

Sheet No. 1 Title Sheet
" " 2 Typical Cross Section of Improvement
" " 3-6 Roadway Plans
" " 7 Miscellaneous Structures
" " 8 Standard Structures
" " 1-10 San Bruno Rd. Overcrossing
" " 1-14 S.F. Airport Overcrossing
" " 1-9 Millbrae Ave. Overcrossing
" " 1-13 Broadway Overcrossing
" " 1-11 Cross Sections

STATE OF CALIFORNIA

DEPARTMENT OF PUBLIC WORKS

DIVISION OF HIGHWAYS

PLAN OF

STATE HIGHWAY

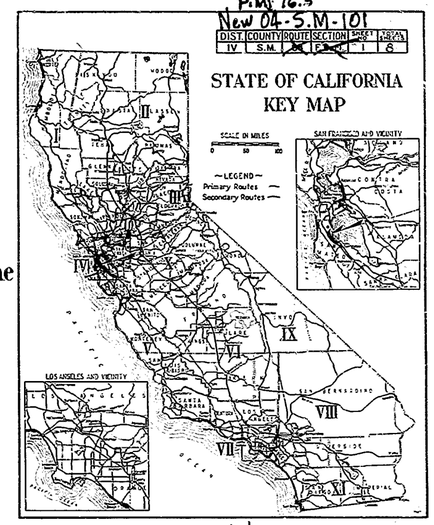
In San Mateo County, between South San Francisco and Broadway in Burlingame

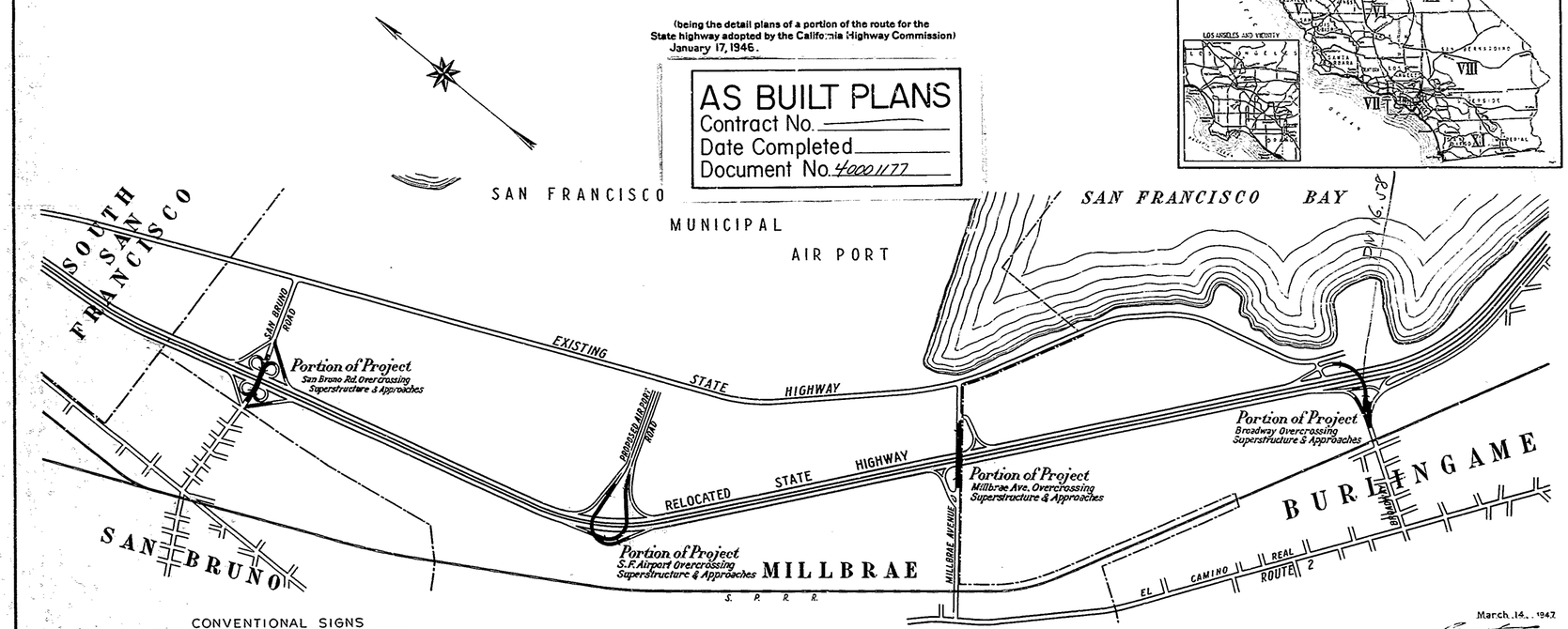
Scale Plan 1 In. = 50 Ft.

(being the detail plans of a portion of the route for the State highway adopted by the California Highway Commission) January 17, 1946.

AS BUILT PLANS
Contract No.
Date Completed
Document No. 40001177

STATE OF CALIFORNIA
KEY MAP





CONVENTIONAL SIGNS

County Line
City or Town Limits
Township Line
Section Line
Grant Line
Township
Note whether Township, Section or Grant
Fence
Guard Rail
Unfenced Property
Right of Way Line
Base or Survey Line
Traveled Way
Railway Tracks
Bank or Retaining Wall
Levee
Culverts
Drop Inlet
Trolley Pole
Power Pole
Power Tower
Telegraph or Telephone Pole
Marsh

-SCALE-
0 1000 2000 3000 FEET

March 14, 1947
District Engineer
Approval Recommended
Engineer Surveys and Plans
Approved March 17, 1947
State Highway Engineer
Civil Engineer License 2084
C. H. PURCELL
Director of Public Works

2-4-49
W.N. Samozich
SOM 9-2-49

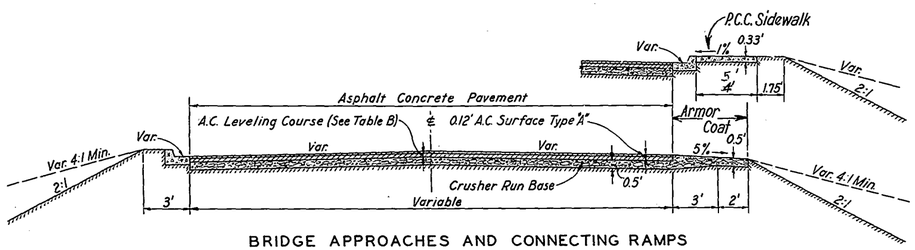
FRA DIV. NO.	STATE	FEDERAL PROJECT NO.	FISCAL YEAR	SHEET NO.	TO AL SHEETS
	CALIF.	U 781(21)	1949	2	52

DIST.	COUNTY	ROUTE	SECTION	SHEET NO.	TOTAL SHEETS
IV	S.M.	68	F, Burl.	2	8

APPROVED March 17, 1947

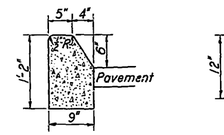
STATE HIGHWAY ENGINEER

CIVIL ENGINEERS PACKAGE NO. 2086



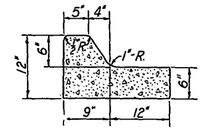
BRIDGE APPROACHES AND CONNECTING RAMPS

SCALE 1" = 4'



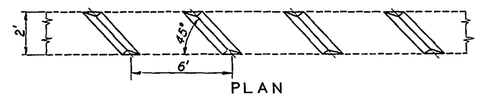
TYPE 1 CURB

SCALE 1" = 1'



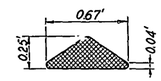
TYPE 2-A CURB & GUTTER

SCALE 1" = 1'



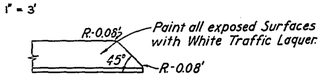
PLAN

SCALE 1" = 3'



CROSS SECTION

SCALE 1" = 6"



SIDE VIEW

SCALE 1" = 6"

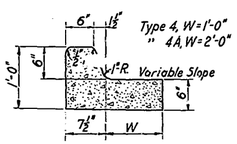
DETAILS OF ASPHALT CONCRETE BARS

TABLE-A

Intersection	Lines	Thickness
San Bruno Ave.	S 13+15 to 15+20.34	0.83'
	S 19+60.73 to 21+60	
	S2 5+70 to 13+00	
	S3 0+40 to 6+00	0.75'
	S5 0+90 to 3+20	
	S6 0+80 to 3+00	
	S7 0+90 to 3+15	0.83'
	S8 1+30 to 3+60	0.75'
San Francisco Airport Main Entrance	T1 2+00 to 4+29.11	0.83'
	T1 14+30.42 to 16+30	
	T3 4+70 to 6+68.75	
	T3 7+01.25 to 19+00	
Millbrae Ave.	M 5+00 to 6+31.48	0.75'
	M 14+46.48 to 16+00	
Broadway	V1 7+50 to 8+40.55	0.83'
	V1 Lt. on Ramp 16+40 to 16+80	
	V1 16+01.56 to 20+40	Variable
	V5 3+50 to 5+00	0.75'
	V10 9+50 to 10+75	

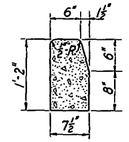
TABLE-B

Intersection	Lines	Thickness
San Bruno Ave.	S, S1, S2, S7	0.21'
	S3, S5, S6, S8	0.13'
San Francisco Airport Main Entrance	T1, T3	0.21'
Millbrae Ave.	M	0.13'
Broadway	V1	0.21'
	V10	0.13'



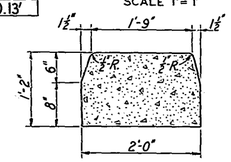
TYPE 4 & 4-A CURB & GUTTER

SCALE 1" = 1'



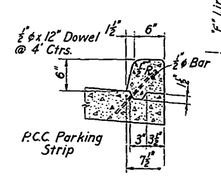
TYPE 5 CURB

SCALE 1" = 1'



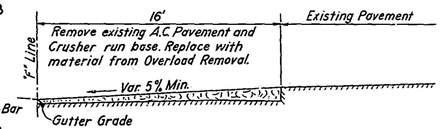
TYPE 6 CURB

SCALE 1" = 1'



TYPE 7 CURB

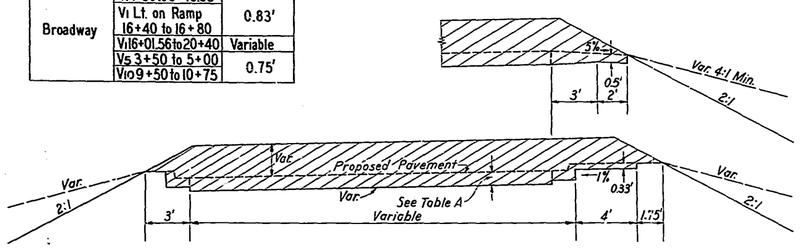
SCALE 1" = 1'



CROSSOVERS AND STORAGE LANES

RT. F 325+00 TO 328+70
LT. " 329+25 TO 333+50
" " 451 +00 TO 454+00
" " 526 +55 TO 529+25
RT. & LT. " 328 +70 TO 329+25
" " " 450 +00 TO 451 +00
" " " 525 +70 TO 526+55

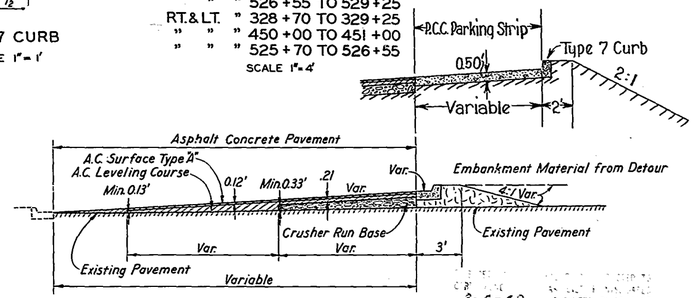
SCALE 1" = 4'



OVERLOAD REMOVAL

SAN BRUNO AVE, S, S1, S2, S3, S5, S6, S7, & S8 LINES
MILLBRAE " T1 & T3 LINES
S.F. AIRPORT M LINE
BROADWAY V1, V5 & V10 LINES

SCALE 1" = 4'



BROADWAY INTERCHANGE

SCALE 1" = 4'

2-4-49
W. N. Samarzich
JUN DATE 9-2-49

(IV-S.M.-68-F, BURL.)
Between So. San Francisco and Broadway in Burlingame

TYPICAL CROSS-SECTIONS

SCALES AS SHOWN

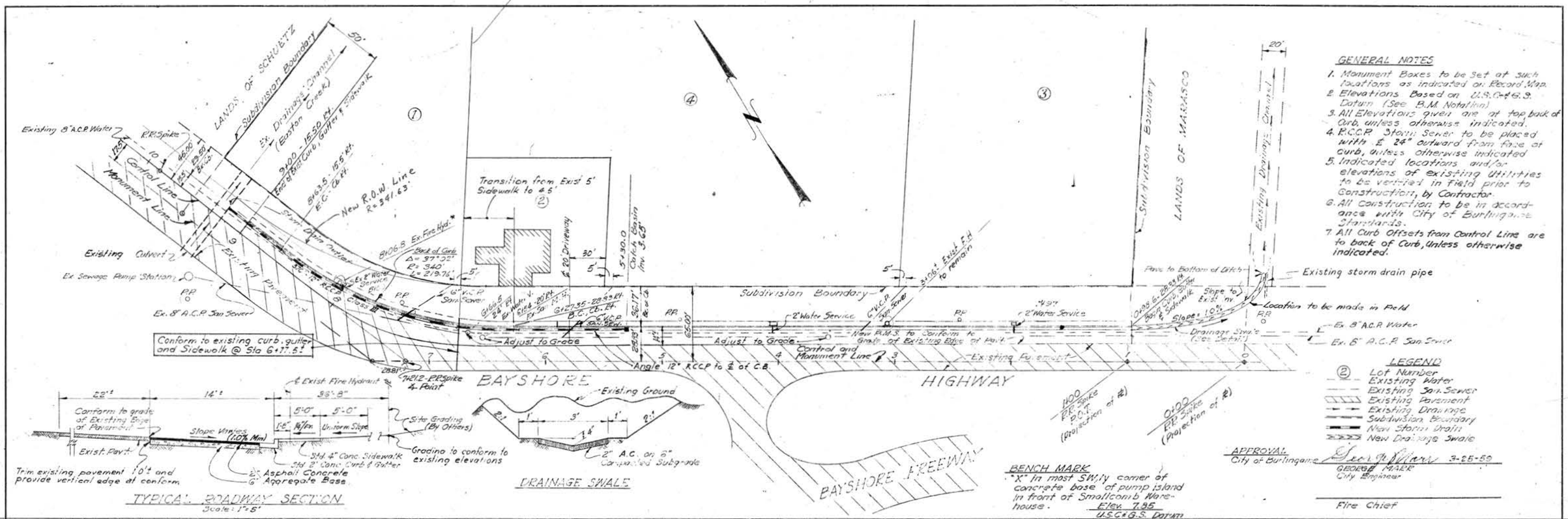
AS BUILT PLANS
Contract No. _____
Date Completed _____
Document No. 40001177

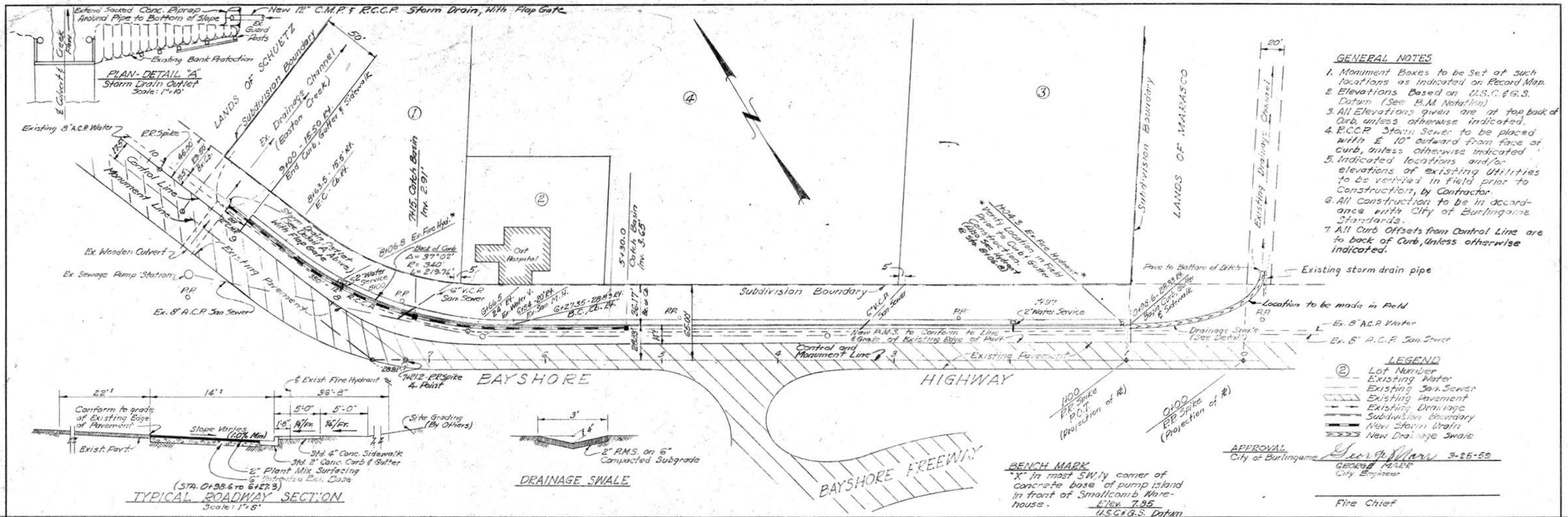
RECOMMENDED March 14, 1947

T. H. Dennis
MAINTENANCE ENGINEER

ENGINEER SURVEYS AND PLANS

CONSTRUCTION ENGINEER


LANDS OF SCHUETZ
Subdivision Boundary
Ex. Drainage Channel (Easton Creek)
Existing 8" A.C.P. Water
R.R. Spike
Control Line
Monument Line
New R.O.W. Line R=341.63'
Storm Drain Outlet
Existing Culvert
Ex. Sewage Pump Station
Ex. 8" A.C.P. San Sewer
Conform to existing curb, gutter and Sidewalk @ Sta 6+17.5'
Transition from Exist 5' Sidewalk to 4.5'
Back of Curb Δ=97°32' R=340 L=219.74'
Ex. Fire Hyd.
Catch Basin Inv. 3.68'
Subdivision Boundary
2" Water Service
6" V.C.P. San Sewer
Adjust to Grade
Control and Monument Line
Angle 12" R.C.C.P. to ℄ of C.B.
Existing Pavement
BAYSHORE HIGHWAY
BAYSHORE FREEWAY
LANDS OF MARASCO
Existing Drainage Channel
Pave to Bottom of Ditch
Existing storm drain pipe
Location to be made in Field
Ex. 8" A.C.P. Water
Ex. 6" A.C.P. San Sewer
Drainage Swale (See Detail)
Conform to grade of Existing Edge of Pavement
Exist. Pavt.
Slope Varies (2.0% Min)
Uniform Slope
Site Grading (By Others)
Grading to conform to existing elevations
Trim existing pavement 1'0" and provide vertical edge at conform.
2" Asphalt Concrete
6" Aggregate Base
Std. 4" Conc. Sidewalk
Std. 2" Conc. Curb & Gutter
TYPICAL ROADWAY SECTION
Scale: 1"=5'
Existing Ground
2" A.C. on 6" Compacted Subgrade
DRAINAGE SWALE
BENCH MARK
"X" in most SW'ly corner of concrete base of pump island in front of Smallcomb Warehouse. Elev. 7.85 U.S.C.&G.S. Datum Mean Sea Level=0
GENERAL NOTES
1. Monument Boxes to be set at such locations as indicated on Record Map.
2. Elevations Based on U.S.C.&G.S. Datum (See B.M. Notation)
3. All Elevations given are at top back of Curb, unless otherwise indicated.
4. R.C.C.P. Storm Sewer to be placed with ℄ 24" outward from face of curb, unless otherwise indicated
5. Indicated locations and/or elevations of existing Utilities to be verified in field prior to Construction, by Contractor.
6. All Construction to be in accordance with City of Burlingame Standards.
7. All Curb Offsets from Control Line are to back of Curb, Unless otherwise indicated.
LEGEND
Lot Number
Existing Water
Existing San. Sewer
Existing Pavement
Existing Drainage
Subdivision Boundary
New Storm Drain
New Drainage Swale
APPROVAL
City of Burlingame
GEORGE MARR
City Engineer
3-25-59
Fire Chief
ARPROVAL: Date: 5-21-64
GEORGE MARR - City Engineer
(For Revisions Dated: 4/64 & 5/64)
Approximate ℄ Easton Creek
Break into existing Conc. Culvert & grout new R.C.C.P.
"Approximate Flowline Easton Creek: 0.0"
12" R.C.C.P. INV. 2.20
12" R.C.C.P. INV. 2.94
MATCH
5'0"-12" R.C.C.P. @ S=.004 Class III
12" R.C.C.P. INV. 2.68'
Top of Curb
Edge of Pavement
Gutter Flowline
Slope Drainage Swale to Existing Pavement @ S=.10%
Impr. Accepted Nov. 16, 1964
5/64 General Revision
4/64 Add San. Sew. Lat. Lot 4
IMPROVEMENT PLANS
PLAN & PROFILE
BEARINT INDUSTRIAL PARK
BURLINGAME
SAN MATEO CO. CALIFORNIA
WILSEY, HAM & BLAIR
R.C.E. No 8724
May 1964
C99-0201-20
D-1
RECEIVED 27 1964
CITY ENGINEER CITY OF BURLINGAME


Extend Socked Conc. Riprap Around Pipe to Bottom of Slope
New 12" C.M.P. & R.C.C.P. Storm Drain, With Flap Gate
Ex. Guard Posts
Existing Bank Protection
Creek Flow
℄ Culvert
PLAN-DETAIL "A"
Storm Drain Outlet
Scale: 1"=10'
Existing 8" A.C.P. Water
P.P. Spike
LANDS OF SCHUETZ
Subdivision Boundary
Ex. Drainage Channel (Easton Creek)
9+00 - 15.50 Rt.
End Curb, Gutter & Sidewalk
8+63.5 - 15.5' Rt.
E.C. Cb. Pt.
Control Line
Monument Line
Slope Paint Outlet Detail "A" Above
Existing Pavement
Ex. Wooden Culvert
Ex. Sewage Pump Station
Ex. 8" A.C.P. San Sewer
7+15. Catch Basin Inv. 2.91'
8+06.8 Ex. Fire Hyd.*
Bkd. of Curb Δ = 97°02' R = 340' L = 219.76'
5' 2" Water Service
6" V.C.P. San Sewer
Cat Hospital
5+30.0 Catch Basin Inv. 3.65'
Subdivision Boundary
6" V.C.P. San Sewer
New P.M.S. to Conform to Line & Grade of Existing Edge of Pavt.
Control and Monument Line
Existing Pavement
10+04.3 Ex. Fire Hydrant* Verify Location in Field Prior to Curb & Gutter Construction (See Sht. 8 of 8)
LANDS OF MARASCO
Subdivision Boundary
Existing Drainage Channel
Pave to Bottom of Ditch
Existing storm drain pipe
Location to be made in Field
2" Water Service
Drainage Swale (See Detail)
Ex. 8" A.C.P. Water
Ex. 8" A.C.P. San Sewer
BAYSHORE HIGHWAY
BAYSHORE FREEWAY
℄ Exist. Fire Hydrant
Conform to grade of Existing Edge of Pavement
Slope Varies (1.0% Min)
Exist. Pavt.
Std. 4" Conc. Sidewalk
Std. 2" Conc. Curb & Gutter
2" Plant Mix Surfacing
6" Untreated Rock Base
(Site Grading (By Others))
(STA. 0+98.6 TO 6+27.9)
TYPICAL ROADWAY SECTION
Scale: 1"=5'
2" P.M.S. on 6" Compacted Subgrade
DRAINAGE SWALE
BENCH MARK
"X" in most SW'ly corner of concrete base of pump island in front of Smallcomb Warehouse. Elev. 7.85 U.S.C.&G.S. Datum
GENERAL NOTES
1. Monument Boxes to be Set at such locations as indicated on Record Map.
2. Elevations Based on U.S.C.&G.S. Datum (See B.M. Notation)
3. All Elevations given are at top back of Curb, unless otherwise indicated.
4. R.C.C.P. Storm Sewer to be placed with ℄ 10' outward from face of curb, unless otherwise indicated
5. Indicated locations and/or elevations of existing Utilities to be verified in field prior to Construction, by Contractor.
6. All Construction to be in accordance with City of Burlingame Standards.
7. All Curb Offsets from Control Line are to back of Curb, unless otherwise indicated.
LEGEND
Lot Number
Existing Water
Existing San. Sewer
Existing Pavement
Existing Drainage
Subdivision Boundary
New Storm Drain
New Drainage Swale
APPROVAL
City of Burlingame
3-25-59
GEORGE F. MARR
City Engineer
Fire Chief
Approximate ℄ Easton Creek
Catch Basin Sta. 7+15
Top of Curb
Edge of Pavement
Gutter Flowline
Slope Drainage Swale to Existing Channel
Socked Concrete Riprap at Pipe Outlet
Ames Model 10-C Flap Gate, or Equal
Approximate Flowline Easton Creek - 0.00'
20'-12" @ 16.9% C.M.P. (Asphalt Dipped) @ S=.004
165'-12" R.C.C.P. @ S=.004
185'-12" R.C.C.P. @ S=.004
12" R.C.C.P. INV. 2.65'
12" R.C.C.P. INV. 2.80'
MATCH
IMPROVEMENT PLANS
PLAN & PROFILE
BEARINT INDUSTRIAL PARK
BURLINGAME
SAN MATEO CO. CALIFORNIA
WILSEY & HAM ENGINEERS
R.C.E. No 8724
583023

B.P.R. DIV. No.	STATE	F.A. PROJECT No.	SHEET No.	TOTAL SHEETS
7	CALIF.			

DIST	COUNTY	ROUTE	P.M.	SHEET No.	TOTAL SHEETS
04	SM	101	16.6/16.6	1	66

INDEX OF SHEETS

Sheet No.	1	Title Sheet
" "	2- 3	Typical Cross-Sections
" "	4	Paving Details
" "	5	Whipple Avenue Grading Site
" "	6- 13	Construction Details & Monument Locations
" "	14	Contract Quantities
" "	15	Miscellaneous Drainage Details
" "	16	Median Barrier Plan
" "	17- 26	Standard Construction Details
" "	27- 41	Electrical Systems
" "	42- 65,49A	Signs
" "	66	Pavement Markers

STATE OF CALIFORNIA
HIGHWAY TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

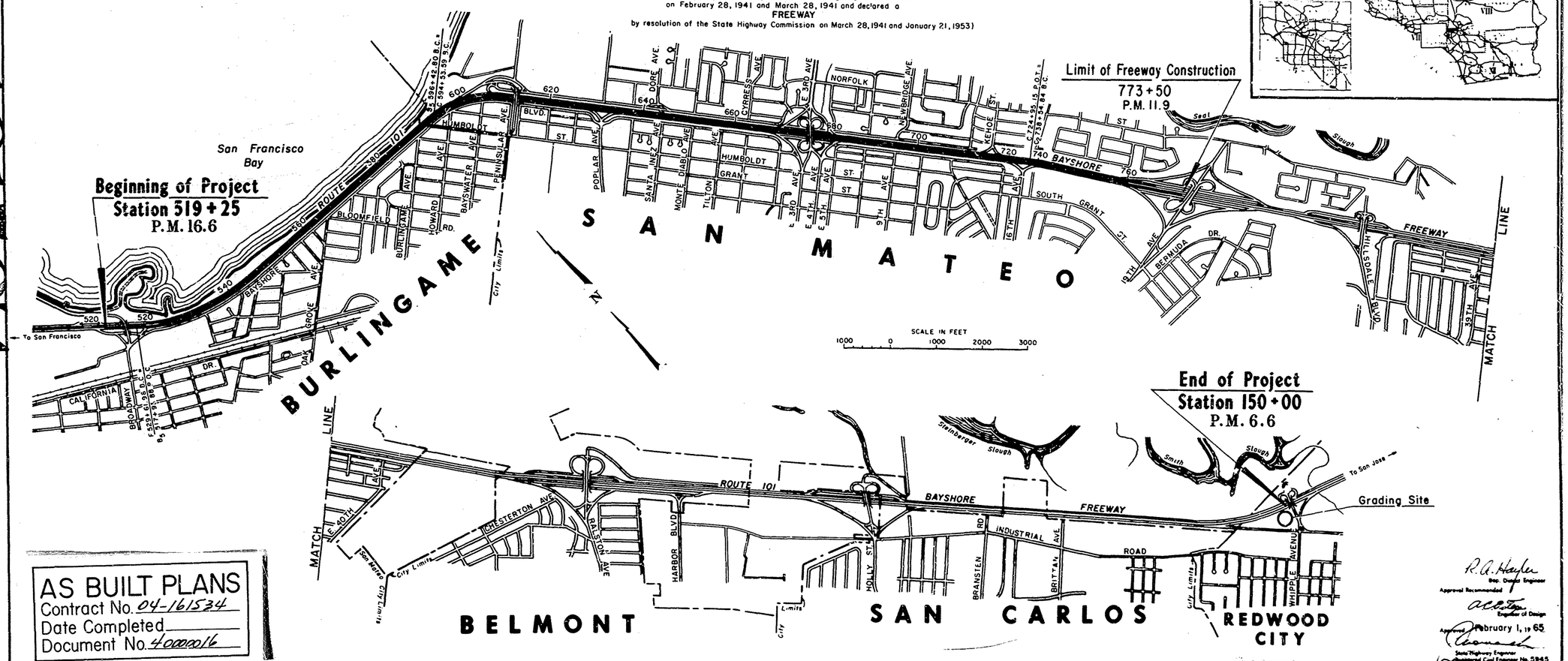
MICROFILMED.

CONTRACT No. 04-161534
DATE ACCEPTED JAN. 19, 1966
AS BUILT
RESIDENT ENGINEER E. W. COBLE
REVISIONS BY JL.B DATE 10-65
DELINEATED BY M. Accardi DATE 6-25-66
DEL
CHECKED BY R. O'Connell DATE 7-9-66

PLANS FOR CONSTRUCTION ON
STATE HIGHWAY
In San Mateo County
between Whipple Avenue in Redwood City and Broadway in Burlingame

(being the detail plans of a portion of the route for the State highway adopted by the California Highway Commission on February 28, 1941 and March 28, 1941 and declared a FREEWAY by resolution of the State Highway Commission on March 28, 1941 and January 21, 1953)

STATE OF CALIFORNIA KEY MAP



AS BUILT PLANS
Contract No. 04-161534
Date Completed
Document No. 40000016

MICROFILMED.

R. A. Hayden
Dep. Design Engineer
Approval Recommended
Engineer of Design
Approved February 1, 1965
State Highway Engineer
Civil Engineer No. 5945
Director of Public Works

Length of Project: 10.0 miles Length of Freeway Construction 4.7 miles

Contract No. 04-161534

161534

MICROFILMED.

D.P.S. DIST.	STATE	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
7	CALIF.		2	

DIST.	COUNTY	ROUTE	POST MILE	SHEET NO.	TOTAL SHEETS
04	SM	101	65.9/66.4	2	6A

R. A. Hayden
DIRECTOR OF HIGHWAYS

APPROVED February 1, 1965

FOR J. C. MONACO
STATE HIGHWAY ENGINEER
REGISTERED CIVIL ENGINEER NO. 17196

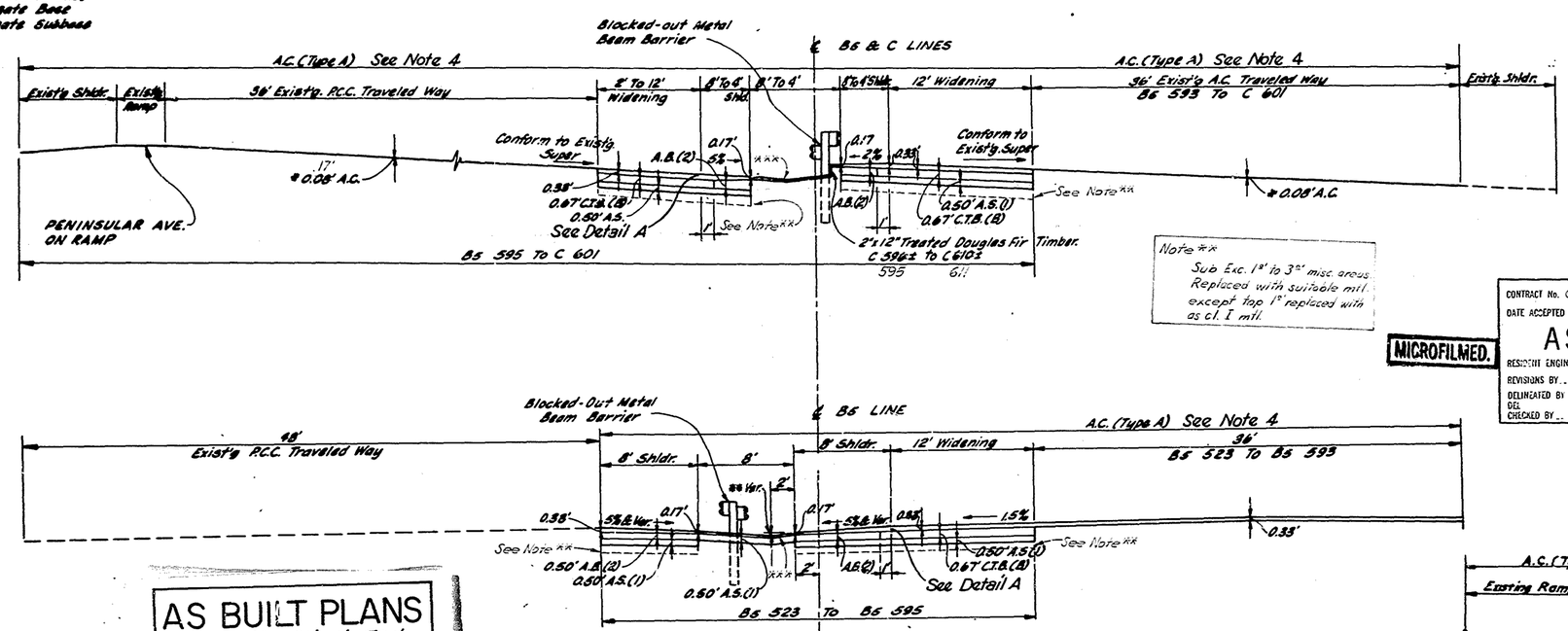
R. L. Lacayo
CHIEF, STATE HIGHWAY ENGINEER
REGISTERED CIVIL ENGINEER No. 35880

ABBREVIATIONS

P.C.C.	Portland Cement Concrete
A.C. (Type A)	Type A Asphalt Concrete
C.T.B. (B)	Class B Cement Treated Base
A.B. (2)	Class 2 Aggregate Base
A.S. (1)	Class 1 Aggregate Subbase
N.B.	Northbound
S.B.	South bound

DESIGN DESIGNATION

A.D.T. (62)	= 103,000	D	= 60%
A.D.T. (85)	= 120,000	T	= 5%
D.H.V.	= 11,000	V	= 60mph



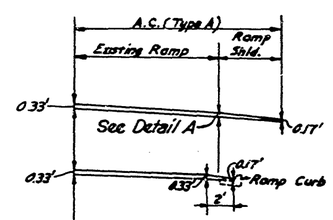
Note ***
Sub Exc. 1" to 3" misc. areas. Replaced with suitable mtl. except top 1" replaced with as cl. I mtl.

MICROFILMED.

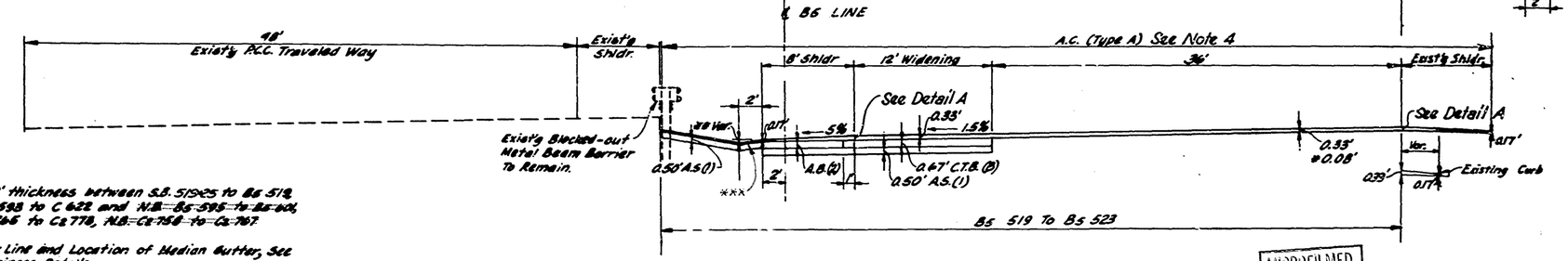
CONTRACT No. 04-161534
DATE ACCEPTED JAN. 19, 1966

AS BUILT

RESIDENT ENGINEER E. W. JOBLE
REVISIONS BY J. L. B. DATE 10-65
DELINEATED BY M. Accarai DATE 6-25-66
DEL
CHECKED BY R. O'Connell DATE 7-9-66



AS BUILT PLANS
Contract No. 04-161534
Date Completed
Document No. 40000016

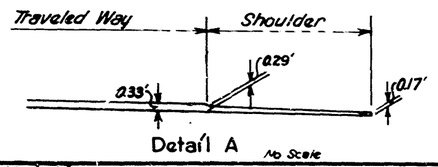


MICROFILMED.

* Use 0.08' thickness between S.B. 519.25 to B6 519, S.B. B6 593 to C 622 and N.B. ~~B5 595 to B5 601~~, S.B. C6 706 to C6 778, N.B. ~~C6 758 to C6 767~~.

** For Flow Line and Location of Median Gutter, See Misc. Drainage Details.

*** Fog seal applied to misc. areas total length of project.



Detail A No Scale

BAYSHORE FREEWAY
19 TH. AVE. O.C. TO BROADWAY O.C.

TYPICAL CROSS-SECTIONS

SCALE: 1" = 5'

Note:
1. Dimensions are subject to tolerances specified in Standard Specifications.
2. For Shoulder slope rates, see Misc. Drainage Details.
3. For Location of Blocked-Out Metal Beam Barrier, See Contract Quantities.
4. Areas requiring 0.08' A.C. resurfacing and the Type A Surface Course on freeway lanes and existing ramps shall be Open Graded Asphalt Concrete. Surface Course for shoulders and misc. areas shall be Type A Asphalt Conc.

PROJECT ENGINEER	DATE	DESIGN ENGINEER	DATE	APPROVAL RECOMMENDED BY	DATE
G. J. Matsui		B. A. Campbell		M. E. Harman	

161531

MICROFILMED.

161534

D.P.S. DIST. NO.	STATE	FEDERAL PROJECT NO.	SHEET NO.	TOTAL SHEETS
7	CALIF.		8	

Dist.	County	Route	Page Mile	Sheet No.	Total No.
04	SM	101	6.4/16.6	3	66

ABBREVIATIONS

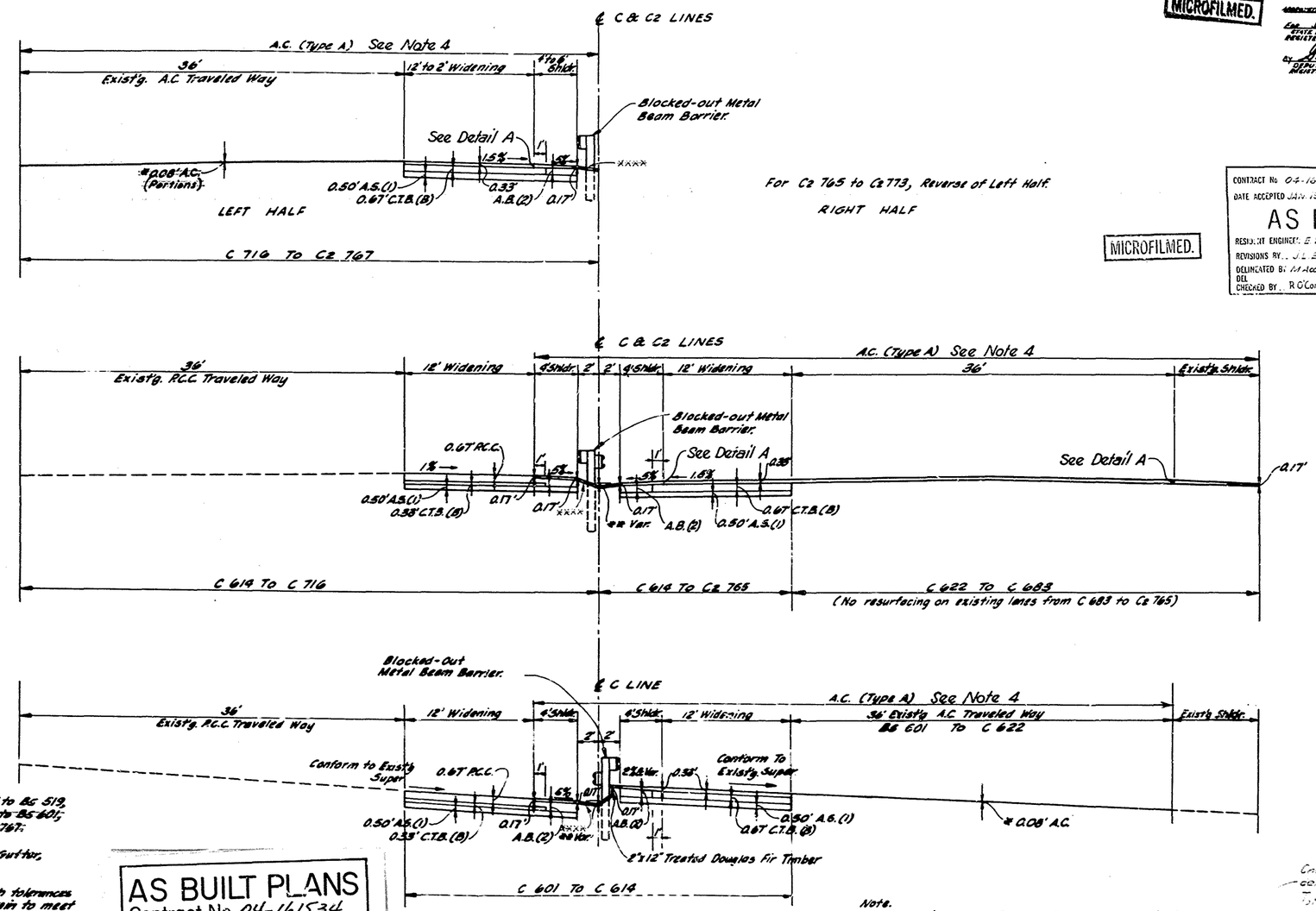
P.C.C.	Portland Cement Concrete
A.C. (Type A)	Type A Asphalt Concrete
C.T.B. (B)	Class B Cement Treated Base
A.B. (2)	Class 2 Aggregate Base
A.S. (1)	Class 1 Aggregate Subbase
N.B.	Northbound
S.B.	Southbound

DESIGN DESIGNATION

A.D.T. (62)	= 103,000	D	= 60%
A.D.T. (85)	= 120,000	T	= 5%
D.H.V.	= 11,000	V	= 60 mph.

R. C. Hayden
Approved February 1 1965
Chief, Office of Highway Engineer
Deputy State Highway Engineer
Registered Civil Engineer No. 5830

MICROFILMED.



* Use 0.011' thickness between S.B. 51.9+45 to BC 519, S.B. BC 593 to C 622 and N.B. BC 498 to BC 601; S.B. C2 765 to C2 773, N.B. C2 758 to C2 767.

** For Flow Line and Location of Median Gutter, See Misc. Drainage Details.

*** A.C. Blanket shall meet curb edges with tolerances of 0" to +½". Use a taper length of 2' min to meet this requirement.

**** Tog seal applied to misc. areas total length of project.

CONTRACT No. 04-161534
DATE ACCEPTED JAN. 13, 1966
AS BUILT
RESIDENT ENGINEER E. W. COBLE
REVISIONS BY J. L. B. DATE 10-65
DELINEATED BY M. Accardi DATE 6-25-66
CHECKED BY R. O'Connell DATE 7-9-66

MICROFILMED.

AS BUILT PLANS
Contract No. 04-161534
Date Completed
Document No. 40000016

Note.
1. Dimensions are subject to Tolerances specified in the Standard Specifications.
2. For Shoulder Slope rates, see Misc. Drainage Details.
3. For Location of Blocked-out Metal Beam Barrier, See Contract Quantities.
4. Areas requiring 0.08' A.C resurfacing and the Surface Course on freeway lanes and existing ramps shall be Open-Graded Asphalt Concrete. Surface Course for shoulders and miscellaneous areas shall be Type A Asphalt Concrete.

Changes to conform to Type A

BAYSHORE FREEWAY
19 TH. AVE. O.C. TO BROADWAY O.C.

TYPICAL CROSS-SECTIONS

SCALE: 1" = 5'

Project Engineer	Date	Design Engineer	Date	Approval Recommended By	Date
G. J. Matsuda	4-4-66	B. A. Campbell	4-4-66	M. E. Hardin	4-4-66

161531

161534

MICROFILMED.

To accompany plans dated February 1, 1965

DISTRICT	COUNTY	ROUTE	Post Miles — Total Project	Sheet No.	Total Sheets
04	SM	101	6.6/16.6	4	66

APPROVAL RECOMMENDED

MICROFILMED.

Engineer of Design
Registered Civil Engineer No. 9837

Assistant State Highway Engineer
Registered Civil Engineer No. 6692

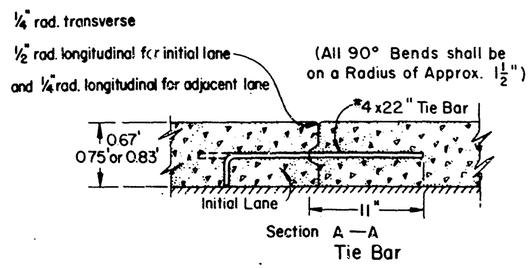
Approved August 25, 1964

State Highway Engineer
Registered Civil Engineer No. 5945

NO CONSTRUCTION CHANGES

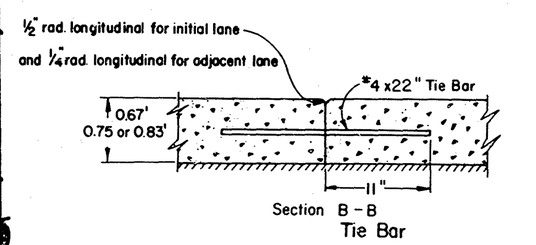
CONTRACT No. 04-161534
DATE ACCEPTED JAN. 19, 1966
AS BUILT
RESIDENT ENGINEER E.W. COBLE
REVISIONS BY ✓ DATE
DELINEATED BY DEL DATE
CHECKED BY DATE

MICROFILMED.



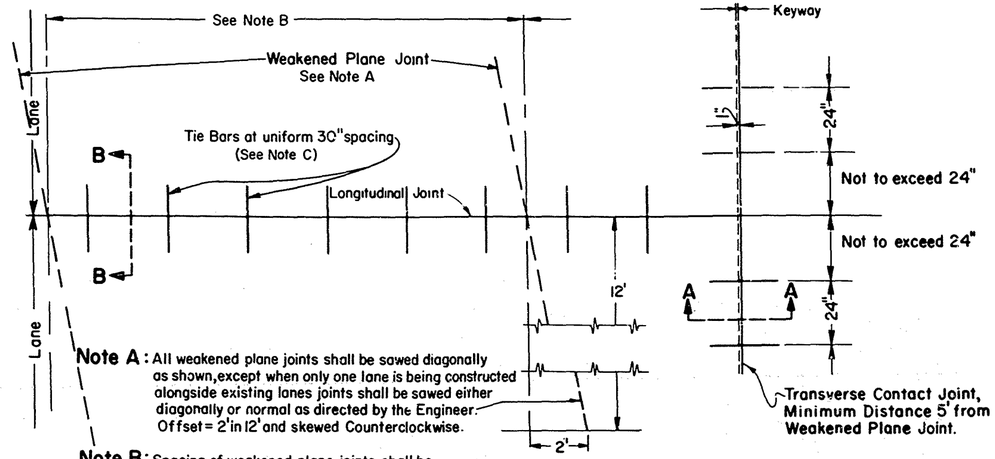
Transverse, or Optional Longitudinal Contact Joint with Keyway

Transverse Contact Joint with Keyway to be placed where ordered by Engineer.
Tie Bar to be placed in the middle 1/3 of the slab.



Longitudinal Contact Joint without Keyway

Tie Bar to be placed in the middle 1/3 of the slab.



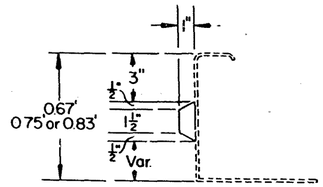
Note A: All weakened plane joints shall be sawed diagonally as shown, except when only one lane is being constructed alongside existing lanes joints shall be sawed either diagonally or normal as directed by the Engineer. Offset = 2' in 12' and skewed Counterclockwise.

Note B: Spacing of weakened plane joints shall be successively 13', 19', 18' 12' and repeat.

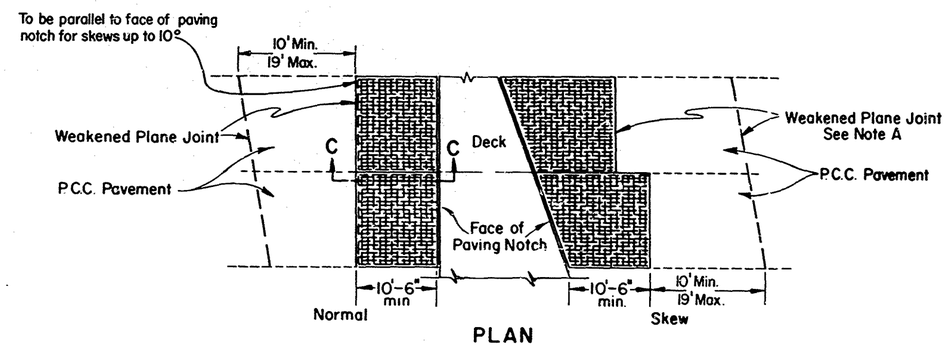
Note C: Tie bars shall be placed in all longitudinal joints except the center joint of 4-lane pavements constructed as two abutting 24' monolithic slabs.

PLAN

MICROFILMED.

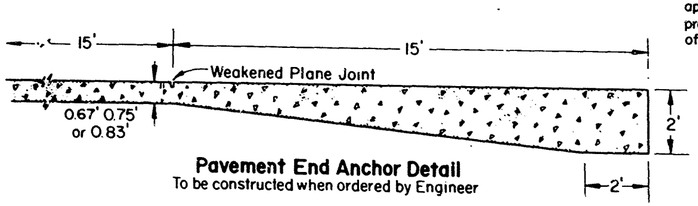


Detail of Metal or Wooden Insert to be placed on Side Forms

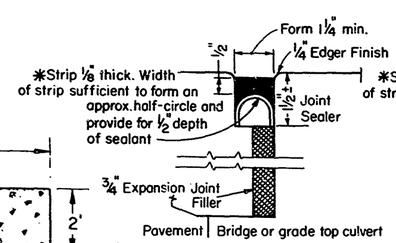


PLAN

AS BUILT PLANS
Contract No. 04-161534
Date Completed
Document No. 40000016

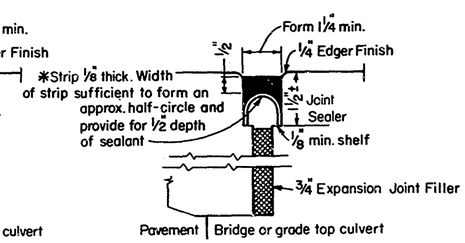


Pavement End Anchor Detail
To be constructed when ordered by Engineer

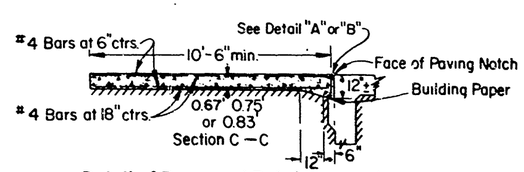


SEALED EXPANSION JOINT
DETAIL "A"

To be used only when the bridge abutment does not provide the shelf shown on Detail "B"



SEALED EXPANSION JOINT
DETAIL "B"



Detail of Pavement Reinforcement at Structure Approaches

* Strip material: See Standard Specifications or Special Provisions.

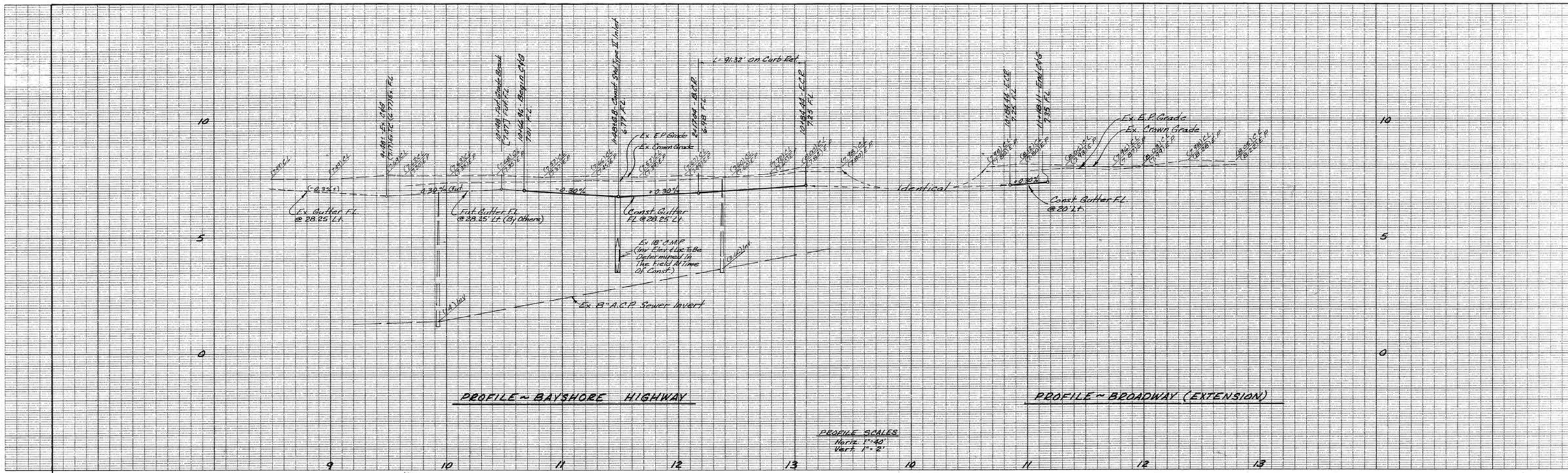
STATE OF CALIFORNIA
HIGHWAY TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

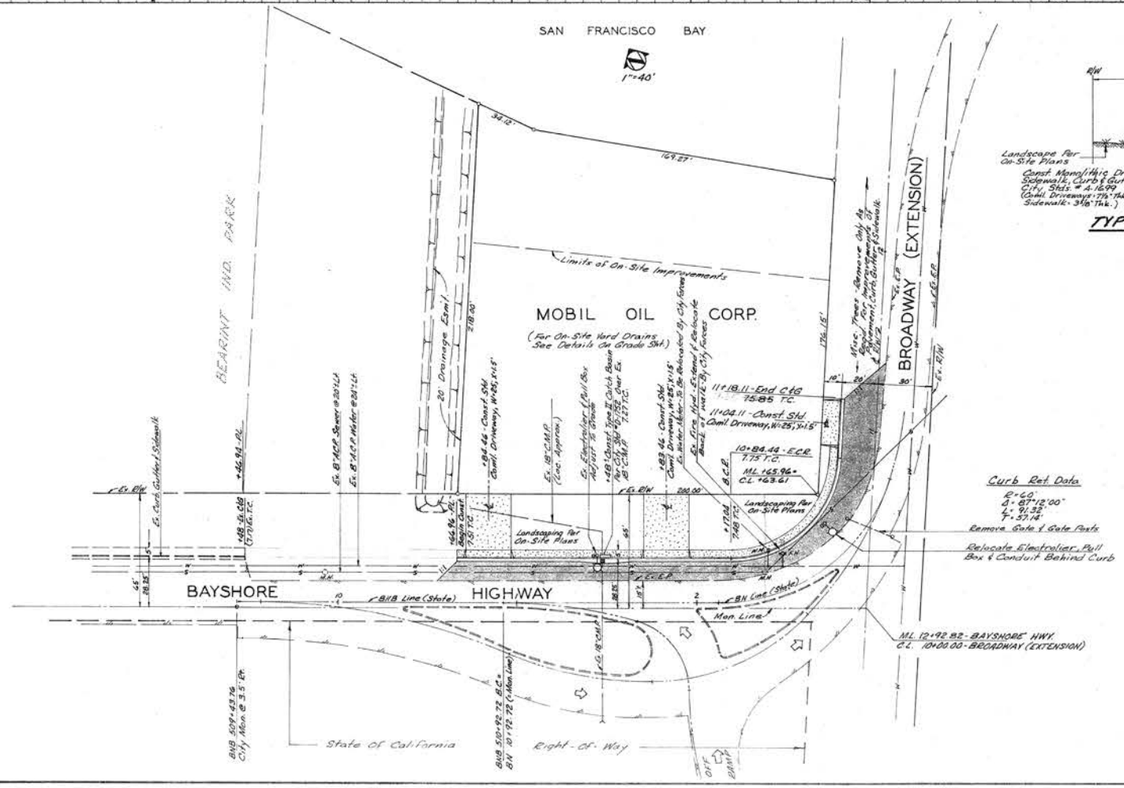
PAVING DETAILS A35-5

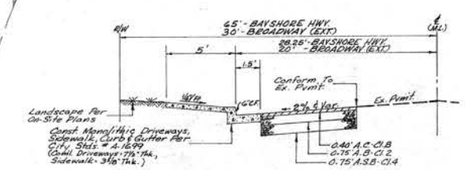
1534

MICROFILMED.

4







TYPICAL HALF STREET SECTION
No Scale

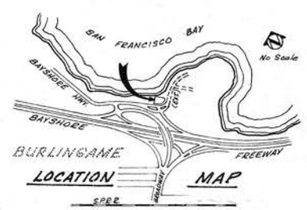
NOTES

1. All work shall conform to the latest Standards and Specifications of the City of Burlingame.
2. It shall be the contractors responsibility to locate and protect all utilities within the area of work.
3. Bench Mark: Elevations shown are to State of California datum. Description: Top of fire hydrant in front of site. Elevation: 10.03'

APPROVAL - CITY OF BURLINGAME

G.J. MARR - CITY ENGINEER — DATE 6-20-68

STATE ENCROACHMENT PERMIT NO. 468-E-762873



NO.	DATE	BY	DESCRIPTION	CHK'D.	CERT.	APP'D.
			ISSUE			

MOBIL OIL CORPORATION
WEST COAST DIVISION MARKETING DEPARTMENT
LOS ANGELES, CALIFORNIA

STREET IMPROVEMENT PLAN
N.W. CORNER
BAYSHORE HWY. & BROADWAY (EXT.)
BURLINGAME CALIFORNIA

HOLM, TAIT & ASSOCIATES
16 MARY STREET, SAN RAFAEL, CALIF
(415) 457-0880

PREPARED UNDER THE SUPERVISION OF
KENNETH E. TAIT R.C.E. 14900 — DATE 3/27/68

DR. BY K. Hastings — CH. BY
F.B. In File — JOB# MOSE 166-A

DRAWN BY — CHECKED BY — SCALE
DATE STARTED — DATE COMPLETED
THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION OR FOR ORDERING MATL. UNLESS CERTIFIED AND DATED. — CERTIFIED — DATED

APPROVALS — ISSUE NO.

DWG. NO. C2576 01M

DIST.	COUNTY	ROUTE	POST MILE—TOTAL PROJECT		
04	SM	101	16.6	1	62

INDEX OF SHEETS

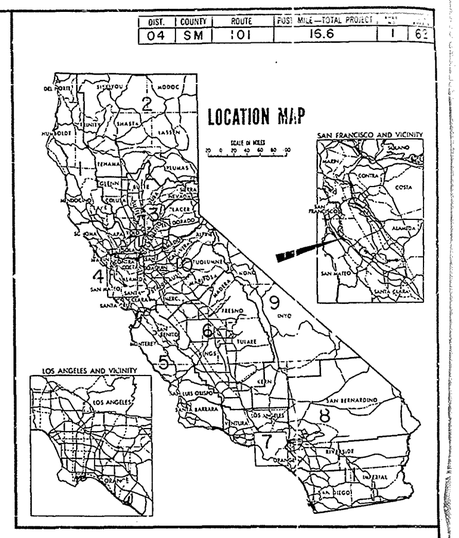
Sheet No.	1	Title Sheet
" "	2	Typical Cross Sections
" "	3	Standard Plans List
" "	4 - 6	Construction Details
" "	7 - 9	Drainage and Miscellaneous Details
" "	10	Miscellaneous Lists
" "	11	Stage Construction
" "	12-16, 16A	Special Details
" "	17-19	Planting
" "	20-22	Irrigation
" "	23-24	Planting and Irrigation Details
" "	25-32, 28A	Sign Plans
" "	33-51	Electrical
" "	52	Pavement Markers
" "	53-62	Broadway O. C. (Widen), Br. No. 35-96
" "	1 - 33	Cross Sections
" "	1 - 4	Drainage Cross Sections

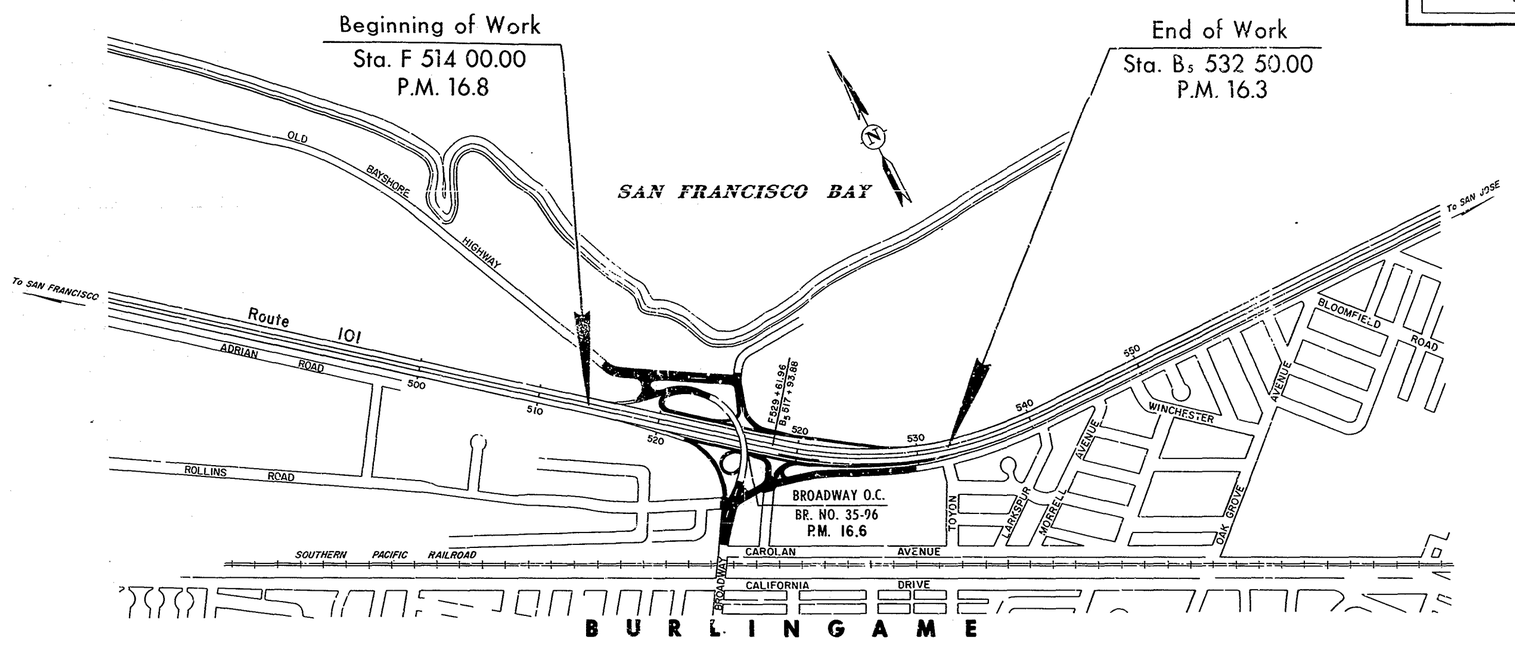
STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

PROJECT PLANS FOR CONSTRUCTION ON
STATE HIGHWAY

IN SAN MATEO COUNTY IN BURLINGAME AT BROADWAY INTERCHANGE

To be supplemented by Standard Plans dated July, 1969





SCALE IN FEET
500 0 500 1000

Length of Work = 0.6 miles

The details of plans are a portion of the route for the State Highway adopted by the California Highway Commission March 28, 1941 and January 17, 1946 and declared a FREEWAY by resolution of the California Highway Commission March 28, 1941 and January 17, 1946.

Project Engineer	Date	Design Engineer	Date	Approval Recommended By	Date

Drawn by	Date
ROLFHAGER	7-15-70
Checked by	Date

CONTRACT No. 04-387204
DATE ACCEPTED 8-23-71
AS BUILT
RESIDENT ENGINEER Ray Brennan
REVISIONS BY L.P. Chen DATE 8/71
DELINEATED BY A. Montoya DATE 10/5/71
CHECKED BY S. Minatoya DATE 10/26/71

District Engineer
Registered Civil Engineer No. 5554

Approved September 14, 1970

State Highway Engineer
Registered Civil Engineer No. 5645

AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 40003919

Bids Open	November 18, 1970
Contract No.	04-387204

04210-387201

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF PUBLIC WORKS.

DATE_____ SIGNATURE_____ TITLE_____

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF PUBLIC WORKS - MICROFILM

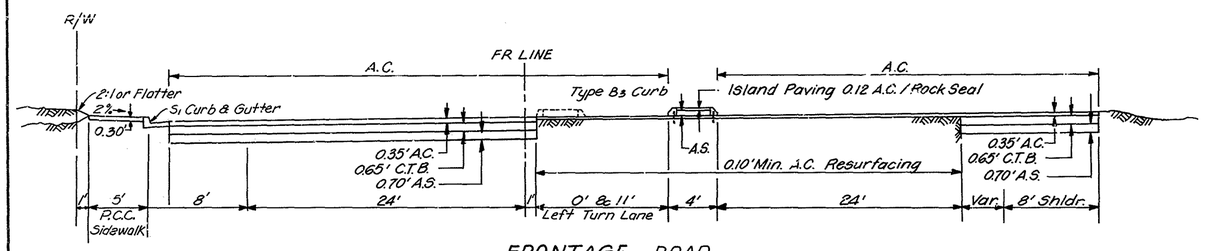
04	SM	101	16.6	2	62

Richard D. Parker
PROJECT ENGINEER — REGISTERED CIVIL ENGINEER No. 14233
DATE APPROVED September 14, 1970

APPROVED [signature]
AS TO FEATURES AFFECTING CITY FACILITIES
DIRECTOR OF PUBLIC WORKS, CITY OF BURLINGAME
CIVIL ENGINEER LICENSE NO. 6678

DESIGN DESIGNATION

Ramp Classification Heavy

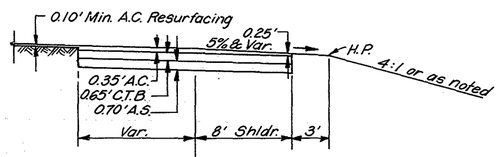


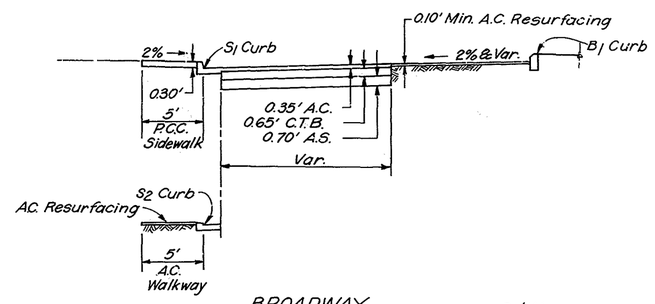
FRONTAGE ROAD
Scale: 1" = 5'

Abbreviations

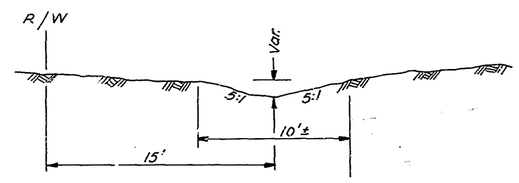
A.C.	Asphalt Concrete (Type B)
C.T.B.	Cement Treated Base (Class A)
A.S.	Aggregate Subbase (Class 4)
P.C.C.	Portland Cement Concrete

Notes:
1. Dimensions shown are subject to tolerances specified in the Standard Specifications.
2. For additional details & location limits, see Construction Details & Cross-Sections.

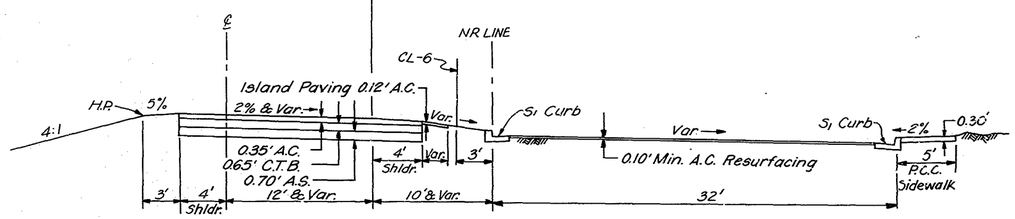




BROADWAY
Scale 1"=5'



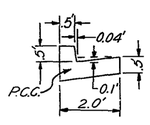
TYPICAL SWALE DITCH
Lt. Sta. "A" 511± to Lt. Sta. "A" 519±
No Scale

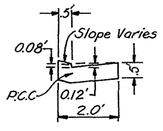


RAMPS & CONNECTOR ROADS

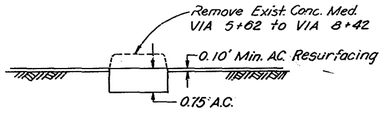
FRONTAGE ROAD
Scale: 1" = 5'

04-S.M-101-16.6





S1 Curb & Gutter — S2 Curb & Gutter
City of Burlingame Standard
Scale: 1" = 2'



Scale: 1" = 2'

NO CONSTRUCTION CHANGES
CONTRACT No. 04-387204
DATE ACCEPTED 8-23-77
AS BUILT
RESIDENT ENGINEER Ray Brennan
REVISIONS BY ... DATE
DESIGNATED BY ... DATE
CHECKED BY ... DATE

AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 4000 3919

TYPICAL CROSS-SECTIONS
SCALE: AS SHOWN

Project Engineer	Date	Design Engineer	Date	Approved Recommended By	Date
R.D. Parker	5/70	G. Anderson	5/70	R.C. Pinetti	5/70

FORM HD 92 PF

04-210 387201

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF PUBLIC WORKS.

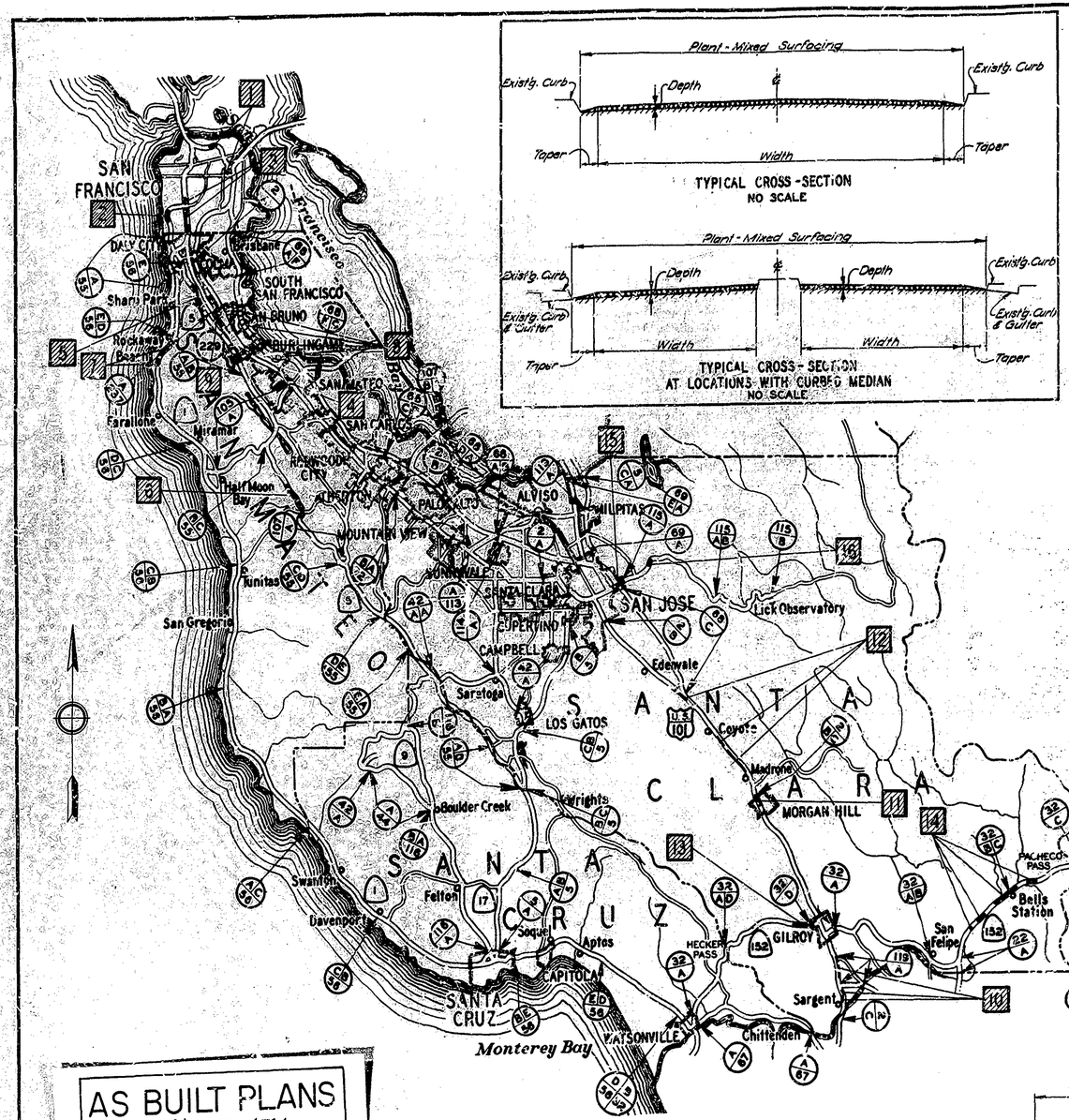
DATE ____ SIGNATURE ____ TITLE ____

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF PUBLIC WORKS - MICROFILM

R.P.D. DIV. NO.	STATE	FEDERAL PROJECT NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
	CALIF.				

04- S.F., S.M., S.C.- Var

DIST.	COUNTY	ROUTE	SECTION	FISCAL YEAR	TOTAL SHEETS
IV	S.F., S.M. & S.C.	Var.	Var.	12	3



INDEX OF SHEETS

Sheet No. 1 Location Map, Typical Cross Section and Contract Quantities
" " 2 Location and Limits of Surfacing in Interchanges at Location No. 8
" " 3 Standard Structures

58-4TC-6

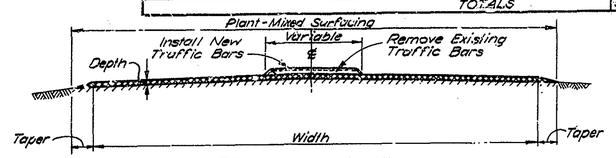
*Open Graded Plant-Mixed Surfacing

Director of Design
Civil Engineer License No. 5411

L. A. Weymouth
District Engineer

February 11, 1957

LOCATION NUMBER	COUNTY, ROUTE, SECTION	LOCATION	MILE LIMITS	TOTAL MILES	WIDTH OF PAVEMENT (Feet)	TAPER (Feet)	DEPTH (Feet)	REMOVE RAISED TRAFFIC BARS	ASPHALTIC EMULSION (PAINT BINDER)	PLANT-MIXED SURFACING	ADJUST D.I. FRAMES & GRATES TO GRADE	ADJUST MONUMENT COVERS TO GRADE	ADJUST M.H. FRAMES & COVERS TO GRADE	INSTALL RAISED TRAFFIC BARS
								Lin. Ft.	Tons	Tons	Each	Each	Each	Lin. Ft.
1	S.F.-2-S.F.	13th St. Viaduct to Broderick St. (Portions)	4.63 - 4.67	0.04	56	2								
			4.67 - 4.70	0.03	53	2								
			4.70 - 4.74	0.04	65	2	0.06	135	11.4	2490*		1	156	735
			4.74 - 4.83	0.09	90	2								
			4.83 - 4.91	0.08	86	2								
			7.02 - 8.12	1.10	58	2								
2	S.F.-55-S.F.	0.2 Mi. North of Lake Merced Blvd. to Sloat Blvd.	0.99 - 1.86	0.87	60		0.08	25	7.6	2140		1	2	25
			1.86 - 1.99	0.13	60-96									
3	S.F.-56-S.F.	San Mateo County Line to Vicente St. (Portions)	0.00 - 0.21	0.21	80	2								
			0.21 - 0.29	0.08	80-92	2								
			0.29 - 0.37	0.08	92	2								
			0.37 - 0.44	0.07	92-82	2								
			0.44 - 0.65	0.21	82	2	0.06		20.8	4460*	4		96	
			0.65 - 0.94 S/B	0.29	42	2								
			0.94 - 1.62	0.68	84	2								
			1.62 - 1.89	0.27	72	2								
			1.92 - 2.24	0.32	58	2								
4	S.M.-2-S.M.	South of 3rd Ave. to Poplar Ave.	3.14 - 3.17	0.03	55-70	1								
			3.17 - 3.28	0.11	70	1	0.08		3.5	1080			41	
			3.28 - 3.37	0.09	50	1								
			3.37 - 3.91	0.54	24	1								
5	S.M.-58-S.Br.	0.5 Mi. South of Sharp Park Road to Manor Drive	S.Br. 2.34-2.44	1.36	24	1	0.08		4.3	1130				
6	S.M.-58-C	0.2 Mi. South of Kings Mtn. Road to 2.9 Mi. North of Kings Mtn. Road	5.32 - 7.38	2.06	20	1	0.08		5.5	1445				
7	S.M.-56-D	0.2 Mi. South of San Pedro Ave. to Hewitt Ave. (Portions)	9.34 - 9.60	0.26	22	1	0.08		3.9	1045				
			9.84 - 10.84	1.00	24	1								
8	S.M.-68-Burl., Milbr., F., F	Burl. Ramps & Overcrossing Approaches	Burl. Ramps	0.47	16-42	1								
		Milbr. " " " "	Milbr. Ramps	0.37	16-28	1	0.08	30	7.2	1980	2	1	6	30
		F (Airport) " " " "	F (Airport) Ramps	0.39	22-36	1								
		F (San Bruno) " " " "	F (San Bruno) Ramps	1.47	14-42	1								
9	S.M.-237-S.Br.	San Bruno Ave. to 0.1 Mi. North of Sneath Lane	0.76 - 0.78	0.02	82-92	1								
			0.78 - 0.81	0.03	92-94	1								
			0.81 - 0.88	0.07	94-52	1								
			0.88 - 1.30	0.42	52	1	0.08		22.7	1620				
			1.30 - 1.36	0.06	52-88	1								
			1.36 - 1.44	0.08	88-52	1								
			1.44 - 1.51	0.07	52	1								
10	S.C.L.-2-C	Sargent Overhead to Gilroy (Portions)	1.05 - 1.49 S/B	0.44	24	1								
			1.47 - 3.01 N/B	1.54	24	1	0.08		9.8	2530				
			4.01 - 4.28 N/B	0.27	20	1								
			4.32 - 5.35 N/B	1.03	20	1								
11	S.C.L.-2-Mo.H., B	Dunne Ave. to Madrone Underpass	Mo.H. 0.62-0.66	0.04	52	1								
			Mo.H. 0.66-0.87	0.21	52-50	1	0.08	950	7.1	1880		2	23	650
			Mo.H. 0.87-8.07	0.86	50	1								
12	S.C.L.-2-B	Madrone to Ford Road (Portions)	1.49 - 4.63 S/B	3.14	20	1								
			5.59 - 6.81 S/B	1.22	20	1								
			10.74 - 10.88 S/B	0.14	20	1								
			10.88 - 10.96 S/B	0.08	20-30	1	0.08		15.0	3900				
			10.96 - 11.12 S/B	0.16	30	1								
			11.12 - 11.22 S/B	0.10	30-60	1								
			11.22 - 11.59 S/B	0.37	30	1								
13	S.C.L.-32-D, Gil.	0.2 Mi. West of Uvas Creek to Miller Ave.	D 6.48 - Gil 0.27	2.43	20	1	0.08		6.1	1595		1	1	
14	S.C.L.-32-B, C	0.3 Mi. West of Killdeer Creek to 3.2 Mi. East of Bells Station (Portions)	B 5.43 - 5.77	0.34	20	1								
			B 6.16 - 7.86	1.70	20	1								
			B 8.43 - 9.31	0.88	20	1	0.08		15.7	4050				
			C 0.00 - 1.07	1.07	20	1								
			C 1.80 - 2.80	1.00	24	1								
			C 2.80 - 2.89	0.09	24-46	1								
			C 2.89 - 3.12	0.23	46	1								
15	S.C.L.-115-S.Js.	24th St. to King Road (Portions)	0.58 - 0.80	0.12	62	1								
			0.80 - 1.00	0.20	60	1	0.08	60	5.4	1480		1	64	60
			1.07 - 1.43	0.36	62	1								
16	S.C.L.-115-A	0.1 Mi. West of Mountain View Ave. to Mt. Hamilton Road (Portion)	2.72 - 3.23	0.51	18	1	0.08		1.3	370				
		TOTALS		32.02				1200	147.9	33,200	6	7	369	900



TYPICAL CROSS-SECTION
AT LOCATIONS WITH RAISED TRAFFIC BARS
NO SCALE

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

PROJECT
IN SAN FRANCISCO, SAN MATEO
AND SANTA CLARA COUNTIES
AT VARIOUS LOCATIONS

DRAWN BY: E.J.L. | DATE: 12-12-56 | SCALE: AS SHOWN

4QT 1560-1

AS BUILT PLANS
Contract No. 58-4TC6
Date Completed —
Document No. 4003983

LOCATION MAP

SCALE IN MILES
5 0 5 10

Project Locations shown thus:

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF PUBLIC WORKS

DATE 11/24/72 SIGNATURE James E. Cook TITLE Sr. Draftsman

MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF PUBLIC WORKS - MICROFILM
SCALE 1" = 50' 0 200 400 600
SCALE 1" = 20' 0 100 200 300

District	County	Route	Post Miles	Sheet No.	Total Sheets
04	SM	101	16.8/17.2	1	5

DEPUTY DISTRICT DIRECTOR OF TRANSPORTATION
REGISTERED CIVIL ENGINEER NO. 8704

DATE APPROVED OCTOBER 17, 1977

INDEX OF SHEETS

Sheet No. 1 Location Map, Typical Cross Section and Quantity Summary
" " 2-4 Pavement Markers
" " 5 Traffic Control System for Lane Closure

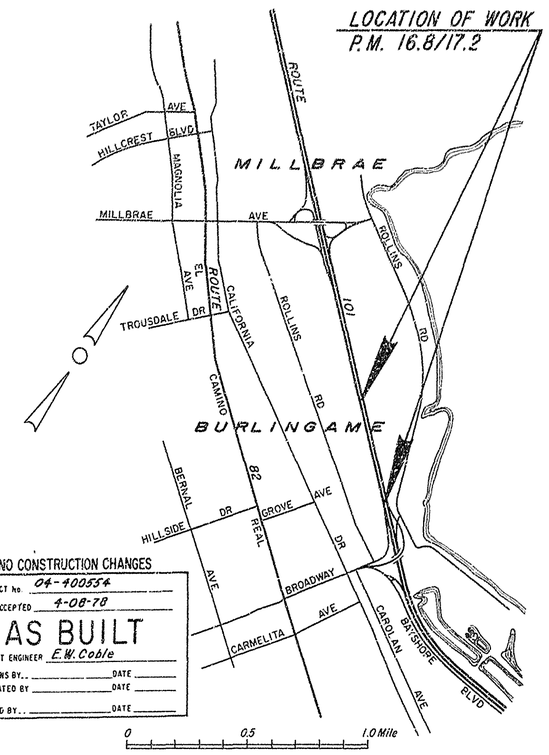
CONTRACT QUANTITIES

REMOVE PAVEMENT MARKER	PAVEMENT MARKER REFLECTIVE	PAVEMENT MARKER NON-REFLECTIVE	(CLASS 4) AGGREGATE SUBBASE	SHOULDER BACKING	AGGREGATE (TYPE A) ASPHALT CONCRETE	PAVING ASPHALT (ASPHALT CONCRETE)	ASPHALTIC EMULSION (PAINT BINDER)
EACH			TON	STATION	TON		
585	163	488	150	17	1620	87	6

PAVING TABLE

PAVE SOUTHBOUND LANES ONLY	
POST MILE	WIDTH (FEET)
16.84	Conform
16.90	63.00
17.00	62.00
17.20	63.00
17.21	Conform

LOCATION OF WORK
P.M. 16.8/17.2

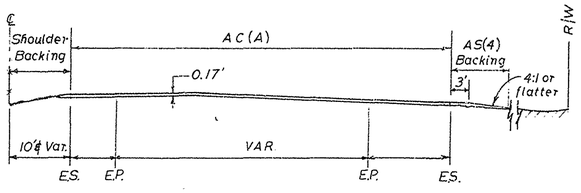


LOCATION MAP

NOTES

1. Dimensions shown are subject to tolerances as specified in the Standard Specifications.
2. Superelevations as directed by the Engineer.
3. Pave full existing width, unless ordered otherwise by the Engineer.
4. Paving table widths shown to be used only as a guide for estimating.

NO CONSTRUCTION CHANGES
CONTRACT No. 04-400554
DATE ACCEPTED 4-08-78
AS BUILT
RESIDENT ENGINEER E.W. Coble
REVISIONS BY.. DATE
DELINEATED BY DATE
DEL CHECKED BY.. DATE



TYPICAL CROSS SECTION
Scale 1"=10'

LEGEND AND ABBREVIATIONS

AC(A) - - Asphalt Concrete (Type A)
AS(4) - - Aggregate Subbase Class 4
Var - - Variable
ES - - Edge of Shoulder

STATE OF CALIFORNIA
BUSINESS AND TRANSPORTATION AGENCY
DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ON
STATE HIGHWAY
IN SAN MATEO COUNTY
IN BURLINGAME ON ROUTE 101
FROM 0.2 MILE NORTH OF
BROADWAY OVERCROSSING TO
0.7 MILE SOUTH OF
MILLBRAE AVENUE OVERCROSSING

to be supplemented by Standard Plans dated March 1977

Contract No. 04 - 400554

Project Engineer	Date	Design Engineer	Date	Approval Recommended by	Date
	9/77		9/77		9/77

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

04322 400551

AS BUILT PLANS
Contract No. 04-400554
Date Completed
Document No.

I HEREBY CERTIFY THAT THIS IS A TRUE AND ACCURATE COPY OF THE ABOVE DOCUMENT TAKEN UNDER MY DIRECTION AND CONTROL ON THIS DATE IN SACRAMENTO, CALIFORNIA PURSUANT TO AUTHORIZATION BY THE DIRECTOR OF TRANSPORTATION.
DATE 10-6-82 SIGNATURE Donald Blackford Canon Microfilm

SCALE 1"=50' MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION - MICROFILM SCALE 1"=50'
SCALE 1"=20' MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION - MICROFILM SCALE 1"=20'
SCALE 1"=10' or 1"=100' MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION - MICROFILM SCALE 1"=10' or 1"=100'
SCALE 1"=40' MICROFILM - STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION - MICROFILM SCALE 1"=40'

DIST	COUNTY	ROUTE	POST MILE TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.4/22.0	1	77

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

F-P101(659)

PROJECT PLANS FOR CONSTRUCTION ON
STATE HIGHWAY
IN SAN MATEO COUNTY
IN BURLINGAME, MILLBRAE AND SOUTH SAN FRANCISCO
FROM 0.2 MILE SOUTH OF BROADWAY OVERCROSSING
TO SOUTH SAN FRANCISCO OVERHEAD, (PORTIONS)

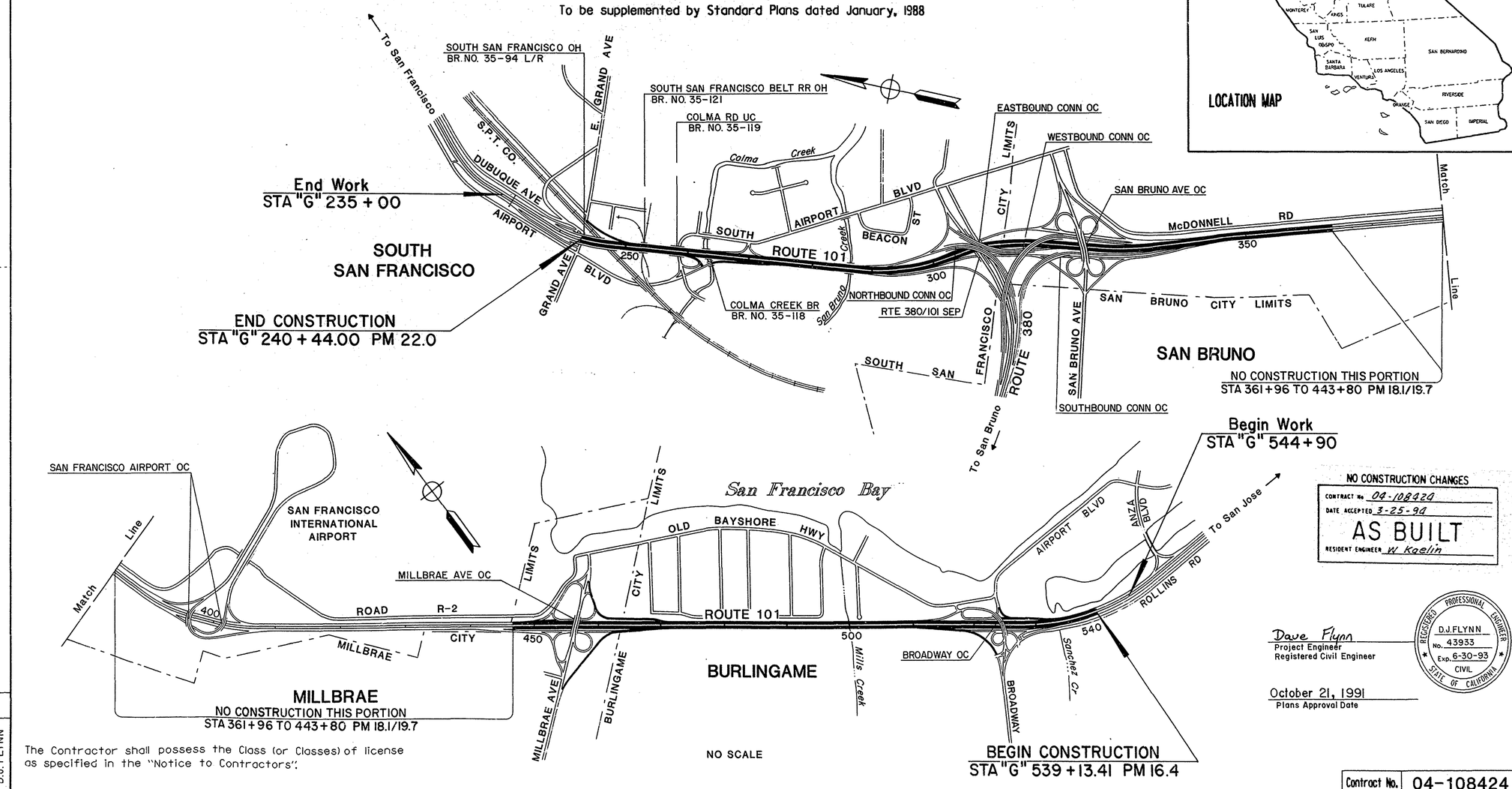
To be supplemented by Standard Plans dated January, 1988

INDEX OF SHEETS

Sheet No.	1	Title and Location Map
" "	2-6	Typical Cross Sections
" "	7	Standard Plans List
" "	8	Key Map and Line Index
" "	9-21	Layouts
" "	22-23	Profiles
" "	24-29	Construction Details 26A, 28A
" "	30-44	Drainage Plans, Profiles, Details and Quantities
" "	45	Stage Construction Plans
" "	46-47	Construction Area Signs
" "	48-62	Pavement Delineation Plans and Quantities
" "	63-65	Summary of Quantities
" "	66-72	Electrical Plans
" "	73-75	New Standard Plans

STRUCTURE PLANS

" "	76-77	Approach Slab Rehabilitation Coloma Creek Bridge No. 35-118



NO CONSTRUCTION CHANGES
CONTRACT No. 04-108424
DATE ACCEPTED 3-25-94
AS BUILT
RESIDENT ENGINEER W. Kaelin

Dave Flynn
Project Engineer
Registered Civil Engineer

REGISTERED PROFESSIONAL ENGINEER D.J. FLYNN No. 43933 Exp. 6-30-93 CIVIL STATE OF CALIFORNIA

October 21, 1991
Plans Approval Date

The Contractor shall possess the Class (or Classes) of license as specified in the "Notice to Contractors".

PROJECT ENGINEER D.J. FLYNN DATE

Contract No. 04-108424

FORM DC-OE-93-PF (REV. 3/88)

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

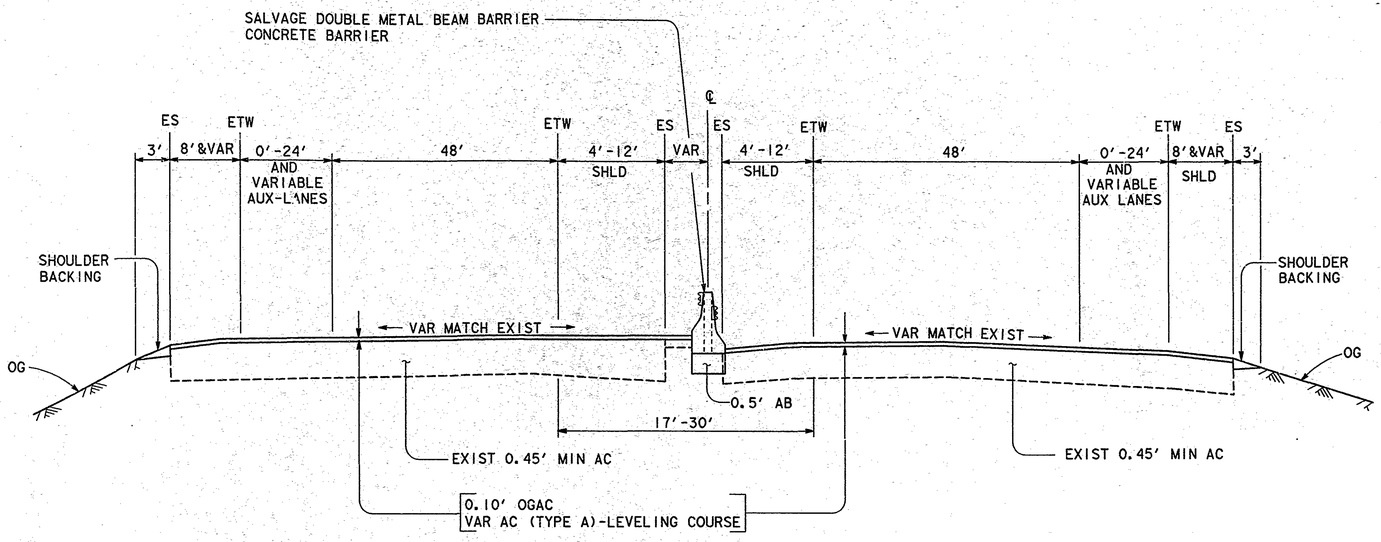
CU 04334 EA 108421

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.4/22.0	2	77

David J. Flynn
REGISTERED CIVIL ENGINEER 7-5-91

10-21-91
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER DAVID J FLYNN No. 43933 Exp. 6-30-93 CIVIL STATE OF CALIFORNIA



NORTHBOUND

SOUTHBOUND

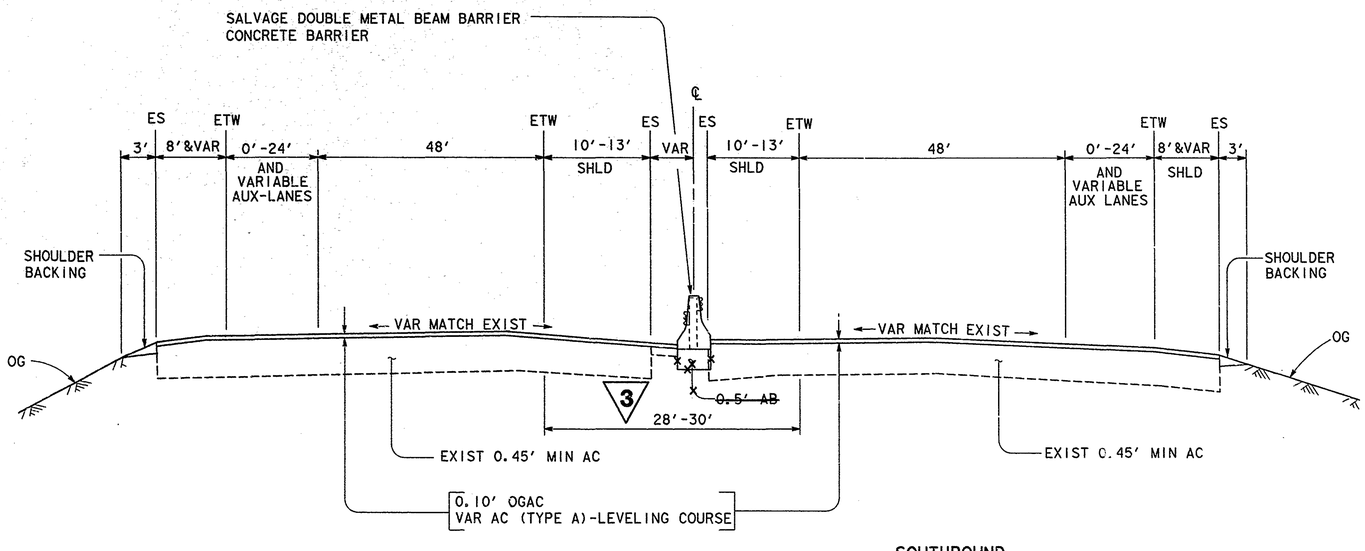
"G" 261+66.47 TO "G" 290+50.00

NOTES:

1. DIMENSIONS OF THE STRUCTURAL SECTIONS ARE SUBJECT TO TOLERANCES SPECIFIED IN THE STANDARD SPECIFICATIONS
2. SUPERELEVATION AS SHOWN OR AS DIRECTED BY THE ENGINEER.
3. SEE PROFILE SHEETS FOR LEVELING.

ABBREVIATIONS:

AUX = AUXILIARY



NORTHBOUND

SOUTHBOUND

"G" 290+50.00 TO 361+96.43

NO Construction Changes

CONTRACT No. 04-108424
DATE ACCEPTED 3/25/94
AS BUILT
RESIDENT ENGINEER W Kaelin

3 **REVISED FOR ADDENDUM NO.3 DATED JANUARY 13, 1992**

TYPICAL CROSS SECTIONS

NO SCALE

X-1

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans **CENTRAL DESIGN**

PROJECT ENGINEER D. J. FLYNN

CALCULATED/DESIGNED BY | CHECKED BY | DATE | REVISED BY | DATE REVISED

FORM DC-OE-92-PF (REV. 3/88)

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

CU 04334 | EA 108421

LAST REVISION 00-00-00

USER-ID: 14ctom0NODE DATE: Fri Apr 28 2000 TIME: 10:32 FILE: /project/trodd/asbuilts/108421/410842x01.asb

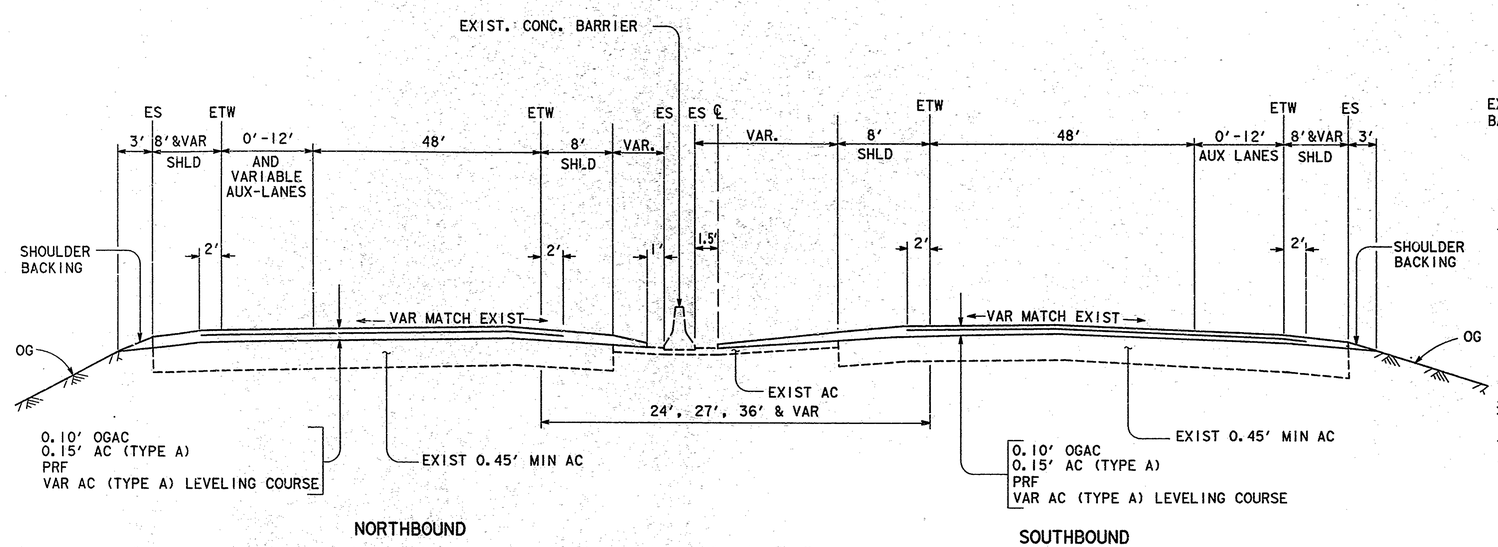
$$$$$$$$$$DGNSPEC$$$$$$$$$$ $$$$$$$SYTIME$$$$$ $$$$$$$USER$$$$$$

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.4/22.0	3	77

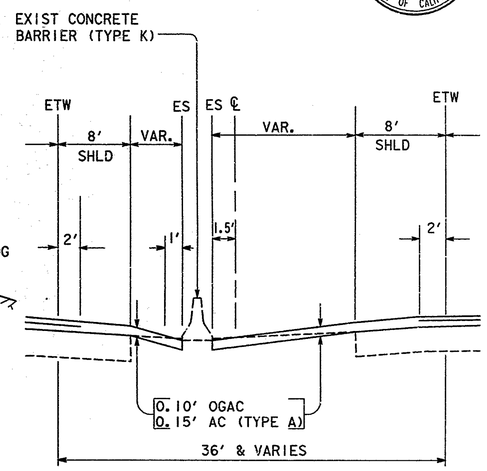
David J. Flynn
REGISTERED CIVIL ENGINEER

10-21-91
PLANS APPROVAL DATE

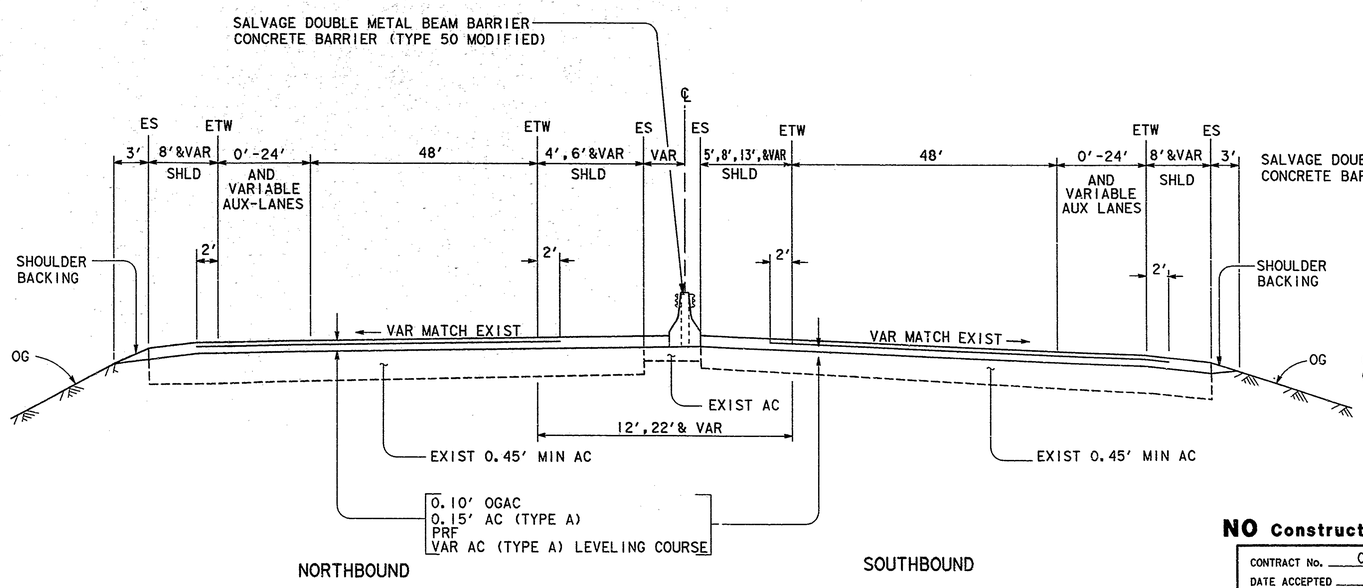
REGISTERED PROFESSIONAL ENGINEER DAVID J FLYNN No. 43933 Exp. 6-30-93 CIVIL STATE OF CALIFORNIA



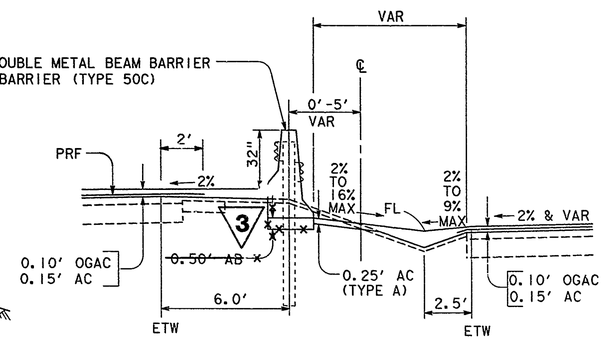
"G" 446+00.00 TO "G" 508+40.00



"G" 473+00.00 TO "G" 507+25.00



"G" 508+40.00 TO "G" 527+85.00



"G" 527+85.00 TO "G" 539+13.41

NO Construction Changes

CONTRACT No. 04-108424
DATE ACCEPTED 3/25/94
AS BUILT
RESIDENT ENGINEER W Kaelin

3 REVISED FOR ADDENDUM NO.3 DATED JANUARY 13, 1992

TYPICAL CROSS SECTIONS

NO SCALE

X-2

DATE	REVISED BY	DATE REVISED

CALCULATED/DESIGNED BY
CHECKED BY
PROJECT ENGINEER D. J. FLYNN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans **CENTRAL DESIGN**

LAST REVISION 00-00-00

FORM DC-OE-92-PF (REV. 3/88)

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

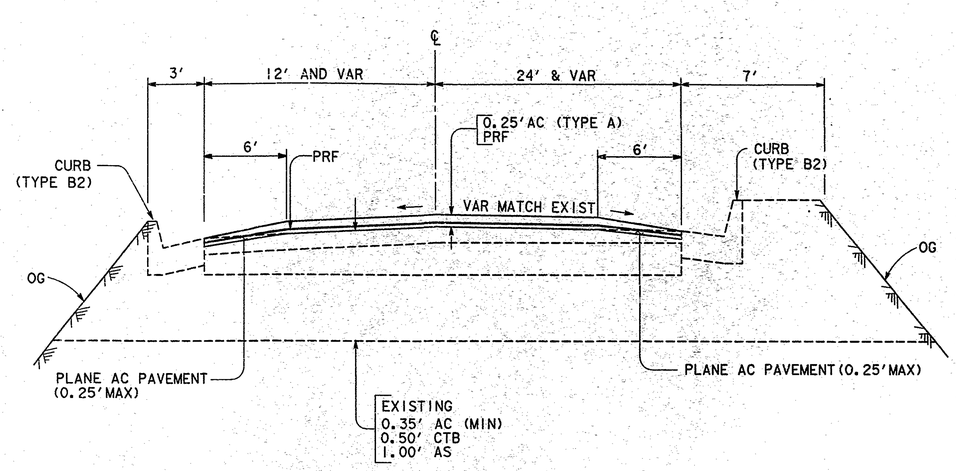
CU 04334 EA 108421

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.4/22.0	4	77

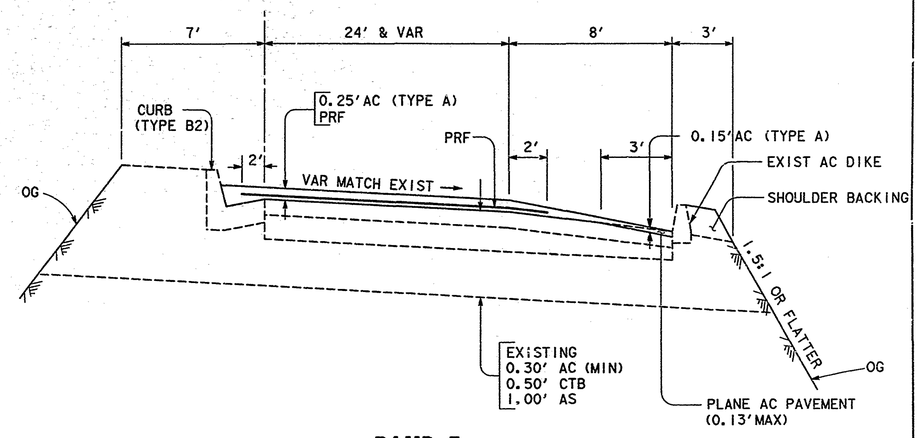
David J. Flynn
REGISTERED CIVIL ENGINEER

10-21-91
PLANS APPROVAL DATE

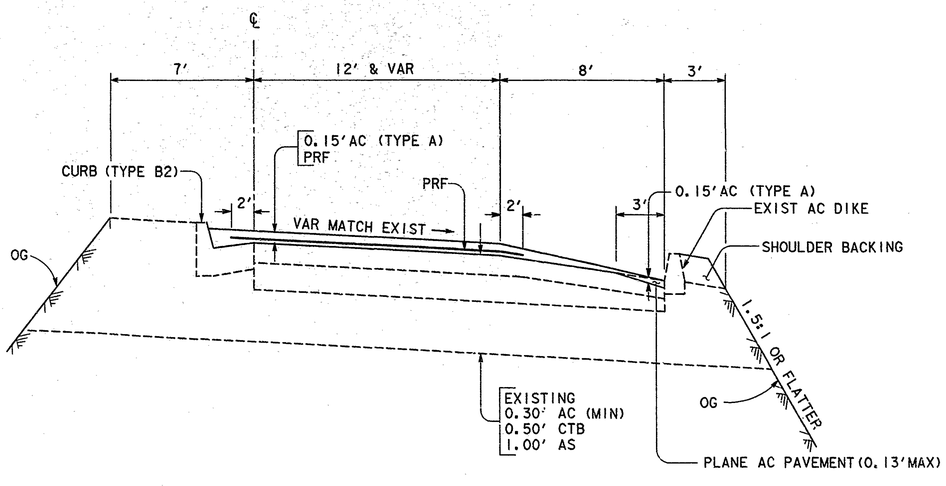
REGISTERED PROFESSIONAL ENGINEER DAVID J FLYNN No. 43933 Exp. 6-30-93 CIVIL STATE OF CALIFORNIA



RAMP 7
SB ON RAMP FROM PRODUCE AVE
STA 62+16 TO 70+75



RAMP 7
SB ON RAMP FROM PRODUCE AVE
STA 70+75 TO 72+59



RAMP 6
SB OFF RAMP TO PRODUCE AVE

AC OVERLAY

RAMP NO	NORTHBOUND	THICKNESS
1	NB COLLECTOR AT BROADWAY	PRF + 0.15'
2	NB OFF RAMP TO EB BROADWAY	0.35'
4	NB OFF RAMP TO EB MILLBRAE AVE	0.15'
	SOUTHBOUND	THICKNESS
8	SB COLLECTOR TO WB MILLBRAE AVE	0.45'
9	SB OFF RAMP TO WB MILLBRAE AVE	0.20'
10	SB ON RAMP FROM EB MILLBRAE AVE	0.15'
11	SB COLLECTOR FROM EB MILLBRAE AVE	PRF + 0.15'
12	SB OFF RAMP AND COLLECTOR AT BROADWAY	0.15'

NO Construction Changes

CONTRACT No. 04-108424
DATE ACCEPTED 3/25/94
AS BUILT
RESIDENT ENGINEER W Kaelin

TYPICAL CROSS SECTIONS

NO SCALE

X-3

DATE	REVISED BY	DATE REVISED

CALCULATED/DESIGNED BY
CHECKED BY

PROJECT ENGINEER D. J. FLYNN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans **CENTRAL DESIGN**

FORM DC-OE-92-I-F (REV. 3/88)

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

CU 04334 | EA 108421

LAST REVISION 00-00-00

JSCRIP: 14ctom@NODE FILE: /project/lrodd/asbuilts/108421/A10842x03.asb DATE: Fri Apr 28 2000 TIME: 10:30

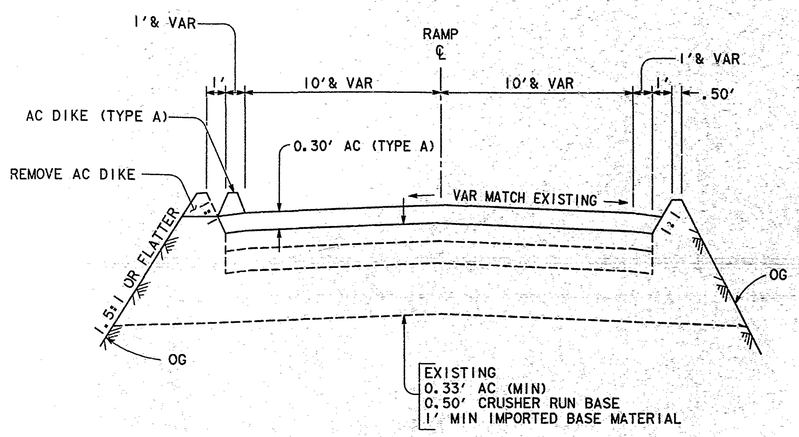
$$$$$$$$ JOBSPEC$$$$$$$$$$ $$$$$$SYTIME$$$$$ $$$$$$USER$$$$$

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.4/22.0	5	77

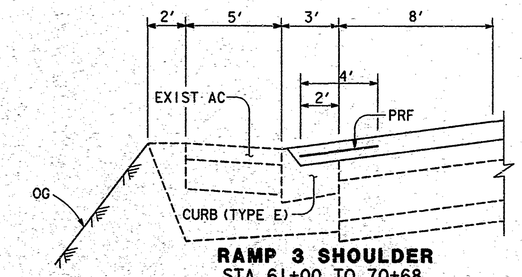
David J. Flynn
REGISTERED CIVIL ENGINEER

10-21-91
PLANS APPROVAL DATE

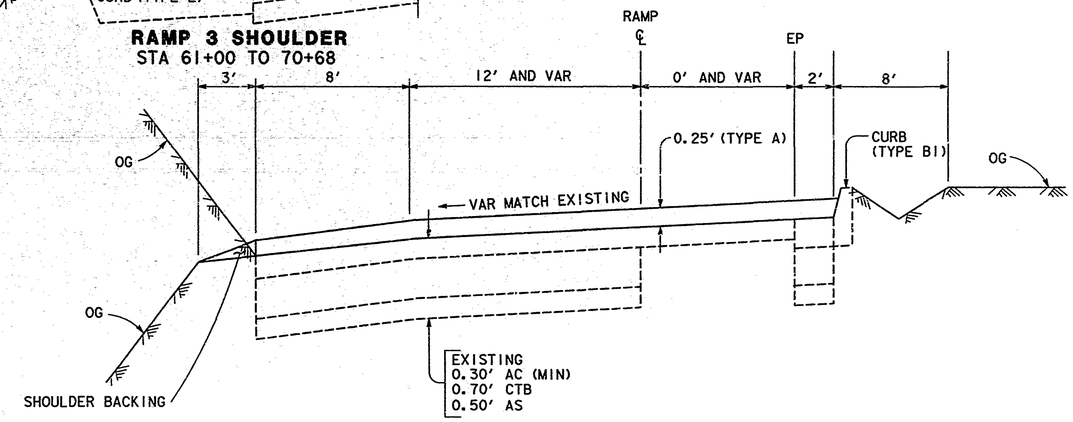
REGISTERED PROFESSIONAL ENGINEER
DAVID J FLYNN
No. 43933
Exp. 6-30-93
CIVIL
STATE OF CALIFORNIA



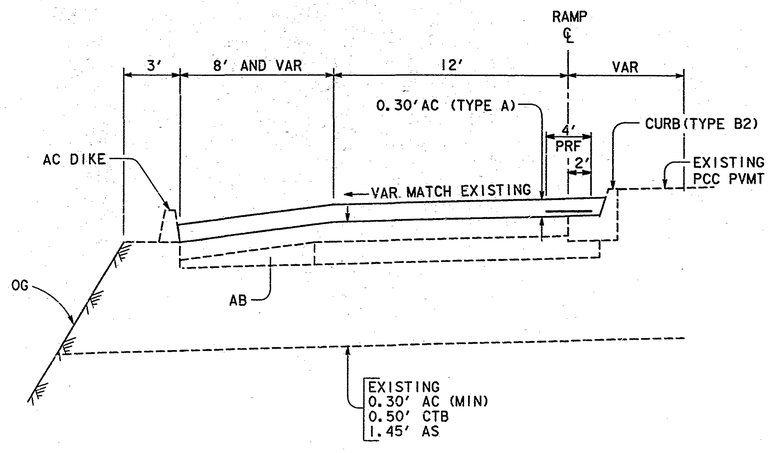
RAMP 5
NB OFF RAMP TO GRAND AVE
STA 40+38.95 TO 45+56.96



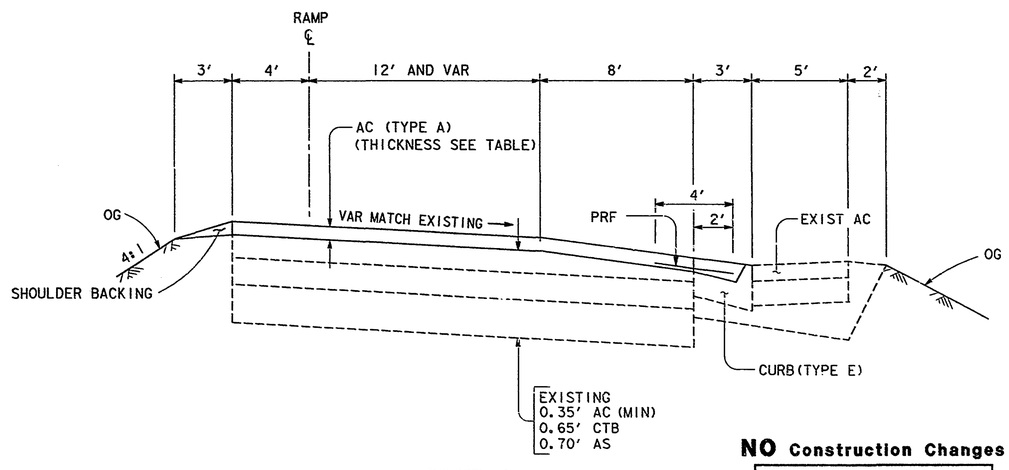
RAMP 3 SHOULDER
STA 61+00 TO 70+68



RAMP 3
NB COLLECTOR AT MILLBRAE AVE



RAMP 5
NB OFF RAMP TO GRAND AVE
STA 45+56.96 TO 49+02



RAMP 1
NB COLLECTOR AT BROADWAY
RAMP 2
NB OFF RAMP TO EB BROADWAY
RAMP 12
SB OFF RAMP AND COLLECTOR AT BROADWAY

NO Construction Changes
CONTRACT No. 04-108424
DATE ACCEPTED 3/25/94
AS BUILT
RESIDENT ENGINEER W Kaelin

TYPICAL CROSS SECTIONS
NO SCALE

X-4

DATE	REVISED BY	DATE REVISED

CALCULATED/DESIGNED BY
CHECKED BY
PROJECT ENGINEER D. J. FLYNN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans **CENTRAL DESIGN**

$$$$$$$$$$DGNSPEC$$$$$$$$$$$$ $$$$$$$$SYTIME$$$$$$ $$$$$$$USER$$$$$$

FORM DC-OE-92-PF (REV. 3/88)

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

CU 04334 | EA 10842i

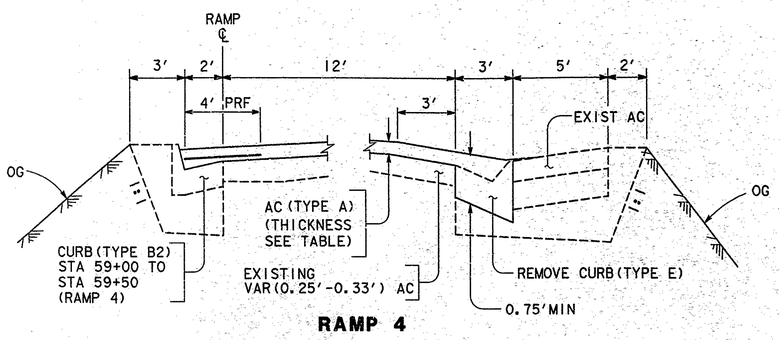
LAST REVISION 00-00-00
USERID: 14ctom0NODE
FILE: /project/frodd/asbuilts/108421/410842x04.asb
DATE: FRI,AUG 28,2000 TIME: 10:28

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	16.4/22.0	6	77

David J. Flynn
REGISTERED CIVIL ENGINEER

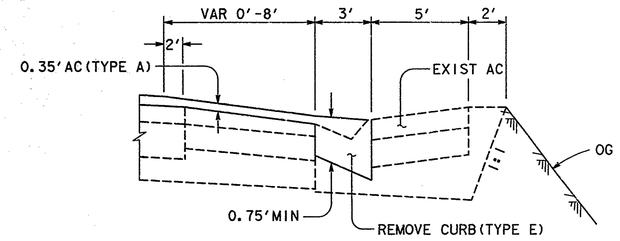
10-21-91
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER DAVID J FLYNN No. 43933 Exp. 6-30-93 CIVIL STATE OF CALIFORNIA

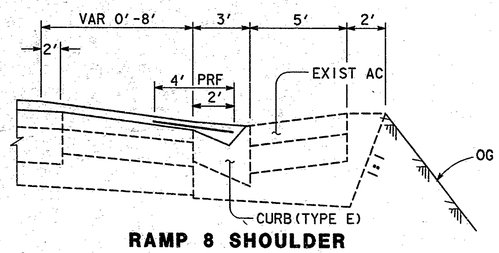


RAMP 4
NB OFF RAMP TO EB MILLBRAE AVE
STA 55+90 TO STA 61+00
(SYMMETRIC ABOUT RAMP CENTERLINE)

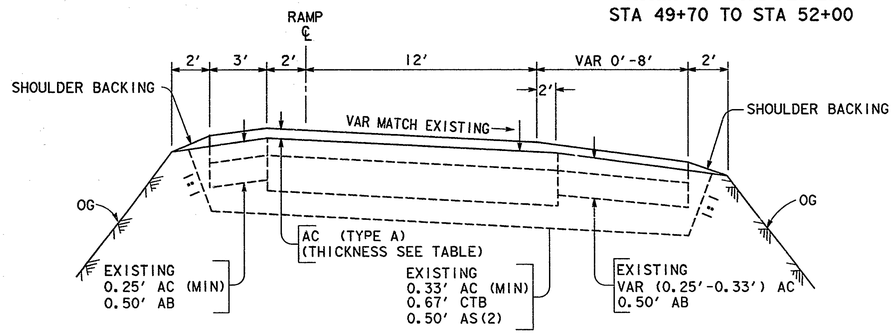
RAMP 10
SB ON RAMP FROM EB MILLBRAE AVE
STA 58+26 TO STA 60+64



RAMP 9 SHOULDER
STA 49+70 TO STA 52+00



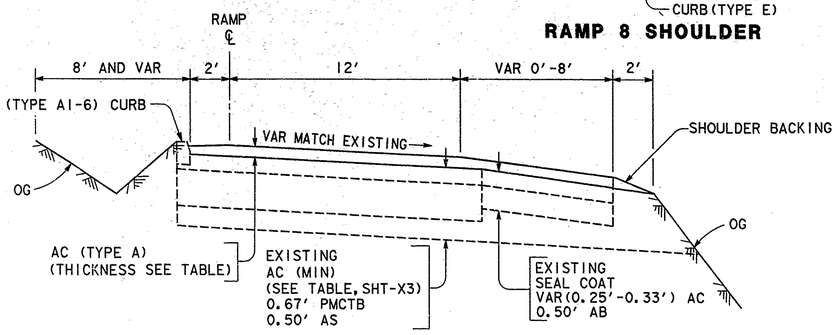
RAMP 8 SHOULDER



RAMP 4
NB OFF RAMP TO EB MILLBRAE AVE
STA 52+94 TO STA 55+90
(SYMMETRIC ABOUT RAMP CENTERLINE)

RAMP 9
SB OFF RAMP TO WB MILLBRAE AVE
STA 49+70 TO STA 55+00

RAMP 10
SB ON RAMP FROM EB MILLBRAE AVE
STA 50+09 TO STA 58+26



RAMP 8
SB COLLECTOR TO WB MILLBRAE AVE

RAMP 11
SB COLLECTOR FROM EB MILLBRAE AVE

NO Construction Changes

CONTRACT No. 04-108424
DATE ACCEPTED 3/25/94
AS BUILT
RESIDENT ENGINEER W Kaelin

TYPICAL CROSS SECTIONS
NO SCALE

X-5

DATE	REVISED BY	DATE REVISED

CALCULATED/DESIGNED BY
CHECKED BY
PROJECT ENGINEER D. J. FLYNN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans **CENTRAL DESIGN**

$$$$$$$$$$$$DGNSPEC$$$$$$$$$$$$ $$$$$$SYTIME$$$$$$ $$$$$$USER$$$$$$

FORM DC-OE-92-PF (REV. 3/88)

FOR REDUCED PLANS ORIGINAL SCALE IS IN INCHES 0 1 2 3

CU 04334 | EA 108421

LAST REVISION 00-00-00
USERID: 14ctomROADE
FILE: /project/road/osburn/fls/108421/410842x05.osb
DATE: Fri Apr 28, 2000 TIME: 10:27

IMPROVEMENT PLAN

FOR RECONSTRUCTION OF

BAYSHORE HIGHWAY

BURLINGAME CALIFORNIA

FEDERAL AID PROJECT NO. M-D466

TO BE SUPPLEMENTED BY STANDARD PLANS DATED JULY, 1984

SCALE FEET 0 300

INDEX OF SHEETS

SHEET NO. 1	TITLE, LOCATION MAP
" " 2	TYPICAL CROSS SECTIONS
" " 3	CONSTRUCTION DETAILS
" " 4-8	SURFACE IMPROVEMENTS
" " 9-11	PLAN & PROFILE - 12" WATER & SANITARY MAINS
" " 12-13	STRIPING AND SIGNING PLAN
" " 14-15	TRAFFIC SIGNALS INTERCONNECT PLAN
" " 16	CONSTRUCTION AREA SIGNS
" " 17	RECONSTRUCT 33" FORCE MAIN SUPPORT

SPECIAL DETAILS

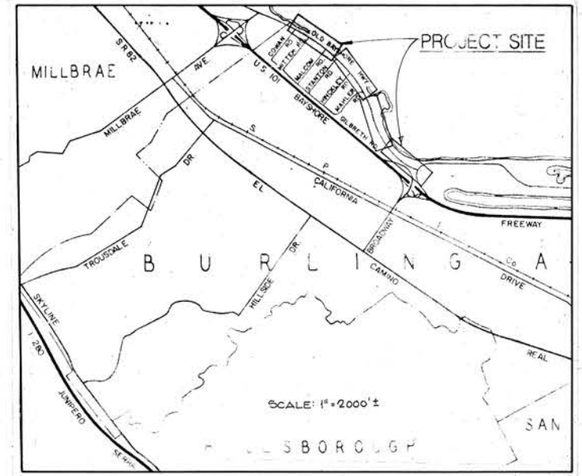
SEE SECTION 11 OF SPECIAL PROVISIONS

PG.	SHEET NAME
1.	Typical Valve Box
2.	Standard Plugged End Assembly
3.	Typical Air Relief Valve
4.	Anchor Block For Valves
5.	Thrust Block For Reducers
6.	Upward Thrust Concrete Anchor Block
7.	Typical Concrete Thrust Blocks
8.	Fire Hydrant Installation
9.	Standard Manhole
10.	Typical Water Service
11.	Typical Service Over 1" Reconnect
12.	Typical 1" Service Reconnect
13.	2" Blowoff
14.	Trench Shoring
15.	4" Sewer Lateral
16.	6" Sewer Lateral
17.	Specifications - Sewer Lateral Connection
18.	Concrete Apron & Valley Gutter
19.	Street Name Sign - Post Mounted

STANDARD PLANS

TO BE USED ON THIS PROJECT

ES-1A	ES-8	D77-B
ES-1B	ES-13	D97-F
ES-4B	A20-A	N8-A
ES-5A	A20-B	N8-B
ES-5B	A74-A	T-10
ES-5C	A74-B	T-11
ES-5F	D74	T-12

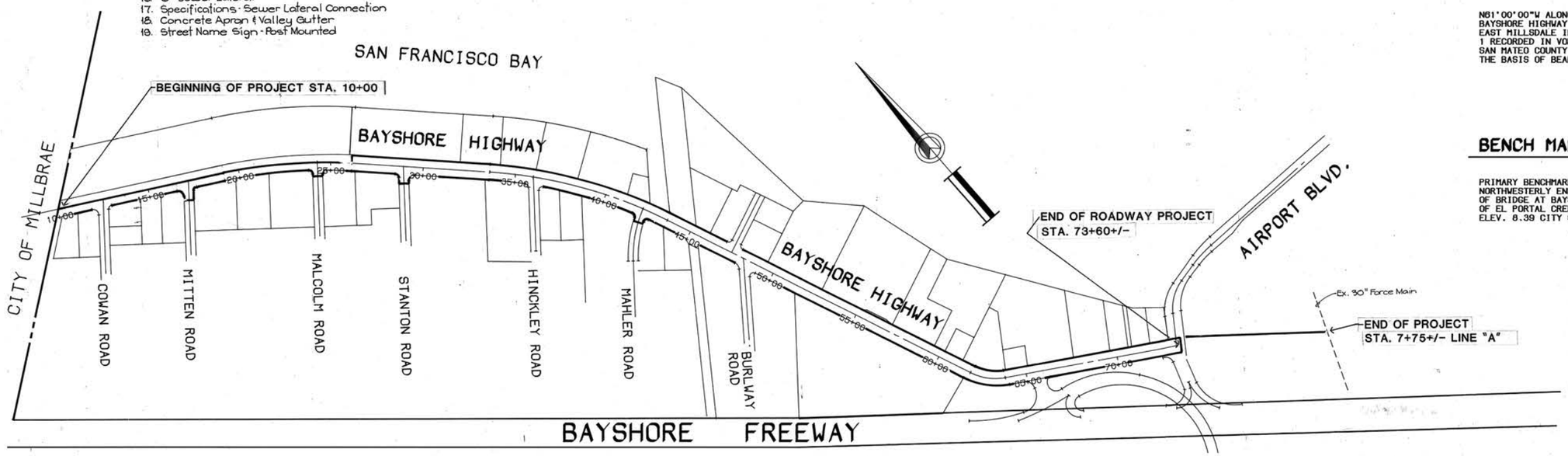


BASIS OF BEARINGS

N61°00'00"W ALONG SOUTHWESTERLY LINE OF BAYSHORE HIGHWAY AS SHOWN ON THE MAP OF EAST MILLSDALE INDUSTRIAL PARK UNIT NO. 1 RECORDED IN VOL. 50 OF MAPS @ PAGE 25 SAN MATEO COUNTY RECORDS WAS TAKEN AS THE BASIS OF BEARINGS SHOWN HEREON.

BENCH MARKS

PRIMARY BENCHMARK "+" CUT IN TOP OF NORTHWESTERLY END OF WESTERLY HEADWALL OF BRIDGE AT BAYSHORE HIGHWAY CROSSING OF EL PORTAL CREEK (MILLBRAE CITY LIMIT) ELEV. 8.39 CITY OF BURLINGAME DATUM



PREPARED BY

MARK THOMAS & CO. INC.

CONSULTING CIVIL ENGINEERS & MUNICIPAL PLANNERS
OFFICES IN SAN JOSE AND CUPERTINO

CITY OF BURLINGAME

APPROVED BY: Ralph E. Kirkup
RALPH E. KIRKUP
DIRECTOR OF PUBLIC WORKS

DATE 3-26-85

APPROVED
AS TO FEATURES AFFECTING STATE FACILITIES
M Gordon
DEPUTY DISTRICT DIRECTOR OF TRANSPORTATION
REGISTERED CIVIL ENGINEER LICENSE NO. 9377

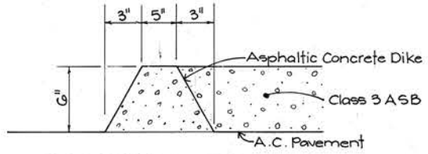
APPROVED BY RK Tanaka
RICHARD K. TANAKA R.C.E. 23233

DATE March 26, 1985

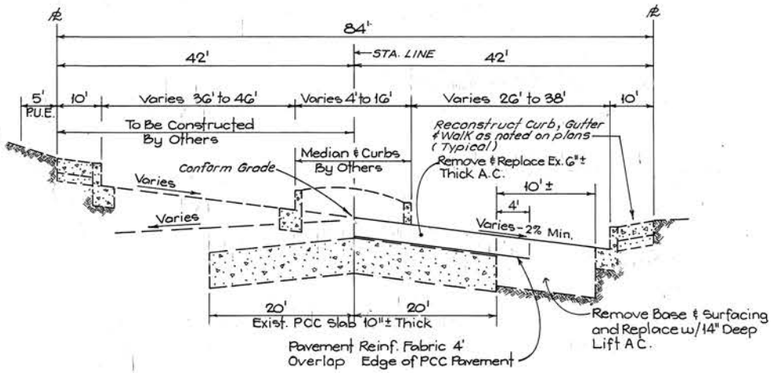
AS CONSTRUCTED

C-2653

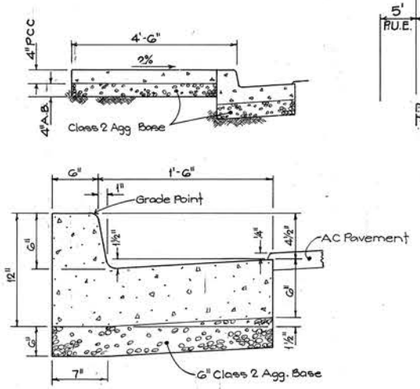
C2653-01M



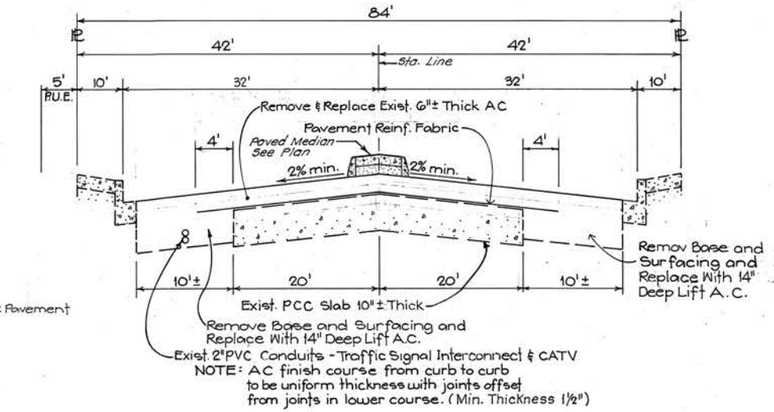
TYPE "A" - HIGH DIKE
NO SCALE



TYPICAL CROSS SECTION
STA. 10+00.00 TO STA. 25+98.36
NO SCALE

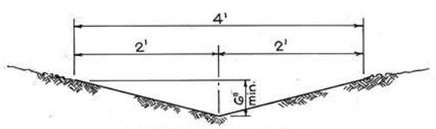


SIDEWALK, CURB & GUTTER DETAIL
NO SCALE

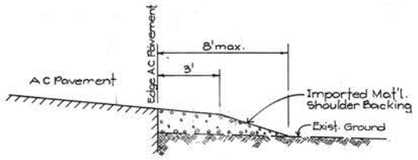


TYPICAL CROSS SECTION
STA. 25+98.36 TO STA. 60+80±
NO SCALE

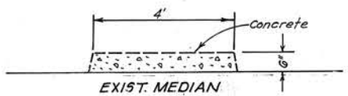
NOTES - STA. 10+00 TO STA. 60+80 ± - PAVEMENT REHABILITATION
1. Rout out and seal cracks in PCC slabs ¾" or wider.
2. Place 1¼" AC leveling course.
3. Place pavement reinforcing fabric.
4. Place AC structural course - 3"±
5. Place AC surface course - 1¾"±



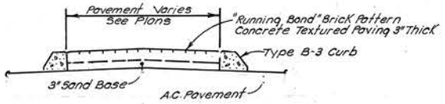
TYPICAL SECTION DITCH EXCAVATION



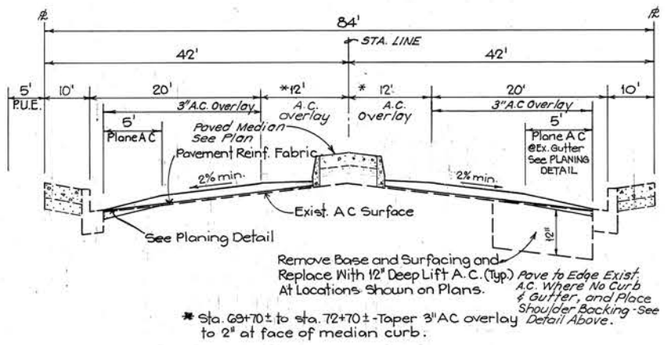
SHOULDER BACKING DETAIL
NO SCALE



EXIST. MEDIAN



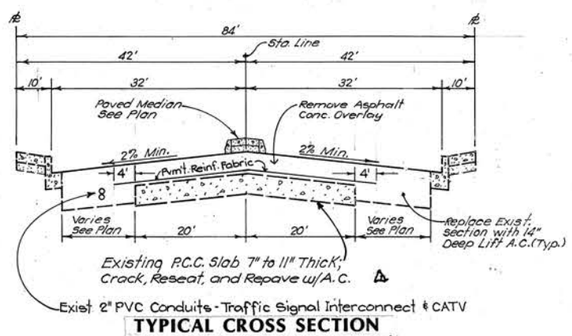
MEDIAN ISLAND TREATMENT
NO SCALE



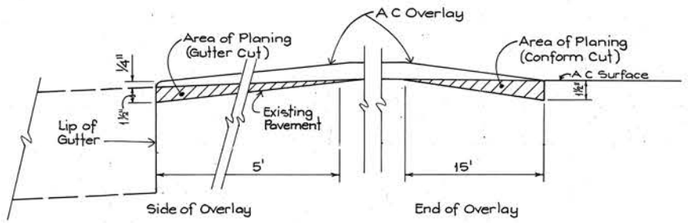
* Sta. 68+70± to sta. 72+70± - Taper 3" AC overlay to 2" at face of median curb.

TYPICAL CROSS SECTION
STA. 63+00 TO STA. 73+60±
NO SCALE

1. Rout out and seal cracks ¼" or wider.
2. Place 1¼" AC leveling course in areas of settled pavement.
3. Place pavement reinforcing fabric across entire pavement.
4. Place 1¾" AC surface course.



TYPICAL CROSS SECTION
STA. 60+80 TO STA. 63+00±
NO SCALE



PAVEMENT PLANING DETAIL
NO SCALE

C-2653

C2653-02M

TYPICAL CROSS SECTIONS

MARK THOMAS & CO. INC.
CONSULTING CIVIL ENGINEERS & MUNICIPAL PLANNERS
OFFICES IN SAN JOSE AND CUPERTINO

DRAWN BY GPW	APPROVED ON APRIL 11, 1985	JOB NO. 84049	SHEET 2
CKD. BY RPO	BY RICHARD K. TANAKA		OF
DATE 4/8/85		FILE NO. LP1457	17

HPLUL-6204(060)

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.5	1	1161

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ON
STATE HIGHWAY
IN SAN MATEO COUNTY
IN SAN MATEO, BURLINGAME AND MILLBRAE
ON ROUTE 101 FROM MILLBRAE AVENUE OVERCROSSING IN MILLBRAE TO 3RD AVENUE OVERCROSSING IN SAN MATEO

To be supplemented by Standard Plans dated July 2004

INDEX OF SHEETS

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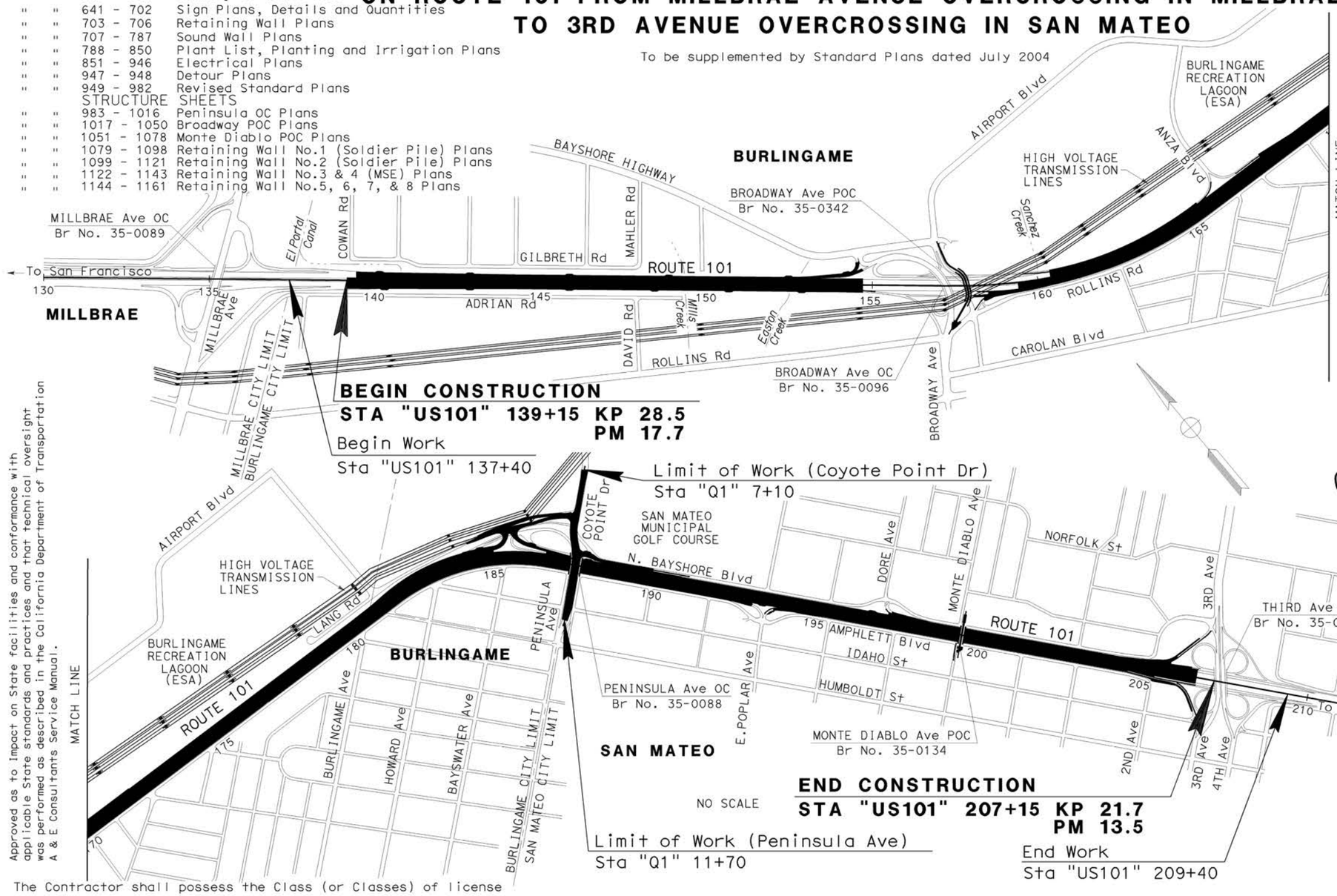
" "	97 - 177	Construction Details
" "	178 - 185	Temporary Water Pollution Control
" "	186 - 212	Erosion Control Plans
" "	213 - 215	Contour Grading
" "	216 - 344	Drainage Plans, Profiles, Details and Quantities
" "	345 - 380	Sanitary Sewer Plans
" "	381 - 411	Utility Plans, Details and Quantities
" "	412 - 555	Stage Construction
" "	556 - 572	Traffic Handling Plans
" "	573 - 574	Construction Area Signs
" "	575 - 602	Pavement Delineation Plans and Quantities
" "	603 - 640	Summary of Quantities
" "	641 - 702	Sign Plans, Details and Quantities
" "	703 - 706	Retaining Wall Plans
" "	707 - 787	Sound Wall Plans
" "	788 - 850	Plant List, Planting and Irrigation Plans
" "	851 - 946	Electrical Plans
" "	947 - 948	Detour Plans
" "	949 - 982	Revised Standard Plans
	STRUCTURE SHEETS	
" "	983 - 1016	Peninsula OC Plans
" "	1017 - 1050	Broadway POC Plans
" "	1051 - 1078	Monte Diablo POC Plans
" "	1079 - 1098	Retaining Wall No.1 (Soldier Pile) Plans
" "	1099 - 1121	Retaining Wall No.2 (Soldier Pile) Plans
" "	1122 - 1143	Retaining Wall No.3 & 4 (MSE) Plans
" "	1144 - 1161	Retaining Wall No.5, 6, 7, & 8 Plans



LOCATION MAP

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Caltrans Metric

APPROVED AS TO FEATURES AFFECTING THE FACILITIES LOCATED WITHIN THE CITY LIMITS OF BURLINGAME — DATE 2-22-06

APPROVED AS TO FEATURES AFFECTING CITY OF SAN MATEO FACILITIES — DATE 1/30/06

PROJECT ENGINEER — DATE 12/16/05
REGISTERED CIVIL ENGINEER

REGISTERED PROFESSIONAL ENGINEER — BALA RAJAPPAN — No. C46802 — Exp. 06/30/07 — CIVIL — STATE OF CALIFORNIA

August 21, 2006
PLANS APPROVAL DATE

Approved as to Impact on State facilities and conformance with applicable State standards and practices and that technical oversight was performed as described in the California Department of Transportation A & E Consultants Service Manual.

PROJECT ENGINEER | DESIGN OVERSIGHT APPROVAL — PRINTED NAME MORTEZA AZIMI — SIGNATURE | REGISTRATION NO. | DATE

The Contractor shall possess the Class (or Classes) of license as specified in the "Notice to Contractors".

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVE, 3rd FLOOR
SAN CARLOS, CALIFORNIA 94070

RAJAPPAN & MEYER
CONSULTING ENGINEERS, INC.
1038 LEIGH AVENUE, SUITE 100
SAN JOSE CA. 95126

Contract No. 04-264204

LAST REVISION 12-16-05 — DATE PLOTTED => 28-AUG-2006 08:30

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.5	2	1161

G. Maryakhin 12/16/05
PROFESSIONAL CIVIL ENGINEER

8-21-06
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Gennady M. Maryakhin No. 38467 Exp. 03/31/07 CIVIL STATE OF CALIFORNIA

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVE, 3rd FLOOR
SAN CARLOS, CALIFORNIA 94070

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Caltrans Metric

NOTES:

1. DIMENSIONS OF THE STRUCTURAL SECTIONS ARE SUBJECT TO TOLERANCES SPECIFIED IN THE STANDARD SPECIFICATIONS.
2. SUPERELEVATION AS SHOWN OR AS DIRECTED BY THE ENGINEER.
3. FOR LOCATION AND TYPE OF AC DIKE, CONCRETE BARRIER, CONCRETE CURB, STBB AND DTBB SEE LAYOUT PLANS. FOR MEDIAN CONCRETE BARRIER PROFILE, SEE SHEETS C-61 TO C-70.
4. FOR LOCATION OF SAWCUT/CONFORM LINES, SEE LAYOUT PLANS.
5. FOR LOCATION AND LIMIT OF UNDERDRAINS, SEE RETAINING WALL PLANS.
6. FOR LOCATION AND TYPE OF RETAINING WALL, SEE RETAINING WALL PLANS AND STRUCTURE PLANS.
7. FOR SOUND WALL LOCATION, SEE SOUND WALL PLANS.
8. FOR LOCATION AND ELEVATION OF DITCHES, SEE DRAINAGE PLANS.
9. EXISTING PAVEMENT SECTIONS BASED ON AS-BUILT PLANS. ACTUAL SECTIONS MAY VARY.
10. FOR STAMPED CONCRETE DETAIL, SEE SHEET C-58.
11. FOR LOCATION AND DETAIL OF CONCRETE BARRIER TYPE 80A, SEE STRUCTURE PLANS.
12. FOR COLD PLANE DETAILS AND LOCATIONS, SEE CONSTRUCTION DETAILS PLANS.
13. FOR SIDE SLOPE INFORMATION NOT SHOWN, SEE CONTOUR GRADING PLANS.
14. FOR SLOPE ROUNDING AND UNIFORM CATCH POINT DETAIL, SEE SHEET X-32.
15. FOR SUBBASE EXTENSION DETAILS, SEE SHEET C-55.
16. FOR GRADE BREAK ELEVATIONS AT LANE LINES, SEE CONSTRUCTION DETAILS PLANS.
17. FOR ASPHALTIC EMULSION (PAINT BINDER) AND LIQUID ASPHALT (PRIME COAT), SEE SP, Q-2

LEGEND & ABBREVIATIONS:

S/C	SAWCUT AND CONFORM
LL	COLD PLANE LIMIT LINE (SEE NOTE 12)
IBM	IMPORTED BASE MATERIAL
CC	CUSHION COURSE
CRB	CRUSHER RUN BASE
WIM	WEIGHT-IN-MOTION
(RCD)	RECONSTRUCTED MBGR
(R/S)	REMOVE EXISTING MBGR AND RECONSTRUCT AT NEW OR EXISTING LOCATIONS OR SALVAGE EXISTING MBGR NOT REQUIRED FOR RECONSTRUCTION WORK
RW	RETAINING WALL

TYPICAL STRUCTURAL SECTIONS:

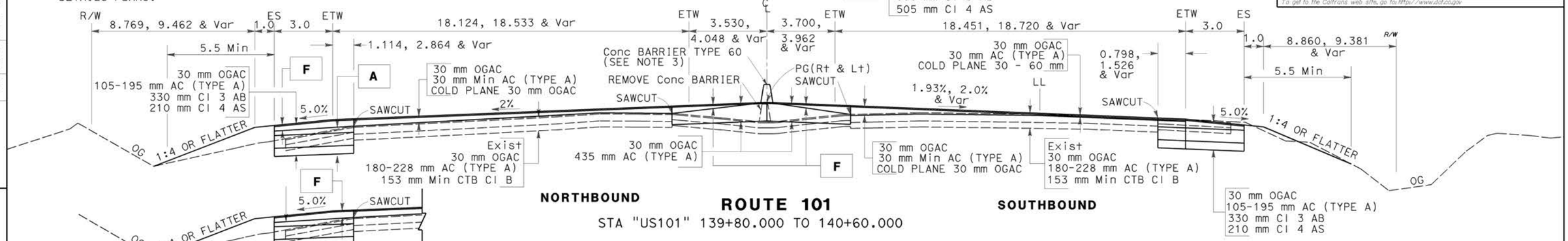
A
- 60 mm Min AC (TYPE A) SHLD
- 150 mm Min AC (TYPE A) TW
- 330 mm Cl 3 AB
- 210 mm Cl 4 AS

B
- 60 mm AC (TYPE A) SHLD
- 150 mm AC (TYPE A) TW
- 330 mm Cl 3 AB
- 210 mm Cl 4 AS

C
- 60 mm Min AC (TYPE A) SHLD
- 150 mm Min AC (TYPE A) TW
- 330 mm Cl 3 AB
- 505 mm Cl 4 AS

D
- 60 mm AC (TYPE A) SHLD
- 150 mm AC (TYPE A) TW
- 330 mm Cl 3 AB
- 505 mm Cl 4 AS

F
- 30 mm OGAC
- Var AC (TYPE A)

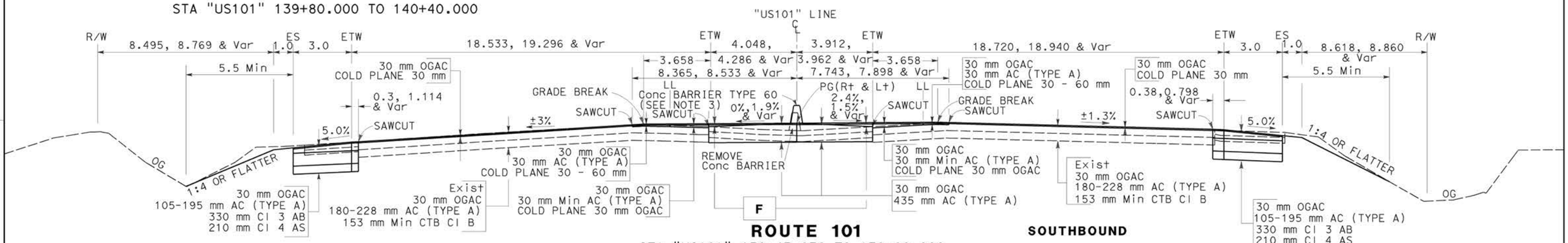


NORTHBOUND — **ROUTE 101** — **SOUTHBOUND**

STA "US101" 139+80.000 TO 140+60.000

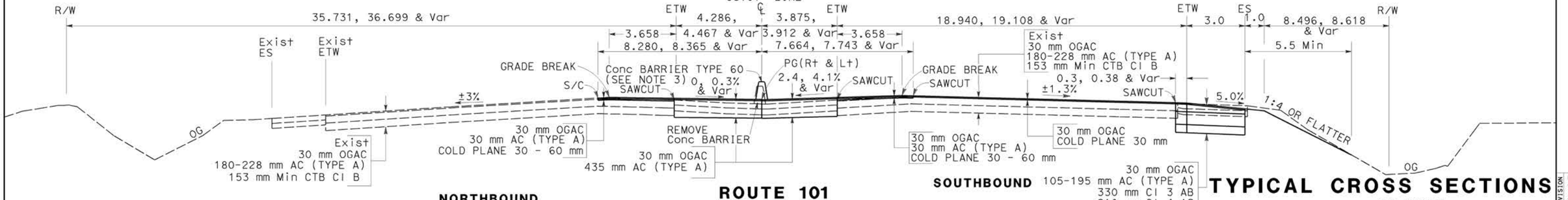
NORTHBOUND

STA "US101" 139+80.000 TO 140+40.000



NORTHBOUND — **ROUTE 101** — **SOUTHBOUND**

STA "US101" 139+43.232 TO 139+80.000



NORTHBOUND — **ROUTE 101** — **SOUTHBOUND**

STA "US101" 139+15.350 TO 139+43.232

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

TYPICAL CROSS SECTIONS

NO SCALE

X-1

DATE	REVISED BY	DATE	REVISED BY
12/05	PK		

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DESIGN OVERSIGHT — MORTEZA AZIMI

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DGN FILE => 426420b001.dgn

CU 04245 — EA 264201

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.5	3	1161

G. Maryakhin 12/16/05
PROFESSIONAL CIVIL ENGINEER

8-21-06
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Gennady M. Maryakhin No. 38467 Exp. 03/31/07 CIVIL STATE OF CALIFORNIA

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVE, 3rd FLOOR
SAN CARLOS, CALIFORNIA 94070

RAJAPPAN & MEYER
CONSULTING ENGINEERS, INC.
1038 LEIGH AVENUE, SUITE 100
SAN JOSE, CALIFORNIA 95126

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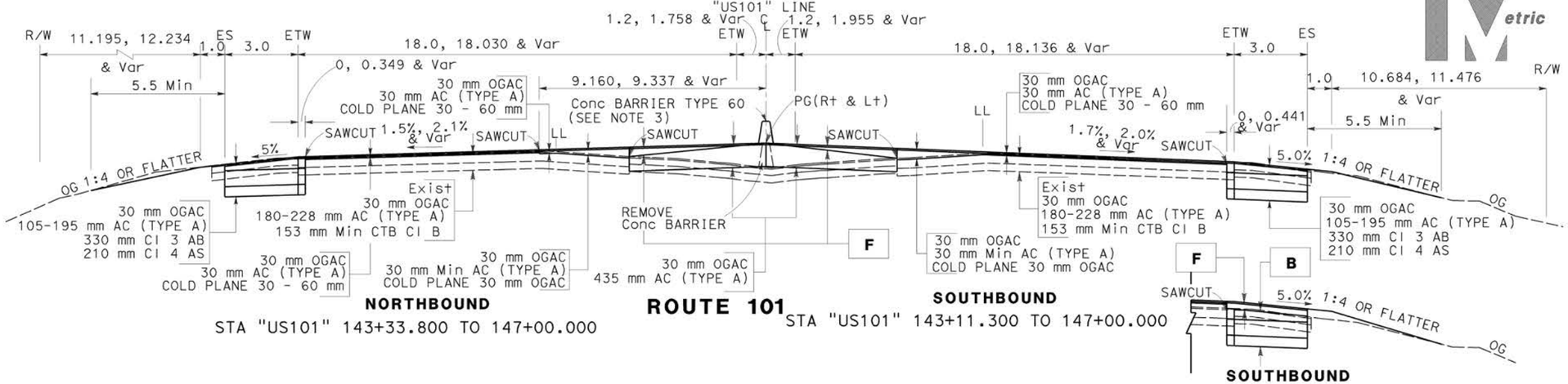
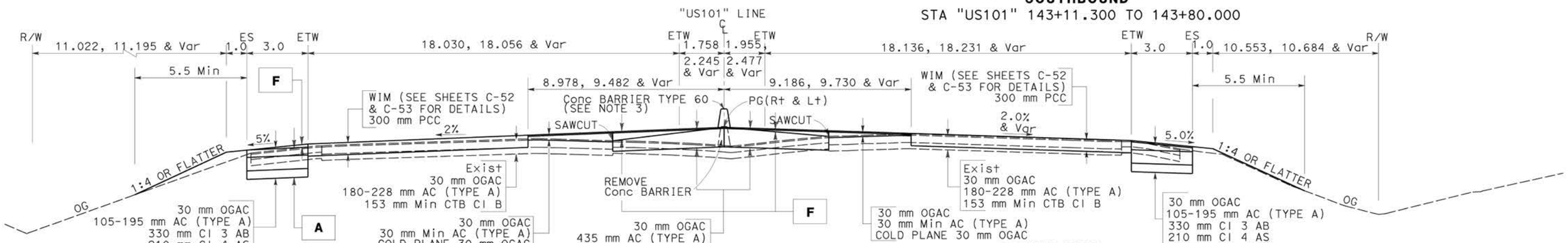


NORTHBOUND
STA "US101" 143+33.800 TO 147+00.000

ROUTE 101

SOUTHBOUND
STA "US101" 143+11.300 TO 147+00.000

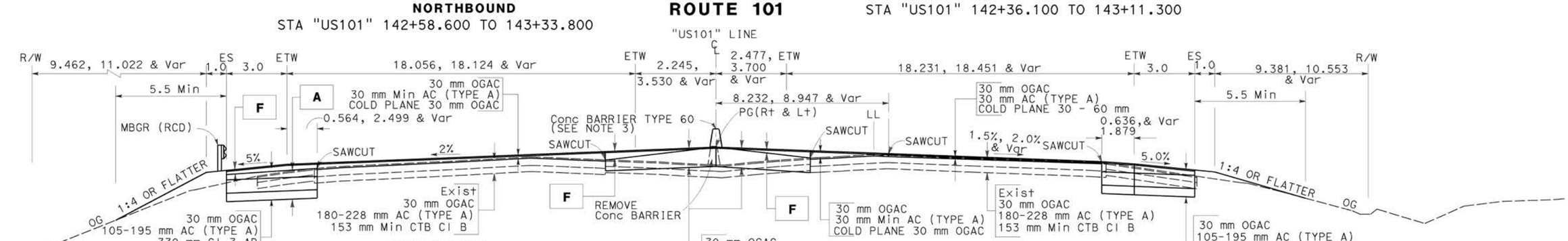
SOUTHBOUND
STA "US101" 143+11.300 TO 143+80.000



NORTHBOUND
STA "US101" 142+58.600 TO 143+33.800

ROUTE 101

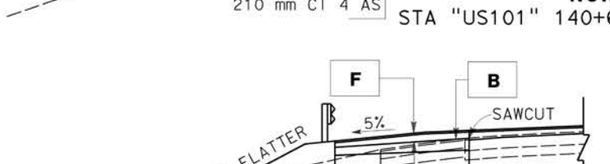
SOUTHBOUND
STA "US101" 142+36.100 TO 143+11.300



NORTHBOUND
STA "US101" 140+60.000 TO 142+58.600

ROUTE 101

SOUTHBOUND
STA "US101" 140+60.000 TO 142+36.100



NORTHBOUND
STA "US101" 141+00.000 TO 142+40.000

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

TYPICAL CROSS SECTIONS
NO SCALE

X-2

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PK	12/05	DATE REVISED

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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.5	4	1161

G. Maryakhin 12/16/05
PROFESSIONAL CIVIL ENGINEER

8-21-06
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Gennady M. Maryakhin No. 38467 Exp. 03/31/07 CIVIL STATE OF CALIFORNIA

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVE, 3rd FLOOR
SAN CARLOS, CALIFORNIA 94070

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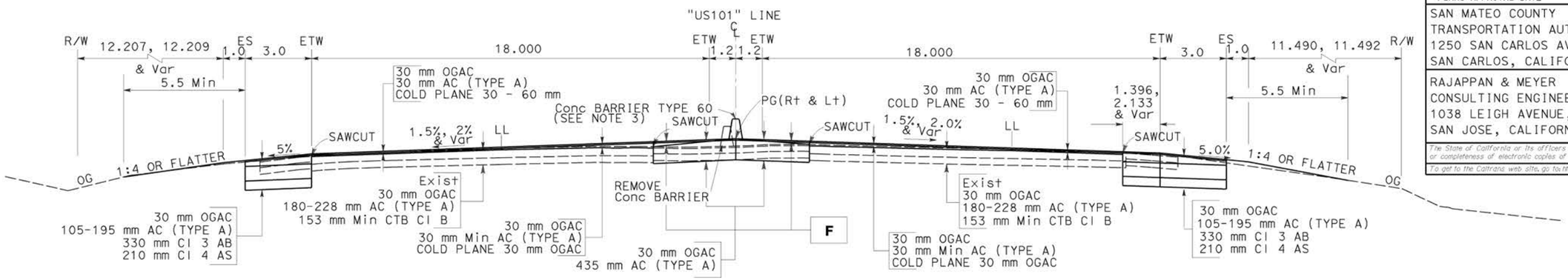
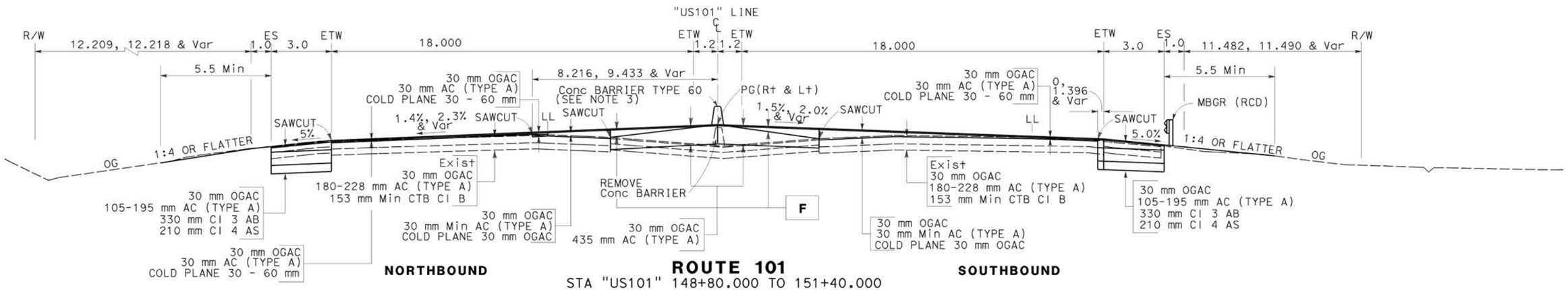


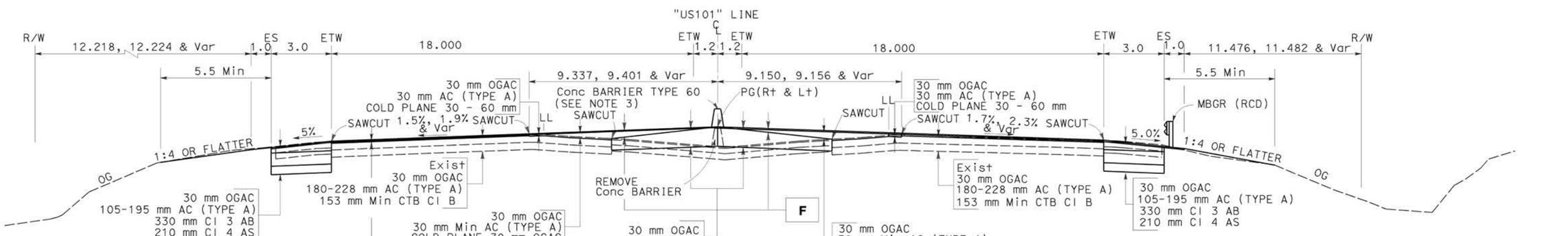
NORTHBOUND **ROUTE 101** SOUTHBOUND

STA "US101" 151+40.000 TO 151+90.000



NORTHBOUND **ROUTE 101** SOUTHBOUND

STA "US101" 148+80.000 TO 151+40.000



NORTHBOUND SOUTHBOUND

STA "US101" 147+00.000 TO 148+80.000

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

TYPICAL CROSS SECTIONS

NO SCALE

X-3

DATE	REVISED BY	DATE	REVISED BY
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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.5	5	1161

G. Maryakhin 10/01/05
PROFESSIONAL CIVIL ENGINEER

8-21-06
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Gennady M. Maryakhin No. 38467 Exp. 03/31/07 CIVIL STATE OF CALIFORNIA

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVE, 3rd FLOOR
SAN CARLOS, CALIFORNIA 94070

RAJAPPAN & MEYER
CONSULTING ENGINEERS, INC.
1038 LEIGH AVENUE, SUITE 100
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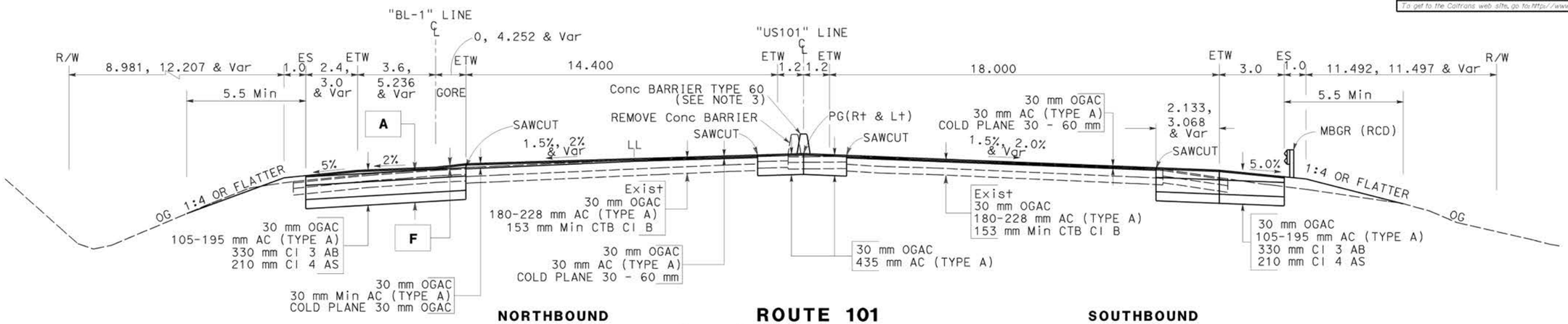
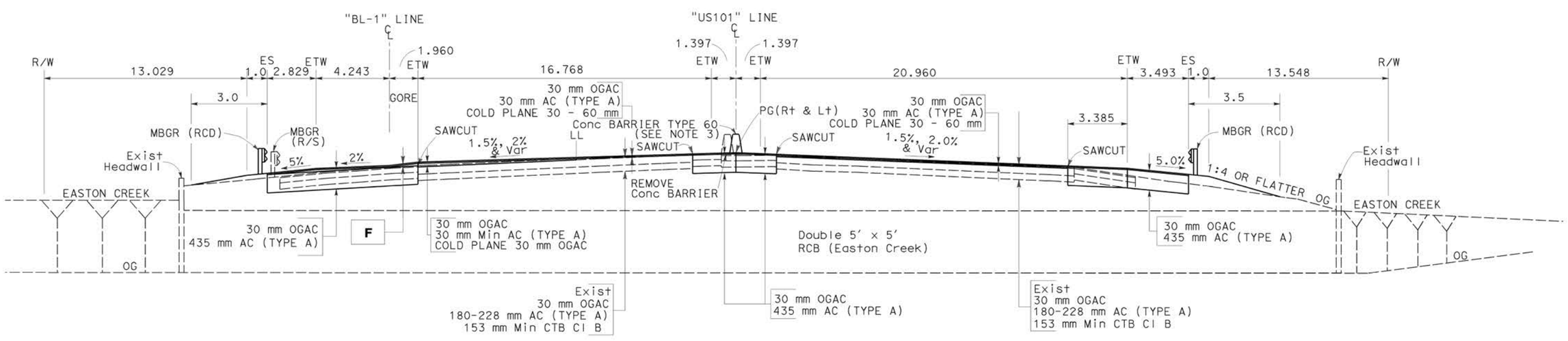


NORTHBOUND **ROUTE 101** **SOUTHBOUND**

STA "US101" 151+90.000 TO 153+39.989



NORTHBOUND **ROUTE 101** **SOUTHBOUND**

STA "US101" 152+63.831
ALONG EASTON CREEK

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

TYPICAL CROSS SECTIONS

NO SCALE

X-4

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CU 04245
EA 264201

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04	SM	101	21.7/28.5	6	1161

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8-21-06
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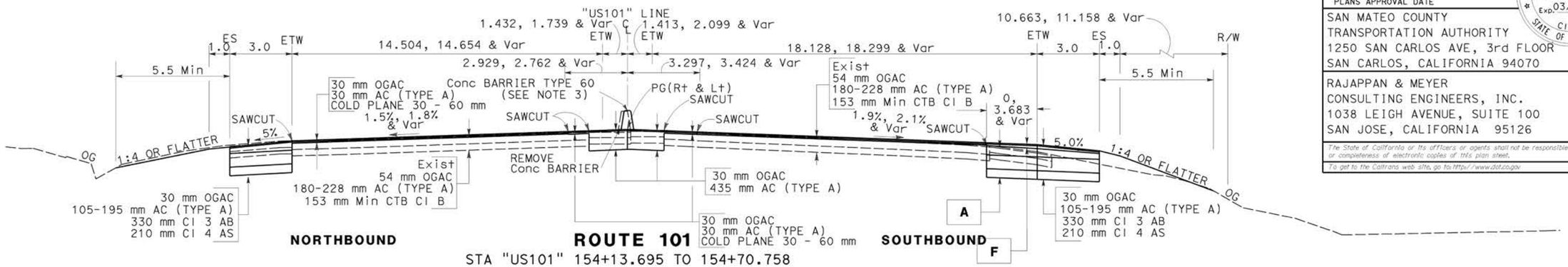

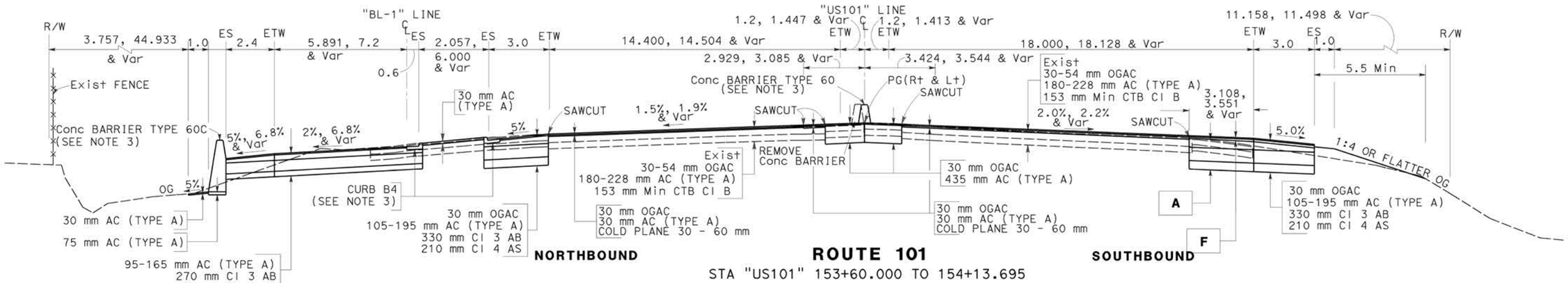

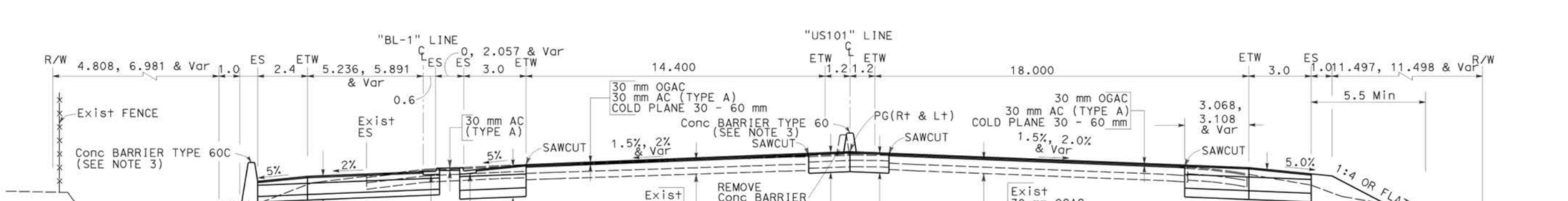

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

TYPICAL CROSS SECTIONS
NO SCALE

X-5

DATE	BY	REVISED	DATE	BY	REVISED
12/05	RO	PK	12/05		

CALCULATED/DESIGNED BY
CHECKED BY
DESIGN OVERSIGHT
MORTEZA AZIMI

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
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DATE PLOTTED => 22-AUG-2006 13:34

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DGN FILE => 426420b005.dgn
CU 04245
EA 264201

NOTE: FOR NOTES AND LEGEND & ABBREVIATIONS, SEE SHEET X-1.

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.5	7	1161

G. Maryakhin 12/16/05
PROFESSIONAL CIVIL ENGINEER

8-21-06
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Gennady M. Maryakhin No. 38467 Exp. 03/31/07 CIVIL STATE OF CALIFORNIA

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVE, 3rd FLOOR
SAN CARLOS, CALIFORNIA 94070

RAJAPPAN & MEYER
CONSULTING ENGINEERS, INC.
1038 LEIGH AVENUE, SUITE 100
SAN JOSE, CALIFORNIA 95126

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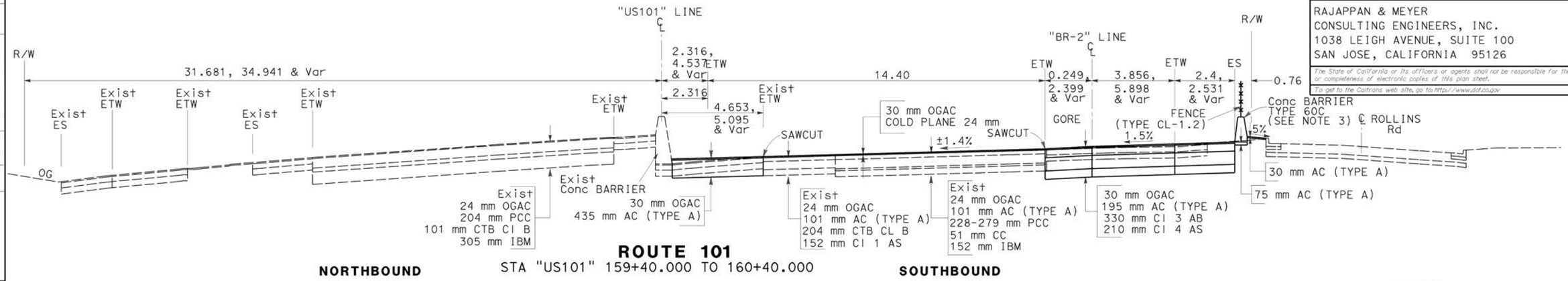
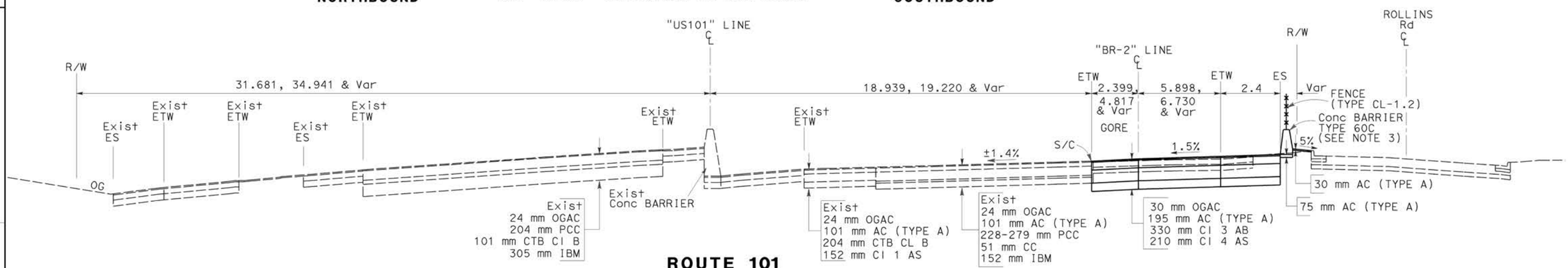
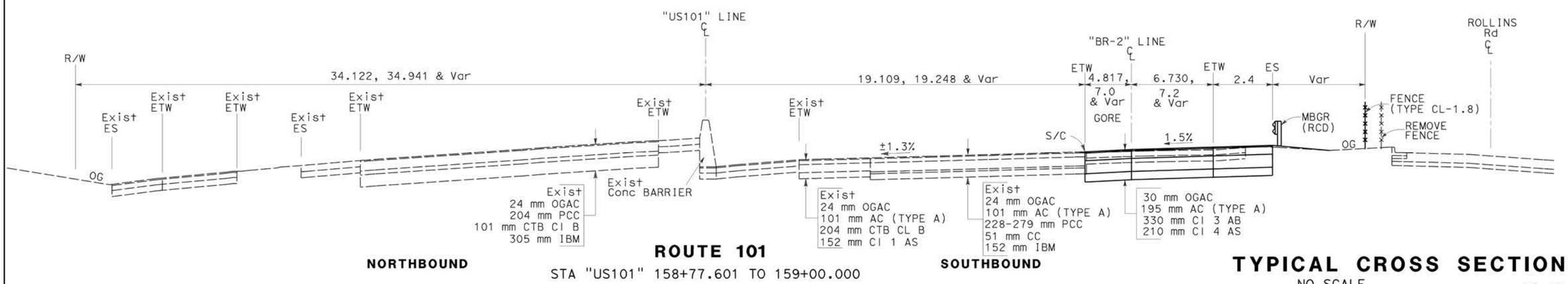


NORTHBOUND — **ROUTE 101** STA "US101" 159+40.000 TO 160+40.000 — SOUTHBOUND



NORTHBOUND — **ROUTE 101** STA "US101" 159+00.000 TO 159+40.000 — SOUTHBOUND



NORTHBOUND — **ROUTE 101** STA "US101" 158+77.601 TO 159+00.000 — SOUTHBOUND

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

TYPICAL CROSS SECTIONS

NO SCALE

X-6

CALCULATED/ DESIGNED BY	RO	DATE 12/05	REVISED BY	DATE	REVISED
CHECKED BY	PK	12/05			

DESIGN OVERSIGHT: MORTEZA AZIMI

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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LAST REVISION 12-16-05

DATE PLOTTED => 24-AUG-2006 09:56

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USERNAME => trmnguye
DGN FILE => 426420b006.dgn

CU 04245 EA 264201

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.5	8	1161

G. Maryakhin 12/16/05
PROFESSIONAL CIVIL ENGINEER

8-21-06
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Gennady M. Maryakhin No. 38467 Exp. 03/31/07 CIVIL STATE OF CALIFORNIA

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVE, 3rd FLOOR
SAN CARLOS, CALIFORNIA 94070

RAJAPPAN & MEYER
CONSULTING ENGINEERS, INC.
1038 LEIGH AVENUE, SUITE 100
SAN JOSE, CALIFORNIA 95126

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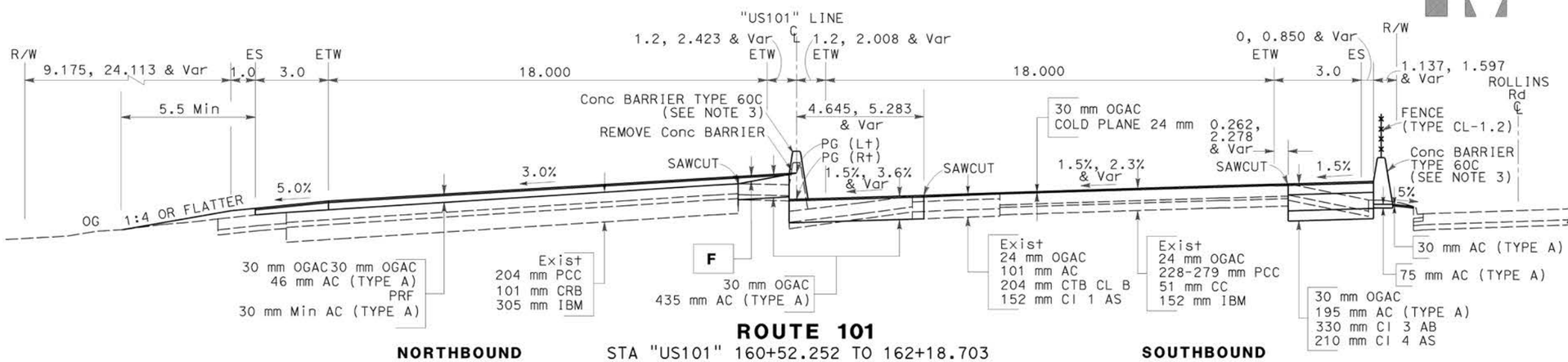
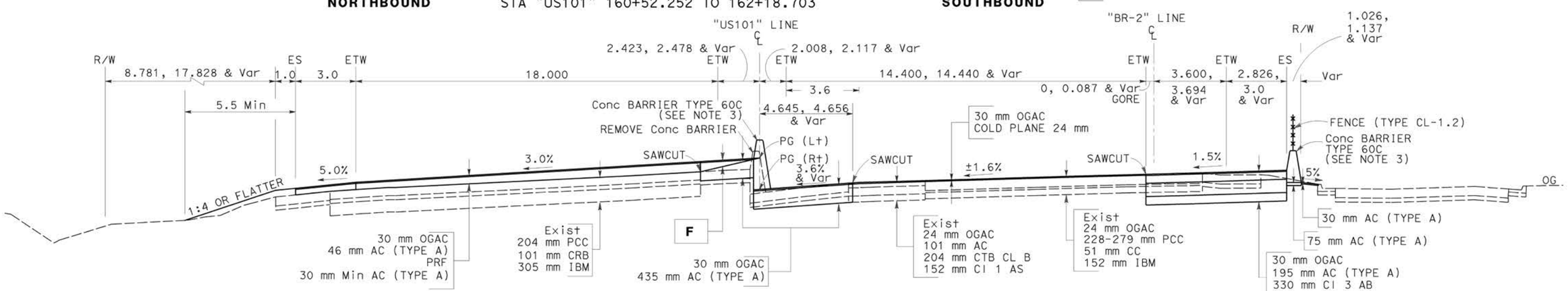
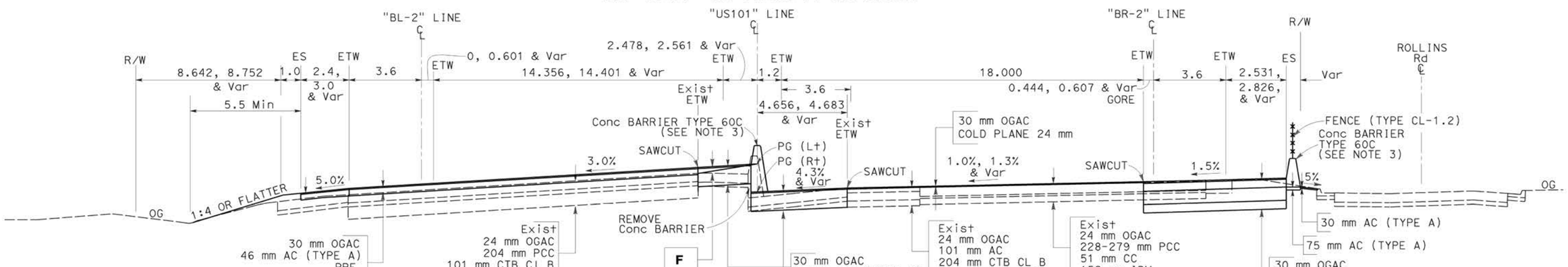
NOTE: FOR NOTES AND LEGEND & ABBREVIATIONS, SEE SHEET X-1.



ROUTE 101
STA "US101" 160+52.252 TO 162+18.703



ROUTE 101
STA "US101" 160+47.985 TO 160+52.252



ROUTE 101
STA "US101" 160+40.000 TO 160+47.985

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

TYPICAL CROSS SECTIONS
NO SCALE

X-7

CALCULATED/ DESIGNED BY	RO	DATE 12/05	REVISED BY	DESIGN OVERSIGHT
CHECKED BY	PK	12/05	DATE REVISED	MORTEZA AZIMI

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 12-16-05
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USERNAME => trmnguye
DGN FILE => 426420b007.dgn

CU 04245 EA 264201

NOTE: FOR NOTES AND LEGEND & ABBREVIATIONS, SEE SHEET X-1.

Caltrans Metric

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.5	9	1161

G. Maryakhin 12/16/05
PROFESSIONAL CIVIL ENGINEER

8-21-06
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Gennady M. Maryakhin No. 38467 Exp. 03/31/07 CIVIL STATE OF CALIFORNIA

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVE, 3rd FLOOR
SAN CARLOS, CALIFORNIA 94070

RAJAPPAN & MEYER
CONSULTING ENGINEERS, INC.
1038 LEIGH AVENUE, SUITE 100
SAN JOSE, CALIFORNIA 95126

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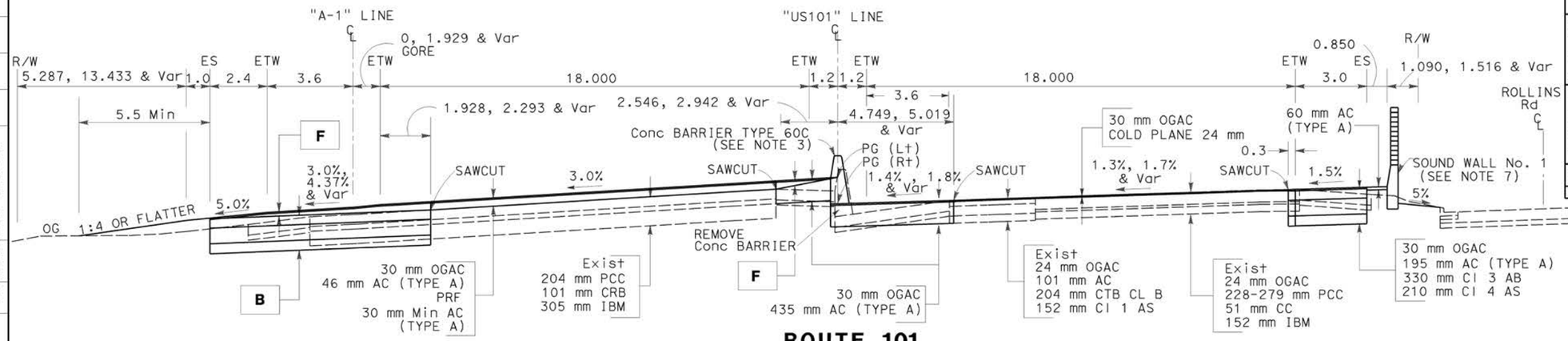
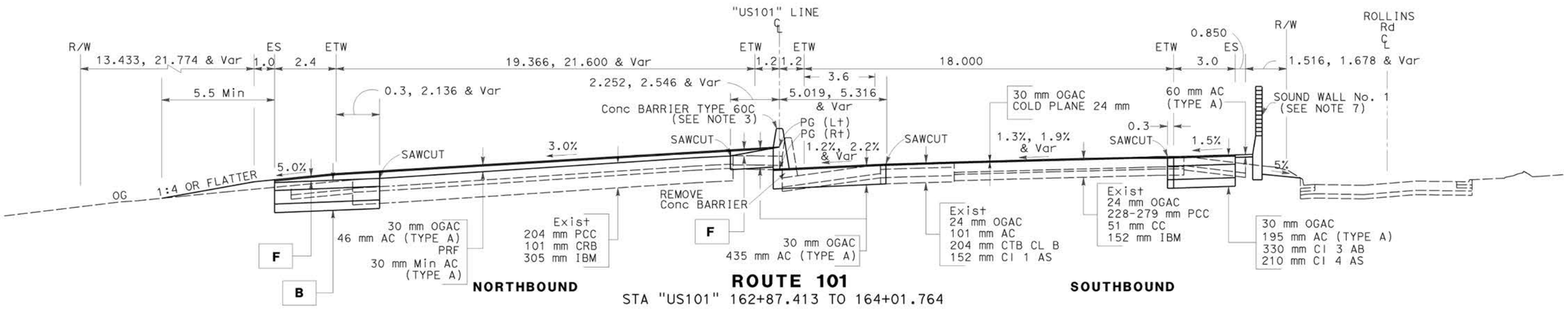
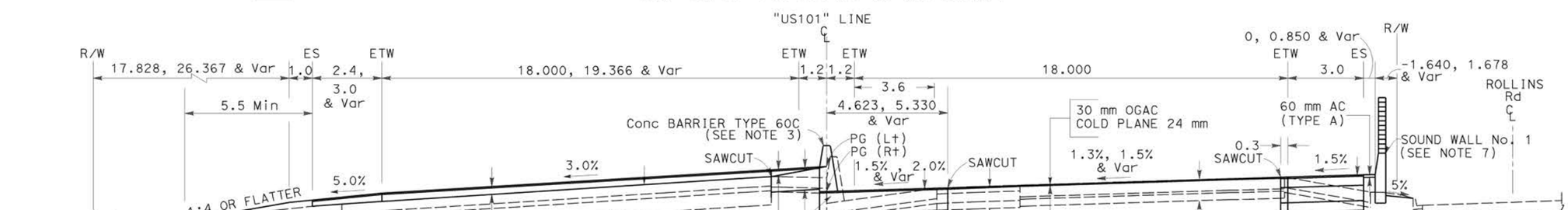


NORTHBOUND **ROUTE 101** STA "US101" 164+01.764 TO 165+00.000 **SOUTHBOUND**



NORTHBOUND **ROUTE 101** STA "US101" 162+87.413 TO 164+01.764 **SOUTHBOUND**



NORTHBOUND **ROUTE 101** STA "US101" 162+18.703 TO 162+87.413 **SOUTHBOUND**

TYPICAL CROSS SECTIONS

NO SCALE

X-8

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DATE	REVISED BY	DATE	REVISED BY
RO 12/05	PK 12/05		

CALCULATED/DESIGNED BY
CHECKED BY
DESIGN OVERSIGHT MORTEZA AZIMI

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION
Caltrans

LAST REVISION 12-16-05
DATE PLOTTED => 24-AUG-2006 09:56

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USERNAME => trmnguye
DGN FILE => 426420b008.dgn
CU 04245
EA 264201

DIST.	COUNTY	ROUTE	POST MILE—TOTAL PROJECT	SHEET	TOTAL SHEETS
04	SM	101	16.6	68	68

September 14, 1970

As-Built Log of Test Borings

As-Built Log of Test Borings sheet is considered an information document only. As such, the State of California registration seal with signature, license number and registration certificate expiration date will not be required. This drawing is available and presented only for the convenience of any bidder, contractor or other interested party.

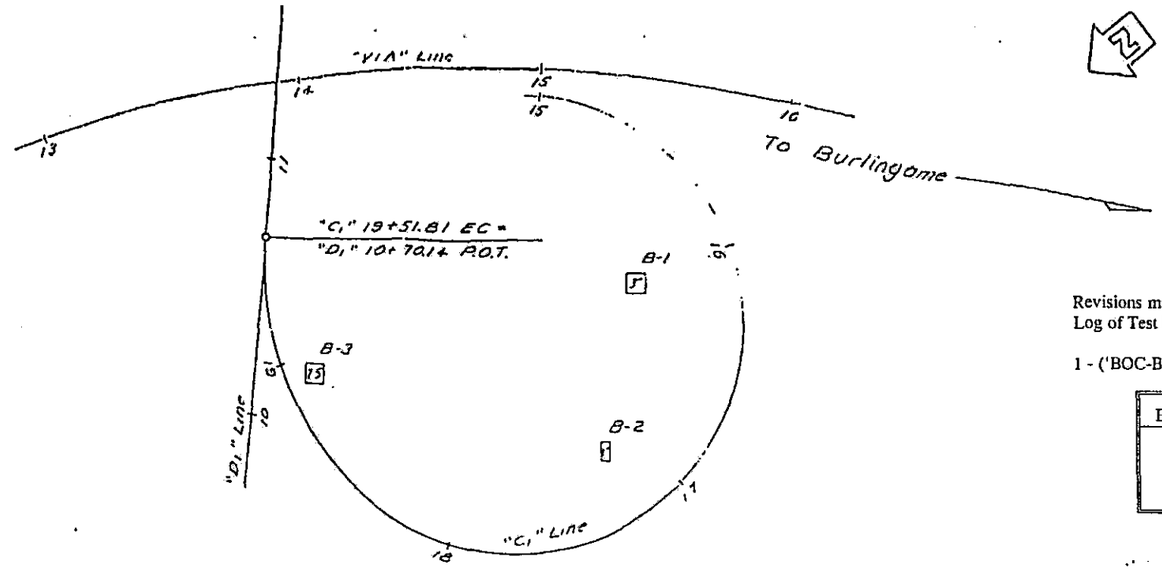
DIST.	COUNTY	ROUTE	KILOMETER POST - TOTAL PROJECT	Sheet No.	Total Sheets
04	SM	101	21.7/28.8		

BROADWAY POC

LOG OF TEST BORINGS 3 OF 3

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.	CU 245 EA 26420K	BRIDGE No. 35-0342
THIS STRUCTURE	SHEET NO.	OF

To accompany plans dated_____



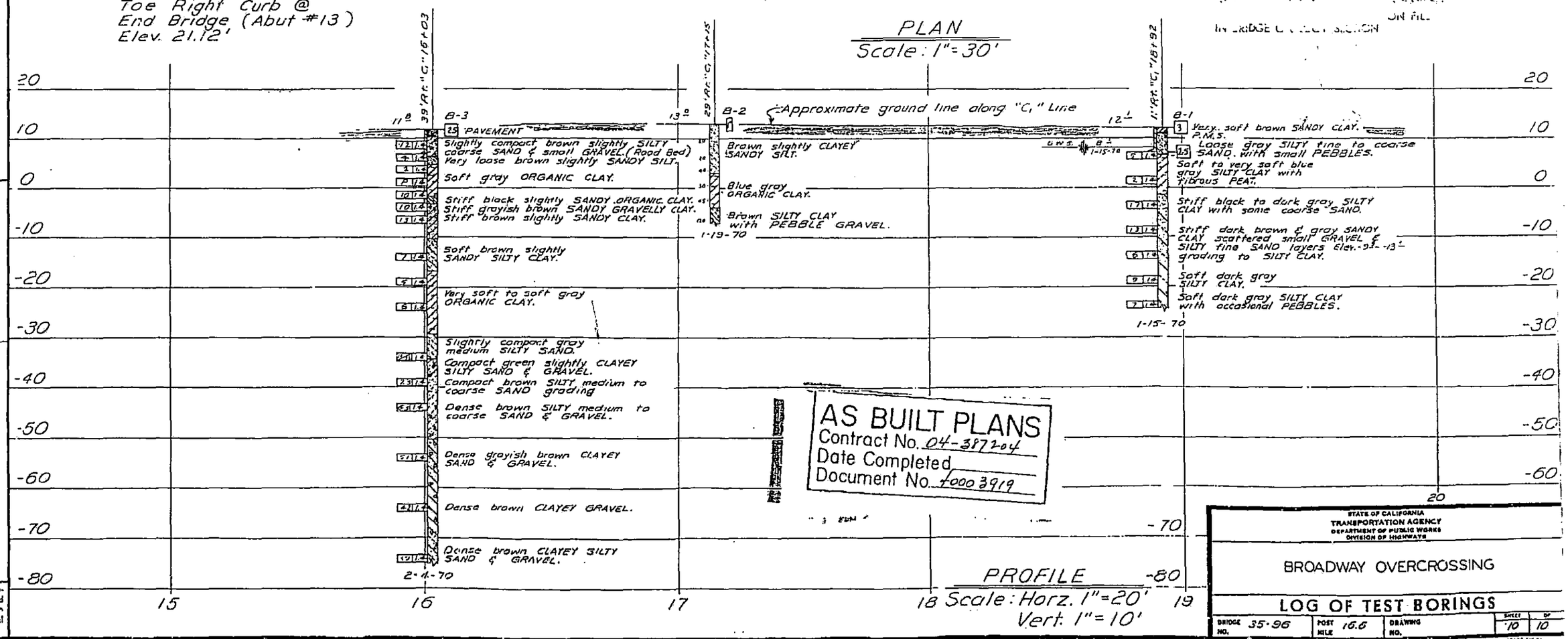
Revisions made to this Log of Test Borings from the original 1970 Log of Test Borings are:

1 - ('BOC-BDWY' Line)-metric stations and offsets:

Boring	Station	Offset (from 'BOC-BDWY')
B-1	9+76	39.2 m Lt.
B-2	9+77	60.6 m Lt.
B-3	10+57	105.0 m Lt.

B.M.
Toe Right Curb @ End Bridge (Abut #13) Elev. 21.12'

PLAN
Scale: 1"=30'



AS BUILT PLANS
Contract No. 04-387204
Date Completed
Document No. 4000 3919

PROFILE
Scale: Horz. 1"=20'
Vert. 1"=10'

STATE OF CALIFORNIA
TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

BROADWAY OVERCROSSING

LOG OF TEST BORINGS

BRIDGE NO.	POST MILE	DRAWING NO.	SHEET	OF
35-96	16.6		10	10

NOTE: Classification of earth materials shown on this sheet is based on field inspection and is not to be construed to imply mechanical analysis.

WO 387201
CU 04205

Disregard prints bearing earlier revision dates

REVISION DATES (PRELIMINARY STAGE ONLY)
2/8/10

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.8		

GEOTECHNICAL PROFESSIONAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/05 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
356 SOUTH MILPITAS BLVD.,
MILPITAS CA 95035

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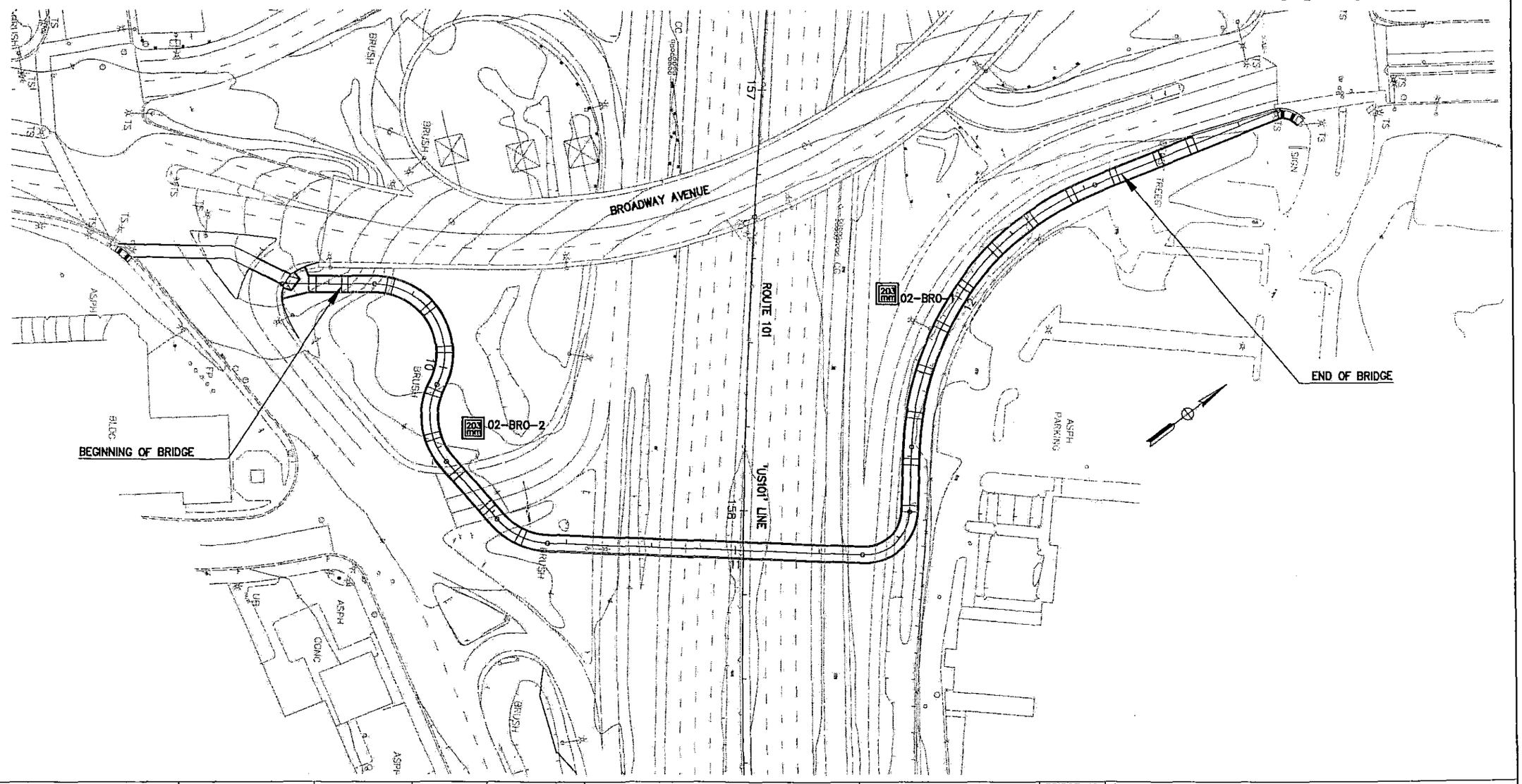
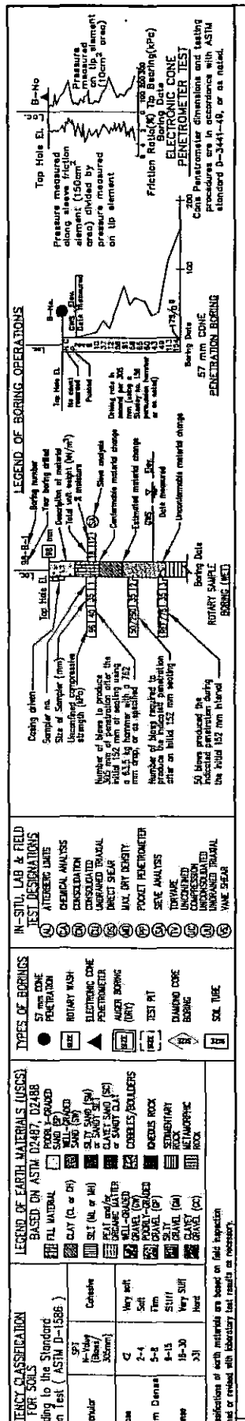
DRAFT

PLAN
1:500





DESIGN OVERSIGHT	FIELD INVESTIGATOR	L. Bhangoo / R. Au	DATE	JAN 2002
	DRAWN BY	R. Au	DATE	FEB 2002
SIGN OFF DATE	CHECKED BY	A. Kozompolis	DATE	FEB 2002

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Y. DAVID WANG
PROJECT ENGINEER

CU 245
EA 26420K

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

BRIDGE NO 35-0342
KP/PM 26.7/16.6

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 2-18-02 | SHEET | OF

BROADWAY POC

LOG OF TEST BORINGS 1 OF 3

C:\ACAD\201191\LOTB\STRUCTURES.DWG

PLATE NO: A-1

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SM	101	21.7/28.8		

GEOTECHNICAL PROFESSIONAL

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER GARY PARIKH No. G.E. 666 Exp. 12/31/05 GEOTECHNICAL STATE OF CALIFORNIA

PARIKH CONSULTANTS, INC.
356 SOUTH MILPITAS BLVD.,
MILPITAS CA 95035

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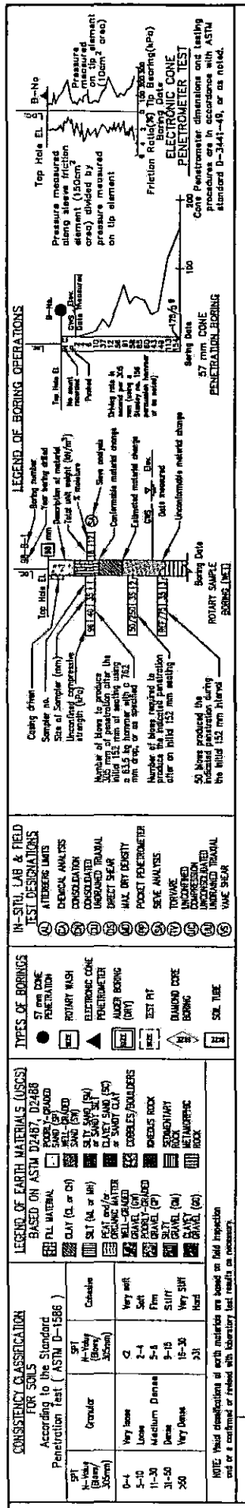
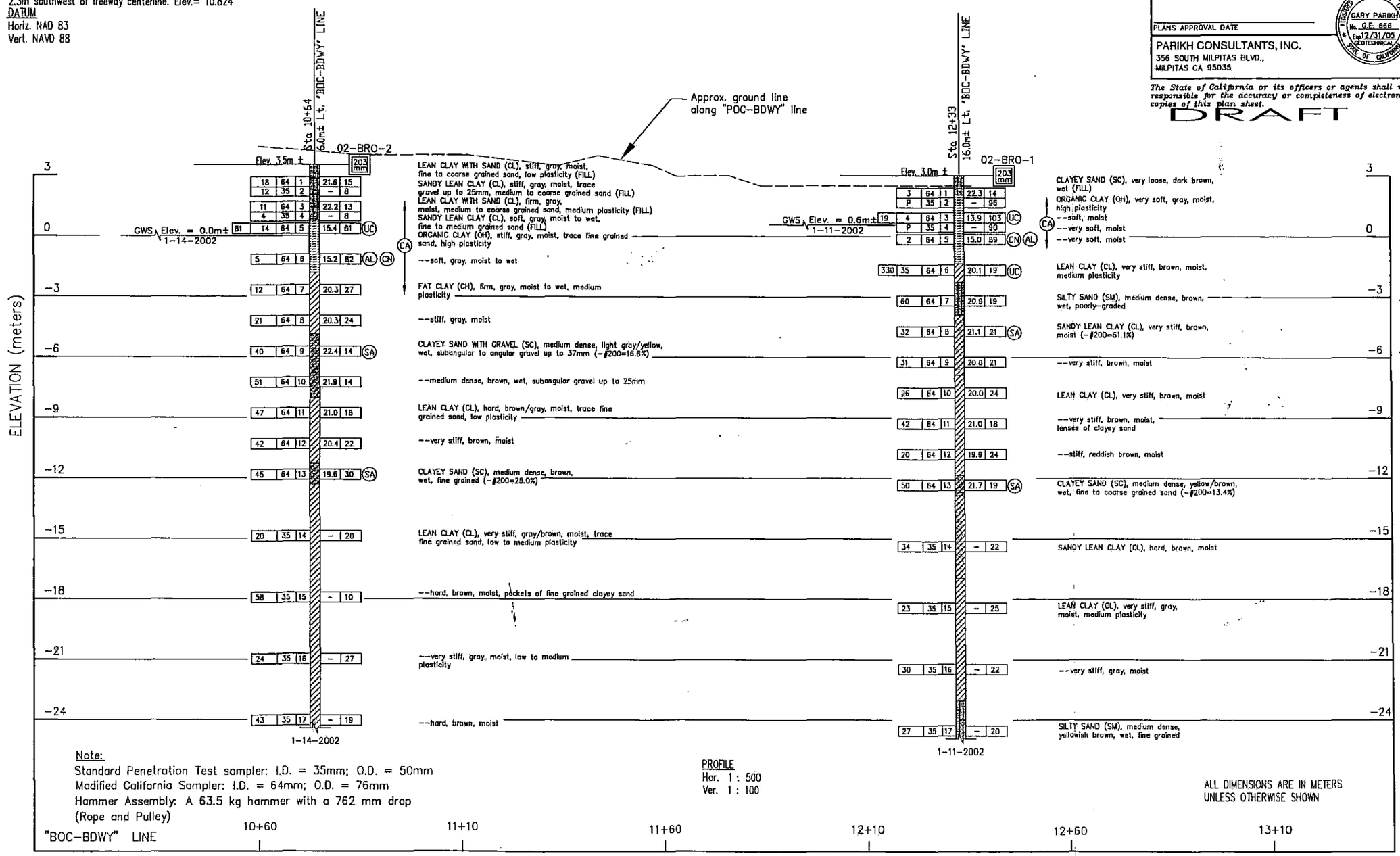
DRAFT



BENCHMARK
BENCHMARK KW-74
Scribbed cross in concrete sidewalk 0.4m southeast of face of curb, on southeast side of Broadway O.C. Bridge (No.35-0096), 2.3m southwest of freeway centerline. Elev.= 10.824
DATUM
Horiz. NAD 83
Vert. NAVD 88

FOR PLAN SHEET SEE SHEET 1 OF 3

Caltrans Metric



Note:
Standard Penetration Test sampler: I.D. = 35mm; O.D. = 50mm
Modified California Sampler: I.D. = 64mm; O.D. = 76mm
Hammer Assembly: A 63.5 kg hammer with a 762 mm drop (Rope and Pulley)

PROFILE
Hor. 1 : 500
Ver. 1 : 100

ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE SHOWN

DESIGN OVERSIGHT	FIELD INVESTIGATOR	L. Bhangoo / R. Au	DATE	JAN 2002
	DRAWN BY	R. Au	DATE	FEB 2002
SIGN OFF DATE	CHECKED BY	A. Kozompolis	DATE	FEB 2002

PREPARED FOR THE
STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

Y. DAVID WANG
PROJECT ENGINEER

BRIDGE NO. 35-0342
KP/PM 26.7/16.6

BROADWAY POC
LOG OF TEST BORINGS 2 OF 3

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS 0 10 20 30 40 50 60 70 80 90 100

CU 245
EA 26420K

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES (PRELIMINARY STAGE ONLY) 2-18-02 | SHEET | OF

C:\ACAD\201191\LOTB\STRUCTURES.DWG

PLATE NO: A-2

Review Discipline:	100% Caltrans Comments - Part 2	By:	
Comments Due By:		**Date:**	April 10, 2013
Reviewed By:	See Initials Column	**Next Meeting Date:**	TBD

TECHNICAL COMMENTS REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: 100% PS&E Plans Date: January 2013

CODE: A - Agree, Will comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

Functional Unit	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp	Final Disp.
	Caltrans Comment and Response Form								
Geotechnical Design and Materials Report									
Material Design	Samia Ara (SA)	1.	Page 5-4	Recommendations; At the top of this page, it states to use design "R-value of 5" for areas with fill greater than or equal to 4 feet. This is in contradiction to the rest of the report where "R-value of 15" is assigned to these areas. Is this a typo?	Yes it was a typo. Have revised the report.	SH	A		
Materials Design	SA	2.	Page 6-2	Light Weight Fill; The second paragraph on this section states that "cellular concrete is not a feasible option". However, as shown on the project plans this option is utilized for this project. Please review.	The discussion referred to replacing the entire embankment fill (as high as 22 feet) with cellular concrete as the only option; however, for lower fill height, this option is more cost effective. Have modified report and elaborated on the application of cellular concrete.	SH	A		
Materials Design	SA	3.	Page 8-1, Table 8-1	This table shows availability of "Aggregate Base Rock, Class 3". However, the project uses "Aggregate Base Rock, Class 2". Please review.	Have updated the table for Class 2 AB.	SH	A		
Materials Design	SA	4.	Page 9-2	Aggregate Base (AB); Specification for Class 3 is provided. Please revise to specifications for Class 2.	Have modified specifications requiring Class 2 AB.	SH	A		

Review Discipline:	65% Caltrans Comments Various Functional Units(See Initials Column)	By:	
Comments Due By:		**Date:**	January 10, 2013
Date Reviewed By:		**Next Meeting Date:**	TBD If needed

TECHNICAL COMMENTS REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: 65% PS&E Plans Updated: June 2012

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

Functional Unit	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
Caltrans Comment and Response Form									
Updated 65% PSE Comments_Broadway.xls									
Caltrans-Materials	Eva Ng	1		"Project Plans (June 29, 2012) a) The project plans should be revised to include rhma-type g if selected as the upper layer in the new structural sections (as per our comment above on the gdmr). b)Typical cross section sheet X-1: the cross-section on the left ("US 101" 500+71.22 to 503+71.01) shows new structural section #4 on a portion of mainline. Structural section #4 does not include OGFC. Should this area receive structural section #1 (0.10' HMA OGFC) consistent with other mainline areas? Please evaluate. c) Typical cross section sheet X-9: the right section for Broadway shows structural section #9 (cellular concrete) within station limits "BWY" 13+44.74 to 13+88.83. These station limits do not match with that presented for cellular concrete on construction details sheet C-25. "	a) This was included per comments on GDMR. Pavemnent structural sections presented on typical cross-section sheets are consistent with the revised GDMR. b) This typical cross section has been revised to include a 0.1' OGFC top layer. c) Agree, the station limits for this area has been revised. See updated typicals for this area.	SH/AG AG AB	A A A		

Review Discipline:	65% Caltrans Comments Various Functional Units(See Initials Column)	By:	
Comments Due By:		**Date:**	January 10, 2013
Date Reviewed By:		**Next Meeting Date:**	TBD If needed

TECHNICAL COMMENTS REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: 65% PS&E Plans Updated: June 2012

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

Functional Unit	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
Caltrans – Design Peninsula	Eva Ng (EN)	2		Please see below for the comments for the geotechnical design and materials report (GDMR) dated (June 21, 2012)		SH			
				· The appendices attached to the report do not coincide with those referred in the report. Also, titles for a few appendices do not match with the contents of the appendices. Again, some appendices (such as Appendix I mentioned on page 7-5) are missing.	• There were typographical errors in the cover pages of Appendices A and B, but the content of Appendices A and B were as stated in the "List of Appendices" of the table of contents. Have revised.		A		
				On page 5-1, a 20-yr traffic index of 10 is selected for on- and off-ramps and for Broadway and other local streets. This TI value of 10 is used to provide pavement structural section recommendations for all these roadways. However, in the set of plans sheet X-1 presents a TI value of 11 for all these roadways and pavement structures corresponding to TI of 11 are presented on this sheet. The two documents, GDMR and set of project plans, should provide consistent information.	• Corrosion Study Report by V&A was inadvertently left out during report production; will include report in next submittal. However, the summary of the corrosion study was presented in Section 7. the electronic version (pdf file) of the report includes the complete report and proper appendix cover pages.		A		
				· On page 5-2, design R-value of 15 is assigned for subgrade soil with fills thicker than 4 feet. Again, in third paragraph on page 5-4, under "Recommendations", a design R-value of 5 is stated for subgrade with fills greater than 4 feet. Please review.	• The hard copy version of the June 21 GDMR was mistakenly reproduced with an older, interim draft of the report. However, the electronic version (pdf file) was the up-to-date report with the consistent TI values as the plan sheet X-1.		A		
				-In the last paragraph on page 5-4 it is stated that Rubberized Hot Mix Asphalt (RHMA) is not considered for this project because it will not be cost effective since the quantity anticipated for this project is low. However, as presented on the quantity sheet Q-3 in the set of plans, the quantity of HMA required for this project is relatively large; therefore, we believe that the quantity of RHMA if used for this project should be adequate to be cost effective for this project. Hence, as per D-4 policy, we strongly recommend that for all new pavement structures, consideration should be given to replace the upper 0.20' of HMA with RHMA- Type G.	• Have revised page 5-4 to be consistent with page 5-2, i.e., the design R-value of 15 should be assigned for fill thicker than 4 feet.		A		
					• Reviewed quantity and made necessary changes to comply with D-4 policy to include RHMA-G in the upper 0.2 foot of the pavement structural section. For US 101 mainline travel way, the		A		

Review Discipline:	65% Caltrans Comments Various Functional Units(See Initials Column)	By:	
Comments Due By:		**Date:**	January 10, 2013
Date Reviewed By:		**Next Meeting Date:**	TBD If needed

TECHNICAL COMMENTS REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: 65% PS&E Plans Updated: June 2012

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

Functional Unit	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
Caltrans-Office of Special Funded Projects	Eduardo Ortega (EO)	3		1. We have reviewed URS: foundation report Broadway Overcrossing (Bridge No. 35-0351) dated June 22, 2012. Foundation report Southbound US 101 On-Ramp (Bridge No. 35-0352k) dated June 25, 2012. Foundation report Retaining Walls Nos. 15, 38, 39, 205, 209, 314, 315 and 316.	1. Noted.	SH	E		
				2. Our previous comments dated 3/20/12 were addressed satisfactorily. Based in our review, we have additional comments for this stage of the project:	2. Noted.		E		
				3. Broadway OC (Replace) section 4.2 states rotary wash drilling was used to advance the borings. But LOTBs shows auger drilling.	3. Agree, have revised per comment.		A		
				4. Section 5.2.4: borings by Caltrans conducted in 1970 and borings by others in 2002 were referenced in this section. Please include these as-built borings in the LOTB sheets.	4. Included as-built LOTB sheets from 1970 investigation of the existing southbound loop ramp. However, borings from the 2002 investigations will not be included because the borings were more than 300 feet east of the replacement overcrossing structure.		A/B		
				5. Section 10.2.1: Table 10-2 has two columns both read total load per support under service limit state. Please correct the mistake. Please remove minus sign associated with the tension loads.	5.Have revised.		A		
				Please present foundation recommendations showing required factored nominal resistance and resistance factors used for each applicable limit state, and the design tips and specified tip elevations for each controlling case. Please refer to memo to designer 3-1 for details.	Have included foundation recommendation table per MTD 3-1.		A		
				Table 10-3: the pile data presented here is not consistent with the data presented on the plans (sheet 6 of 32).	Have updated plans to be consistent with foundation report.		A		
				What is the estimated settlement under service load?	Estimated settlement at both abutments and bent is approximately 0.1 inch.		A		
				6. Section 10.4, CDSM: Please specify horizontal extent of					

Review Discipline:	65% Caltrans Comments Various Functional Units(See Initials Column)	By:	
Comments Due By:		**Date:**	January 10, 2013
Date Reviewed By:		**Next Meeting Date:**	TBD If needed

TECHNICAL COMMENTS REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: 65% PS&E Plans Updated: June 2012

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

Functional Unit	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
Caltrans-Office of Special Funded Projects	Eduardo Ortega (EO)	4		9. Add "(replace)" to the bridge name on cover page.	9. Have revised per comment.	SH	A		
				10. LOTBs: description of borings R-11-014 and R-11-013 show values of UC, UU strength that are inconsistent with the lab results. Please check and correct. Please also check other LOTBs.	10. Have revised per comment.		A		
				11. SB US 101 on-ramp section 4.2 states rotary wash drilling was used to advance the borings. But LOTBs shows auger drilling.	11. Have revised per comment.		A		
				12. Section 5.2.1: borings by Caltrans conducted in 1970 were referenced in this section. Please include these as-built borings in the LOTB sheets.	12. Have included as-built LOTB sheets from 1970 investigation of the existing southbound loop ramp.		A		
				13. Section 10.2.1: • Table 10-2 has two columns both read total load per support under service limit state. Please correct the mistake. Please remove minus sign associated with the tension loads.	13. Have revised per comment.		A		
				• Please present foundation recommendations showing required factored nominal resistance and resistance factors used for each applicable limit state, and the design tips and specified tip elevations for each controlling case. Please refer to memo to designer 3-1 for details.	Have included foundation recommendations table per MTD 3-1.		A		
				• What is the estimated settlement under service load?	Estimated settlement at both abutments under service load is 0.1 inch.		E		
				• Piles may not be able to achieve the required capacity when driven to the specified tip elevation. If this happens during pile installation, piles should be allowed to set up for certain time and then re-struck. Please include appropriate statement accordingly.	Have revised report to include the discussion about pile set up and restrikes.		A		
				14. Section 10.4, CDSM: please specify horizontal extent of CDSM. Plans should show the extent of CDSM.	14. Have included plans showing CDSM extents.		A		
				15. Please include soil profiles showing soil parameters used in the analyses.	15. Have included a figure showing the soil profile and soil parameters used in the analyses.		A		

Review Discipline:	Caltrans Comments Various Functional Units(See Initials Column)	By:	
Comments Due By:		**Date:**	February 15, 2012
Date Reviewed By:		**Next Meeting Date:**	TBD If needed

TECHNICAL COMMENT REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: 35% PS&E Plans Updated: December 2011

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

AGCY	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
Caltrans Comment and Response Form									
Materials				On Page 2-2, existing typical structural sections are provided on Table 2-1. The structural section for US-101 presented on this table is weaker than the existing structural sections for on- and off ramps. Is this true? Please verify.	There was a typo for the thickness of existing AC overlay; it should have been 0.15 foot, not 1.43 feet. Have been incorporated in this June 2012 submittal.	SH	A		
				On Page 5-2, R-value for US 101 mainline and on- and off-ramps are selected as 15 and 5, respectively. Again, on Page 5-4 through 5-6, R-value of 15 is assigned to both mainline and ramps when fill thickness is greater than 4 feet, whereas R-value of 5 is assigned to both mainline and ramps placed on subgrade with fill thickness less than 4 feet. The criteria for selection of R-value contradicts between these pages. Please review.	Table 5-3 has been revised to be consistent with design sections presented in Section 5.3.				
				On Page 5-4 and 5-5, a full depth HMA section (HMA thickness of 1.70') is recommended for construction of US 101. From a review of project Vicinity Map we understand that construction along US 101 will be of narrow width with tapers at merging. Proper compaction of 1.7' thick HMA layer at this situation will be extremely difficult. Hence, we suggest using structural section with HMA over LCB for construction of US 101. Please revise the recommendation for mainline structural section.	Because of complex staging requirements, it was understood that full depth HMA paving was preferred to HMA over LCB sections due to time restraint in LCB cure. Nevertheless, an alternative including LCB has been included in the updated Materials Report. Also understood that saw cut lines on existing pavement would be updated so that a minimum width of 4 feet for pavement widening has been adopted; i.e. the need for narrow width widening has been eliminated.				

Review Discipline:	Caltrans Comments Various Functional Units(See Initials Column)	By:	
Comments Due By:		**Date:**	February 15, 2012
Date Reviewed By:		**Next Meeting Date:**	TBD If needed

TECHNICAL COMMENT REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: 35% PS&E Plans Updated: December 2011

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

AGCY	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
Geotechnical	OE	1	Seismic	**I.** For some reason, URS is mixing the old and new Caltrans Seismic Design Criteria (SDC). All the reports make references to the Deterministic Caltrans Seismic Hazard Map, as well as Sadigh's Attenuation Relationship Equation. In addition, Mw is used instead of Mmax. Furthermore, the soil profiles are referred to as type D or E. These are all references to the old SDC which are no longer valid.	Consistent references to the SDC 1.6 (November 2011) have been incorporated into Seismic Design Criteria section, including Mmax and appropriate application of probabilistic hazard assessment. References to deterministic relationship, Mw and soil profiles have been deleted.				
		2	Seismic	**II.** The ARS curve shown on page 15 of the Type Selection Report does not match the spectra I generated using the same inputs.	Consistent ARS curves have been provided to the structural designer for 65% design calculations.				

Review Discipline:	Caltrans Comments Various Functional Units(See Initials Column)	By:	
Comments Due By:		**Date:**	February 15, 2012
Date Reviewed By:		**Next Meeting Date:**	TBD If needed

TECHNICAL COMMENT REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: 35% PS&E Plans Updated: December 2011

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

AGCY	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
		3	Seismic	**III**. I have in my previous reviews of reports by URS Corporation requested certain data be included as part of the Seismic Design Recommendations. The consultant is required to perform the following tasks and include them in their next submittal. - One plate containing the Probabilistic and Deterministic Response Spectra generated from Caltrans ARS On-line (V1.0.4). In addition, the ARS curve generated from the 2008 USGS Interactive Deaggregation Site with 20% increase for directivity shall also be added for comparison. This Plate shall be titled Acceleration Response Spectrum.Comparisons. - A second plate containing the governing ARS curve shall be generated and titled Recommended Acceleration Response Spectrum.	The updated result plots have been re-titled to Acceleration Response Spectrum Comparisons. A new figure titled Recommended Acceleration Spectrum has been added.				
		4	Seismic	**IV**. URS is using a Shear Wave Velocity of 820 fps (250 m/s). The consultant shall show the calculations used to determine these values. Will these values apply to all the structures within this project? If not, recommendations for different structures including the ARS curve shall reflect the correct soil parameters.	Has included calculations in appendix G. These values apply to all structures within the project limits.	A			
		5	Seismic	**V**. The liquefaction analysis and the triggering mechanism(s) used for said analysis shall conform to the latest Caltrans SDC.	The reference to SDC 1.6 (November 2011) has been incorporated into the liquefaction analysis and triggering mechanism discussion.	A			

Review Discipline:	Caltrans Comments Various Functional Units(See Initials Column)	By:	
Comments Due By:		**Date:**	February 15, 2012
Date Reviewed By:		**Next Meeting Date:**	TBD If needed

TECHNICAL COMMENT REVIEW AND RESPONSE

Broadway Interchange Reconstruction Project CT-EA# 04-235844 PM 16.3/17.1 in San Mateo County	Submittal: 35% PS&E Plans Updated: December 2011

CODE: A - Will Comply; B - Caltrans to Evaluate; C - Will Not Incorporate; D - SMCTA to Evaluate; E - No Action Required, F - City to Evaluate

AGCY	INIT	Item No.	Drawing or Page No.	Review Comments	Designer Responses	Rev. By	Init. Disp	JRT Disp.	Final Disp.
		6	6.3.1 Light Weight Fill	If Light Weight Fill is used, the over-excavation should be shored and EPS block should be encapsulated in geomembrane (gasoline resistance).	Discussions on shoring requirements for foundation excavation and EPS blocks encapsulation in geomembrane have been added to the revised reports.	A			

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-19-11	10-19-11	37° 35' 36.771" / 122° 21' 58.308" NAD83	A-11-021
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 9' Lt Sta ~ 196+18.21 B1	10 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			D120	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			Dry	6.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	Dark grayishbrown topsoil.		1	2 3 5	8	94							
	1	SILTY GRAVEL with SAND (GM); loose; brown; dry to moist; coarse, subangular to subrounded GRAVEL; subangular to subrounded SAND; low plasticity fines [FILL].							7	101				PA, PI, R
8.00	2	SILTY, CLAYEY SAND (SC-SM); loose; brown; moist; trace fine SAND; low plasticity fines. At EL. 7.0 ft, becomes wet.												Bag sample 2 to 5 ft
	3			2	2 1 1	2	0							
6.00	4													
	5			3	0 0 1	1	0							
4.00	6													
	7	Bottom of Borehole at 6.5 ft.												
2.00	8													
	9													
0.00	10													
	11													
-2.00	12													
	13													
-4.00	14													
	15													
-6.00	16													
	17													
-8.00	18													
	19													
-10.00	20													
	21													
-12.00	22													
	23													
-14.00	24													
	25													

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San Jose, CA 95113

REPORT TITLE				HOLE ID
BORING RECORD				A-11-021
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-27-11	10-27-11	37° 35' 34.204" / 122° 21' 48.988" NAD83	A-11-022
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 24' Lt Sta ~ 30+99.63 BYSH	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			D120	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			Dry	3.0 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		6 incehs Asphalt Concrete over 12 inches Aggregate Base.												
	1														
9.00	2		SILTY SAND (SM); medium dense; dark brown; moist [FILL].		1	8 8 8	16	94		16	101				Bag sample 1.5 to 3 ft
	3														
7.00	4		Boring abandoned due to hard drilling.. Bottom of Borehole at 3.0 ft.												
	5														
5.00	6														
	7														
3.00	8														
	9														
1.00	10														
	11														
-1.00	12														
	13														
-3.00	14														
	15														
-5.00	16														
	17														
-7.00	18														
	19														
-9.00	20														
	21														
-11.00	22														
	23														
-13.00	24														
	25														

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-022
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-19-11	10-19-11	37° 35' 31.063" / 122° 21' 49" NAD83	A-11-023
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 12' Lt Sta ~ 205+70.16 B1	10 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			D120	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 5 ft AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement				6.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SILT with SAND (ML); medium stiff to stiff; dark grayish brown and reddish brown; moist; coarse SAND; [FILL].												
7.50	2			1	5 2 3	5	94		27	94	PP = 0.50			Bag sample 2 to 5 ft
	3	SANDY lean CLAY (CL); medium stiff; brown; moist to wet; coarse to fine SAND.		2	2 2 3	5	94							
5.50	4	ORGANIC fat CLAY (OH/CH); soft; black mottled with gray; moist to wet; BAY MUD.							38	81	PP = 0.13			
	5	At EL. 4.5 ft, becomes wet.		3	2 2 2	4	67		62	60	PP = 0.13			
3.50	6													
	7	Bottom of Borehole at 6.5 ft.												
1.50	8													
	9													
-0.50	10													
	11													
-2.50	12													
	13													
-4.50	14													
	15													
-6.50	16													
	17													
-8.50	18													
	19													
-10.50	20													
	21													
-12.50	22													
	23													
-14.50	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-023
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-19-11	10-19-11	37° 35' 31.524" / 122° 21' 43.942" NAD83	A-11-024
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 31' Lt Sta ~ 207+67.19 B1	10 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			D120	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 4.5 ft AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement				6.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SANDY SILT with GRAVEL (ML); medium dense; brown; dry; coarse to fine, subangular to subrounded GRAVEL; low plasticity fines.												
	1			1	8 9 11	20	94		13	107				
7.50	2	CLAYEY GRAVEL with SAND (GC); medium dense; gray and brown; dry to moist; subangular to subrounded GRAVEL; up to 2 in. dia. [FILL].												
	3			2	6 6 5	11	78							
5.50	4													
	5	At EL. 5.0 ft, becomes loose; wet.		3	4 2 4	6	33							
3.50	6													
	7	Bottom of Borehole at 6.5 ft.												
1.50	8													
	9													
-0.50	10													
	11													
-2.50	12													
	13													
-4.50	14													
	15													
-6.50	16													
	17													
-8.50	18													
	19													
-10.50	20													
	21													
-12.50	22													
	23													
-14.50	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-024
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-19-11	10-19-11	37° 35' 29.732" / 122° 21' 46.332" NAD83	A-11-025
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 1' Rt Sta ~ 408+07.07 B4	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			D120	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 6.1 ft AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement				6.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	Silty SAND with Gravel/Silty GRAVEL with Sand (SM/GM); very dense; brown; dry; coarse gravel up to 1.5 inches diameter; subangular coarse sand; fine gravel; low plasticity fines [FILL].		1	18 28 33	61	56							
9.00	2													Bag sample 2 to 5 ft
	3	SANDY SILT (ML); medium stiff; yellowish brown; dry to moist; fine SAND; low plasticity fines.		2	4 4 4	8	61		14	105	PP = 0.25			
7.00	4													
	5			3	2 1 1	2	0							
5.00	6													
	7	Bottom of Borehole at 6.5 ft.												
3.00	8													
	9													
1.00	10													
	11													
-1.00	12													
	13													
-3.00	14													
	15													
-5.00	16													
	17													
-7.00	18													
	19													
-9.00	20													
	21													
-11.00	22													
	23													
-13.00	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-025
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-19-11	10-19-11	37° 35' 30.825" / 122° 21' 45.17" NAD83	A-11-026
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 62' Rt Sta ~ 35+60.43 BYSH	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			D120	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			Dry	6.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SANDY SILT (ML); stiff; dark grayish brown; dry; fine SAND [FILL].												
	1			1	3 6 8	14	94		10					
9.00	2	At EL. 9.5 ft, becomes brown; dry to moist.												Bag sample 2 to 5 ft
	3			2	8 9 14	23	89							
7.00	4													
	5	SANDY lean CLAY (CL); very stiff; olive gray mottled with bluish gray; moist to wet; trace coarse, subangular GRAVEL; coarse SAND.		3	5 4 5	9	67		15	116	PP = 1.75			
5.00	6													
	7	Bottom of Borehole at 6.5 ft.												
3.00	8													
	9													
1.00	10													
	11													
-1.00	12													
	13													
-3.00	14													
	15													
-5.00	16													
	17													
-7.00	18													
	19													
-9.00	20													
	21													
-11.00	22													
	23													
-13.00	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-026
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-27-11	10-27-11	37° 35' 29.591" / 122° 21' 42.318" NAD83	A-11-027
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 51' Rt Sta ~ 38+21.43 BYSH	12 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			D120	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			Dry	6.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SANDY lean CLAY with GRAVEL (CL); very stiff; yellowish brown mottled with dark gray; dry to moist; coarse to fine, subangular GRAVEL; coarse to medium SAND [FILL].												
	1			1	15 17 16	33	94		7	121				
10.00	2													Bag sample 2 to 5 ft
	3	At EL. 9.0 ft, becomes stiff; gray; moist; fine SAND; BAY MUD.		2	7 9 7	16	61		7					
8.00	4													
	5	At EL. 7.5 ft, observed coarse gravel up to 1.5 inches diameter.		3	3 3 3	6	5							
6.00	6													
	7	Bottom of Borehole at 6.5 ft.												
4.00	8													
	9													
2.00	10													
	11													
0.00	12													
	13													
-2.00	14													
	15													
-4.00	16													
	17													
-6.00	18													
	19													
-8.00	20													
	21													
-10.00	22													
	23													
-12.00	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-027
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	11-1-11	11-1-11	37° 35' 29.934" / 122° 21' 36.814" NAD83	A-11-028
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 3' Lt Sta ~ 25+19.34 BWY	12 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			CME 75	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	71%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			Dry	6.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SANDY lean CLAY (CL); very stiff; dark brown mottled with brown and yellowish brown; dry; trace GRAVEL [FILL].												
	1			1	10 17 17	34	67		8	108				PA, PI, R
10.00	2													Bag sample 2 to 5 ft
	3			2	9 7 10	17	100		11					
8.00	4	Sandy Lean CLAY/Clayey SAND (CL/SC); very stiff/medium dense; dark grayish brown mottled with brownish yellow; dry to moist [FILL].												
	5			3	9 4 3	7	89							
6.00	6	Well-graded GRAVEL with SAND (GW); loose; fine, subrounded GRAVEL; medium to fine SAND; slight organic odor [FILL].												
	7	Black organic wood bebris. Bottom of Borehole at 6.0 ft.												
4.00	8													
	9													
2.00	10													
	11													
0.00	12													
	13													
-2.00	14													
	15													
-4.00	16													
	17													
-6.00	18													
	19													
-8.00	20													
	21													
-10.00	22													
	23													
-12.00	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-028
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	11-4-11	11-4-11	37° 35' 30.479" / 122° 21' 34.987" NAD83	A-11-029
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 2' Rt Sta ~ 26+76.5 BWY	12 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			CME 75	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	71%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			Dry	6.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	Silty SAND/Sandy SILT (SM/ML); medium dense; yellowish brown; moist; fine sand; 6 inch pocket of poorly graded sand (SP) [FILL].												
	1			1	7 8 11	19	100		7	114	PP = 1.50			
9.50	2	Interbedded layers of Silty SAND/Lean CLAY (SM/CL); very stiff/medium dense; dark grayish brown; moist; trace coarse to fine, subrounded GRAVEL; coarse to fine SAND; piece of brick found in sample [FILL].							15					
	3			2	6 12 15	27	67							Bag sample 3 to 5 ft
7.50	4													
	5	Concrete pieces.		3	12 21 5	26	17							
5.50	6													
	7	Bottom of Borehole at 6.5 ft.												
3.50	8													
	9													
1.50	10													
	11													
-0.50	12													
	13													
-2.50	14													
	15													
-4.50	16													
	17													
-6.50	18													
	19													
-8.50	20													
	21													
-10.50	22													
	23													
-12.50	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-029
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	11-1-11	11-1-11	37° 35' 24.56" / 122° 21' 38.952" NAD83	A-11-030
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 34' Lt Sta ~ 416+15.25 B4	9 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			CME 75	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	71%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 5.5 ft AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement				7.0 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		SILTY GRAVEL with SAND (GM); dense; dark brown to brown; dry; some ashpalt binder [FILL].												
	1				1	21 13 15	28	72							
6.50	2														
	3		ORGANIC fat CLAY (OH/CH); very soft; black; moist; with peat; organic odor [BAY MUD].		2	2 1 1	2	78				PP = 0.05			Bag sample 0 to 5 ft
4.50	4														
	5														
2.50	6		At EL. 3.0 ft, becomes gray; wet; slight organic odor.		3	0 0 0	0	100		99	45	PP = 0.05 UC = 0.08			
	7		Bottom of Borehole at 7.0 ft.												
0.50	8														
	9														
-1.50	10														
	11														
-3.50	12														
	13														
-5.50	14														
	15														
-7.50	16														
	17														
-9.50	18														
	19														
-11.50	20														
	21														
-13.50	22														
	23														
-15.50	24														
	25														

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-030
DIST. 04	COUNTY San Mateo	ROUTE Broadway	POSTMILE 16.3/17.1	EA 04-04-235844 (URS
PROJECT OR BRIDGE NAME US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY M. Thummaluru	DATE 11-23-11	SHEET 1 of 1	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-27-11	10-27-11	37° 35' 22.149" / 122° 21' 34.98" NAD83	A-11-031
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 35' Lt Sta ~ 420+16.28 B4	9 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			D120	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			Dry	6.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SILTY, CLAYEY GRAVEL with SAND (GC-GM); medium dense; dark gray; dry to moist; coarse to fine, subangular GRAVEL; [FILL].												
	1			1	8 5 6	11	67							
6.50	2													
	3	ORGANIC fat CLAY (OH/CH); very soft to soft; dark gray; moist; slight organic odor; BAY MUD.												Bag sample 2.5 to 5 ft
				2	2 1 1	2	67				PP = 0.13			
4.50	4													
	5	At EL. 3.5 ft, with strong organic odor.		3	1 1 1	2			101	46	UC = 0.09			
2.50	6													
	7	Bottom of Borehole at 6.5 ft.												
0.50	8													
	9													
-1.50	10													
	11													
-3.50	12													
	13													
-5.50	14													
	15													
-7.50	16													
	17													
-9.50	18													
	19													
-11.50	20													
	21													
-13.50	22													
	23													
-15.50	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-031
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-20-11	10-20-11	37° 35' 19.626" / 122° 21' 30.549" NAD83	A-11-032
DRILLING CONTRACTOR: Taber Drilling			BOREHOLE LOCATION (Offset, Station, Line): ~ 91' Lt Sta ~ 524+62.51 US101	SURFACE ELEVATION: 10 ft NAVD 88
DRILLING METHOD: Solid-Stem Auger			DRILL RIG: D120	BOREHOLE DIAMETER: 6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID): Modified CA (1.96")			SPT HAMMER TYPE: 140lb/30in - Auto	HAMMER EFFICIENCY, ERi: 93%
BOREHOLE BACKFILL AND COMPLETION: Cement			GROUNDWATER READINGS: DURING DRILLING Dry; AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING: 6.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SANDY lean CLAY (CL); stiff; dark grayish brown; moist; trace coarse, subrounded GRAVEL; fine SAND [FILL].												
	1		X	1	5 6 5	11	94		12	118				
8.00	2													Bag sample 2 to 5 ft
	3	At EL. 7.0 ft, becomes brown.	X	2	6 2 3	5	11							
6.00	4													
	5	ORGANIC fat CLAY (OH/CH); soft; dark gray; moist; peat; strong organic odor [BAY MUD].	X	3	2 1 1	2	66		75		PP = 0.25			
4.00	6													
	7	Bottom of Borehole at 6.5 ft.												
2.00	8													
	9													
0.00	10													
	11													
-2.00	12													
	13													
-4.00	14													
	15													
-6.00	16													
	17													
-8.00	18													
	19													
-10.00	20													
	21													
-12.00	22													
	23													
-14.00	24													
	25													

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-032
DIST. 04	COUNTY San Mateo	ROUTE Broadway	POSTMILE 16.3/17.1	EA 04-04-235844 (URS
PROJECT OR BRIDGE NAME: US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY M. Thummaluru	DATE 11-23-11	SHEET 1 of 1	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	11-1-11	11-1-11	37° 35' 20.641" / 122° 21' 43.806" NAD83	A-11-033
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 25' Rt Sta ~ 14+00.47 BWY	14 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			CME 75	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	71%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			N/A	6.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	CLAYEY GRAVEL with SAND (GC); dense; brown to dark grayish brown; dry to moist [FILL].												
	1			1	11 18 14	32	94							
12.00	2	SANDY lean CLAY (CL); stiff; dark grayish brown; moist; trace GRAVEL [FILL].												Bag sample 2 to 5 ft
	3			2	8 5 4	9	67		17	106				
10.00	4	Lean CLAY (CL); stiff; olive gray; moist; trace GRAVEL; medium to fine SAND.												
	5			3	3 5 4	9	72		19	109	PP = 1.0			
8.00	6	Bottom of Borehole at 6.0 ft.												
	7													
6.00	8													
	9													
4.00	10													
	11													
2.00	12													
	13													
0.00	14													
	15													
-2.00	16													
	17													
-4.00	18													
	19													
-6.00	20													
	21													
-8.00	22													
	23													
-10.00	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-033
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-25-11	10-25-11	37° 35' 21.055" / 122° 21' 38.085" NAD83	A-11-034
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 25' Rt Sta ~ 318+62.37 B3	12 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			D120	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			Dry	6.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	Silty SAND with Gravel to Sandy SILT with Gravel (SM/ML); loose; brown; dry; fine sand; subrounded fine to coarse gravel [FILL].												
	1		X	1	6 5 5	10	61		11	99				
9.50	2													Bag sample 2 to 5 ft
	3	At EL. 8.5 ft, becomes medium dense.	X	2	4 10 13	23	94		17	106				
7.50	4													
	5	Lean CLAY (CL); medium stiff; dark gray; moist; strong organic odor.	X	3	4 4 5	9	72		22	102	PP = 0.35			
5.50	6													
	7	Bottom of Borehole at 6.5 ft.												
3.50	8													
	9													
1.50	10													
	11													
-0.50	12													
	13													
-2.50	14													
	15													
-4.50	16													
	17													
-6.50	18													
	19													
-8.50	20													
	21													
-10.50	22													
	23													
-12.50	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-034
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-25-11	10-25-11	NAD83	A-11-035
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			' Lt Sta ~	
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Solid-Stem Auger			D120	6 in.
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			Dry	6.5 ft

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0		Silty SAND with Gravel/Sandy SILT with Gravel (SM/ML); medium dense/very stiff; dark brown; moist; fine sand; some Lean CLAY (CL) interbeds.												
	1				1	8 9 13	22	100		12	111				
	2														Bag sample 2 to 5 ft
	3				2	6 7 4	11	72		9					
	4														
	5		Lean CLAY (CL) and Organic Fat CLAY (OH/CH); soft; dark yellowish brown mottled with dark gray; moist; strong organic odor [BAY MUD].		3	2 1 1	2	72		23		PP = 0.15			Sample transition from fill to bay mud
	6														
	7		Bottom of Borehole at 6.5 ft.												
	8														
	9														
	10														
	11														
	12														
	13														
	14														
	15														
	16														
	17														
	18														
	19														
	20														
	21														
	22														
	23														
	24														
	25														

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REPORT TITLE				HOLE ID
BORING RECORD				A-11-035
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-23-11	1 of 1	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	11-2-11	11-2-11	37° 35' 33.398" / 122° 21' 53.035" NAD83	R-11-001
DRILLING CONTRACTOR: Taber Drilling			BOREHOLE LOCATION (Offset, Station, Line): ~ 4.5' Lt Sta ~ 201+62.50 B1	SURFACE ELEVATION: 11 ft NAVD 88
DRILLING METHOD: Rotary Wash			DRILL RIG: SIMCO 2400	BOREHOLE DIAMETER: 4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID): Modified CA (1.96"), SPT (1.44")			SPT HAMMER TYPE: 140lb/30in - Rope & Cathead	HAMMER EFFICIENCY, ERi: N/A
BOREHOLE BACKFILL AND COMPLETION: Cement			GROUNDWATER READINGS: DURING DRILLING 15 ft; AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING: 50.0 ft

ELEVATION (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Remarks
0	SILTY SAND (SM); loose; dark brown; dry to moist; low plasticity fines; trace clay and gravel [FILL].										
		X	1	5 5 5	10	100		21			
9.00	At EL. 9.0 ft, becomes brown mottled with reddish brown.										
		X	2	3 2 2	4	78		22	94		
5	ORGANIC fat CLAY (OH/CH); very soft; dark gray; moist; peat; organic odor [BAY MUD].	X	3	1 1 2	3	0					No recovery
5.00											
3.00	At EL. 3.5 ft, becomes dark gray mottled with black and gray.	X	4	1 2 1	3	67		57			
1.00		X	5	0 1 1	2			109	40		Sample disturbed (used sand catcher)
-1.00											
-3.00											
15		X	6	0 0 0	0			92	48	UC = 0.13	Began rotary wash at 15 ft Sample disturbed (used sand catcher)
-5.00											
-7.00											
19	Lean CLAY (CL); soft; dark gray; moist.										
-9.00	At EL. -9.0 ft, becomes dark gray; wet.	X	7	0 0 0	0	100		21	107	UC = 0.19	
-11.00											
-13.00											
25											

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-001
DIST. 04	COUNTY San Mateo	ROUTE Broadway	POSTMILE 16.3/17.1	EA 04-04-235844 (URS
PROJECT OR BRIDGE NAME: US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY M. Thummaluru	DATE 11-10-11	SHEET 1 of 2	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Lean CLAY (CL) *(continued)*.		8	4 10 15	25	78		19	113	PP = 1.88 UC = 1.88			
-15.00	26		At EL. -15.0 ft, becomes very stiff; yellowish brown with black speckles; trace fine SAND; medium plasticity fines.												
	27														
-17.00	28														
	29		Sandy Lean CLAY/Clayey SAND (CL/SC); very stiff/medium dense; yellowish brown with brown and olive gray mottles; moist; low plasticity fines.												
-19.00	30				9	5 7 10	17	89		21	108	PP = 1.50 UC = 0.90			
	31														
-21.00	32														
	33														
-23.00	34		CLAYEY SAND with GRAVEL (SC); medium dense; yellowish brown mottled with brown and olive gray; moist; coarse to fine, subrounded GRAVEL.												
	35				10	8 9 10	19	61		19	111				
-25.00	36														
	37														
-27.00	38														
	39														
-29.00	40				11	7 9 17	26	39							
	41														
-31.00	42														
	43														
-33.00	44														
	45		Well-graded GRAVEL with SILT (GW-GM); medium dense; brown; moist to wet; fine, subangular to subrounded GRAVEL; coarse to medium SAND.		12	20 18 10	28	56							
-35.00	46														
	47														
-37.00	48														
	49		Lean CLAY (CL); stiff to very stiff; olive gray to bluish gray; moist; wood fragments in shoe.		13	5 9 10	19	100		22	95	PP = 1.50 UC = 0.73			
-39.00	50		Bottom of Borehole at 50.0 ft.												
	51														
-41.00	52														
	53														
-43.00	54														
	55														

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-001**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-10-11**	SHEET **2 of 2**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-26-11	10-26-11	37° 35' 29.594" / 122° 21' 40.794" NAD83	R-11-002
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 12.5' Lt Sta ~ 39+26.40 BYSH	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 6 ft / AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING
Cement				40.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	12 inches Asphalt Concrete over 18 inches Aggregate Base [FILL].												
8.50	2													Bag sample from 2.5 to 5 feet
	3	SILT to Sandy SILT (ML); Stiff; brown; moist; fine sand [FILL].												
6.50	4													
	5			1	4 6 6	12	0							
4.50	6	SILT to Sandy SILT (ML); loose to medium dense; dark bluish gray; wet; fine sand [FILL].												
	7			2	7 4 2	6	22							PI
2.50	8	ORGANIC fat CLAY (OH/CH); soft; dark gray; wet; strong organic odor with full shells [BAY MUD].		3	0 1 1	2	100		84					
	9													
0.50	10			4			93							Shelby pushed with 150 to 200 psi pressure
	11													
-1.50	12													Began rotary wash at 12 feet
	13													
-3.50	14													
	15	At EL. -4.5 ft, with broken shell pieces.		5	1 1 8	9	100		55	68	UC = 0.14			
-5.50	16	CLAYEY SAND with GRAVEL (SC); medium dense to dense; reddish brown; moist to wet; fine, subangular to subrounded GRAVEL; coarse to medium SAND.												
	17													
-7.50	18													
	19													
-9.50	20			6	5 14 20	34			11	132				PI
	21													
-11.50	22													
	23													
-13.50	24	SILTY SAND (SM); medium dense; brown; moist; trace coarse to fine, subrounded GRAVEL; fine SAND.												
	25													

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URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-002
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-8-11	1 of 2	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		SILTY SAND (SM) *(continued)*.		7	7 13 12	25			17	116				PA
-15.50	26														
	27														
-17.50	28														
	29														
-19.50	30				8	11 6 7	13	78		25	101				
	31		Poorly graded SAND with SILT (SP-SM) to Silty SAND (SM); loose to medium dense; brown; moist; fine SAND.												
-21.50	32				9	4 3 5	8	33							
	33														
-23.50	34		Lean CLAY (CL); very stiff; brown; moist; medium plasticity fines.												
	35				10	6 4 8	12	100				PP = 1.75			
-25.50	36														
	37														
-27.50	38														
	39		SANDY lean CLAY (CL); medium stiff; reddish brown; moist.		11	5 12 26	38	94		14	121	PP = 0.63 UC = 0.44			
-29.50	40		CLAYEY GRAVEL with SAND (GC); very dense.												
			Bottom of Borehole at 40.0 ft.												
	41														
-31.50	42														
	43														
-33.50	44														
	45														
-35.50	46														
	47														
-37.50	48														
	49														
-39.50	50														
	51														
-41.50	52														
	53														
-43.50	54														
	55														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-002**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-8-11**	SHEET **2 of 2**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J.Lopez	10-7-11	10-7-11	37° 35' 27.927" / 122° 21' 39.637" NAD83	R-11-003
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 4' Rt Sta ~ 22+12.05 BWY	9 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	103%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 5 ft / AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING
Cement				80.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	0	SANDY lean CLAY with GRAVEL (CL); yellowish brown mottled with black; moist [FILL].											
	1												Bag sample 0 to 5 feet
7.00	2												
	3	ORGANIC fat CLAY (OH/CH); very soft; dark greenish gray; moist to wet; trace fine, subangular to subrounded GRAVEL; trace coarse SAND; organic odor with peat [BAY MUD].											
5.00	4												
	5			1	0 0 1	1	100		115	41	UC = 0.10		Began rotary wash at 5 feet
3.00	6												
	7			2			0						
1.00	8												Shelby pushed with <100 psi pressure
	9												
-1.00	10	At El. -1.0 ft, no sand or gravel.		3	1 1 1	2	78		96	47	UC = 0.07		
	11												
-3.00	12			4					14	116			Shelby pushed with 100 psi pressure from 12 to 13 feet PA, PI Shelby pushed with 1,000 psi from 13 to 14.5 feet
	13	Well-graded SAND with CLAY and GRAVEL (SW-SC); medium dense; dark gray; wet; coarse to fine, subangular to subrounded GRAVEL; coarse to fine SAND.											
-5.00	14												
	15			5	16 10 11	21	100		19	114			
-7.00	16	CLAYEY SAND with GRAVEL (SC); medium dense; brown and dark brown; moist; coarse to fine, subangular to subrounded GRAVEL; coarse to fine SAND.											
	17			6	7 9 9	18	78						PA, PI
-9.00	18			7	8 13 17	30			12	126			
	19												
-11.00	20			8	5 9 11	20	33						
	21												
-13.00	22												
	23												
-15.00	24												
	25												

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-003
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-28-11	1 of 3	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		CLAYEY SAND with GRAVEL (SC) *(continued)*.		9	7 4 6	10	89							
-17.00	26		SILTY SAND with GRAVEL (SM); medium dense; yellowish brown; moist to wet.							18	117				PA
	27														
-19.00	28														
	29		Lean CLAY (CL); very stiff; brown mottled with dark yellowish brown and black specks; moist.												
-21.00	30				10	5 5 8	13					PP = 1.25			
	31														
-23.00	32														
	33														
-25.00	34														
	35				11			83				PP = 1.25			Shelby pushed with 100 psi pressure from 35 to 36.5 feet
-27.00	36		At EL. -27.0 ft, becomes very stiff; dark gray; coarse to fine, subrounded GRAVEL.												Shelby pushed with 1,200 psi pressure from 36.5 to 37.5 feet
	37														
-29.00	38														
	39														
-31.00	40		At EL. -31.0 ft, becomes stiff; dark yellowish brown mottled with brownish gray; some fine SAND.		12	4 5 5	10	100		29	95	PP = 0.63 UC = 0.58			
	41														
-33.00	42														
	43														
-35.00	44														
	45				13	10 12 10	22	100							
-37.00	46		CLAYEY GRAVEL with SAND (GC); medium dense; yellowish brown mottled with brown; moist; medium plasticity fines.							15					
	47		Lean CLAY with GRAVEL (CL); stiff to very stiff; reddish brown mottled with grayish brown and black specks; moist; gravel interbeds.												
-39.00	48														
	49														
-41.00	50				14	5 5 6	11	100		19	111	PP = 1.0			
	51														
-43.00	52														
	53														
-45.00	54														
	55		Clayey SAND with Gravel to Clayey GRAVEL with Sand												

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URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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San Jose, CA 95113

REPORT TITLE				HOLE ID
BORING RECORD				**R-11-003**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-28-11**	SHEET **2 of 3**	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method Casing Depth	Remarks
	55		(SC/GC); very dense; reddish brown mottled with brown; moist.		15	16 41 22	63							
-47.00	56													
	57													
-49.00	58													
	59													
-51.00	60		Lean CLAY (CL); stiff; brown mottled with grayish brown; moist.		16	7 4 5	9	11						
	61													
-53.00	62				17	6 6 5	11	89						
	63				18	5 4 9	13	22						
-55.00	64													
	65		At EL. -55.5 ft, with some coarse GRAVEL; some SAND.											
-57.00	66													
	67													
-59.00	68													
	69													
-61.00	70		At EL. -60.5 ft, becomes very stiff; decrease in plasticity.		19	8 12 18	30	100		24	101	PP = 1.05 UC = 1.53		
	71													
-63.00	72													
	73													
-65.00	74													
	75		Fat CLAY (CH); stiff; bluish gray; moist; trace coarse, subrounded GRAVEL.		20	5 8 7	15			38	80	PP = 1.2 UC = 0.77		
-67.00	76													
	77													
-69.00	78													
	79		At EL. -69.5 ft, becomes very stiff; with brown specks.		21	5 5 6	11					PP = 1.8		
-71.00	80		Bottom of Borehole at 80.0 ft.											
	81													
-73.00	82													
	83													
-75.00	84													
	85													

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE **BORING RECORD**				HOLE ID **R-11-003**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-28-11**	SHEET **3 of 3**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J.Lopez	10-27-11	10-27-11	37° 35' 27.42" / 122° 21' 37.862" NAD83	R-11-004
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 47' Rt Sta ~ 52+44.03 HTL	10 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			5 ft / N/A	40.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	8 inches Asphalt Concrete over 12 inches Aggregate Base [FILL].												
8.00	2	ORGANIC fat CLAY (OH/CH); very soft; black; moist to wet; strong organic odor; some decayed wood [BAY MUD].												Bag sample 2 - 5 ft
6.00	4													
	5	At EL. 5.0 ft, sand interbed (5 inches thick).		1	2 0 1	1	89		154	33				Began rotary wash at 5 ft Decayed wood in sample
4.00	6													
2.00	8													
0.00	10	At EL. 0.0 ft, no decaying wood.		2	2 0 1	1	100		88	51	UC = 0.12			
-2.00	12													
-4.00	14	CLAYEY SAND (SC); medium dense; brownish gray; moist; coarse to medium SAND.												
	15			3	8 7 10	17	94		15	122				
-6.00	16													
-8.00	18													
	19	At EL. -9.0 ft, becomes brown; trace coarse to fine, subangular to subrounded GRAVEL; coarse to fine, subangular to subrounded SAND.												
-10.00	20			4	13 11 6	17	78		17	117	UC = 0.72			PA, PI
-12.00	22													
	23			5	4 3 6	9	67							
-14.00	24													
	25													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-004
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-18-01	1 of 2	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Clayey SAND/Clayey GRAVEL (SC/GC); brown; moist; medium dense; angular to subangular coarse sand; fine gravel; occassional sand and gravel interbeds.		6	16 10 10	20	89		16	116				PI
-16.00	26														
	27														
-18.00	28														
	29														
-20.00	30		At EL. -20.0 ft, becomes loose; wet.		7	5 4 4	8	44							
	31														
-22.00	32														
	33														
-24.00	34		Lean CLAY (CL); stiff; brown; moist; low plasticity fines.												
	35				8	4 4 5	9	100		25					
-26.00	36														
	37														
-28.00	38		At EL. -28.0 ft, grades to Lean CLAY with SAND (CL); mottled.												
	39				9	4 6 9	15	100		20	108	UC = 0.87			
-30.00	40		Bottom of Borehole at 40.0 ft.												
	41														
-32.00	42														
	43														
-34.00	44														
	45														
-36.00	46														
	47														
-38.00	48														
	49														
-40.00	50														
	51														
-42.00	52														
	53														
-44.00	54														
	55														

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-004**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-18-01**	SHEET **2 of 2**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
A. Cheung	9-29-11	9-29-11	37° 35' 28.047" / 122° 21' 47.977" NAD83	R-11-005
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 7' Rt Sta ~ 208+21.10 B2	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	103%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING	AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			12.5 ft	N/A	61.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	16 inches ASPHALT CONCRETE over 26 inches AGGREGATE BASE [FILL].												
9.00	1, 2, 3													Bag sample 3.5 - 5 feet
7.00	4	CLAYEY SAND with GRAVEL (SC); medium dense; light brown; moist [FILL].												
5.00	5, 6	At EL. 6.0 ft, becomes olive gray to dark gray.		1	7 7 6	13	56							PI
3.00	7, 8													
1.00	9, 10	ORGANIC fat CLAY (OH/CH); medium stiff; dark gray; moist; slight organic odor [BAY MUD].		2			100		83	50	UU = 0.33			Shelby pushed with 300 psi pressure C, PI
-1.00	11, 12													
-3.00	13, 14													Began rotary wash at 12.5 feet
-5.00	15, 16	Fat CLAY (CH); soft to medium stiff; dark gray; moist; slight organic odor.		3			100		32	87	UU = 0.24			Shelby pushed with 300 psi pressure
-7.00	17, 18													
-9.00	19, 20	At EL. -9.0 ft, becomes dark grayish brown; trace GRAVEL.												
-11.00	21, 22			4	2 2 3	5	100		33	85	PP = 0.38 UC = 0.35			
-13.00	23, 24, 25													

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URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-005
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-12-11	1 of 3	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Lean CLAY (CL); stiff; dark gray and reddish brown; moist.		5	3 3 4	7	89		24	101	PP = 0.75 UC = 0.66			
-15.00	26														
	27														
-17.00	28		CLAYEY GRAVEL (GC); dense; brown and grayish brown; moist.												
	29														
-19.00	30				6	10 14 22	36								
	31														
-21.00	32														
	33														
-23.00	34														
	35				7	5 6 22	28								
-25.00	36		Lean CLAY with SAND (CL); very stiff; brown mottled with grayish brown; moist; trace GRAVEL; fine SAND.							14	122	UC = 1.34			
	37		Lean to fat CLAY (CL/CH); very stiff; gray to olive gray; moist.		8	5 6 7	13	89		23	103	PP = 2.25 UC = 1.48			
-27.00	38														
	39														
-29.00	40		At EL. -29.0 ft, becomes stiff.		9	5 4 5	9	100		38	83	PP = 1.38 UC = 0.73			
	41														
-31.00	42														
	43														
-33.00	44														
	45		Sandy Lean CLAY to Clayey SAND (CL/SC); stiff, moist, gray to olive gray; trace gravel; some sandy silt lenses.		10	4 4 4	8	100		22	105	PP = 1.00			
-35.00	46														
	47														
-37.00	48														
	49														
-39.00	50		Fat CLAY (CH); medium stiff to stiff; gray to dark gray; moist; slight organic odor.		11	4 4 3	7	100		37	84	PP = 0.50 UC = 0.49			
	51														
-41.00	52														
	53														
-43.00	54														
	55														

(continued)

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE **BORING RECORD**				HOLE ID **R-11-005**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**		DATE **10-12-11**	SHEET **2 of 3**

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		Fat CLAY (CH) *(continued)*.		12			100							Shelby pushed with 250 psi pressure
-45.00	56														
	57														
-47.00	58														
	59														
-49.00	60				13	3 3 4	7	100		46	76	PP = 0.25 UC = 0.63			
	61														
-51.00	62		Bottom of Borehole at 61.5 ft.												
	63														
-53.00	64														
	65														
-55.00	66														
	67														
-57.00	68														
	69														
-59.00	70														
	71														
-61.00	72														
	73														
-63.00	74														
	75														
-65.00	76														
	77														
-67.00	78														
	79														
-69.00	80														
	81														
-71.00	82														
	83														
-73.00	84														
	85														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-005**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-12-11**	SHEET **3 of 3**	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	9-28-11	9-29-11	37° 35' 27.216" / 122° 21' 46.808" NAD83	R-11-006
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 6' Rt Sta ~ 209+47.19 B2	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	103%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS: DURING DRILLING 14.5 ft; AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING
Cement				60.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	9 inches ASPHALT CONCRETE over 2 inches AGGREGATE BASE [FILL].												
	1	Sandy Lean CLAY with Gravel/Clayey SAND with Gravel (CL/SC); stiff; gray; moist; low plasticity [FILL].												
8.50	2													Bag sample 2 to 5 feet
	3													
6.50	4													
	5			1	10 7 5	12	67							
4.50	6	Clayey GRAVEL to Gravelly Lean CLAY with SAND (GC/CL); medium dense/stiff; olive gray and brown; moist; subangular to subrounded GRAVEL, max. 1.5 in. dia.; medium plasticity fines [FILL].												
	7			2			67							Shelby pushed with 400 psi pressure from 6.5 to 8 feet
2.50	8	ORGANIC fat CLAY (OH/CH); soft to medium stiff; dark gray; moist; slight organic odor [BAY MUD].												Shelby pushed with 300 psi pressure from 8 to 9 feet
	9								65					
0.50	10													
	11													
-1.50	12													
	13													
-3.50	14	Fat CLAY (CH); medium stiff; black; moist; peat; slight organic odor.												
	15													Began rotary wash at 14.5 feet
-5.50	16			3	2 2 3	5	100		38	82	PP = 0.38 UC = 0.38			
	17	Lean CLAY (CL); stiff; black; moist; peat observed; slight organic odor.		4			87		27	95	UU = 0.55			C, PI Shelby pushed with 120 psi pressure
-7.50	18													
	19	At EL. -8.5 ft, becomes stiff; fine sand; shells.												
-9.50	20	At EL. -9.5 ft, with trace fine GRAVEL.		5	3 4 5	9	100		28	96	PP = 0.75 UC = 0.80			
	21													
-11.50	22													
	23													
-13.50	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-006
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-12-11	1 of 3	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Lean CLAY (CL) *(continued)*. At EL. -14.5 ft, becomes dark gray and dark brownish gray with trace ironoxide staining; trace fine GRAVEL.		6	3 4 6	10	100		26	99	PP = 1.00 UC = 0.92			
-15.50	26														
	27														
-17.50	28														
	29														
-19.50	30		SANDY lean CLAY with GRAVEL (CL); stiff; gray mottled with reddish brown; moist; fine, subrounded GRAVEL; coarse SAND.		7	4 7 11	18	28		17	116				
	31														
-21.50	32		CLAYEY GRAVEL with SAND (GC); medium dense; gray and brown; moist to wet; coarse to fine, subangular GRAVEL; coarse to fine SAND; low to medium plasticity fines.		8	9 10 11	21	89							
	33														
-23.50	34														
	35				9	13 10 4	14								
-25.50	36		Fat CLAY (CH); stiff; brown and gray mottled with yellowish brown; moist.												
	37														
-27.50	38														
	39														
-29.50	40		Sandy Lean CLAY with Gravel/Clayey SAND with Gravel (CL/SC); grayish green and gray brown; moist; stiff/medium dense; fine to coarse sand; low plasticity; subrounded to subangular gravel.		10	5 6 9	15	100		19	110	PP = 0.75			
	41														
-31.50	42														
	43														
-33.50	44														
	45														
-35.50	46														
	47														
-37.50	48														
	49														
-39.50	50		Fat CLAY (CH); medium stiff; dark gray; moist; slight organic odor; broken shells in sample; trace black organics.		11	5 4 4	8	100		44	77	PP = 0.88 UC = 0.42			
	51														
-41.50	52														
	53														
-43.50	54														
	55														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-006**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-12-11**	SHEET **2 of 3**	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		Fat CLAY (CH) *(continued)*.												
-45.50	56														
	57														
-47.50	58		At EL. -47.5 ft, becomes gray; no shells or organics.												
	59				12	3 3 3	6	100		57	66	UC = 0.34			
-49.50	60		Bottom of Borehole at 60.0 ft.												
	61														
-51.50	62														
	63														
-53.50	64														
	65														
-55.50	66														
	67														
-57.50	68														
	69														
-59.50	70														
	71														
-61.50	72														
	73														
-63.50	74														
	75														
-65.50	76														
	77														
-67.50	78														
	79														
-69.50	80														
	81														
-71.50	82														
	83														
-73.50	84														
	85														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-006**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-12-11**	SHEET **3 of 3**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-16-11	10-16-11	37° 35' 26.585" / 122° 21' 46.301" NAD83	R-11-007
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 27' Rt Sta ~ 210+19.87 B2	10 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS: DURING DRILLING 9.5 ft; AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING
Cement				80.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SANDY lean CLAY with GRAVEL (CL); stiff; dark brown; moist; low plasticity fines; [FILL].												
7.50	2													
5.50	4													
	5		X	1	4 4 5	9	100		14	124	PP = 0.60 UC = 0.55			
3.50	6													
	7	ORGANIC fat CLAY (OH/CH); soft; dark olive gray mottled with black; moist; organic odor; BAY MUD.												
1.50	8		X	2	2 2 1	3	100		47	73	UC = 0.19			
	9			3			67							Shelby pushed with 100 psi pressure
-0.50	10													
	11													
-2.50	12													Began rotary wash at 11.5 feet
	13													
-4.50	14	At EL. -4.0 ft, becomes very soft; slight organic odor; shell fragments; small gravel; moist to wet.	X	4	1 1 1	2	100		72	57	UC = 0.11			PI
	15													
-6.50	16													
	17	Lean CLAY (CL); stiff; black; moist; slight organic odor; medium sand pockets.												
-8.50	18		X	5	4 5 6	11	89		27	97	PP = 0.63 UC = 0.93			
	19													
-10.50	20		X	6	5 5 6	11	100		24	100	PP = 0.63 UC = 0.86			
	21													
-12.50	22													
	23													
-14.50	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-007
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-28-11	1 of 3	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Lean CLAY (CL) *(continued)*. At EL. -15.5 ft, becomes dark gray mottled with reddish brown.		7	4 4 4	8	100		27	97	PP = 0.65 UC = 0.66			
-16.50	26														
	27														
-18.50	28														
	29														
-20.50	30				8	4 3 3	6	100							
	31		SILT with Sand to Lean CLAY with Sand (ML/CL); medium stiff to stiff; reddish brown mottled with gray; moist; low to medium plasticity; fine sand.							20	110				
-22.50	32		SANDY lean CLAY (CL); medium stiff; reddish brown mottled with gray; moist; trace coarse to medium SAND.		9	3 3 5	8	100		20	111	PP = 0.50 UC = 0.31			
	33														
-24.50	34														
	35		Clayey SAND with Gravel to Sandy Lean CLAY with Gravel (SC/CL); medium dense/medium stiff; reddish brown mottled with gray; moist.		10	5 5 8	13	100		15	115	UC = 0.29			
-26.50	36														
	37														
-28.50	38														
	39														
-30.50	40		At EL. -30.5 ft, becomes bluish green; wet; fine SAND.		11	5 5 5	10	100		26	98	PP = 0.75 UC = 0.46			
	41														
-32.50	42														
	43														
-34.50	44														
	45		SILT (ML); dark brownish gray; moist; low plasticity fines.												
-36.50	46		Fat CLAY (CH); stiff; dark gray and black; moist; slight organic odor.		12	5 6 6	12	100		30	92	PP = 0.63 UC = 0.60			
	47				13			100							Shelby pushed with 300 psi pressure
-38.50	48														
	49														
-40.50	50				14	3 3 5	8	100				PP = 0.50			
	51														
-42.50	52														
	53														
-44.50	54														
	55														

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URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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100 W. San Fernando St, Suite 200
San Jose, CA 95113

REPORT TITLE				HOLE ID
BORING RECORD				**R-11-007**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-28-11**	SHEET **2 of 3**	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		Fat CLAY (CH) *(continued)*.		15	5 5 5	10	100		46	75	PP = 0.50 UC = 0.34			
-46.50	56		At EL. -45.5 ft, with some organics.												
	57														
-48.50	58														
	59		SILT (ML); very stiff; dark greenish gray; moist; with clay and fine sand.												
-50.50	60				16	8 12 19	31	100		18	112	PP = 1.75			
	61														
-52.50	62														
	63														
-54.50	64		Lean CLAY with SAND (CL); hard; bluish gray; moist; fine SAND.												
	65				17	10 13 19	32	100		17	115	PP = 2.25			
-56.50	66		At EL. -56.5 ft, with 2 inch thick medium sand lense.												
	67														
-58.50	68														
	69														
-60.50	70				18	10 10 13	23	100				PP = 2.25			
	71														
-62.50	72														
	73														
-64.50	74														
	75		CLAYEY GRAVEL with SAND (GC); very dense; brown and gray; moist; coarse to fine, angular to subangular GRAVEL; coarse to fine SAND.		19	39 50/5"	50/ 5"	61							
-66.50	76														Sampler advanced 11 in.
	77														
-68.50	78		Lean CLAY (CL); very stiff; brown mottled with gray; moist; low to medium plasticity fines.												
	79				20	10 11 15	26	67		27	103	PP = 1.05 UC = 1.09			
-70.50	80		Bottom of Borehole at 80.0 ft.												
	81														
-72.50	82														
	83														
-74.50	84														
	85														

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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San Jose Office

100 W. San Fernando St, Suite 200
San Jose, CA 95113

REPORT TITLE				HOLE ID
BORING RECORD				**R-11-007**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-28-11**	SHEET **3 of 3**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lpoez	10-17-11	10-17-11	37° 35' 26.007" / 122° 21' 44.866" NAD83	R-11-008
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 4' Lt Sta ~ 211+45.37 B2	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING	AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			5 ft	N/A	80.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	Silty SAND with Gravel/Sandy SILT with Gravel (SM/ML); brown; dry to moist; fine to coarse sand; fine to coarse gravel; low plasticity fines [FILL].												
8.50	2													
6.50	4													
	5	CLAYEY GRAVEL with SAND (GC); loose to medium dense; gray to dark gray; moist; moderate plasticity clay [FILL].		1	5 6 4	10	61							PA, PI
4.50	6													
	7													Began rotary wash at 6.5 feet
2.50	8	At EL. 3.0 ft, with high plasticity clay.		2	4 5 7	12	61		13	123	PP = 1.13			
	9	ORGANIC fat CLAY (OH/CH); medium stiff; dark gray; moist to wet; coarse GRAVEL; strong organic odor; organics [BAY MUD].												
0.50	10			3	2 1 1	2	100		76	54	UC = 0.40			
-1.50	12													
-3.50	14													
	15	Fat CLAY (CH); stiff; dark gray; moist; slight organic odor.		4	3 2 4	6	100		30	93	UC = 0.70			
-5.50	16													
-7.50	18	Lean CLAY (CL); very stiff; dark gray mottled with reddish brown; moist; slight organic odor.												
-9.50	20			5	4 6 7	13	100		26	101	PP = 0.88 UC = 1.20			
-11.50	22			6			93							Shelby pushed with 250 psi pressure
-13.50	24	At EL. -13.5 ft, with trace to some sand.												
	25													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-008
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-31-11	1 of 3	

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25	Lean CLAY (CL) *(continued)*.												
-15.50	26	At EL. -14.5 ft, becomes stiff; dark brownish gray; trace fine GRAVEL; trace medium to fine SAND.		7	4 4 6	10	100		19	111	PP = 0.63 UC = 0.77			
	27													
-17.50	28													
	29	SANDY lean CLAY with GRAVEL (CL); stiff; brown mottled with reddish gray; moist; fine, subangular GRAVEL; coarse to fine SAND.												
-19.50	30			8	5 4 6	10	100				PP = 0.80 UC = 0.65			
	31													
-21.50	32													
	33													
-23.50	34													
	35			9	5 9 10	19	100		16	117				PA, PI
-25.50	36	CLAYEY SAND (SC); medium dense; grayish brown mottled with reddish brown; moist; trace GRAVEL.												
	37													
-27.50	38													
	39													
-29.50	40			10	9 9 10	19	100							
	41	SILTY SAND (SM); medium dense; reddish brown and brownish gray; moist; trace GRAVEL; fine SAND.												
-31.50	42			11	8 5 5	10	33							
	43	Fat CLAY (CH); medium stiff; dark gray; moist; interbedded sandy lean clay lenses (up to 6 inches thick).		12	3 3 3	6	100				PP = 0.45			
-33.50	44													
	45	At EL. -34.5 ft, with organics.		13	3 3 3	6			58	65	UC = 0.44			
-35.50	46													
	47	SANDY lean CLAY (CL); very stiff; grayish blue; moist; coarse to fine SAND; some black nodules.												
-37.50	48													
	49													
-39.50	50	At EL. -39.5 ft, observed minor coarse sand; occassional gravel; plant and wood debris.		14	6 9 13	22	100		19	113	PP = 1.30 UC = 1.38			
	51													
-41.50	52													
	53													
-43.50	54													
	55													

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-008**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-31-11**	SHEET **2 of 3**	

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	55	SANDY lean CLAY (CL) *(continued)*.											
		At EL. -44.5 ft, becomes greenish gray.		15	5 6 16	22	100		22	106	PP = 0.90		
-45.50	56	At EL. -45.5 ft, becomes stiff; reddish brown mottled with grayish blue; trace to some fine GRAVEL; coarse to fine SAND.											
	57												
-47.50	58												
	59												
-49.50	60	SILTY SAND with GRAVEL (SM); dense; reddish brown mottled with grayish brown; moist.		16	7 17 27	44	100		16	118			
	61												
-51.50	62												
	63												
-53.50	64												
	65	Lean CLAY (CL); stiff; gray; moist; some sand interbeds less than 1/4 inch thick.		17	7 7 9	16			25	98	PP = 0.35 UC = 0.60		
-55.50	66												
	67												
-57.50	68												
	69												
-59.50	70	At EL. -59.5 ft, becomes very stiff.		18	6 7 12	19	100				PP = 1.25		
	71												
-61.50	72												
	73												
-63.50	74												
	75			19	9 20 22	42							
-65.50	76	Sandy Lean CLAY to Clayey SAND (CL/SC); hard/dense; yellowish brown mottled with reddish brown; moist; trace fine gravel.									PP = >2.25		
	77												
-67.50	78												
	79	CLAYEY GRAVEL with SAND (GC); very dense; reddish brown and brown; moist.		20	21 40 50/5"	90/ 11"	100						
-69.50	80	Bottom of Borehole at 80.0 ft.											Sampler advanced 17 in.
	81												
-71.50	82												
	83												
-73.50	84												
	85												

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-008**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-31-11**	SHEET **3 of 3**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	9-27-11	9-28-11	37° 35' 22.425" / 122° 21' 43.912" NAD83	R-11-010
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 58' Lt Sta ~ 15+60.57 BWY	12 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	103%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING	AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			12.5 ft	N/A	51.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	6 inches ASPHALT CONCRETE over 18 inches AGGREGATE BASE underlain by 18 inches AGGREGATE SUBBASE [FILL].												
9.50	2													
7.50	4	Silty SAND with GRAVEL/Sandy SILT with GRAVEL (SM/ML); stiff/medium dense; brown and gray mottling; dry to moist; low plasticity; subrounded gravel up to 1 inch diameter; fine to medium sand [FILL].												
	5			1	7 7 10	17	78		18	100				PA, PI
5.50	6													
3.50	8	ORGANIC fat CLAY (OH/CH); medium stiff; dark gray to olive gray; moist; slight organic odor; some peat; organic odor [BAY MUD].												
1.50	10			2	2 2 3	5	100		74	56	PP = 0.38 UC = 0.34			
-0.50	12			3			60							Shelby pushed with 200 psi pressure
-2.50	14	At EL. -2.5 ft, with shells.												
-4.50	16													
	17	Lean CLAY (CL); medium stiff; gray mottled with olive brown; moist; trace to some subrounded coarse, reddish brown sand to fine gravel.												
-6.50	18			4			60		21	106	PP = 0.38 UU = 0.49			Shelby pushed with 300-350 psi pressure
-8.50	20													
	21													Began rotary wash at 20.5 feet
-10.50	22													
-12.50	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-010
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-12-11	1 of 2	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Lean CLAY (CL) *(continued)*.		5	2 2 2	4	78		25	103	PP = 0.38 UC = 0.29			
-14.50	26		At EL. -14.5 ft, becomes grayish brown; trace fine SAND.												
	27														
-16.50	28														
	29														
-18.50	30				6	3 2 4	6			27	100	UC = 0.32			PI
	31														
-20.50	32														
	33														
-22.50	34		At EL. -22.5 ft, becomes very stiff; olive gray mottled with gray; trace fine SAND; increase in fine sand content.												
	35				7	3 6 9	15			17	117	PP = 1.5 UC = 1.00			
-24.50	36														
	37														
-26.50	38														
	39		SILTY GRAVEL with SAND (GM); dense; brown and gray; moist; coarse to fine, subangular to subrounded GRAVEL; coarse to medium SAND.												
-28.50	40				8	13 19 20	39	94							
	41														
-30.50	42		CLAYEY SAND with GRAVEL (SC); medium dense; reddish brown mottled with yellowish brown and gray; moist; low to medium plasticity fines.		9	9 11 11	22	89							PA
	43											PP = 1.25			
-32.50	44														
	45														
-34.50	46														
	47														
-36.50	48														
	49														
-38.50	50		Sandy Lean CLAY to Clayey SAND (CL/SC); stiff/medium dense; moist; brown mottled with reddish brown; fine sand; trace gravel.		10	7 6 5	11	94		16	123				
	51														
-40.50	52		Bottom of Borehole at 51.5 ft.												
	53														
-42.50	54														
	55														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-010**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-12-11**	SHEET **2 of 2**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
A. Cheung	10-6-11	10-6-11	37° 35' 26.467" / 122° 21' 41.629" NAD83	R-11-011
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 64' Lt Sta ~ 20+08.70 BWY	10 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	103%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 5 ft / AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING
Cement				101.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	0	SANDY lean CLAY with GRAVEL (CL); light brown and grayish brown [FILL].											
	1												Bag sample from 0 to 5 feet
7.50	2												
	3	Obstruction at 3 feet.											
5.50	4												
	5			1	3 1 1	2	44						Began rotary was at 5 feet
3.50	6	ORGANIC fat CLAY (OH/CH); very soft to soft; greenish gray; wet; organic odor [BAY MUD].							69		UC = 0.15		
	7			2			87						Shelby pushed with 250 psi pressure
1.50	8								87	48	UU = 0.14		C, PI
	9												
-0.50	10			3	0 0 1	1	100		94	47	UC = 0.09		
	11												
-2.50	12	GRAVELLY lean CLAY (CL).											
	13												
-4.50	14												
	15			4	5 6 6	12	33						
-6.50	16	SANDY lean CLAY with GRAVEL (CL); stiff; reddish brown and grayish brown; moist.											
	17												
-8.50	18												
	19												
-10.50	20	Lean CLAY (CL); very stiff; reddish brown and grayish brown with trace black speckling; moist; trace GRAVEL.		5	4 4 5	9			23	105	UC = 1.17		
	21												
-12.50	22												
	23												
-14.50	24												
	25												

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-011
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-28-11	1 of 4	

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	25	Lean CLAY (CL) *(continued)*.											
-16.50	26	At EL. -15.5 ft, with trace fine SAND; decrease in plasticity.		6	3 5 6	11							Unlined sampler
	27												
-18.50	28												
	29												
-20.50	30	At EL. -20.5 ft, with increase in plasticity.		7	7 9 11	20			21	97	PP = 1.75 UC = 1.77		
	31												
-22.50	32												
	33												
-24.50	34	Fat CLAY (CH); stiff; olive gray mottled with reddish brown black specks; moist.											
	35			8	3 4 4	8			46	75	PP = 0.50 UC = 0.52		
-26.50	36												
	37												
-28.50	38												
	39												
-30.50	40	SILTY, CLAYEY SAND with GRAVEL (SC-SM); medium dense; light brown and grayish brown; wet.		9	7 8 11	19	0						No recovery
	41												
-32.50	42			10	9 12 12	24	100						PA, PI
	43												
-34.50	44												
	45			11	11 8 7	15	100						PA, PI
-36.50	46	CLAYEY SAND with GRAVEL (SC); medium dense; light brown and grayish brown; moist; well-graded sand.											
	47												
-38.50	48												
	49	Lean CLAY with SAND (CL); medium stiff; light brown and grayish brown; moist; fine sand.											
-40.50	50			12	4 4 5	9	33						
	51	Lean CLAY (CL); stiff; gray mottled with reddish brown; moist; trace GRAVEL; trace SAND.											
-42.50	52												
	53												
-44.50	54												
	55												

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-011**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-28-11**	SHEET **2 of 4**	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		Lean CLAY (CL) *(continued)*.		13	5 5 6	11	100		26	100	UC = 0.50			
-46.50	56														
	57														
-48.50	58														
	59														
-50.50	60		Poorly graded SAND with GRAVEL (SP); very dense; reddish brown and dark gray; moist.		14	7 32 50/5.5"	82/ 11.5"	100		9	133				
	61														Sampler advanced 17.5 in.
-52.50	62		SILTY SAND (SM); medium dense; brown and dark gray; moist.		15	24 10 12	22	100							
	63														
-54.50	64														
	65		At EL. -55.5 ft, becomes dense.		16	13 24 20	44	100							
-56.50	66														
	67														
-58.50	68														
	69														
-60.50	70				17	14 4 7	11	100							
	71		Lean CLAY (CL); very stiff; greenish gray; moist; slight organic odor.												
-62.50	72														
	73														
-64.50	74														
	75		At EL. -65.5 ft, with dark gray nodules; trace fine SAND.		18	6 14 17	31	100		14	125	PP = 0.88 UC = 1.19			
-66.50	76														
	77														
-68.50	78														
	79														
-70.50	80		At EL. -70.5 ft, no nodules.		19	6 7 9	16	100		24	102	PP = 1.38 UC = 1.15			
	81														
-72.50	82														
	83														
-74.50	84														
	85														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-011**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-28-11**	SHEET **3 of 4**	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		Lean CLAY (CL) *(continued)*. At EL. -75.5 ft, becomes reddish brown mottled with greenish gray; trace GRAVEL; trace SAND.		20	6 10 14	24	100		19	113	PP = 1.38 UC = 1.50			
-76.50	86														
	87														
-78.50	88														
	89														
-80.50	90				21	8 15 21	36	100		17	113				
	91		Silty SAND to Sandy SILT (SM/ML); dense; reddish brown mottled with gray; moist; trace gravel.												
-82.50	92														
	93														
-84.50	94		Lean CLAY (CL); very stiff; olive gray mottled with reddish brown; moist; trace GRAVEL.												
	95				22	9 11 15	26			18	112	PP = 1.88 UC = 1.79			
-86.50	96														
	97														
-88.50	98														
	99		Fat CLAY (CH); very stiff; dark greenish gray; moist; trace GRAVEL.												
-90.50	100				23	9 15 20	35	89							
	101														
-92.50	102		Bottom of Borehole at 101.5 ft.												
	103														
-94.50	104														
	105														
-96.50	106														
	107														
-98.50	108														
	109														
-100.50	110														
	111														
-102.50	112														
	113														
-104.50	114														
	115														

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San Jose, CA 95113

REPORT TITLE				HOLE ID
BORING RECORD				**R-11-011**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-28-11**	SHEET **4 of 4**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-24-11	10-26-11	37° 35' 24.943" / 122° 21' 41.656" NAD83	R-11-013
DRILLING CONTRACTOR: Taber Drilling			BOREHOLE LOCATION (Offset, Station, Line): ~ 1' Lt Sta ~ 514+12.61 US101	SURFACE ELEVATION: 13 ft NAVD 88
DRILLING METHOD: Rotary Wash			DRILL RIG: D120	BOREHOLE DIAMETER: 4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID): Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			SPT HAMMER TYPE: 140lb/30in - Auto	HAMMER EFFICIENCY, ERi: 93%
BOREHOLE BACKFILL AND COMPLETION: Cement			GROUNDWATER READINGS: DURING DRILLING 8 ft; AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING: 100.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	12 inches Asphalt Concrete over 12 inches aggregate base [FILL].												
11.00	2	SANDY lean CLAY with GRAVEL (CL); hard; brown and gray; dry to moist; glass fragments [FILL].		1	4 17 40	57	100		13	120				PA, PI
9.00	4	SILTY, CLAYEY SAND with GRAVEL (SC-SM); dense; brown; dry to moist [FILL].		2	29 25 14	39	89		7	127				
7.00	6			3	13 7 5	12	56							
	7	At EL. 6.0 ft, becomes loose; moist; increase in clay; some rock fragments to 1.5".												
5.00	8			4	3 2 1	3	22							
3.00	10	SANDY lean CLAY (CL); soft; bluish gray to dark gray; wet; some GRAVEL; organic odor [FILL].		5	2 3 4	7			23	103	UC = 0.15			
1.00	12	ORGANIC fat CLAY (OH/CH); soft to medium stiff; dark gray; moist to wet; organic odor [BAY MUD].		6			100		77	51	UU = 0.25			Shelby pushed with 200 psi pressure C, PI
-1.00	14													Began rotary wash at 13.5 feet
-3.00	16	At EL. -3.0 ft, with some nodules and shells.		7	1 1 1	2	100		80	53	UC = 0.22			
-7.00	20	CLAYEY SAND with GRAVEL (SC); medium dense; bluish gray and grayish brown; moist to wet; coarse to fine GRAVEL; coarse to fine, subangular SAND; low to medium plasticity fines.		8	5 6 9	15	0							No recovery
-9.00	22			9	7 8 9	17	100							PA, PI
-11.00	24													
	25													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-013
DIST. 04	COUNTY San Mateo	ROUTE Broadway	POSTMILE 16.3/17.1	EA 04-04-235844 (URS
PROJECT OR BRIDGE NAME: US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY M. Thummaluru	DATE 11-7-11	SHEET 1 of 4	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		CLAYEY SAND with GRAVEL (SC) *(continued)*. At EL. -12.0 ft, becomes brown and reddish brown.		10	13 13 15	28	83		15	122				
-13.00	26														
	27														
-15.00	28														
	29														
-17.00	30				11	5 6 9	15	89							
	31		Lean CLAY (CL); very stiff; brown to reddish brown with black speckles; moist.							22	106	UC = 1.31 PP = 0.9			
-19.00	32														
	33														
-21.00	34														
	35		Lean to fat CLAY (CL/CH); very stiff; reddish brown mottled with grayish brown; moist.		12	6 7 8	15	100		28	96	PP = 0.5 UC = 1.42			
-23.00	36														
	37														
-25.00	38														
	39														
-27.00	40				13	5 8 11	19	100				PP = 2.25			
	41														
-29.00	42														
	43														
-31.00	44		Clayey SAND with Gravel to Clayey GRAVEL with Sand (SC/GC); dense; reddish brown; moist; fine to coarse sand; fine to coarse subrounded gravel.												
	45				14	13 18 13	31	94		16	115				
-33.00	46														
	47														
-35.00	48														
	49														
-37.00	50				15	13 15 15	30			16	117				
	51		At EL. -38.0 ft, with some clayey sand (SC) interbeds.												
-39.00	52														
	53														
-41.00	54		Lean CLAY (CL); stiff; grayish brown mottled with reddish brown; moist to wet; trace fine SAND.												
	55														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-013**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-7-11**	SHEET **2 of 4**	

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55	Lean CLAY (CL) *(continued)*.		16	4 5 6	11	100		30	92	PP = 0.38 UC = 0.62			Stop drilling 10/24/11 Resume drilling 10/26/11
-43.00	56													
	57													
-45.00	58													
	59	Clayey SAND to Sandy Lean CLAY (SC/CL); medium dense/stiff; reddish brown; dry to moist; fine grained sand; low plasticity fines; sandy silt interbeds.												
-47.00	60			17	6 7 13	20			24	104				
	61													
-49.00	62			18	7 8 9	17	78							
	63													
-51.00	64													
	65													
-53.00	66													
	67													
-55.00	68													
	69	Fat CLAY (CH); stiff; bluish gray; moist; slight organic odor.												
-57.00	70			19	5 5 6	11	100		41	80	PP = 0.88 UC = 0.89			
	71													
-59.00	72													
	73													
-61.00	74	At EL. -61.0 ft, with trace nodules.												
	75	Lean CLAY with SAND (CL); hard; greenish gray; moist; medium to fine SAND.		20	10 17 22	39	100		18	114	PP = 2.25 UC = 2.44			
-63.00	76													
	77													
-65.00	78													
	79													
-67.00	80			21	6 13 19	32	100							
	81	Sandy Lean CLAY to Clayey SAND (CL/SC); medium dense; brownish gray and reddish brown; moist; fine sand; low plasticity.							23	104				
-69.00	82													
	83													
-71.00	84													
	85													

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-013**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-7-11**	SHEET **3 of 4**	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		*(continued)*.												
-73.00	86														
	87														
-75.00	88														
	89														
-77.00	90		Lean CLAY with SAND (CL); very stiff; brownish gray mottled with reddish brown; moist; trace GRAVEL.		22	18 15 16	31	94							
	91														
-79.00	92														
	93														
-81.00	94														
	95														
-83.00	96		At El. -83.0 ft, no sand or gravel.												
	97														
-85.00	98														
	99				23	8 12 16	28	100		26	99	UC = 1.02			
-87.00	100		Bottom of Borehole at 100.0 ft.												
	101														
-89.00	102														
	103														
-91.00	104														
	105														
-93.00	106														
	107														
-95.00	108														
	109														
-97.00	110														
	111														
-99.00	112														
	113														
-101.00	114														
	115														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-013**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-7-11**	SHEET **4 of 4**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-18-11	10-18-11	37° 35' 24.22" / 122° 21' 42.126" NAD83	R-11-014
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 4' Lt Sta ~ 17+85.71 BWY	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS — DURING DRILLING: 6 ft; AFTER DRILLING (DATE): N/A	TOTAL DEPTH OF BORING
Cement				100.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	0	SANDY SILT with GRAVEL (ML); brown; moist [FILL].											
9.00	2												
7.00	4												
	5	Lean CLAY with SAND (CL); medium stiff; dark brown and gray; moist; occassional gravel [FILL].		1	3 3 7	10	28		22				
5.00	6												
	7												Began rotary wash at 6.5 feet
3.00	8			2	0 2 4	6	67						
	9	ORGANIC fat CLAY (OH/CH); soft; dark gray; moist to wet; some fine GRAVEL; some coarse SAND; organic odor [BAY MUD].		3			90		64	62	UC = 0.08		Shelby pushed with 500 psi pressure from 9 to 10 feet
1.00	10												Shelby pushed with 300 psi pressure from 10 to 11.5 feet
	11												
-1.00	12												
	13												
-3.00	14												
	15	SILTY SAND (SM); loose; dark gray; wet; coarse to medium SAND.		4	3 3 2	5	94		22	104			
-5.00	16												
	17	Fat CLAY (CH); medium stiff; dark gray; moist; trace GRAVEL; trace SAND; slight organic odor.											
-7.00	18												
	19			5	2 2 3	5	100		36	86	UC = 0.43		PI
-9.00	20												
	21												
-11.00	22	Lean CLAY (CL); stiff; dark gray; moist; trace GRAVEL; slight organic odor; coarse sand interbeds (1-inch thick).											
	23												
-13.00	24			6	3 4 5	9	67		27	97	UC = 0.79		
	25												

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-014
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-27-11	1 of 4	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method Casing Depth	Remarks
	25		Lean CLAY (CL) *(continued)*.		7			100		22	103	UU = 0.54		Shelby pushed with 350 psi pressure C, PI
-15.00	26													
	27													
-17.00	28													
	29		At EL. -18.0 ft, becomes soft to medium stiff; very dark grayish brown mottled with dark gray; some coarse to fine GRAVEL; some medium SAND.											
-19.00	30				8	2 2 3	5	100		21	109	PP = 0.1 UC = 0.19		
	31													
-21.00	32													
	33													
-23.00	34													
	35		At EL. -24.0 ft, becomes very stiff; olive gray mottled with bluish gray; moist; trace fine SAND.		9	4 4 5	9	100				PP = 1.20		
-25.00	36													
	37													
-27.00	38													
	39													
-29.00	40		At EL. -29.0 ft, becomes stiff; reddish brown mottled with olive gray; trace fine GRAVEL; trace coarse, subangular to subrounded SAND.		10	5 7 7	14	100		21	106	PP = 0.75 UC = 0.69		
	41													
-31.00	42													
	43													
-33.00	44													
	45		At EL. -34.0 ft, becomes very stiff; trace olive gray mottling; fine sand; no gravel.		11	7 9 11	20	100		24	103	PP = 1.40 UC = 1.82		
-35.00	46													
	47													
-37.00	48													
	49		At EL. -38.0 ft, becomes stiff; reddish brown mottled with brownish gray; decrease in plasticity.											
-39.00	50				12	4 5 6	11	100		31	92	UC = 0.66		
	51													
-41.00	52													
	53													
-43.00	54													
	55		SILTY SAND with GRAVEL (SM); dense; reddish brown											

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-014**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-27-11**	SHEET **2 of 4**	

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55	and brownish gray; moist.		13	9 25 29	54	100		11	128				
-45.00	56													
	57	SILTY GRAVEL with SAND (GM); very dense; brown mottled with grayish brown; moist; low plasticity fines; some interbeds of lean clay (CL).		14	13 22 29	51	78							
-47.00	58													
	59													
-49.00	60			15	20 14 18	32	83				PP = 2.25			
	61	SILT (ML); stiff; reddish brown mottled with brownish gray; moist; trace fine SAND; low plasticity fines.							24	101	UC = 0.89			
-51.00	62													
	63													
-53.00	64													
	65	Lean to fat CLAY (CL/CH); very stiff; dark bluish gray; moist.		16	8 10 11	21	100		31	92	UC = 1.26			
-55.00	66													
	67													
-57.00	68													
	69	SANDY lean CLAY (CL); very stiff; yellowish brown mottled with reddish brown and olive gray; moist; fine, subrounded GRAVEL; coarse to medium SAND; some clayey sand (SC) interbeds.												
-59.00	70			17	10 19 28	47	100		16	118	PP = 1.85 UC = 1.25			
	71													
-61.00	72													
	73													
-63.00	74													
	75	SILTY GRAVEL with SAND (GM); very dense; reddish brown and brown; moist; coarse to fine, subangular to subrounded SAND.		18	33 50/5"	50/ 5"	33							
-65.00	76													Sampler advanced 11 in.
	77													
-67.00	78													
	79													
-69.00	80			19	34 50/4"	50/ 4"	33							
	81													Sampler advanced 10 in.
-71.00	82													
	83													
-73.00	84													
	85													

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San Jose, CA 95113

REPORT TITLE				HOLE ID
BORING RECORD				**R-11-014**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-27-11**	SHEET **3 of 4**	

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85	SILTY GRAVEL with SAND (GM) *(continued)*.		20	8 46 50/6"	96/ 12"	33							
-75.00	86													Sampler advanced 18 in.
	87													
-77.00	88													
	89													
-79.00	90			21	20 17 21	38	89							
	91	Sandy Lean CLAY to Clayey SAND (CL/SC); very stiff/dense; brown mottled with grayish brown; moist; fine to coarse sand with some fine to coarse subangular gravel up to 1" diameter.							18	113				
-81.00	92										PP = 1.75			
	93													
-83.00	94													
	95	Lean CLAY (CL); hard; yellowish brown mottled with olive brown; moist.		22	14 18 27	45	100				PP = 2.25			
-85.00	96													
	97													
-87.00	98			23			100							Shelby pushed with 500 psi pressure from 97.5 to 99 feet
	99													Shelby pushed with 1,200 psi pressure from 99 to 100 feet
-89.00	100	Bottom of Borehole at 100.0 ft.												
	101													
-91.00	102													
	103													
-93.00	104													
	105													
-95.00	106													
	107													
-97.00	108													
	109													
-99.00	110													
	111													
-101.00	112													
	113													
-103.00	114													
	115													

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-014**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-27-11**	SHEET **4 of 4**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
A. Cheung	10-3-11	10-3-11	37° 35' 22.846" / 122° 21' 41.952" NAD83	R-11-015
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 67' Rt Sta ~ 16+65.50 BWY	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	103%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 12.5 ft / AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING
Cement				81.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SILTY SAND with GRAVEL (SM) [FILL].												
	1													
8.50	2													
	3													
6.50	4	ORGANIC fat CLAY (OH/CH); very soft; gray and olive gray; wet; strong organic odor; BAY MUD; organic odor.												
	5			1	1 0 1	1	100		87	49	UC = 0.12			
4.50	6													
	7													
2.50	8													
	9													
0.50	10	At EL. 0.5 ft, becomes moist to wet; no organics.		2	0 0 1	1	56		96	47	UC = 0.10			
	11													
-1.50	12			3			100							Shelby pushed with 500 psi pressure Began rotary wash at 12.5 feet
	13	Lean CLAY (CL); stiff; gray mottled with reddish brown and greenish gray; moist.												
-3.50	14								19	110	UU = 0.86			
	15			4	3 5 5	10	56							PI
-5.50	16	CLAYEY SAND with GRAVEL (SC); loose; grayish brown; moist to wet; angular GRAVEL; angular SAND.							14	122				
	17													
-7.50	18													
	19	SANDY SILT (ML); loose; gray mottled with brown; moist; fine SAND.												
-9.50	20			5	2 1 2	3	100							
	21	Lean CLAY (CL); medium stiff; brown to gray; moist.												
-11.50	22													
	23													
-13.50	24													
	25													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-015
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-12-11	1 of 3	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Lean CLAY (CL) *(continued)*. At EL. -14.5 ft, with reddish brown organics.		6	3 2 4	6	100		28	96	PP = 0.5 UC = 0.48			
-15.50	26		Poorly graded SAND with SILT and GRAVEL (SP-SM); medium dense; grayish brown; wet; coarse SAND.												
	27		Fat CLAY (CH); stiff; dark gray; moist.												
-17.50	28														
	29														
-19.50	30				7	2 2 3	5	100							
	31														
-21.50	32														
	33														
-23.50	34														
	35		At EL. -24.5 ft, with black mottles; trace brown organics.		8	4 3 6	9	44		30	93	UC = 0.69			
-25.50	36														
	37														
-27.50	38														
	39		SILTY, CLAYEY SAND with GRAVEL (SC-SM); medium dense; gray; wet; coarse to medium SAND.												
-29.50	40				9	8 9 12	21	56		13	124				PA, PI
	41														
-31.50	42		SILTY GRAVEL with SAND (GM); medium dense; grayish brown; wet; subrounded GRAVEL.		10	13 12 12	24	56							
	43														
-33.50	44		Lean CLAY (CL); medium stiff to stiff; light brown mottled with reddish brown; moist; trace fine SAND.												
	45				11	3 4 5	9	89							
-35.50	46														
	47														
-37.50	48														
	49														
-39.50	50				12	6 10 13	23	89		21	107				
	51		CLAYEY SAND with GRAVEL (SC); medium dense; grayish brown and reddish brown; moist.												
-41.50	52		SILTY SAND (SM); dense; moist; fine SAND; brownish gray and reddish gray.		13	10 10 20	30								
	53														
-43.50	54														
	55		Poorly graded SAND with GRAVEL (SP); very dense;												

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-015**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-12-11**	SHEET **2 of 3**	

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	55	grayish brown and reddish brown; moist.		14	25 26 34	60	44		10				
-45.50	56												
	57												
-47.50	58												
	59												
-49.50	60	Lean to fat CLAY (CL/CH); medium stiff; grayish green; moist.		15	7 6 7	13	78						
	61												
-51.50	62			16			100		32	86	UU = 0.66		Shelby pushed with 350 psi pressure C, PI
	63												
-53.50	64												
	65	SANDY lean CLAY with GRAVEL (CL); very stiff; brown and grayish brown mottled with light brown; moist.		17	10 21 22	43	33		16	116	UC = 1.46		
-55.50	66												
	67												
-57.50	68	CLAYEY GRAVEL with SAND (GC); very dense; brown and reddish brown; moist.											
	69												
-59.50	70			18	25 43 31	74	33		11				
	71												
-61.50	72												
	73												
-63.50	74												
	75	SANDY lean CLAY (CL); very stiff; brown; moist; trace GRAVEL.		19	6 10 13	23	44		16	116	PP = 1.75		
-65.50	76												
	77												
-67.50	78												
	79												
-69.50	80	Lean CLAY with SAND (CL); very stiff; light reddish brown mottled with gray; moist; trace GRAVEL; fine SAND.		20	7 11 14	25	33		18	114	UC = 1.89		
	81												
-71.50	82	Bottom of Borehole at 81.5 ft.											
	83												
-73.50	84												
	85												

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-015**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-12-11**	SHEET **3 of 3**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
A. Cheung	10-4-11	10-4-11	37° 35' 22.879" / 122° 21' 40.993" NAD83	R-11-017
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 39' Rt Sta ~ 315+67.55 B3	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	103%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING	AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			14.5 ft	N/A	101.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	SILTY CLAY (CL-ML); trace organics [FILL].												
	1													Bag sample from 0 to 5 feet.
9.00	2													
	3													
7.00	4	ORGANIC fat CLAY (OH/CH); medium stiff; grayish green with reddish brown oxidation; moist [BAY MUD].												
	5			1	2 3 2	5	89		68	59	PP = 0.5 UC = 0.28			
5.00	6	At EL. 5.0 ft, becomes gray; trace nodules, slight organic odor.												
	7													
3.00	8													
	9													
1.00	10	At EL. 1.0 ft, becomes soft; strong organic odor.		2	0 1 0	1	94		97	46	UC = 0.15			
	11													
-1.00	12			3			100							
	13	Lean CLAY (CL); stiff; olive gray with reddish brown nodules; moist; trace SAND.												Shelby pushed with 200 psi pressure
-3.00	14								24					
	15													
-5.00	16			4	3 4 3	7	89		22	105	PP = 0.75 UC = 0.52			Began rotary wash at 15 feet. PI
	17													
-7.00	18													
	19													
-9.00	20	At EL. -9.0 ft, with some reddish gray nodules; occassional coarse sand and gravel interbeds.		5	3 3 4	7	56		18	112				
	21													
-11.00	22													
	23													
-13.00	24													
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-017
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-13-11	1 of 4	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		Lean CLAY (CL) *(continued)*. At EL. -14.0 ft, becomes medium stiff; increase in gravel.		6	3 2 2	4	100		21	106	UC = 0.41			
-15.00	26														
	27														
-17.00	28														
	29														
-19.00	30		At EL. -19.0 ft, becomes stiff; light brown mottled with grayish green; trace SAND.		7	3 3 5	8			21	106	PP = 0.75 UC = 0.85			
	31														
-21.00	32														
	33														
-23.00	34														
	35		At EL. -24.0 ft, becomes very stiff; trace GRAVEL; lenses; some clayey sand interbeds.		8	6 8 15	23			18	112	PP = 1.75			
-25.00	36														Observed drilling fluid seeping out from the ground next to rig. Drive casing to 20 feet.
	37														
-27.00	38														
	39														
-29.00	40		At EL. -29.0 ft, becomes brown mottled with reddish brown; trace to some well-graded sand.		9	9 11 12	23	100							
	41														
-31.00	42														
	43														
-33.00	44														
	45		At EL. -34.0 ft, becomes stiff; reddish brown mottled with grayish brown; no sand.		10	5 5 5	10	100		28	96	UC = 0.81			
-35.00	46														
	47				11					25	100	UU = 0.97			C, PI
-37.00	48														Shelby pushed with 250 psi pressure
	49														
-39.00	50				12	11 14 25	39	89							
	51		CLAYEY SAND with GRAVEL (SC); dense; reddish brown and grayish brown; moist; coarse to medium SAND.							11	124				
-41.00	52														
	53														
-43.00	54														
	55														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-017**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-13-11**	SHEET **2 of 4**	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		CLAYEY SAND with GRAVEL (SC) *(continued)*.		13	9 13 10	23	100							
-45.00	56		Lean CLAY (CL); stiff; reddish brown mottled with grayish brown; moist.												
	57														
-47.00	58														
	59														
-49.00	60				14	4 7 8	15	100		21	106	PP = 0.75 UC = 1.28			
	61		At EL. -50.0 ft, becomes very stiff; dark gray.												
-51.00	62														
	63														
-53.00	64														
	65		At EL. -54.0 ft, becomes hard; with sand; trace dark reddish brown nodules.		15	8 16 17	33	100		16	116	PP = 1.38 UC = 2.58			
-55.00	66														
	67														
-57.00	68														
	69														
-59.00	70				16	7 8 11	19	67							
	71		At EL. -59.5 ft, becomes olive gray mottled with reddish brown.												
-61.00	72														
	73														
-63.00	74														
	75				17	6 11 16	27								
-65.00	76		At EL. -64.5 ft, becomes reddish brown mottled with grayish green; trace medium to fine SAND; occassional gravel; trace reddish brown nodules.							16	116	UC = 2.07			
	77														
-67.00	78														
	79														
-69.00	80		At EL. -69.0 ft, becomes very stiff; trace GRAVEL.		18	6 10 16	26	67				PP = 1.88			
	81														
-71.00	82														
	83														
-73.00	84														
	85														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-017**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-13-11**	SHEET **3 of 4**	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	85		Lean CLAY (CL) *(continued)*.												
-75.00	86		At EL. -74.0 ft, with no sand or gravel.		19	7 7 15	22	89		20	111	PP = 1.88 UC = 1.83			
	87														
-77.00	88														
	89		At EL. -77.5 ft, becomes hard; increase in plasticity.												
-79.00	90				20	9 16 23	39	89				PP = 2.25			
	91														
-81.00	92														
	93														
-83.00	94														
	95		At EL. -84.0 ft, with trace black mottles.		21	9 17 30	47	100		15	118	PP = >2.25 UC = 3.32			
-85.00	96														
	97														
-87.00	98														
	99														
-89.00	100				22	9 14 20	34								
	101														
-91.00	102		Bottom of Borehole at 101.5 ft.												
	103														
-93.00	104														
	105														
-95.00	106														
	107														
-97.00	108														
	109														
-99.00	110														
	111														
-101.00	112														
	113														
-103.00	114														
	115														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-017**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-13-11**	SHEET **4 of 4**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
A. Cheung	10-5-11	10-5-11	37° 35' 22.128" / 122° 21' 39.931" NAD83	R-11-018
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 38' Rt Sta ~ 316+81.69 B3	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	103%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 16 ft / AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING
Cement				81.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	GRAVELLY SILT (ML); brown; 1-foot cobbles in top 1 foot [FILL].												
9.00	2													
7.00	4	GRAVELLY lean CLAY (CL); stiff; olive gray and dark gray with trace gray nodules; moist [FILL].												
	5			1	6 5 4	9	33		8	128				
5.00	6													
3.00	8	ORGANIC fat CLAY (OH/CH); soft; gray; moist; slight organic odor [BAY MUD].												
1.00	10			2	1 1 1	2	100		89	49	UC = 0.25			
-1.00	12			3			100							Shelby pushed with 200 psi pressure
-3.00	14	Lean CLAY (CL); stiff; grayish brown mottled with olive gray with dark reddish brown nodules; moist; trace GRAVEL; some silty sand (SM) interbeds.							26					
-5.00	16			4	2 4 4	8	50		19	111	PP = 0.63 UC = 0.63			Began rotary wash at 16 feet
-7.00	18	At EL. -7.0 ft, becomes stiff to very stiff; light brown to reddish brown mottled with gray; trace SAND.												
-9.00	20			5	5 6 8	14	89		18	113	PP = 1.25 UC = 1.04			
-11.00	22													
-13.00	24	CLAYEY SAND with GRAVEL (SC); medium dense; brown and reddish brown; moist.												
	25													

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-018
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	10-13-11	1 of 3	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		CLAYEY SAND with GRAVEL (SC) *(continued)*.		6	8 12 14	26	89							
-15.00	26														
	27														
-17.00	28														
	29		Poorly graded SAND with GRAVEL (SP); dense; grayish brown and reddish brown; wet.												
-19.00	30				7	14 19 26	45	67		13	124				
	31														
-21.00	32														
	33		SANDY lean CLAY (CL); stiff; light brown mottled with reddish brown; moist; trace GRAVEL.												
-23.00	34														
	35				8	4 6 7	13	50		17	116	PP = 0.38 UC = 0.73			
-25.00	36														
	37														
-27.00	38														
	39														
-29.00	40		Lean CLAY (CL); very stiff; reddish brown mottled with brown and grayish brown; moist; trace GRAVEL.		9	5 7 10	17	89		24	103	PP = 1.75 UC = 1.24			
	41														
-31.00	42														
	43														
-33.00	44														
	45		At EL. -34.0 ft, becomes trace to some fine sand.		10	3 5 5	10	89							
-35.00	46														
	47														
-37.00	48														
	49														
-39.00	50		At EL. -39.0 ft, becomes stiff.		11	4 5 5	10	56		27	97	PP = 0.75 UC = 0.52			
	51														
-41.00	52														
	53														
-43.00	54														
	55														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-018**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-13-11**	SHEET **2 of 3**	

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ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	55		Lean CLAY (CL) *(continued)*.		12	5 16 28	44	50							
-45.00	56		Poorly graded SAND with GRAVEL (SP); dense; light brown and grayish brown; wet.												
	57														
-47.00	58														
	59														
-49.00	60		At EL. -49.0 ft, becomes very dense; trace clay.		13	15 23 31	54	100							
	61														
-51.00	62														
	63														
-53.00	64														
	65		CLAYEY SAND (SC); medium dense; light brown and grayish brown; wet.		14	5 5 4	9	11							
-55.00	66														
	67														
-57.00	68														
	69		Lean CLAY (CL); very stiff; grayish brown and reddish brown mottled with gray; moist; trace GRAVEL; trace to some fine sand.												
-59.00	70				15	8 11 12	23	67		17	122	PP = 0.63 UC = 1.17			
	71														
-61.00	72														
	73														
-63.00	74														
	75		At EL. -64.0 ft, becomes hard; increase in gravel content.		16	8 13 18	31	89		18	114	PP = 0.75 UC = 2.28			
-65.00	76														
	77														
-67.00	78														
	79														
-69.00	80		At EL. -69.0 ft, becomes very stiff; olive gray and gray; some GRAVEL; occassional sand lenses.		17	8 10 14	24	50		16	115	UC = 1.41			
	81														
-71.00	82		Bottom of Borehole at 81.5 ft.												
	83														
-73.00	84														
	85														

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-018**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **10-13-11**	SHEET **3 of 3**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	11-4-11	11-4-11	37° 35' 20.53" / 122° 21' 40.735" NAD83	R-11-020
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 46' Lt Sta ~ 28+09.56 RLN	14 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			CME 75	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	71%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS: DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			N/A	41.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	0	Clayey SAND/Sandy Lean CLAY (SC/CL); medium dense/very stiff; moist; brown; fine sand [FILL].											
12.00	2												
	3		X	1	7 8 8	16	94				PP = 1.25		PA, PI
10.00	4												
	5		X	2	3 3 4	7	94		22	97			
8.00	6												
	7	Lean CLAY (CL); stiff; dark grayish brown mottled with yellowish brown; moist; trace fine GRAVEL; trace medium to fine SAND; minor fine rootlets [FILL].											
6.00	8		X	3	5 3 3	6	67						Began rotary wash at 7.5 feet
	9	ORGANIC fat CLAY (OH/CH); stiff; black mottled with olive gray; moist; peat; strong organic odor [BAY MUD].							46	71	PP = 0.75		
4.00	10		X	4	3 2 3	5	78		66	52	PP = 0.75 UC = 0.43		
2.00	12												
0.00	14												
	15	Lean CLAY (CL); soft to medium stiff; black; moist to wet.	X	5	0 2 3	5	100		24		PP = 1.30		
-2.00	16												
-4.00	18												
-6.00	20	SILTY, CLAYEY SAND with GRAVEL (SC-SM); medium dense; dark grayish brown; moist to wet; coarse to medium, subrounded SAND. At EL. -7.0 ft, with 4 inch coarse subrounded to rounded gravel lense. At EL. -7.5 ft, becomes dark grayish brown mottled with brown; coarse, subrounded GRAVEL.	X	6	7 13 16	29	89						
-8.00	22												
-10.00	24												
	25												

(continued)

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-020
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-18-11	1 of 2	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		SILTY, CLAYEY SAND with GRAVEL (SC-SM) *(continued)*.												
-12.00	26		At EL. -12.0 ft, with fine SAND.												
	27														
-14.00	28		Fat CLAY (CH); medium stiff to stiff; dark grayish brown; moist.												
	29														
-16.00	30				7	4 5 5	10	100		30	93	PP = 0.50 UC = 0.47			
	31														
-18.00	32														
	33														
-20.00	34														
	35														
-22.00	36														
	37														
-24.00	38														
	39														
-26.00	40				8	5 7 15	22	100		39	81	PP = 0.45 UC = 0.37			
	41		CLAYEY SAND with GRAVEL (SC); medium dense; greenish gray; moist.												
-28.00	42		Bottom of Borehole at 41.5 ft.												
	43														
-30.00	44														
	45														
-32.00	46														
	47														
-34.00	48														
	49														
-36.00	50														
	51														
-38.00	52														
	53														
-40.00	54														
	55														

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-020**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-18-11**	SHEET **2 of 2**	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-20-11	10-20-11	37° 35' 39.533" / 122° 22' 2.645" NAD83	R-11-036
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 15' Lt Sta ~ 191+70.93 B1	10 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44"), Shelby (2.97")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 13.5 ft / AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING
Cement				50.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	Silty GRAVEL with Sand/SILT with Gravel and Sand (GM/ML); Brown; dry to moist; subangular to subrounded gravel and sand [FILL].												
8.00	2													
6.00	4	ORGANIC fat CLAY (OH/CH); soft; dark gray; moist; strong organic odor [BAY MUD].												
	5		X	1	2 4 4	8	0							
4.00	6													
2.00	8													
0.00	10	At EL. 0.0 ft, contains shell fragments.	X	2	0 1 1	2	67		81	53	PP = 0.10 UC = 0.17			
-2.00	12													
-4.00	14													
	15		X	3	1 2 1	3	94		70	58	PP = 0.10 UC = 0.13			Began rotary wash at 15 feet
-6.00	16													
-8.00	18													
-10.00	20	At EL. -10.0 ft, becomes very soft; no shell fragments.	X	4	2 1 1	2	78		77	56	PP = 0.00 UC = 0.09			
-12.00	22													
-14.00	24													
	25													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-036
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-7-11	1 of 2	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		ORGANIC fat CLAY (OH/CH) *(continued)*.		5	2 1 2	3	100		81	51	PP = 0.05 UC = 0.07			
-16.00	26														
	27														
-18.00	28														
	29														
-20.00	30		At EL. -20.0 ft, with peat.		6	3 2 2	4	78		72	56	PP = 0 UC = 0.09			
	31														
-22.00	32														
	33														
-24.00	34														
	35		SILTY SAND (SM); medium dense; dark gray; wet; coarse to fine SAND.		7	7 5 2	7	94		20	105				
-26.00	36		Fat CLAY (CH); soft; dark gray with some black nodules; wet.							32	89	UC = 0.14 PP = 0.10			
	37														
-28.00	38														
	39														
-30.00	40		Lean CLAY (CL); medium stiff; dark gray with some black nodules; wet; 3 inch sand lense at 40 feet.		8	4 3 3	6	100		24	103	PP = 0.35 UC = 0.28			
	41														
-32.00	42														
	43														
-34.00	44														
	45		Fat CLAY (CH); stiff; yellowish brown mottled with grayish brown; moist.		9	5 6 7	13	100				PP = 0.60			
-36.00	46														
	47														
-38.00	48														
	49				10	4 3 4	7			51	71	UC = 0.75			
-40.00	50		Bottom of Borehole at 50.0 ft.												
	51														
-42.00	52														
	53														
-44.00	54														
	55														

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE **BORING RECORD**				HOLE ID **R-11-036**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-7-11**	SHEET **2 of 2**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	10-20-11	10-20-11	37° 35' 18.304" / 122° 21' 27.495" NAD83	R-11-037
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 87' Lt Sta ~ 527+49.78 US101	9 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			D120	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44")			140lb/30in - Auto	93%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING 7.5 ft / AFTER DRILLING (DATE) N/A	TOTAL DEPTH OF BORING
Cement				50.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method / Casing Depth	Remarks
	0	SILTY SAND with GRAVEL (SM); brown; moist to wet; coarse to fine, subangular to subrounded GRAVEL; medium to fine SAND [FILL].											
7.00	2												
5.00	4	CLAYEY SAND with GRAVEL (SC); medium dense; brown and reddish brown; moist; moderately plastic.											
	5		X	1	4 7 8	15	100		18	113			
3.00	6												
	7												
1.00	8		X	2	5 9 14	23	78		16	116			Began rotary wash at 7.5 feet
	9												
-1.00	10		X	3	9 8 7	15	78						
-3.00	12												
	13												
-5.00	14	At EL. -5.0 ft, becomes dense.	X	4	8 13 19	32	100		16	117			
-7.00	16												
	17	Lean CLAY with SAND (CL); stiff; brown and brownish gray with black speckles; moist.											
-9.00	18		X	5	3 4 6	10	100		24	101	UC = 0.81		
	19	At EL. -10.0 ft, with some sandy silt (ML) lenses.	X	6	4 3 4	7	100						
-11.00	20												
	21	At EL. -12.0 ft, becomes medium stiff.	X	7	5 5 6	11	100				PP = 0.38		
-13.00	22												
	23	CLAYEY SAND with GRAVEL (SC); medium dense; brown and brownish gray; moist.											
-15.00	24		X	8	7 9 13	22	100		13	123			
	25												

(continued)

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-037
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-8-11	1 of 2	

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		CLAYEY SAND with GRAVEL (SC) *(continued)*. At EL. -16.0 ft, becomes very dense.		9	42 33 23	56	100		8	135				
-17.00	26														
	27														
-19.00	28														
	29														
-21.00	30		At EL. -21.0 ft, becomes dark gray mottled with reddish brown.		10	10 9 12	21	94		22	106				
	31														
-23.00	32		Lean CLAY (CL); stiff; gray mottled with grayish brown; moist.		11	5 2 4	6	100							
	33														
-25.00	34														
	35		At EL. -26.0 ft, becomes very stiff; brownish gray to reddish brown; some coarse, subrounded GRAVEL, max. 1.5 in. dia..		12	4 5 7	12	100		25	100	UC = 1.05			
-27.00	36														
	37														
-29.00	38														
	39														
-31.00	40		SANDY lean CLAY (CL); very stiff; reddish brown; moist; fine SAND.		13	9 14 17	31	100		20	109	UC = 1.07			
	41														
-33.00	42														
	43														
-35.00	44		CLAYEY GRAVEL with SAND (GC); very dense; reddish brown; moist; subangular to subrounded GRAVEL; medium to fine SAND.												
	45				14	43 31 37	68			11	128				
-37.00	46														
	47														
-39.00	48		Clayey SAND to Lean CLAY (SC/CL); stiff/medium dense, reddish brown mottled with brownish gray; moist; fine sand; some silty sand (SM) lenses.												
	49				15	8 5 8	13			25	100				
-41.00	50		Bottom of Borehole at 50.0 ft.												
	51														
-43.00	52														
	53														
-45.00	54														
	55														

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-037**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-8-11**	SHEET **2 of 2**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	11-4-11	11-4-11	37° 35' 15.438" / 122° 21' 16.264" NAD83	R-11-038
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 89' Lt Sta ~ 537+23.99 US101	11 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			CME 75	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96")			140lb/30in - Auto	71%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING	AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			4.5 ft	N/A	51.5 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	Surficial organic soil; brown to dark brown; moist [FILL].												
8.50	2	Sandy Lean CLAY/Clayey SAND (CL/SC); stiff/medium dense; brown mottled with yellowish brown; moist; fine to medium sand.												
	3			1	9 6 7	13	100		17	111	PP = 0.63			
6.50	4													
	5			2	10 14 12	26	94							
4.50	6	Clayey SAND with Gravel/Clayey GRAVEL with Sand (SC/GC); brown mottled with strong brown; moist; medium dense; fine to coarse sand with subrounded to subangular fine gravel.							12	122				
	7													
2.50	8													
	9													
0.50	10			3	4 9 7	16	89							Began rotary wash at 10 ft
	11	SANDY lean CLAY (CL); stiff to very stiff; brown mottled with yellowish brown; moist; fine SAND; low to medium plasticity fines.							19	109	UC = 0.92 PP = 1.00			
-1.50	12													
	13													
-3.50	14	Lean to fat CLAY (CL/CH); very stiff; yellowish brown mottled with black; moist.												
	15			4	0 5 6	11	100		22		PP = 1.25			Unlined sampler
-5.50	16													
	17													
-7.50	18													
	19													
-9.50	20	SANDY lean CLAY (CL); stiff; brown mottled with reddish brown; moist; fine SAND.		5	2 6 8	14	100		22	105	PP = 0.88 UC = 0.68			
	21													
-11.50	22													
	23													
-13.50	24													
	25													

(continued)

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REPORT TITLE				HOLE ID
BORING RECORD				R-11-038
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-19-11	1 of 2	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		SANDY lean CLAY (CL) *(continued)*.												
-15.50	26														
	27														
-17.50	28														
	29														
-19.50	30				6	6 9 12	21			22	108				
	31		CLAYEY SAND with GRAVEL (SC); medium dense; olive brown mottled with yellowish brown; moist; coarse to fine, subrounded GRAVEL; coarse to fine, subrounded SAND.												
-21.50	32														
	33														
-23.50	34														
	35														
-25.50	36														
	37														
-27.50	38														
	39														
-29.50	40				7	7 18 15	33	100		13	126				
	41		Lean to fat CLAY (CL/CH); very stiff; olive brown mottled with yellowish brown; moist; medium plasticity fines.									PP = 1.25			
-31.50	42														
	43														
-33.50	44														
	45														
-35.50	46														
	47														
-37.50	48														
	49		Poorly graded SAND with SILT (SP-SM); dense; dark yellowish brown; moist; fine SAND.												
-39.50	50				8	8 13 26	39	100		21	105				
	51														
-41.50	52		Bottom of Borehole at 51.5 ft.												
	53														
-43.50	54														
	55														

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

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REPORT TITLE				HOLE ID
BORING RECORD				**R-11-038**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-19-11**	SHEET **2 of 2**	

LOGGED BY	BEGIN DATE	COMPLETION DATE	BOREHOLE LOCATION (Lat/Long or North/East and Datum)	HOLE ID
J. Lopez	11-2-11	11-2-11	37° 35' 19.333" / 122° 21' 44.938" NAD83	R-11-040
DRILLING CONTRACTOR			BOREHOLE LOCATION (Offset, Station, Line)	SURFACE ELEVATION
Taber Drilling			~ 5' Rt Sta ~ 12+42.38 BWY	15 ft NAVD 88
DRILLING METHOD			DRILL RIG	BOREHOLE DIAMETER
Rotary Wash			CME 75	4-7/8 inch
SAMPLER TYPE(S) AND SIZE(S) (ID)			SPT HAMMER TYPE	HAMMER EFFICIENCY, ERi
Modified CA (1.96"), SPT (1.44")			140lb/30in - Auto	71%
BOREHOLE BACKFILL AND COMPLETION			GROUNDWATER READINGS DURING DRILLING / AFTER DRILLING (DATE)	TOTAL DEPTH OF BORING
Cement			11 ft / N/A	50.0 ft

ELEVATION (ft)	DEPTH (ft)	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	0	Asphalt Concrete over Aggregate Base.												
	1													
13.00	2	SANDY lean CLAY with GRAVEL (CL); stiff; dark grayish brown; moist [FILL].		1	21/0.25	REF	6							Sampler advanced 0.25 in.
	3													
11.00	4			2	3 3 2	5	61		11 10					
	5	Fat CLAY (CH); stiff; black; moist; slight organic odor; peat; black.		3	3 3 5	8	100		28	93	PP = 0.5			
9.00	6													
	7													
7.00	8													
	9	Lean CLAY with Sand/Sandy Lean CLAY (CL); stiff; brown; moist; low plasticity fines; fine sand.												
5.00	10			4	4 4 5	9	89		19	97	PP = 0.75			No recovery in first attempt. Sample recovered with a sand catcher.
	11													
3.00	12													
	13													
1.00	14													
	15			5	3 4 7	11	50		22	97	PP = 0.63			
-1.00	16													
	17													
-3.00	18													
	19													
-5.00	20	At EL. -5.0 ft, becomes wet; coarse sand and fine gravel.		6	0 3 4	7	89		20	115				Began rotary wash at 20 ft
	21													
-7.00	22													
	23													
-9.00	24													
	25													

(continued)

URS

San Jose Office

100 W. San Fernando St, Suite 200
San Jose, CA 95113

REPORT TITLE				HOLE ID
BORING RECORD				R-11-040
DIST.	COUNTY	ROUTE	POSTMILE	EA
04	San Mateo	Broadway	16.3/17.1	04-04-235844 (URS
PROJECT OR BRIDGE NAME				
US 101/Broadway Interchange				
BRIDGE NUMBER	PREPARED BY	DATE	SHEET	
	M. Thummaluru	11-19-11	1 of 2	

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

ELEVATION (ft)	DEPTH (ft)	Material Graphics	DESCRIPTION	Sample Location	Sample Number	Blows per 6 in.	Blows per Foot	Recovery (%)	RQD (%)	Moisture Content (%)	Dry Unit Weight (pcf)	Shear Strength (tsf)	Drilling Method	Casing Depth	Remarks
	25		At EL. -10.0 ft, with fine sand with minor coarse sand; fine gravel interbeds. *(continued)*.		7	0 4 5	9	89		19	119				
-11.00	26														
	27														
-13.00	28														
	29														
-15.00	30				8	5 9 15	24	89		18	113	PP = 0.55			
	31														
-17.00	32		Clayey GRAVEL with Sand/Clayey SAND with Gravel (GC/SC); medium dense; brown; moist to wet; coarse sand; fine gravel.												
	33														
-19.00	34														
	35				9	6 8 12	20	0							
-21.00	36														
	37				10	8 9 8	17	28		13					
-23.00	38														
	39														
-25.00	40														
	41														
-27.00	42														
	43														
-29.00	44														
	45		Poorly graded SAND with SILT (SP-SM); dense; olive gray; wet; fine SAND; low plasticity fines.		11	14 22 23	45	89		21	108				
-31.00	46														
	47														
-33.00	48		At EL. -33.0 ft, becomes medium dense.												
	49				12	8 10 15	25	100							
-35.00	50		Bottom of Borehole at 50.0 ft.												
	51														
-37.00	52														
	53														
-39.00	54														
	55														

URS BORING RECORD 200802 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/17/12

URS

San Jose Office

100 W. San Fernando St, Suite 200
San Jose, CA 95113

REPORT TITLE				HOLE ID
BORING RECORD				**R-11-040**
DIST. **04**	COUNTY **San Mateo**	ROUTE **Broadway**	POSTMILE **16.3/17.1**	EA **04-04-235844 (URS**
PROJECT OR BRIDGE NAME **US 101/Broadway Interchange**				
BRIDGE NUMBER	PREPARED BY **M. Thummaluru**	DATE **11-19-11**	SHEET **2 of 2**	

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
04	SM	101	16.3/17.1		

GEOTECHNICAL PROFESSIONAL DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Stephen Huang No. C 42289 Exp. 03/31/12 GEOTECHNICAL STATE OF CALIFORNIA

The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

URS CORPORATION
100 WEST SAN FERNANDO STREET, SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY TRANSPORTATION AUTHORITY
1250 SAN CARLOS AVENUE
SAN CARLOS, CA 94070-1306

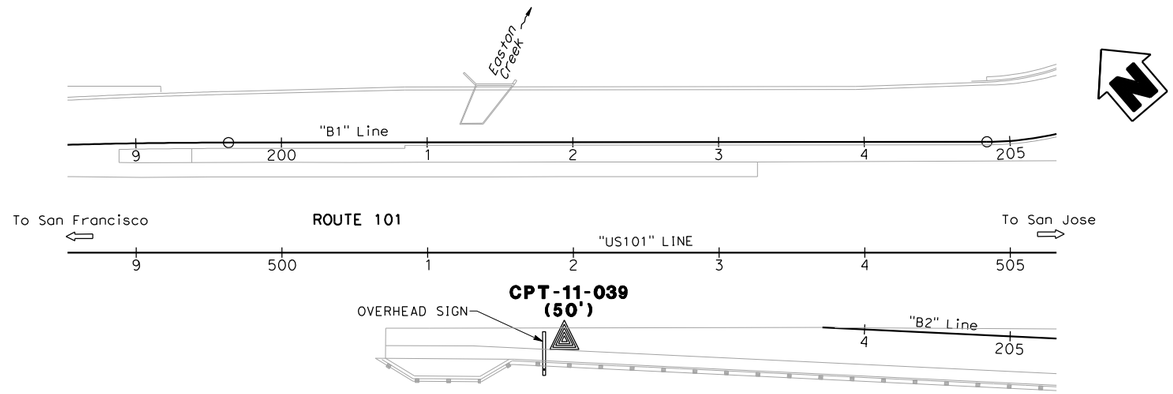
BENCH MARK

All elevations based on vertical datum NAVD88.
All stations and offsets based on horizontal datum NAD83

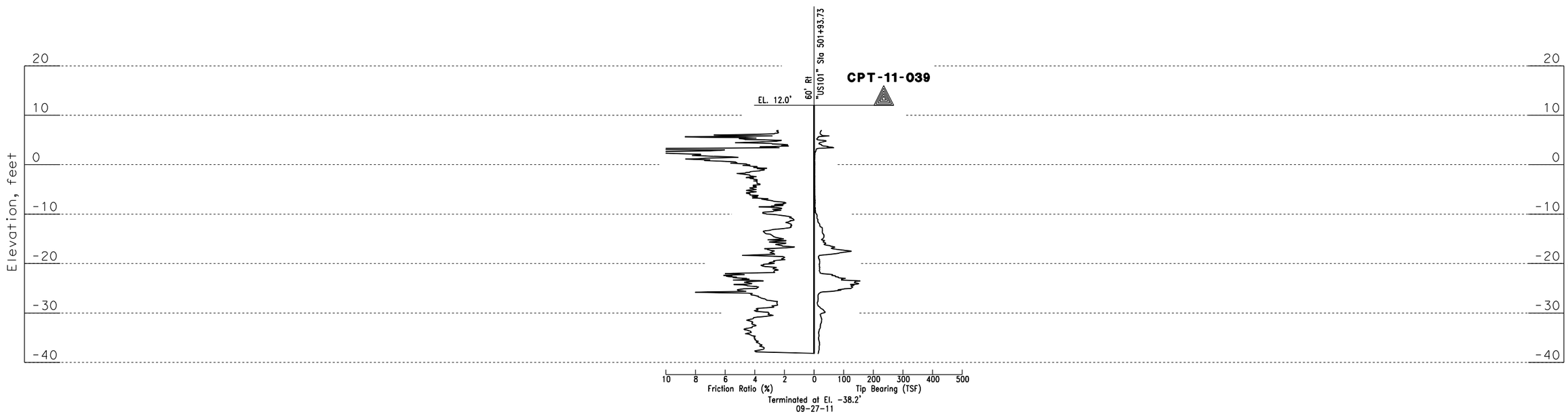
BM No. 1, Monument 501, El 9.35, N2045276.165 E6019489.935
BM No. 2, Monument 1003, El 10.93, N2043769.910 E6021712.494
BM No. 3, Monument 505, El 10.21, N2043140.717 E6021760.224
BM No. 4, Monument 74, El 35.48, N2042621.214 E6022476.873
BM No. 5, Monument 510, El 12.66 N2042355.119 E6022633.562

NOTES

1. This LOTB Sheet was prepared in accordance with the Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).
2. Standard Penetration test sampler I.D. = 1.44 inch (1.4)
   Modified California sampler I.D. = 1.96 inch (2.0)
   Thin-walled Shelby tube sampler I.D. = 2.97 inch (3.0)



PLAN
1" = 50'



PROFILE
Ver. 1" = 10'
Hor. 1" = 25'

"BYSH" LINE
500+00 501+00 502+00 503+00 504+00

DESIGN OVERSIGHT	DRAWN BY	B. VUONG	J. LOPEZ / A. CHEUNG	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	S. HUANG	BRIDGE NO. XX-XXXX
SIGN OFF DATE	CHECKED BY	A. M. MOORE	FIELD INVESTIGATION BY: DATE:		PROJECT ENGINEER	POST MILES X-XX

OVERHEAD SIGN SS2-5
LOG OF TEST BORINGS 1 OF 1

GS GEOTECHNICAL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 0703
PROJECT NUMBER & PHASE: 04000006841 CONTRACT NO.: 04-235844

DISREGARD PRINTS BEARING EARLIER REVISION DATES → 06-14-12

REVISION DATES | SHEET | OF

FILE => LOTB-14.dgn

USERNAME => madhu_thudari UPDATED => 6/26/2012 TIME PLOTTED => 2:38:02 PM

TABLE E-1
SUMMARY OF LABORATORY TEST RESULTS

						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
A-11-021	10/19/2011	196+18.21	B1	Lt. 9	1.0			100	98	96	91	87	83	79	75	57	30		25	5	20		7.4	101
A-11-021	10/19/2011	196+18.21	B1	Lt. 9	2.0-5.0													48						
A-11-022	10/27/2011	30+99.63	BYSH	Lt. 24	1.5																		15.9	101
A-11-023	10/19/2011	205+70.16	B1	Lt. 12	1.0																		27.1	94
A-11-023	10/19/2011	205+70.16	B1	Lt. 12	4.3																	1070	38.1	81
A-11-023	10/19/2011	205+70.16	B1	Lt. 12	5.0																		61.9	60
A-11-024	10/19/2011	207+67.19	B1	Lt. 31	1.0																		13.1	107
A-11-025	10/19/2011	408+07.07	B4	Rt. 1	2.5																		14.4	105
A-11-026	10/19/2011	35+60.43	BYSH	Rt. 62	1.0																		9.5	
A-11-026	10/19/2011	35+60.43	BYSH	Rt. 62	5.0																		14.9	116
A-11-027	10/27/2011	38+21.43	BYSH	Rt. 51	1.0																		7.3	121
A-11-027	10/27/2011	38+21.43	BYSH	Rt. 51	3.0																		7.3	
A-11-028	11/1/2011	25+19.34	BWY	Lt. 3	1.0			99	95	93	90	85	81	78	72	59	46		29	13	16		8.4	108
A-11-028	11/1/2011	25+19.34	BWY	Lt. 3	2.5																		10.6	
A-11-028	11/1/2011	25+19.34	BWY	Lt. 3	2.0 - 5.0													24						
A-11-029	11/4/2011	26+76.5	BWY	Rt. 2	1.3																		6.5	114
A-11-029	11/4/2011	26+76.5	BWY	Rt. 2	2.3																		14.6	
A-11-030	11/1/2011	416+15.25	B4	Lt. 34	1.0																			
A-11-030	11/1/2011	416+15.25	B4	Lt. 34	5.5																	300	99	45
A-11-031	10/27/2011	420+16.28	B4	Lt. 35	1.0																			
A-11-031	10/27/2011	420+16.28	B4	Lt. 35	5.0																	350	101.5	46
A-11-032	10/20/2011	524+62.51	US101	Lt. 91	1.0																		11.5	118
A-11-032	10/20/2011	524+62.51	US101	Lt. 91	5.0																		75.2	
A-11-033	11/1/2011	14+00.47	BWY	Rt. 25	2.5																		17.4	106
A-11-033	11/1/2011	14+00.47	BWY	Rt. 25	4.5																		19.3	109
A-11-034	10/25/2011	318+62.37	B3	Rt. 25	1.0																		10.7	99
A-11-034	10/25/2011	318+62.37	B3	Rt. 25	3.0																		17.1	106
A-11-034	10/25/2011	318+62.37	B3	Rt. 25	5.0																		22.1	102
A-11-035	10/25/2011			Lt.	1.0																		12	111
A-11-035	10/25/2011			Lt.	3.0																		8.6	
A-11-035	10/25/2011			Lt.	5.0																		22.6	
R-11-001	11/2/2011	201+62.50	B1	Lt. 4.5	1.0																		20.6	
R-11-001	11/2/2011	201+62.50	B1	Lt. 4.5	3.5																		21.6	94
R-11-001	11/2/2011	201+62.50	B1	Lt. 4.5	7.5																		56.6	

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Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-001	11/2/2011	201+62.50	B1	Lt. 4.5	10.0																		108.7	40
R-11-001	11/2/2011	201+62.50	B1	Lt. 4.5	15.0																	510	92.2	48
R-11-001	11/2/2011	201+62.50	B1	Lt. 4.5	20.0																	740	20.6	107
R-11-001	11/2/2011	201+62.50	B1	Lt. 4.5	25.0																	7520	18.7	113
R-11-001	11/2/2011	201+62.50	B1	Lt. 4.5	30.0																	3610	20.6	108
R-11-001	11/2/2011	201+62.50	B1	Lt. 4.5	35.0																		18.9	111
R-11-001	11/2/2011	201+62.50	B1	Lt. 4.5	48.5																	2920	21.6	95
R-11-002	10/26/2011	39+26.40	BYSH	Lt. 12.5	6.5														24	22	2			
R-11-002	10/26/2011	39+26.40	BYSH	Lt. 12.5	8.0																		84.3	
R-11-002	10/26/2011	39+26.40	BYSH	Lt. 12.5	15.0																	540	54.8	68
R-11-002	10/26/2011	39+26.40	BYSH	Lt. 12.5	20.0														31	17	14		11.1	132
R-11-002	10/26/2011	39+26.40	BYSH	Lt. 12.5	25.0			100	99	99	90	79	70	63	49	33	15						16.8	116
R-11-002	10/26/2011	39+26.40	BYSH	Lt. 12.5	30.0																		25.2	101
R-11-002	10/26/2011	39+26.40	BYSH	Lt. 12.5	38.5																	1760	13.8	121
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	5																	370	115.2	41
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	10																	270	96.2	47
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	12			92	85	80	64	49	39	31	24	17	12		30	18	12		14.1	116
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	16																		18.9	114
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	16.5			100	92	86	73	57	45	34	25	18	14		32	17	15			
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	18																		11.9	126
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	26			100	97	95	83	72	63	53	41	28	19						17.9	117
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	40																	2300	28.6	95
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	46																		14.8	
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	50																		18.8	111
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	70																	6110	24.4	101
R-11-003	10/7/2011	22+12.05	BWY	Rt. 4	75																	3070	37.8	80
R-11-004	10/27/2011	52+44.03	HTL	Rt. 47	5																		154.0	33
R-11-004	10/27/2011	52+44.03	HTL	Rt. 47	10																	480	88.0	51
R-11-004	10/27/2011	52+44.03	HTL	Rt. 47	15																		14.9	122
R-11-004	10/27/2011	52+44.03	HTL	Rt. 47	20			100	98	97	92	81	74	67	58	49	31		27	15	12	2860	16.6	117
R-11-004	10/27/2011	52+44.03	HTL	Rt. 47	25														30	15	15		16.3	116
R-11-004	10/27/2011	52+44.03	HTL	Rt. 47	35																		24.8	
R-11-004	10/27/2011	52+44.03	HTL	Rt. 47	38.5																	3490	20.1	108
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	5														26	14	12			

TABLE E-1
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						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	10														81	30	51	1333	83.0	50
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	15																	947	31.8	87
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	20.5																	1410	32.7	85
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	25																	2620	24.4	101
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	36																	5350	14.4	122
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	37																	5920	23.2	103
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	40																	2910	38.1	83
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	45																		22.0	105
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	50																	1940	37.2	84
R-11-005	9/29/2011	208+21.10	B2	Rt. 7	60																	2520	45.9	76
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	8.8																		64.7	
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	15																	1500	37.8	82
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	16.5														39	16	23	2203	26.9	95
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	20																	3200	27.6	96
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	25																	3660	26.5	99
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	30																		17.0	116
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	40																		19.0	110
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	50																	1670	43.6	77
R-11-006	9/28/2011	209+47.19	B2	Rt. 6	58.5																	1370	56.9	66
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	5																	2200	13.8	124
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	7.5																	750	47.2	73
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	13.5														74	28	46	430	71.9	57
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	17.5																	3730	27.2	97
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	20																	3440	24.4	100
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	25																	2630	27.3	97
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	31																	530	20.1	110
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	32																			
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	32.3																	1250	20.0	111
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	35																	1160	15.2	115
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	40																	1840	25.7	98
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	46																	2400	30.4	92
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	55																	1340	45.8	75
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	60																		18.0	112
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	65																		16.8	115

TABLE E-1
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						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-007	10/16/2011	210+19.87	B2	Rt. 27	78.5																	4370	27.3	103
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	5												25		25	13	12			
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	7.5																		13.2	123
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	10																	1580	75.5	54
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	15																	2780	30.2	93
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	20																	4810	26.3	101
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	25																	3060	19.1	111
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	30																	2590		
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	36			100	98	96	90	75	65	56	47	38	31		33	17	16		16.1	117
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	45																	1740	58.3	65
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	50																	5520	18.9	113
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	55																		21.7	106
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	60																		16.1	118
R-11-008	10/17/2011	211+45.37	B2	Lt. 4	65																	2400	25.4	98
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	5												45		25	22	3	3130	17.5	100
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	10																	1360	73.6	56
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	18																	1941	20.7	106
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	25																	1140	25.0	103
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	30														30	16	14	1280	26.5	100
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	35																	3980	17.3	117
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	41.5			93	87	83	71	61	53	47	39	30	22							
R-11-010	9/27/2011	15+60.57	BWY	Lt. 58	50																	850	16.5	123
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	6.1																	580	69.3	
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	6.3																			
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	8														109	42	67	555	86.7	48
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	10																	350	94.2	47
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	20																	4670	22.9	105
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	30																	7090	21.1	97
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	35																	2080	46.2	75
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	41.5			100	95	92	79	71	63	55	44	32	23		22	17	5			
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	45			96	92	90	82	70	61	55	48	40	33		34	16	18			
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	55																	2010	25.7	100
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	60																		9.3	133
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	75																	4750	13.8	125
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	80																	4590	24.1	102
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	85																	6010	18.6	113
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	91																		16.8	113
R-11-011	10/6/2011	20+08.70	BWY	Lt. 64	95																	7150	18.5	112
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	2			90	86	84	61	52	46	41	36	29	20		23	17	6		13.3	120
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	4.5																		6.6	127
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	9.5																	600	23.0	103

TABLE E-1
SUMMARY OF LABORATORY TEST RESULTS

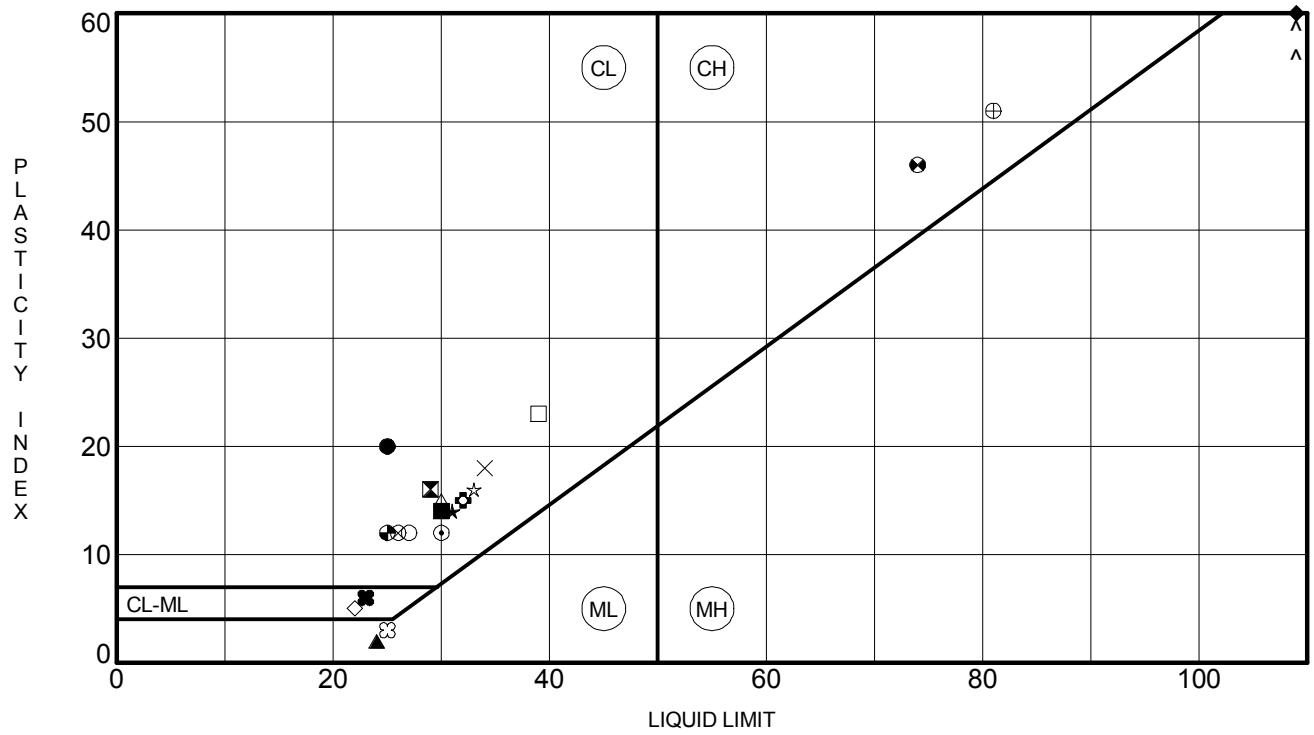
						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	11														92	37	55	985	77.3	51
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	15																	880	80.1	53
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	22			100	97	96	81	68	57	47	37	29	22		29	16	13			
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	25																		15.3	122
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	31																	5250	21.7	106
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	35																	5690	27.8	96
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	45																		16.1	115
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	50																		16.0	117
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	55																	2480	30.5	92
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	60																		23.6	104
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	70																	3560	41.1	80
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	75																	9750	18.4	114
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	81																		22.8	104
R-11-013	10/24/2011	514+12.61	US101	Lt. 1	98.5																	4070	26.2	99
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	5																		21.7	
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	8.7																	320	64.0	62
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	15																		22.3	104
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	18.5														58	20	38	1730	35.9	86
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	23.5																	3170	26.7	97
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	25														40	17	23	2166	22.3	103
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	30																	770	20.8	109
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	40																	2760	21.5	106
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	45																	7280	23.7	103
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	50																	2640	30.6	92
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	55																		11.2	128
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	61.2																	3570	24.3	101
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	65																	5050	31.1	92
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	70																	4990	15.5	118
R-11-014	10/18/2011	17+85.71	BWY	Lt. 4	91																		18.1	113
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	5																	490	87.0	49
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	10																	400	95.8	47
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	13.5																	3421	18.8	110
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	15														31	15	16			
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	16.2																		13.5	122
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	25																	1910	28.0	96
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	35																	2750	30.4	93
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	40			100	99	98	87	69	59	51	42	38	21		21	17	4		13.1	124
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	51																		20.9	107
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	55																		10.2	
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	61.5														47	17	30	2648	32.4	86
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	65																	5820	16.3	116
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	70																		11.2	
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	75																		16.4	116
R-11-015	10/3/2011	16+65.50	BWY	Rt. 67	80																	7550	17.5	114
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	5																	1110	67.6	59
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	10																	580	97.2	46

TABLE E-1
SUMMARY OF LABORATORY TEST RESULTS

						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	13.5																		24.0	
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	15														35	17	18	2080	22.5	105
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	20																		18.5	112
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	25																	1630	21.3	106
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	30																	3400	20.9	106
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	35																		18.2	112
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	45																	3250	28.4	96
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	46.5														37	17	20	3881	25.4	100
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	51																		11.1	124
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	60																	5110	21.2	106
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	65																	10320	15.8	116
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	76																	8280	16.0	116
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	85																	7310	19.8	111
R-11-017	10/4/2011	315+67.55	B3	Rt. 39	95																	13270	14.7	118
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	5																		8.4	128
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	10																	980	89.2	49
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	13.8																		26.0	
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	15																	2530	19.2	111
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	20																	4170	18.3	113
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	30																		12.8	124
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	35																	2930	16.7	116
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	40																	4960	23.5	103
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	50																	2090	27.1	97
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	70																	4690	16.7	122
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	75																	9120	18.0	114
R-11-018	10/5/2011	316+81.69	B3	Rt. 38	80																	5640	16.3	115
R-11-020	11/4/2011	28+09.56	RLN	Lt. 46	3								99	99	97	87	53		28	20	8			
R-11-020	11/4/2011	28+09.56	RLN	Lt. 46	5																		22.4	97
R-11-020	11/4/2011	28+09.56	RLN	Lt. 46	8.8																		46.2	71
R-11-020	11/4/2011	28+09.56	RLN	Lt. 46	10																	1720	65.9	52
R-11-020	11/4/2011	28+09.56	RLN	Lt. 46	15																		23.8	
R-11-020	11/4/2011	28+09.56	RLN	Lt. 46	16																			
R-11-020	11/4/2011	28+09.56	RLN	Lt. 46	30																	1890	29.7	93
R-11-020	11/4/2011	28+09.56	RLN	Lt. 46	40																	1470	38.6	81
R-11-036	10/20/2011	191+70.93	B1	Lt. 15	10																	690	80.9	53
R-11-036	10/20/2011	191+70.93	B1	Lt. 15	15																	500	69.8	58
R-11-036	10/20/2011	191+70.93	B1	Lt. 15	20																	370	76.9	56
R-11-036	10/20/2011	191+70.93	B1	Lt. 15	25																	260	81.2	51
R-11-036	10/20/2011	191+70.93	B1	Lt. 15	30																	370	71.8	56
R-11-036	10/20/2011	191+70.93	B1	Lt. 15	35																		20.4	105
R-11-036	10/20/2011	191+70.93	B1	Lt. 15	36																	550	31.6	89
R-11-036	10/20/2011	191+70.93	B1	Lt. 15	40																	1120	23.7	103
R-11-036	10/20/2011	191+70.93	B1	Lt. 15	48.5																	3010	50.9	71
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	5																		17.7	113
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	7.5																		16.4	116
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	13.5																		15.6	117

TABLE E-1
SUMMARY OF LABORATORY TEST RESULTS

						Sieve Analysis Results (Percent Passing)													Atterberg Limits				In-Place Conditions	
Boring or Sample No.	Date Sampled	Station	Line	Distance from Line (feet)	Depth (feet)	%<1.5-in	%<1-in	%<3/4-in	%<1/2-in	%<3/8-in	%<#4	%<#8	%<#16	%<#30	%<#50	%<#100	%<#200	R-value	Liquid Limit	Plastic Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Water Content (%)	Dry Unit Weight (pcf)
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	17.5																	3230	24.1	101
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	23.5																		13.2	123
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	25																		8.2	135
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	30																		22.4	106
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	35																	4190	25.0	100
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	40																	4290	19.6	109
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	45																		10.8	128
R-11-037	10/20/2011	527+49.78	US101	Lt. 87	48.5																		24.5	100
R-11-038	11/4/2011	537+23.99	US101	Lt. 89	3																		17.5	111
R-11-038	11/4/2011	537+23.99	US101	Lt. 89	6																		12.4	122
R-11-038	11/4/2011	537+23.99	US101	Lt. 89	11																	3660	19.0	109
R-11-038	11/4/2011	537+23.99	US101	Lt. 89	15																		22.1	
R-11-038	11/4/2011	537+23.99	US101	Lt. 89	20																	2720	22.2	105
R-11-038	11/4/2011	537+23.99	US101	Lt. 89	31																		21.7	108
R-11-038	11/4/2011	537+23.99	US101	Lt. 89	40																		12.9	126
R-11-038	11/4/2011	537+23.99	US101	Lt. 89	50																		21.4	105
R-11-040	11/2/2011	12+42.38	BWY	Rt. 5	3.5																		11.4	
R-11-040	11/2/2011	12+42.38	BWY	Rt. 5	4.5																		10.2	
R-11-040	11/2/2011	12+42.38	BWY	Rt. 5	5																	2740	28.5	93
R-11-040	11/2/2011	12+42.38	BWY	Rt. 5	10																		19.5	97
R-11-040	11/2/2011	12+42.38	BWY	Rt. 5	15																		21.7	97
R-11-040	11/2/2011	12+42.38	BWY	Rt. 5	20																		19.5	115
R-11-040	11/2/2011	12+42.38	BWY	Rt. 5	25																		18.7	119
R-11-040	11/2/2011	12+42.38	BWY	Rt. 5	30																		17.7	113
R-11-040	11/2/2011	12+42.38	BWY	Rt. 5	36.5																		13.4	
R-11-040	11/2/2011	12+42.38	BWY	Rt. 5	45																		20.8	108



	Sample Identification/Depth (ft)		LL	PL	PI	Fines	Classification
●	A-11-021	1.0	25	5	20	30	CLAYEY SAND (SC) ()
⧗	A-11-028	1.0	29	13	16	46	CLAYEY SAND (SC) ()
▲	R-11-002	6.5	24	22	2		SILT to Sandy SILT (ML)
★	R-11-002	20.0	31	17	14		CLAYEY SAND with GRAVEL (SC)
⊙	R-11-003	12.0	30	18	12	12	WELL-GRADED SAND with CLAY and GRAVEL (SW-SC) (
✿	R-11-003	16.5	32	17	15	14	CLAYEY SAND with GRAVEL (SC) ()
○	R-11-004	20.0	27	15	12	31	CLAYEY SAND (SC) ()
△	R-11-004	25.0	30	15	15		()
⊗	R-11-005	5.0	26	14	12		CLAYEY SAND with GRAVEL (SC)
⊕	R-11-005	10.0	81	30	51		ORGANIC fat CLAY (CH)
□	R-11-006	16.5	39	16	23		Lean CLAY (CL)
⊛	R-11-007	13.5	74	28	46		ORGANIC fat CLAY (CH)
◕	R-11-008	5.0	25	13	12	25	CLAYEY SAND (SC)
☆	R-11-008	36.0	33	17	16	31	CLAYEY SAND (SC)
☒	R-11-010	5.0	25	22	3	45	SILTY SAND (SM)
■	R-11-010	30.0	30	16	14		Lean CLAY (CL)
◆	R-11-011	8.0	109	42	67		ORGANIC fat CLAY (CH)
◇	R-11-011	41.5	22	17	5	23	SILTY, CLAYEY SAND with GRAVEL (SC-SM) ()
╳	R-11-011	45.0	34	16	18	33	CLAYEY SAND with GRAVEL (SC) ()
✖	R-11-013	2.0	23	17	6	20	SILTY, CLAYEY SAND with GRAVEL (SC-SM) ()

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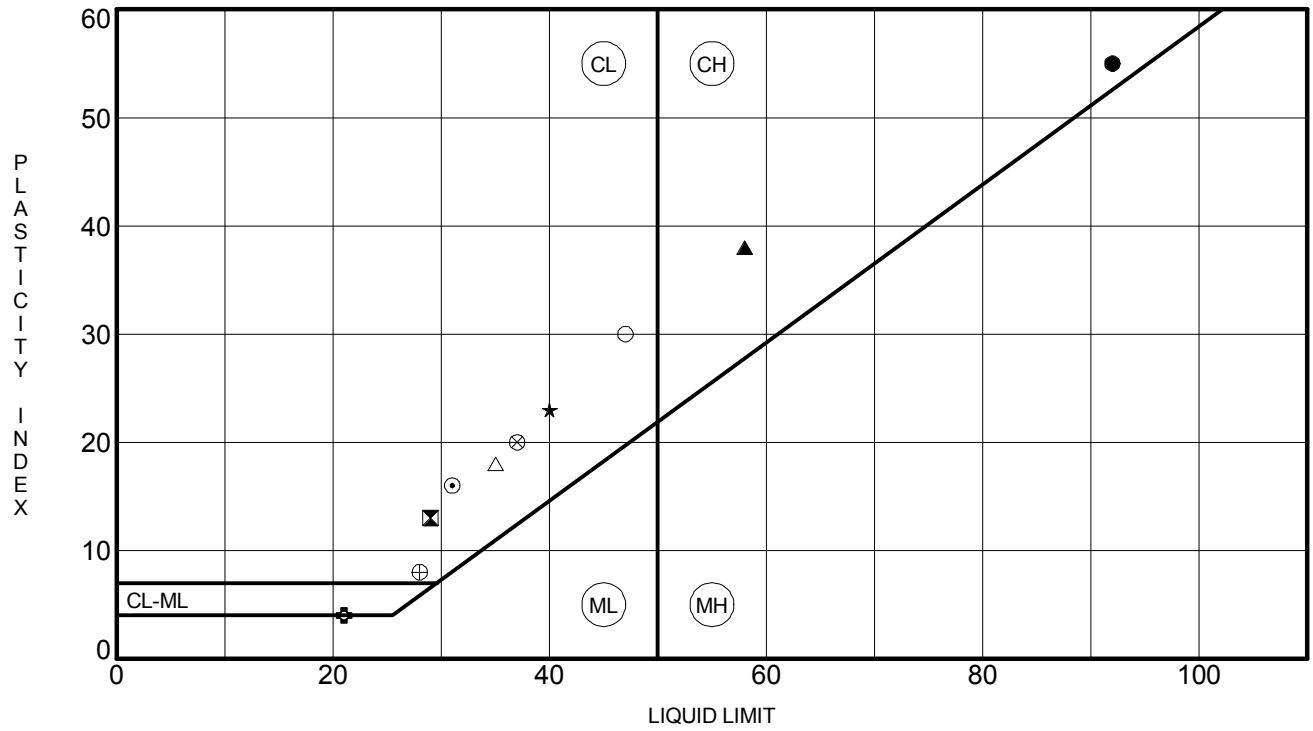
San Jose, CA 95113

ATTERBERG LIMITS RESULTS

Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS ATTERBERG LIMITS 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/2/12



	Sample Identification/Depth (ft)		LL	PL	PI	Fines	Classification
●	**R-11-013**	**11.0**	**92**	**37**	**55**		**ORGANIC fat CLAY (CH)**
⊠	**R-11-013**	**22.0**	**29**	**16**	**13**	**22**	**CLAYEY SAND with GRAVEL (SC) ()**
▲	**R-11-014**	**18.5**	**58**	**20**	**38**		**Fat CLAY (CH)**
★	**R-11-014**	**25.0**	**40**	**17**	**23**		**Lean CLAY (CL)**
⊙	**R-11-015**	**15.0**	**31**	**15**	**16**		**CLAYEY SAND with GRAVEL (SC)**
✿	**R-11-015**	**40.0**	**21**	**17**	**4**	**21**	**SILTY, CLAYEY SAND (SC-SM)**
○	**R-11-015**	**61.5**	**47**	**17**	**30**		**Lean to fat CLAY (CL/CH)**
△	**R-11-017**	**15.0**	**35**	**17**	**18**		**Lean CLAY (CL)**
⊗	**R-11-017**	**46.5**	**37**	**17**	**20**		**Lean CLAY (CL)**
⊕	**R-11-020**	**3.0**	**28**	**20**	**8**	**53**	**SANDY LEAN CLAY (CL) ()**

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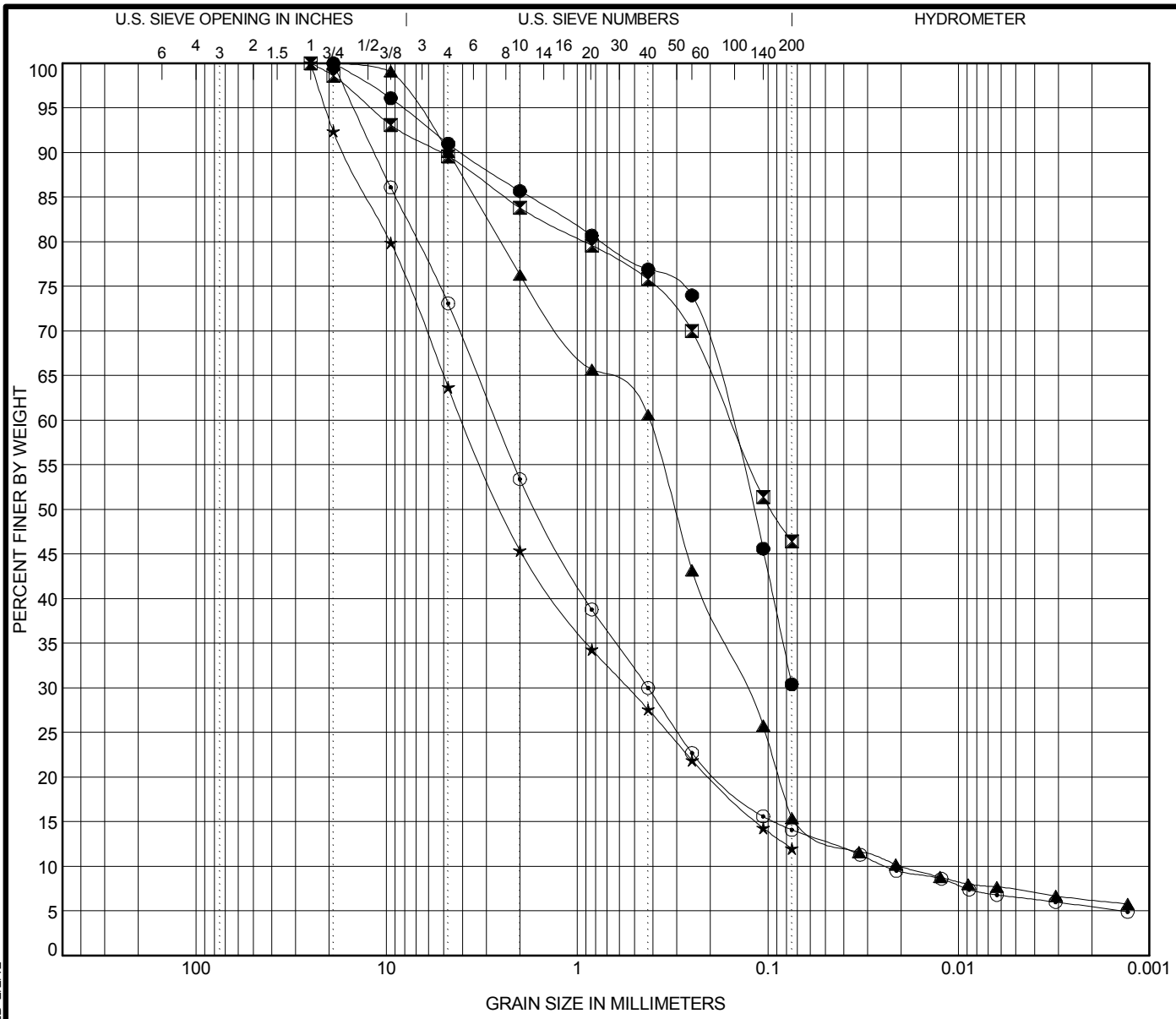
ATTERBERG LIMITS RESULTS

Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS ATTERBERG LIMITS 28645286-BROADWAY INTERCHANGE RECONSTRUCTION_SM.GPJ SNJ_CT.GLB 2/2/12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Identification/Depth (ft)		Classification	LL	PL	PI	Cc	Cu
●	A-11-021	1.0	CLAYEY SAND (SC)	25	5	20		
⊠	A-11-028	1.0	CLAYEY SAND (SC)	29	13	16		
▲	R-11-002	25.0					2.06	21.14
★	R-11-003	12.0	WELL-GRADED SAND with CLAY and GRAVEL (SW-SC)	30	18	12	1.33	71.83
⊙	R-11-003	16.5	CLAYEY SAND with GRAVEL (SC)	32	17	15	2.82	111.66

	Sample Identification/Depth (ft)		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	A-11-021	1.0	19	0.164			9.0	60.6	30.4	
⊠	A-11-028	1.0	25	0.158			10.4	43.2	46.4	
▲	R-11-002	25.0	19	0.417	0.13	0.02	9.9	74.7	8.0	7.4
★	R-11-003	12.0	25	3.988	0.542		36.3	51.7	12.0	
⊙	R-11-003	16.5	19	2.672	0.425	0.024	26.9	59.0	7.6	6.5

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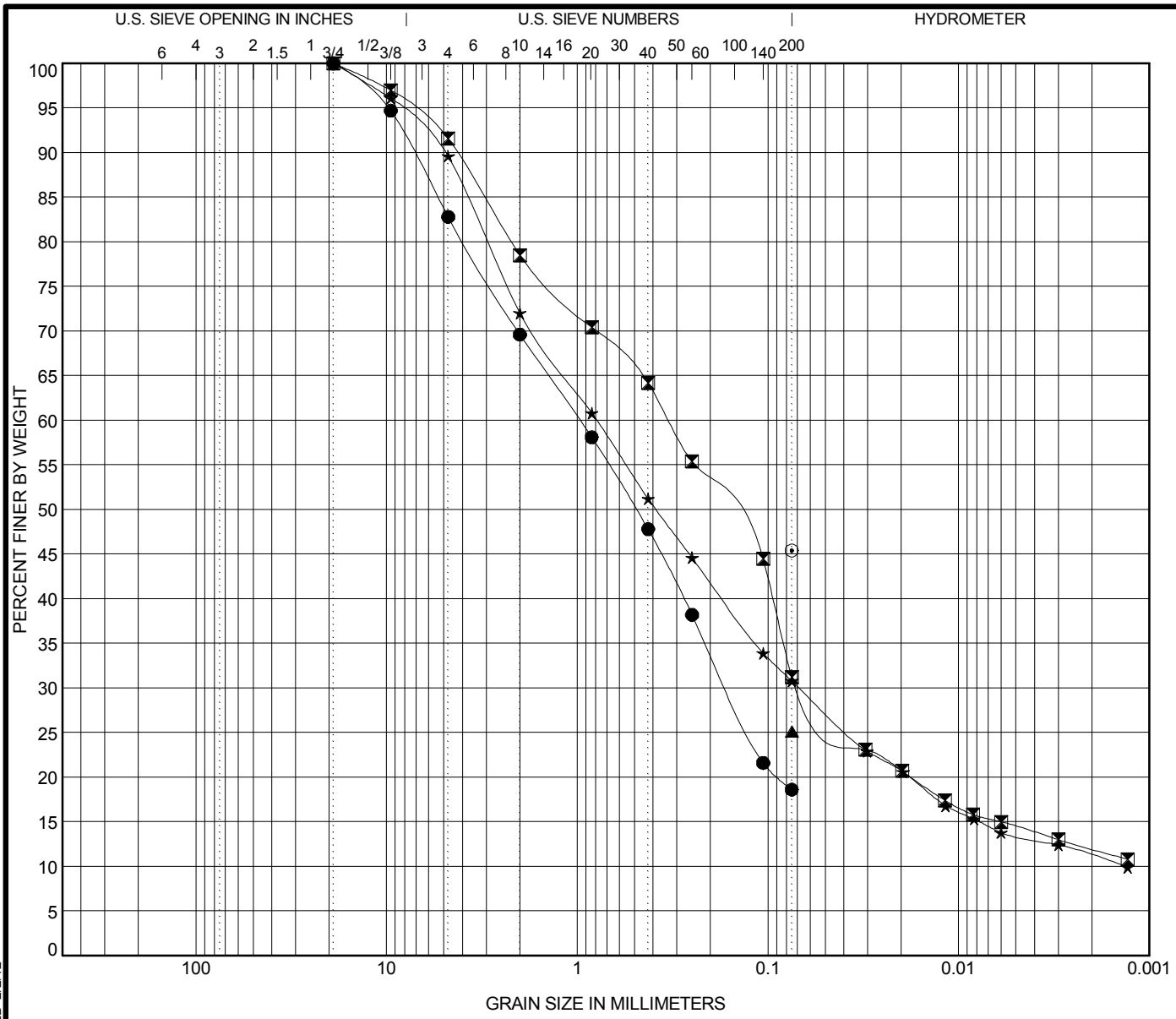
San Jose Office

100 W. San Fernando, Ste 200
San Jose, CA 95113

GRAIN SIZE DISTRIBUTION

Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS GRAIN SIZE 28645286-BROADWAY INTERCHANGE RECONSTRUCTION SM.GPJ SNJ_CT.GLB 2/2/12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Identification/Depth (ft)		Classification	LL	PL	PI	Cc	Cu
●	R-11-003	26.0						
⊠	R-11-004	20.0	CLAYEY SAND (SC)	27	15	12		
▲	R-11-008	5.0	CLAYEY SAND	25	13	12		
★	R-11-008	36.0	CLAYEY SAND	33	17	16	4.39	590.41
⊙	R-11-010	5.0	SILTY SAND	25	22	3		

	Sample Identification/Depth (ft)		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-11-003	26.0	19	0.969	0.164		17.2	64.2	18.6	
⊠	R-11-004	20.0	19	0.33	0.066		8.4	60.4	16.7	14.5
▲	R-11-008	5.0	0.075						25.1	
★	R-11-008	36.0	19	0.794	0.068	0.001	10.4	58.8	17.4	13.4
⊙	R-11-010	5.0	0.075						45.4	

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GRAIN SIZE DISTRIBUTION

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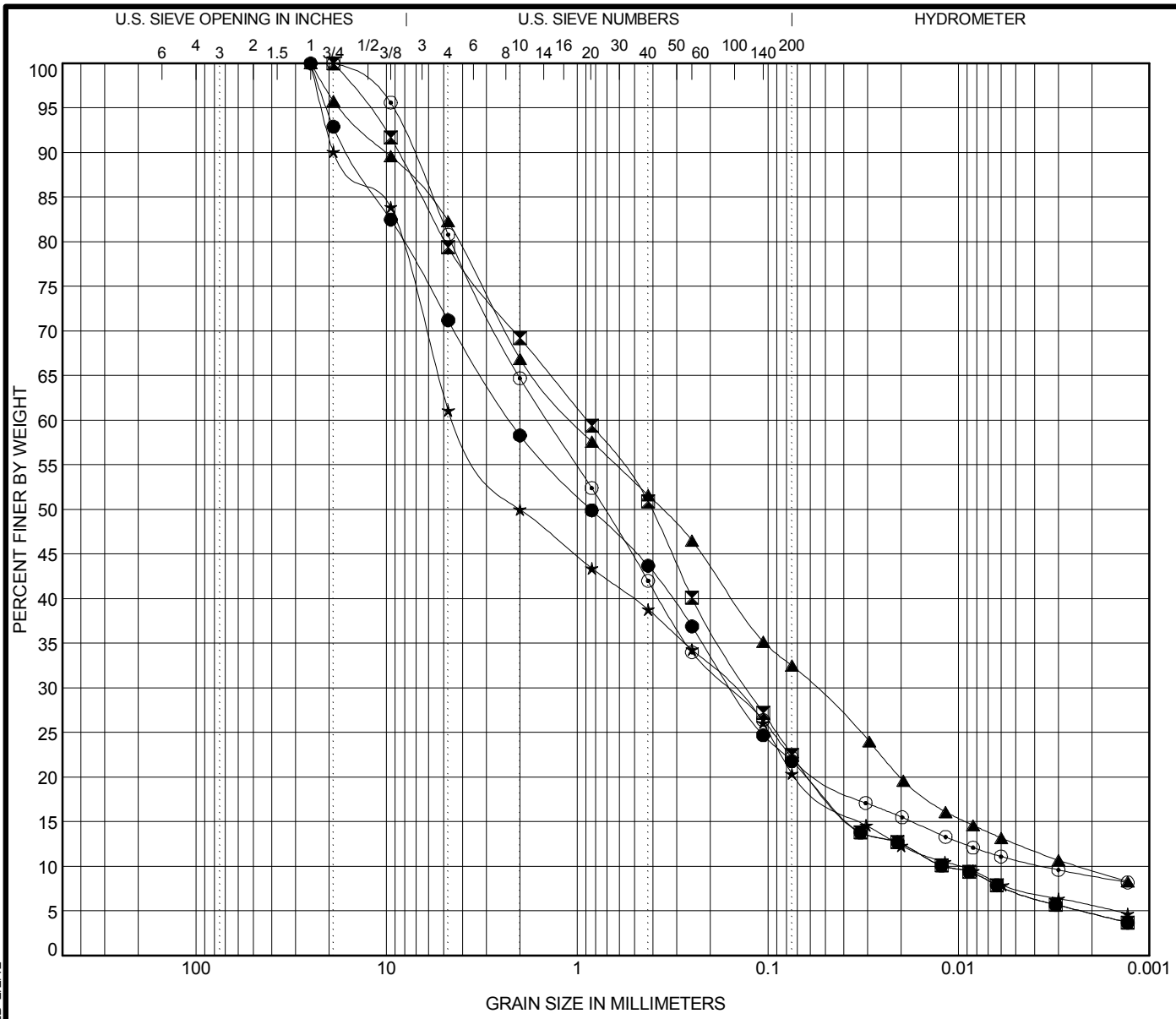
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS GRAIN SIZE 28645286-BROADWAY INTERCHANGE RECONSTRUCTION SM.GPJ SNJ_CT.GLB 2/2/12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Identification/Depth (ft)		Classification	LL	PL	PI	Cc	Cu
●	R-11-010	41.5	CLAYEY SAND with GRAVEL				0.90	191.16
⊠	R-11-011	41.5	SILTY, CLAYEY SAND with GRAVEL (SC-SM)	22	17	5	1.57	75.55
▲	R-11-011	45.0	CLAYEY SAND with GRAVEL (SC)	34	16	18	1.31	447.00
★	R-11-013	2.0	SILTY, CLAYEY SAND with GRAVEL (SC-SM)	23	17	6	0.59	437.91
⊙	R-11-013	22.0	CLAYEY SAND with GRAVEL (SC)	29	16	13	4.89	397.81

	Sample Identification/Depth (ft)		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	R-11-010	41.5	25	2.241	0.154	0.012	28.8	49.4	14.6	7.2
⊠	R-11-011	41.5	19	0.886	0.128	0.012	20.6	56.9	15.3	7.2
▲	R-11-011	45.0	25	1.051	0.057	0.002	17.7	49.8	20.0	12.5
★	R-11-013	2.0	25	4.36	0.159	0.01	38.9	40.7	12.9	7.5
⊙	R-11-013	22.0	19	1.436	0.159	0.004	19.2	58.6	11.5	10.7

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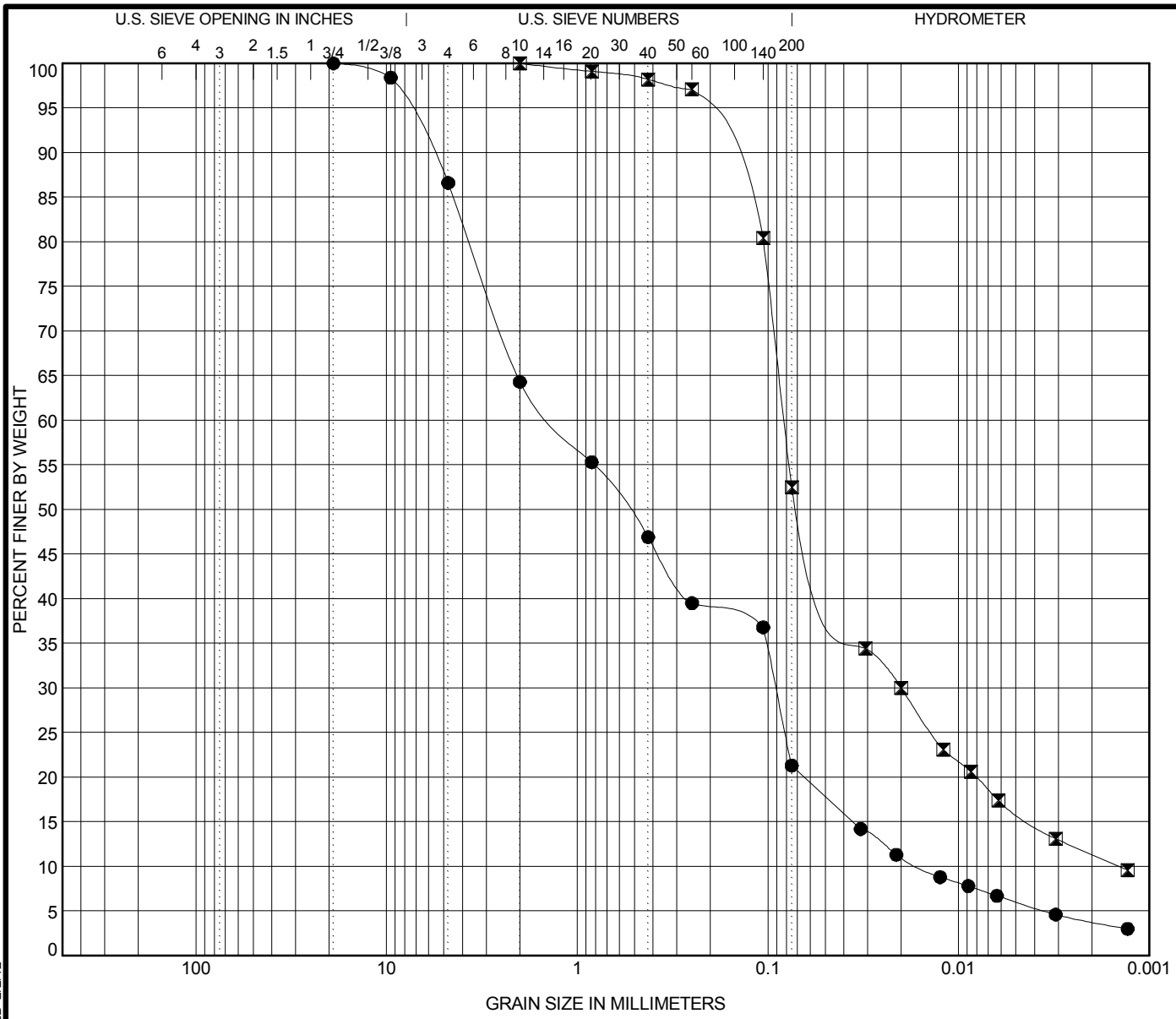
GRAIN SIZE DISTRIBUTION

Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS GRAIN SIZE 28645286-BROADWAY INTERCHANGE RECONSTRUCTION SM.GPJ SNJ_CT.GLB 2/2/12



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample Identification/Depth (ft)		Classification	LL	PL	PI	Cc	Cu
●	**R-11-015**	**40.0**	**SILTY, CLAYEY SAND**	**21**	**17**	**4**	**0.39**	**82.03**
⧗	**R-11-020**	**3.0**	**SANDY LEAN CLAY (CL)**	**28**	**20**	**8**	**3.38**	**57.33**

	Sample Identification/Depth (ft)		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**R-11-015**	**40.0**	**19**	**1.321**	**0.091**	**0.016**	**13.4**	**65.3**	**15.3**	**6.0**
⧗	**R-11-020**	**3.0**	**2**	**0.082**	**0.02**	**0.001**	**0.0**	**47.5**	**36.4**	**16.1**

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GRAIN SIZE DISTRIBUTION

Project Name: US 101/Broadway Interchange
Location: San Mateo Broadway 16.3/17.1
Number: 04-235844 (URS 28645286)

URS GRAIN SIZE 28645286-BROADWAY INTERCHANGE RECONSTRUCTION SM.GPJ SNJ_CT.GLB 2/2/12

Project No.: 28645286.02

Project: Broadway / I-101 Interchange

Date: January 10, 2012

Unconfined Compressive Strength of Lime Treated Soil
CTM 373 (Modified)

Description: Baymud remolded w/ high calcium lime

Source of Admixture: Griffin Soil Stabilization, Pleasanton

As-received moisture of Baymud 56%
Percent of Admix - based on the wet weight of soil
Height/Diameter Ratio - Approx. 1:1
Test Age: 7 days

Remolding and Strength Test Summary					
Admix. Increments	3 + 3 %	5 + 4 %	9%	7 + 5 %	9 + 6 %
Final % of Admix	6%	9%	9%	12%	15%
Compaction Pressure (psi)	60	105	70	130	270
Unconfined Compressive Strength (psf)					
Specimen A	5277	8878	6508	12588	16003
Specimen B	6327	10130	7227	12727	17263
Average of 2 specimens	**5802**	**9504**	**6868**	**12658**	**16633**

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Broadway Interchange
Job No. : 28645286.02
Boring # : A-11-030/ A-11-031
Sample # : A 3% + 3
Depth (ft) : 3-5
Date tested : 01/05/12
Soil (Visual Description) : Dark olive gray fat clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

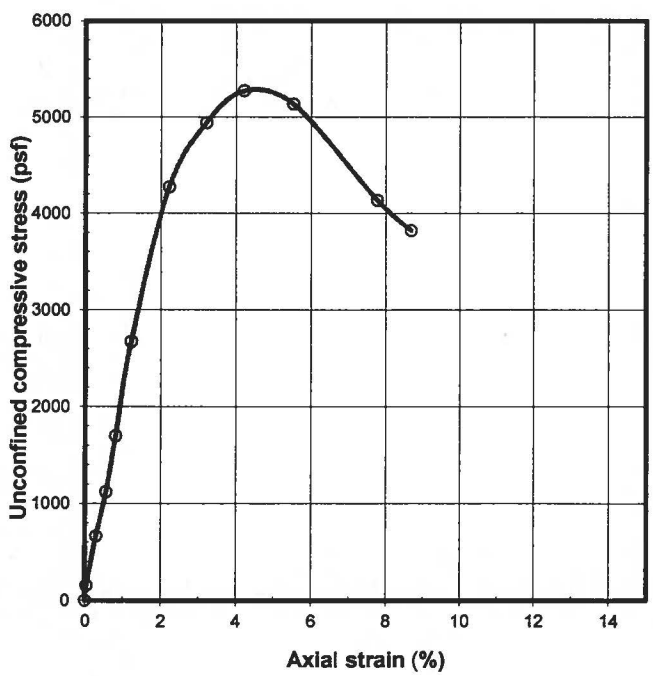
Specimen:

Total wt.	=	1445.9	gms
Ht.	=	4.04	in
Ave dia.	=	4.009	in
Area	=	12.626	sq.in
Volume	=	835.1	c.c.
Shearing rate	=	0.03	inch/min
Shearing rate	=	1.25	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	1.204	
Ht/Dia ratio	=	1.01	
Moisture	=	41.3	%
Total density	=	108.0	pcf
Dry density	=	76.5	pcf
Saturation	=	92.7	%
Unconfined compressive strength	=	5277	psf
Shear strength	=	2639	psf
Strain @ failure	=	4.21	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.002	13.7	0.04	156.5
0.012	58.5	0.29	664.8
0.022	98.9	0.55	1122.2
0.033	150.2	0.81	1699.2
0.049	237.1	1.21	2672.0
0.089	383.4	2.21	4276.3
0.129	447.9	3.21	4944.7
0.170	483.1	4.21	5277.4
0.223	476.8	5.52	5137.6
0.313	393.3	7.77	4137.6
0.350	367.1	8.68	3823.5



(see worksheet for sketch of failure)

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Broadway Interchange
Job No. : 28645286.02
Boring # : A-11-030/ A-11-031
Sample # : B 3% + 3
Depth (ft) : 3-5
Date tested : 01/05/12
Soil (Visual Description) : Dark olive gray fat clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

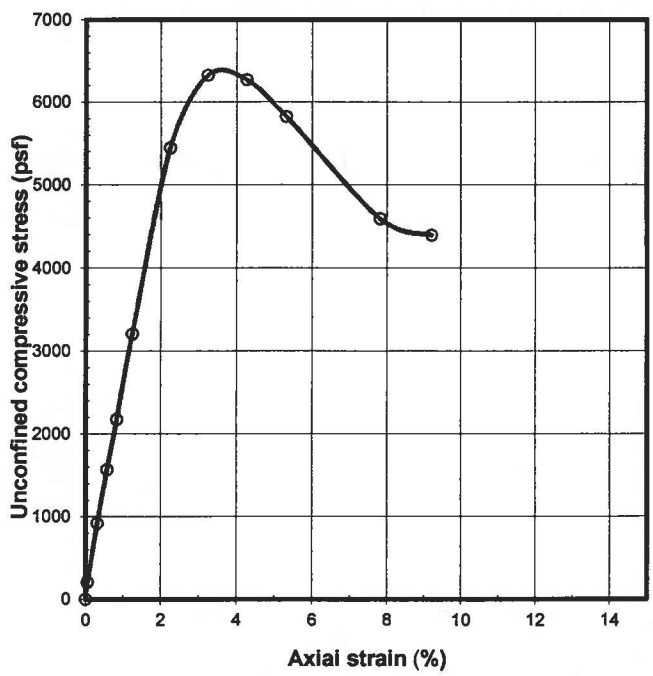
Specimen:

Total wt. =	1420.4	gms	
Ht. =	4.00	in	
Ave dia. =	4.010	in	
Area =	12.636	sq.in	
Volume =	827.9	c.c.	
Shearing rate =	0.03	inch/min	
Shearing rate =	1.25	%/min	
Gs (assumed) =	2.70		

Test Report:

Void ratio =	1.222	
Ht/Dia ratio =	1.00	
Moisture =	41.2	%
Total density =	107.1	pcf
Dry density =	75.8	pcf
Saturation =	91.0	%
Unconfined compressive strength =	6327	psf
Shear strength =	3163	psf
Strain @ failure =	3.24	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.002	18.3	0.05	208.3
0.012	80.8	0.31	917.7
0.023	138.8	0.57	1572.2
0.033	192.4	0.83	2174.8
0.050	285.0	1.24	3206.9
0.090	488.7	2.24	5443.6
0.130	573.8	3.24	6326.6
0.170	574.8	4.26	6271.3
0.212	539.6	5.31	5822.7
0.312	437.2	7.81	4592.7
0.368	424.8	9.20	4394.8



(see worksheet for sketch of failure)

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Broadway Interchange
Job No. : 28645286.02
Boring # : A-11-030/ A-11-031
Sample # : A 5% + 4
Depth (ft) : 3-5
Date tested : 01/05/12
Soil (Visual Description) : Dark olive gray fat clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

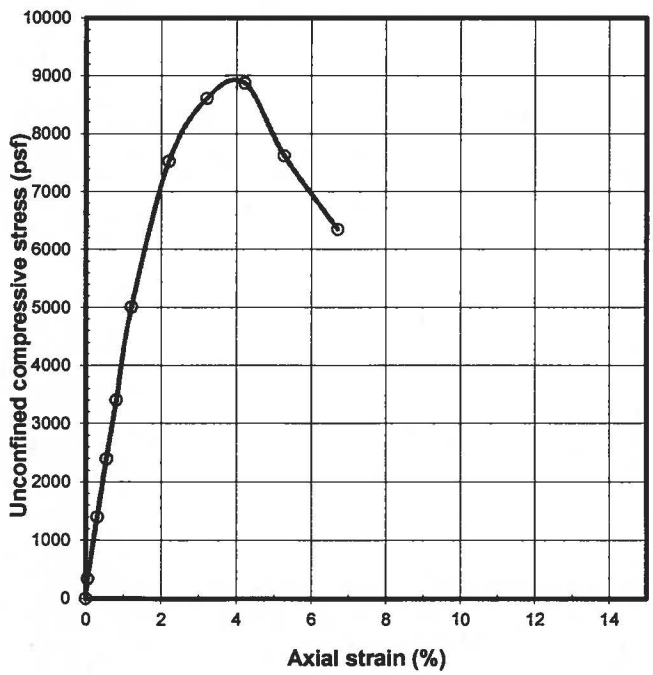
Specimen:

Total wt.	=	1439.3	gms
Ht.	=	3.96	in
Ave dia.	=	4.003	in
Area	=	12.592	sq.in
Volume	=	816.5	c.c.
Shearing rate	=	0.03	inch/min
Shearing rate	=	1.25	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	1.112	
Ht/Dia ratio	=	0.99	
Moisture	=	37.9	%
Total density	=	110.0	pcf
Dry density	=	79.8	pcf
Saturation	=	92.0	%
Unconfined compressive strength	=	8878	psf
Shear strength	=	4439	psf
Strain @ failure	=	4.21	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.002	29.7	0.05	339.4
0.012	122.9	0.30	1401.3
0.021	210.5	0.54	2394.2
0.032	300.4	0.80	3407.3
0.048	443.2	1.20	5007.2
0.087	673.2	2.20	7529.5
0.127	778.1	3.21	8612.9
0.166	810.4	4.21	8877.6
0.208	703.7	5.27	7623.8
0.265	595.0	6.71	6347.4



(see worksheet for sketch of failure)

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Broadway Interchange
Job No. : 28645286.02
Boring # : A-11-030/ A-11-031
Sample # : B 5% + 4
Depth (ft) : 3-5
Date tested : 01/05/12
Soil (Visual Description) : Dark olive gray fat clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

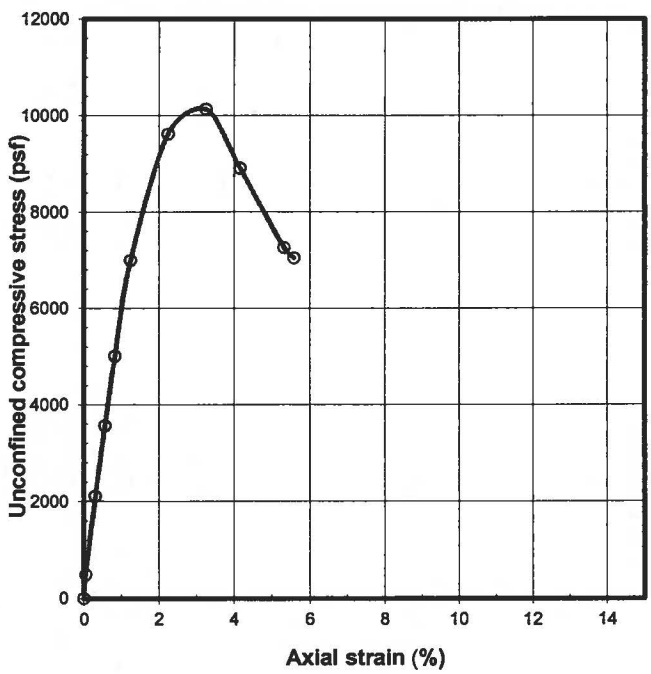
Specimen:

Total wt.	=	1498.1	gms
Ht.	=	4.11	in
Ave dia.	=	4.008	in
Area	=	12.620	sq.in
Volume	=	849.9	c.c.
Shearing rate	=	0.03	inch/min
Shearing rate	=	1.25	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	1.108	
Ht/Dia ratio	=	1.03	
Moisture	=	37.6	%
Total density	=	110.0	pcf
Dry density	=	79.9	pcf
Saturation	=	91.7	%
Unconfined compressive strength	=	10130	psf
Shear strength	=	5065	psf
Strain @ failure	=	3.25	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.002	43.7	0.05	497.9
0.013	185.6	0.30	2111.2
0.023	314.4	0.56	3566.7
0.034	442.6	0.83	5009.0
0.051	620.5	1.24	6993.3
0.092	862.2	2.24	9617.8
0.133	917.5	3.25	10129.8
0.171	814.9	4.15	8913.0
0.218	671.9	5.31	7260.0
0.229	653.8	5.57	7044.9



(see worksheet for sketch of failure)

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Broadway Interchange
Job No. : 28645286.02
Boring # : A-11-030/ A-11-031
Sample # : A 9%
Depth (ft) : 3-5
Date tested : 01/04/12
Soil (Visual Description) : Dark olive gray fat clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

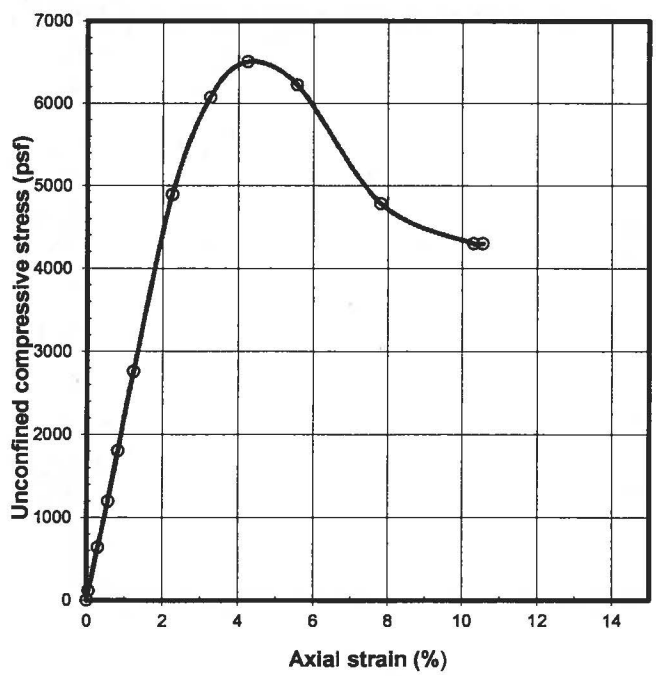
Specimen:

Total wt.	=	1454.3	gms
Ht.	=	4.06	in
Ave dia.	=	4.015	in
Area	=	12.666	sq.in
Volume	=	843.1	c.c.
Shearing rate	=	0.03	inch/min
Shearing rate	=	1.25	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	1.125	
Ht/Dia ratio	=	1.01	
Moisture	=	35.8	%
Total density	=	107.6	pcf
Dry density	=	79.3	pcf
Saturation	=	85.8	%
Unconfined compressive strength	=	6508	psf
Shear strength	=	3254	psf
Strain @ failure	=	4.25	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.002	10.3	0.05	117.4
0.012	56.8	0.30	643.4
0.023	106.2	0.56	1200.4
0.033	160.3	0.82	1807.9
0.050	246.1	1.23	2763.1
0.091	440.2	2.24	4892.5
0.132	552.3	3.25	6074.7
0.173	597.8	4.25	6507.8
0.226	579.9	5.55	6227.2
0.317	456.6	7.80	4786.3
0.419	422.0	10.30	4303.0
0.429	422.9	10.55	4300.8



(see worksheet for sketch of failure)

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Broadway Interchange
Job No. : 28645286.02
Boring # : A-11-030/ A-11-031
Sample # : B 9%
Depth (ft) : 3-5
Date tested : 01/04/12
Soil (Visual Description) : Dark olive gray fat clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

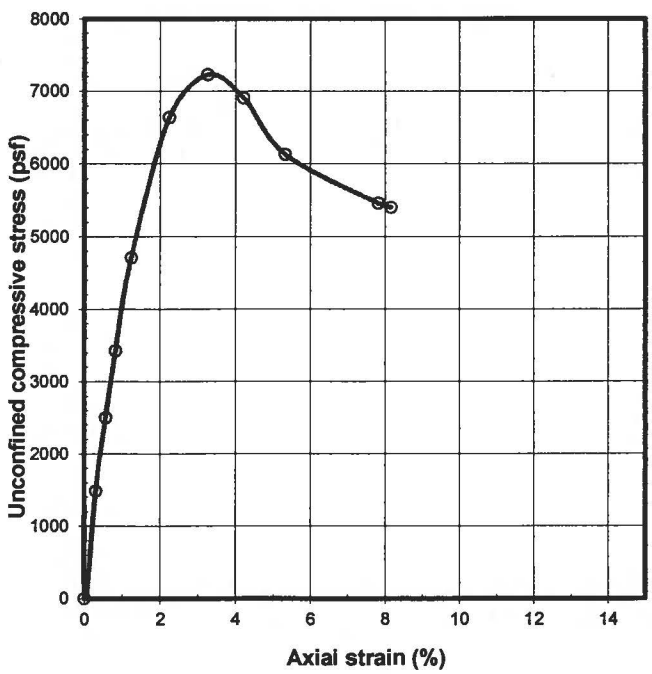
Specimen:

Total wt.	=	1402.1	gms
Ht.	=	3.90	in
Ave dia.	=	4.011	in
Area	=	12.643	sq.in
Volume	=	807.6	c.c.
Shearing rate	=	0.03	inch/min
Shearing rate	=	1.25	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	1.129	
Ht/Dia ratio	=	0.97	
Moisture	=	36.9	%
Total density	=	108.3	pcf
Dry density	=	79.1	pcf
Saturation	=	88.2	%
Unconfined compressive strength	=	7227	psf
Shear strength	=	3613	psf
Strain @ failure	=	3.25	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.002	-4.3	0.05	-49.3
0.012	131.1	0.30	1488.9
0.022	221.1	0.56	2504.3
0.032	303.5	0.82	3428.0
0.048	419.2	1.23	4715.4
0.087	596.0	2.24	6636.5
0.127	655.8	3.25	7226.7
0.164	633.0	4.20	6907.2
0.207	568.6	5.31	6132.5
0.304	520.2	7.81	5463.0
0.318	516.8	8.16	5406.0



(see worksheet for sketch of failure)

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Broadway Interchange
Job No. : 28645286.02
Boring # : A-11-030/ A-11-031
Sample # : A 7% + 5
Depth (ft) : 3-5
Date tested : 01/05/12
Soil (Visual Description) : Dark olive gray fat clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

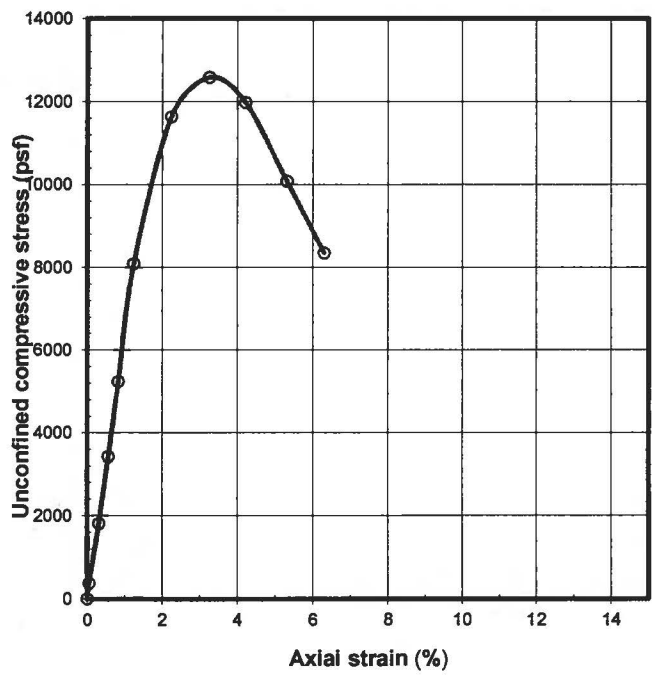
Specimen:

Total wt. =	1510.9	gms
Ht. =	4.05	in
Ave dia. =	4.001	in
Area =	12.576	sq.in
Volume =	835.2	c.c.
Shearing rate =	0.03	inch/min
Shearing rate =	1.25	%/min
Gs (assumed) =	2.70	

Test Report:

Void ratio =	1.013	
Ht/Dia ratio =	1.01	
Moisture =	34.9	%
Total density =	112.9	pcf
Dry density =	83.7	pcf
Saturation =	92.9	%
Unconfined compressive strength =	12588	psf
Shear strength =	6294	psf
Strain @ failure =	3.25	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.002	32.8	0.05	375.8
0.012	158.8	0.30	1812.6
0.023	300.9	0.56	3426.3
0.033	461.3	0.83	5238.4
0.050	715.4	1.24	8090.2
0.091	1039.2	2.24	11633.2
0.132	1136.2	3.25	12588.0
0.170	1091.7	4.21	11974.8
0.215	929.9	5.30	10083.3
0.255	778.4	6.29	8352.7



(see worksheet for sketch of failure)

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Broadway Interchange
Job No. : 28645286.02
Boring # : A-11-030/ A-11-031
Sample # : B 7% + 5
Depth (ft) : 3-5
Date tested : 01/05/12
Soil (Visual Description) : Dark olive gray fat clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

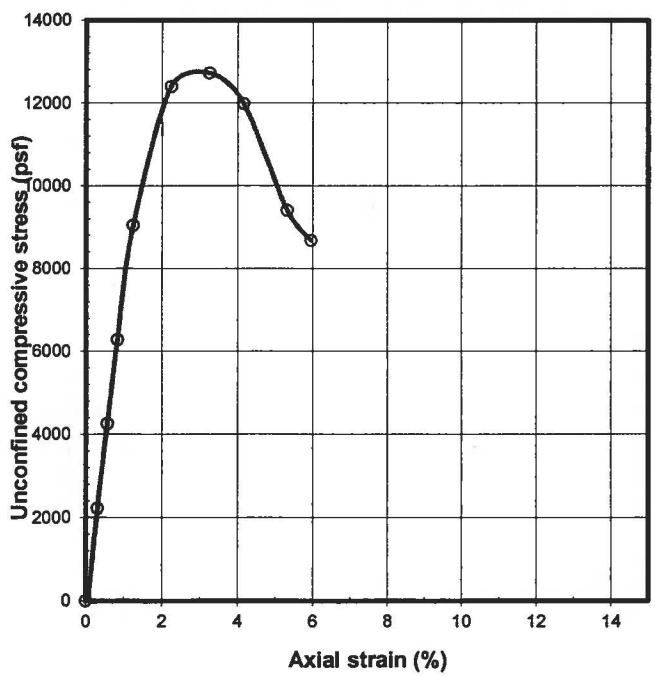
Specimen:

Total wt.	=	1513.8	gms
Ht.	=	4.07	in
Ave dia.	=	4.006	in
Area	=	12.607	sq.in
Volume	=	841.2	c.c.
Shearing rate	=	0.03	inch/min
Shearing rate	=	1.25	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	1.018	
Ht/Dia ratio	=	1.02	
Moisture	=	34.5	%
Total density	=	112.3	pcf
Dry density	=	83.5	pcf
Saturation	=	91.5	%
Unconfined compressive strength	=	12727	psf
Shear strength	=	6363	psf
Strain @ failure	=	3.25	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.002	-6.8	0.05	-77.6
0.012	195.8	0.30	2230.1
0.023	375.4	0.56	4263.6
0.034	554.3	0.82	6279.1
0.050	801.8	1.24	9045.2
0.091	1109.8	2.24	12393.1
0.132	1151.6	3.25	12726.5
0.169	1095.2	4.15	11990.6
0.216	869.9	5.31	9408.1
0.242	807.3	5.95	8672.2



(see worksheet for sketch of failure)

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Broadway Interchange
Job No. : 28645286.02
Boring # : A-11-030/ A-11-031
Sample # : A 9% + 6
Depth (ft) : 3-5
Date tested : 01/06/12
Soil (Visual Description) : Dark olive gray fat clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

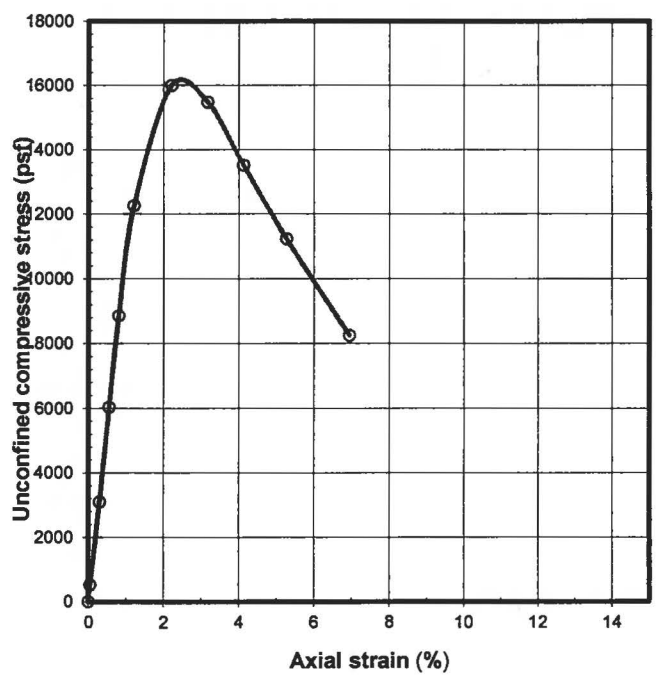
Specimen:

Total wt.	=	1475.7	gms
Ht.	=	4.00	in
Ave dia.	=	4.036	in
Area	=	12.797	sq.in
Volume	=	838.2	c.c.
Shearing rate	=	0.03	inch/min
Shearing rate	=	1.25	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	1.017	
Ht/Dia ratio	=	0.99	
Moisture	=	31.6	%
Total density	=	109.9	pcf
Dry density	=	83.5	pcf
Saturation	=	83.7	%
Unconfined compressive strength	=	16003	psf
Shear strength	=	8002	psf
Strain @ failure	=	2.21	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.002	46.3	0.05	520.7
0.012	276.7	0.30	3103.9
0.022	538.8	0.55	6030.1
0.032	793.1	0.80	8853.9
0.048	1102.8	1.20	12261.1
0.088	1454.3	2.21	16003.5
0.127	1420.8	3.17	15481.5
0.165	1253.4	4.12	13524.1
0.210	1053.4	5.27	11229.4
0.277	788.1	6.94	8253.0



(see worksheet for sketch of failure)

UNCONFINED COMPRESSION TEST - Uc
ASTM D-2166

Client : URS
Project : Broadway Interchange
Job No. : 28645286.02
Boring # : A-11-030/ A-11-031
Sample # : B 9% + 6
Depth (ft) : 3-5
Date tested : 01/06/12
Soil (Visual Description) : Dark olive gray fat clay

Dial factor = 1.0 in/unit
Load factor = 1.0 lb/unit

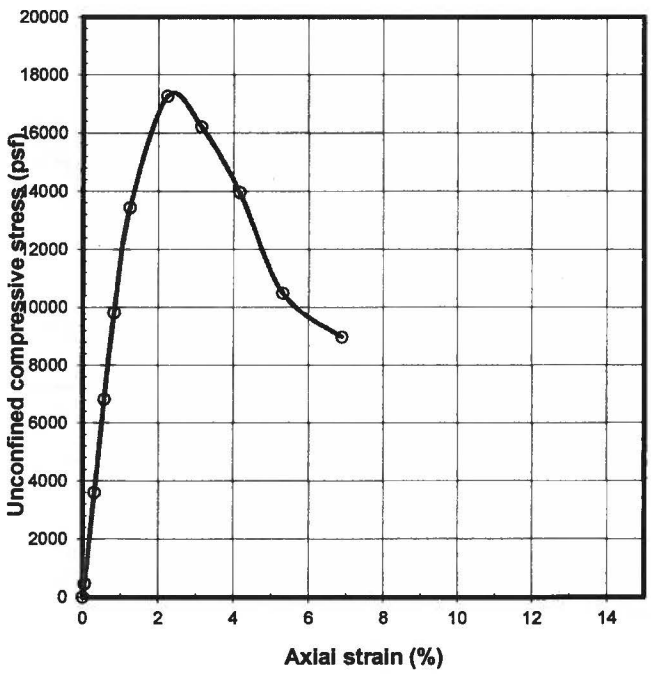
Specimen:

Total wt.	=	1504.8	gms
Ht.	=	4.05	in
Ave dia.	=	4.010	in
Area	=	12.636	sq.in
Volume	=	839.5	c.c.
Shearing rate	=	0.03	inch/min
Shearing rate	=	1.25	%/min
Gs (assumed)	=	2.70	

Test Report:

Void ratio	=	0.976	
Ht/Dia ratio	=	1.01	
Moisture	=	31.2	%
Total density	=	111.9	pcf
Dry density	=	85.3	pcf
Saturation	=	86.3	%
Unconfined compressive strength	=	17263	psf
Shear strength	=	8631	psf
Strain @ failure	=	2.24	%

Dial Read.	Load Read.	Axial Strain (%)	Unconfined Compressive Stress (psf)
0.002	41.4	0.05	471.8
0.012	317.1	0.31	3602.2
0.023	603.1	0.57	6833.3
0.034	868.1	0.83	9811.0
0.050	1194.1	1.24	13438.7
0.091	1549.5	2.24	17262.7
0.127	1468.8	3.14	16212.5
0.169	1278.7	4.16	13965.6
0.215	972.6	5.31	10495.0
0.279	845.8	6.89	8974.5



(see worksheet for sketch of failure)

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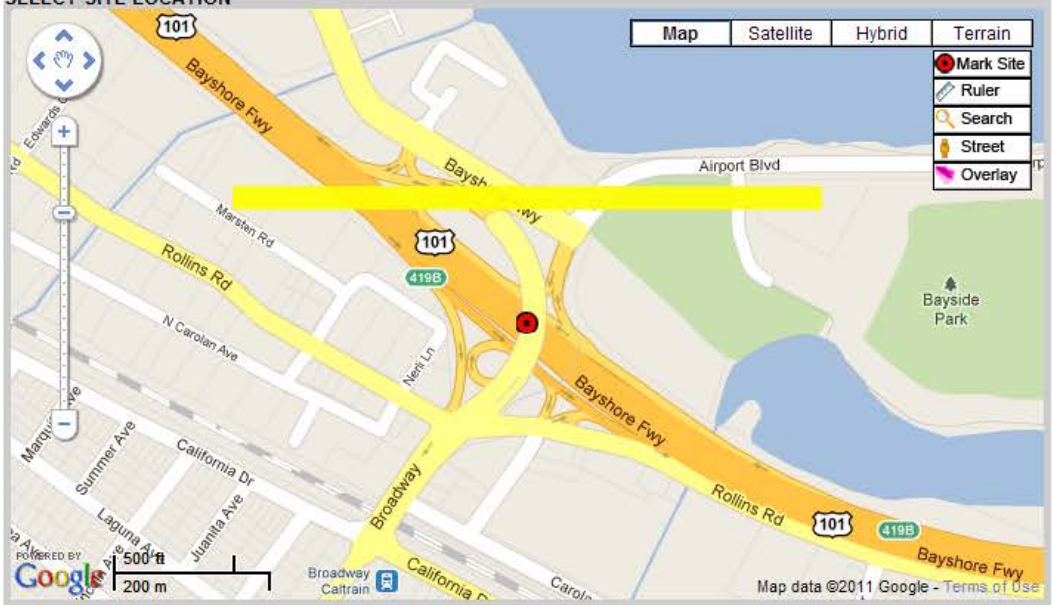
USGS science for a changing world

PACIFIC EARTHQUAKE

Caltrans ARS Online (v1.0.4)

This web-based tool calculates both deterministic and probabilistic acceleration response spectra for any location in California based on criteria provided in *Appendix B of Caltrans Seismic Design Criteria*. More...

SELECT SITE LOCATION



Latitude: 37.59006138 Longitude: -122.36124068 V_{S30}: 250 m/s Calculate

Done Internet 100%

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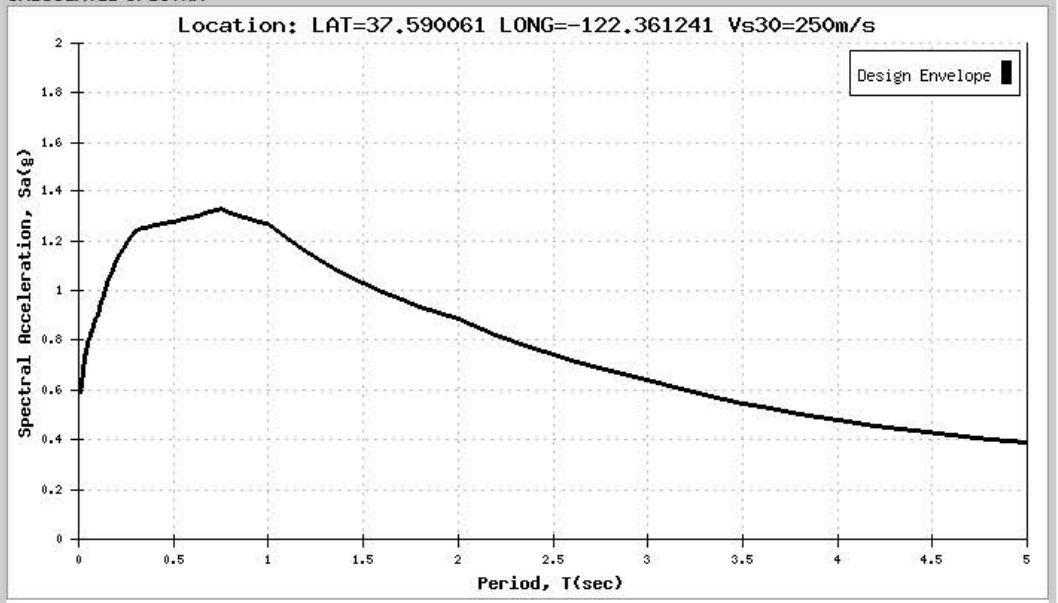
CALCULATED SPECTRA



View Tabular Data | Remove Envelope | Hide Near Fault Adjustment | Axis Scale

Printer Friendly View | Show Basin Factor

Apply Near Fault Adjustment To:

NOTE: Caltrans SDC requires application of a Near Fault Adjustment factor for sites less than 25 km (Rrup) from the causative fault.

☑ Deterministic Spectrum Using

4.37 Km San Andreas fault zone (Peninsula section)

☑ Probabilistic Spectrum Using

3.6 Km (Recommend Performing Deaggregation To Verify)

◉ Show Spectrum with Adjustment Only

○ Show Spectrum with and without near fault Adjustment

OK

Done | Internet | 100%

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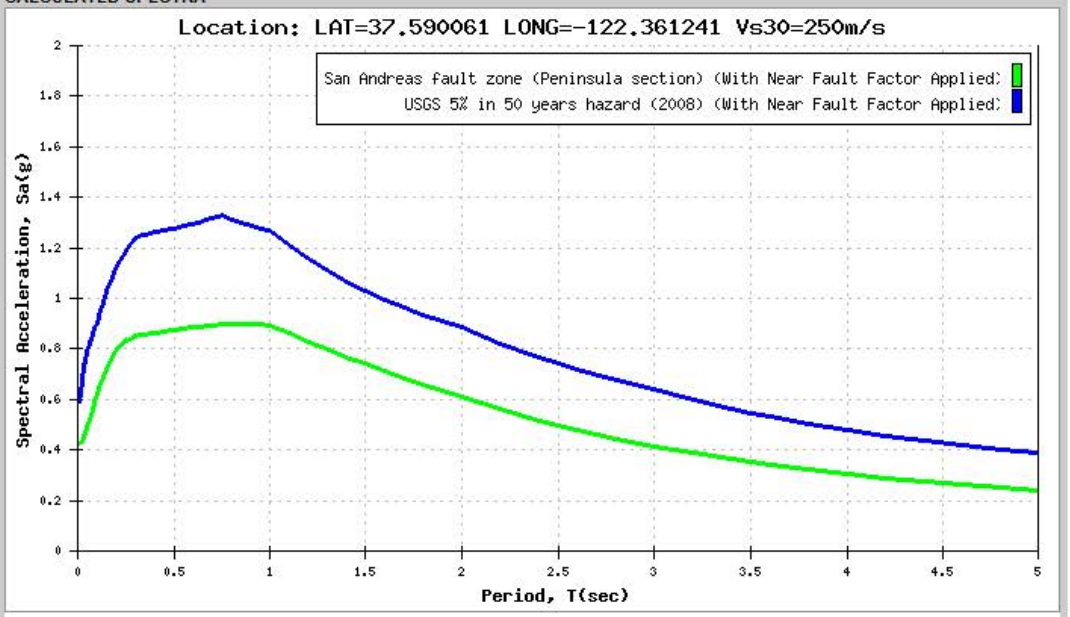
CALCULATED SPECTRA



View Tabular Data | Show Envelope Only | Hide Near Fault Adjustment | Axis Scale

Printer Friendly View | Show Basin Factor

Apply Near Fault Adjustment To:

NOTE: Caltrans SDC requires application of a Near Fault Adjustment factor for sites less than 25 km (Rrup) from the causative fault.

☑ Deterministic Spectrum Using

4.37 Km San Andreas fault zone (Peninsula section)

☑ Probabilistic Spectrum Using

3.6 Km (Recommenc Performing Deaggregation To Verify)

◉ Show Spectrum with Adjustment Only

○ Show Spectrum with and without near fault Adjustment

OK

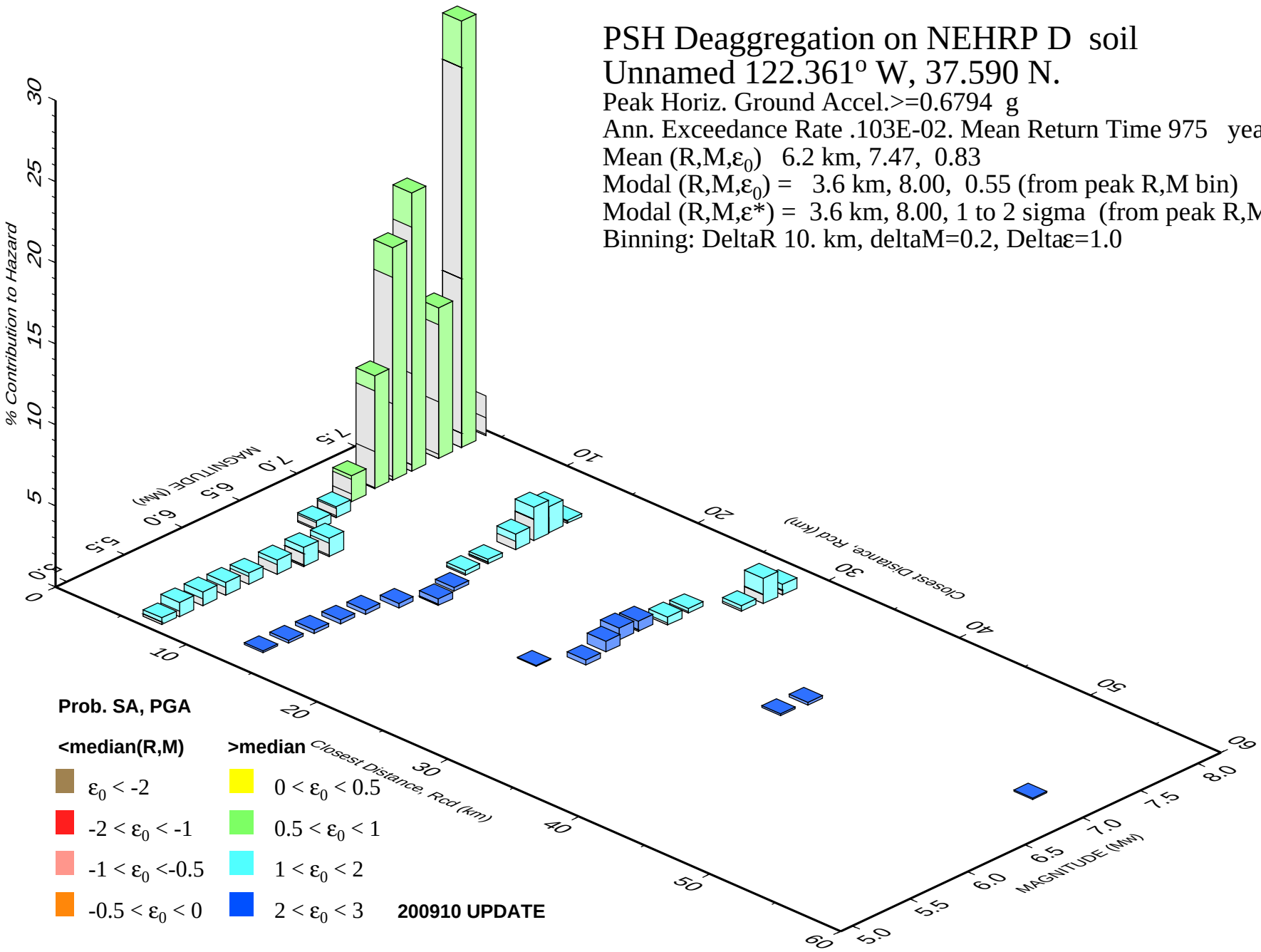
Done | Internet | 100%

Estimate of Shear Wave Velocity
Vs30
U.S. 101 Broadway Interchange Reconstruction

PointID	Depth	BottomDepth	Velocity	Layer Thickness (ft)	D/V			
CPT-11-012	5	19	712.42	14	0.019651			
CPT-11-012	19	24	560.99	5	0.008913			
CPT-11-012	24	29	690.71	5	0.007239			
CPT-11-012	29	34	780.73	5	0.006404			
CPT-11-012	34	39	661.5	5	0.007559			
CPT-11-012	39	44	976.38	5	0.005121			
CPT-11-012	44	49	810.03	5	0.006173			
CPT-11-012	49	54	1125.74	5	0.004442	Vs30=	807	ft/sec
CPT-11-012	54	64	829.14	10	0.012061		246	m/sec
CPT-11-012	64	69	1027.24	5	0.004867			
CPT-11-012	69	74	745.56	5	0.006706			
CPT-11-012	74	79	709.29	5	0.007049			
CPT-11-012	79	84	1061.63	5	0.00471			
CPT-11-012	84	99	962.13	15	0.01559			
CPT-11-016	8	19	874.3	11	0.012581			
CPT-11-016	19	24	736.1	5	0.006793			
CPT-11-016	24	29	721.03	5	0.006935			
CPT-11-016	29	34	912.6	5	0.005479			
CPT-11-016	34	39	835.17	5	0.005987			
CPT-11-016	39	44	1189.99	5	0.004202			
CPT-11-016	44	49	776.36	5	0.00644			
CPT-11-016	49	54	808.12	5	0.006187			
CPT-11-016	54	59	1067.12	5	0.004686	Vs30=	964	ft/sec
CPT-11-016	59	64	942.63	5	0.005304		294	m/sec
CPT-11-016	64	69	915.29	5	0.005463			
CPT-11-016	69	74	1176.56	5	0.00425			
CPT-11-016	74	79	1765.74	5	0.002832			
CPT-11-016	79	84	1489.91	5	0.003356			
CPT-11-016	84	89	1479.46	5	0.00338			
CPT-11-016	89	94	1216.5	5	0.00411			
CPT-11-016	94	99	782.35	5	0.006391			

PSH Deaggregation on NEHRP D soil
Unnamed 122.361° W, 37.590 N.

Peak Horiz. Ground Accel.>=0.6794 g
Ann. Exceedance Rate .103E-02. Mean Return Time 975 years
Mean (R,M,ε_0) 6.2 km, 7.47, 0.83
Modal (R,M,ε_0) = 3.6 km, 8.00, 0.55 (from peak R,M bin)
Modal (R,M,ε*) = 3.6 km, 8.00, 1 to 2 sigma (from peak R,M,ε bin)
Binning: DeltaR 10. km, deltaM=0.2, Deltaε=1.0



GMT 2012 Jan 22 17:16:24 **Distance (R), magnitude (M), epsilon (E0,E) deaggregation for a site on soil with average vs= 250. m/s top 30 m. USGS CGHT PSHA2008 UPDATE Bins with lt 0.05% contrib. omitted**

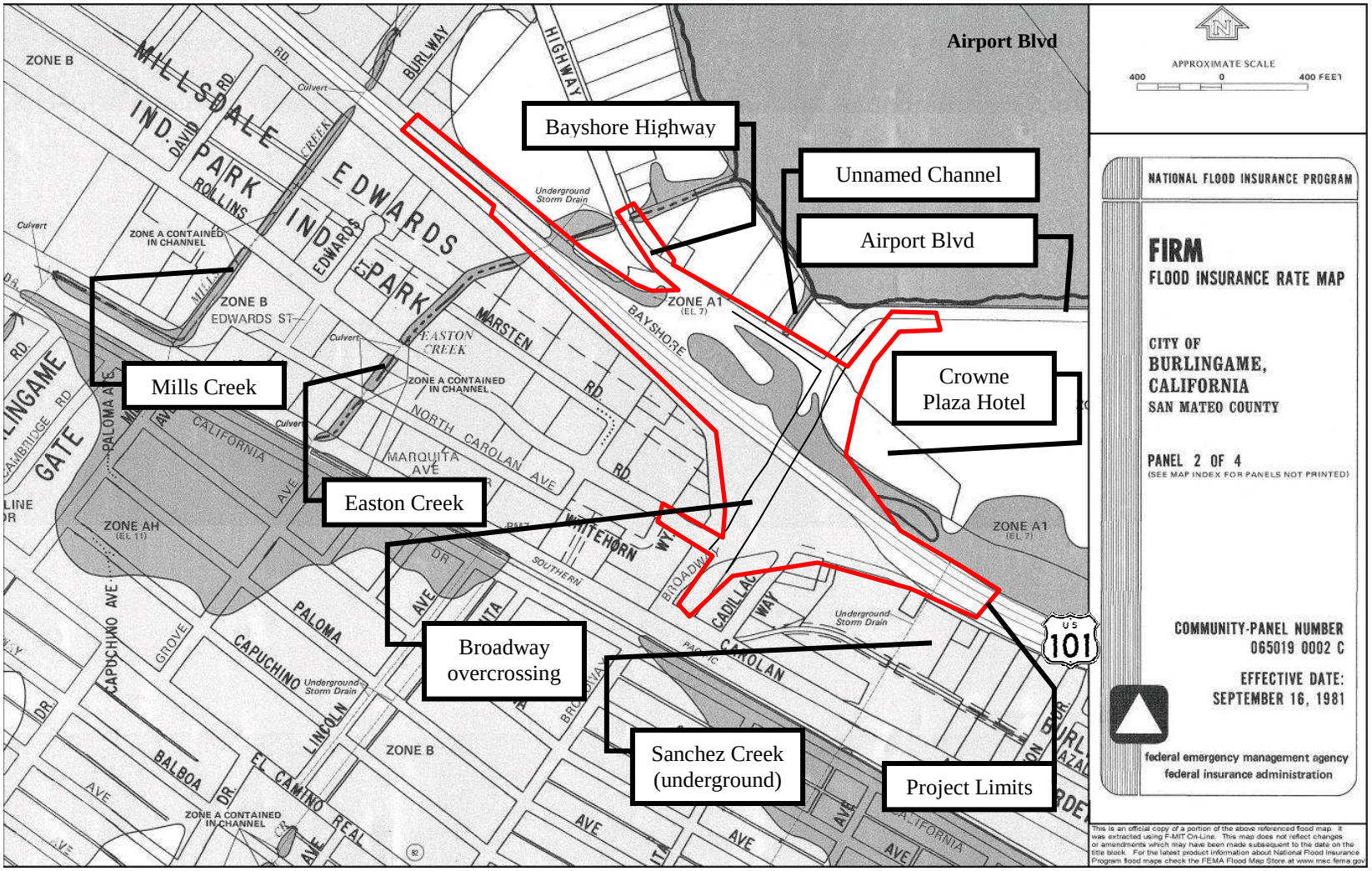
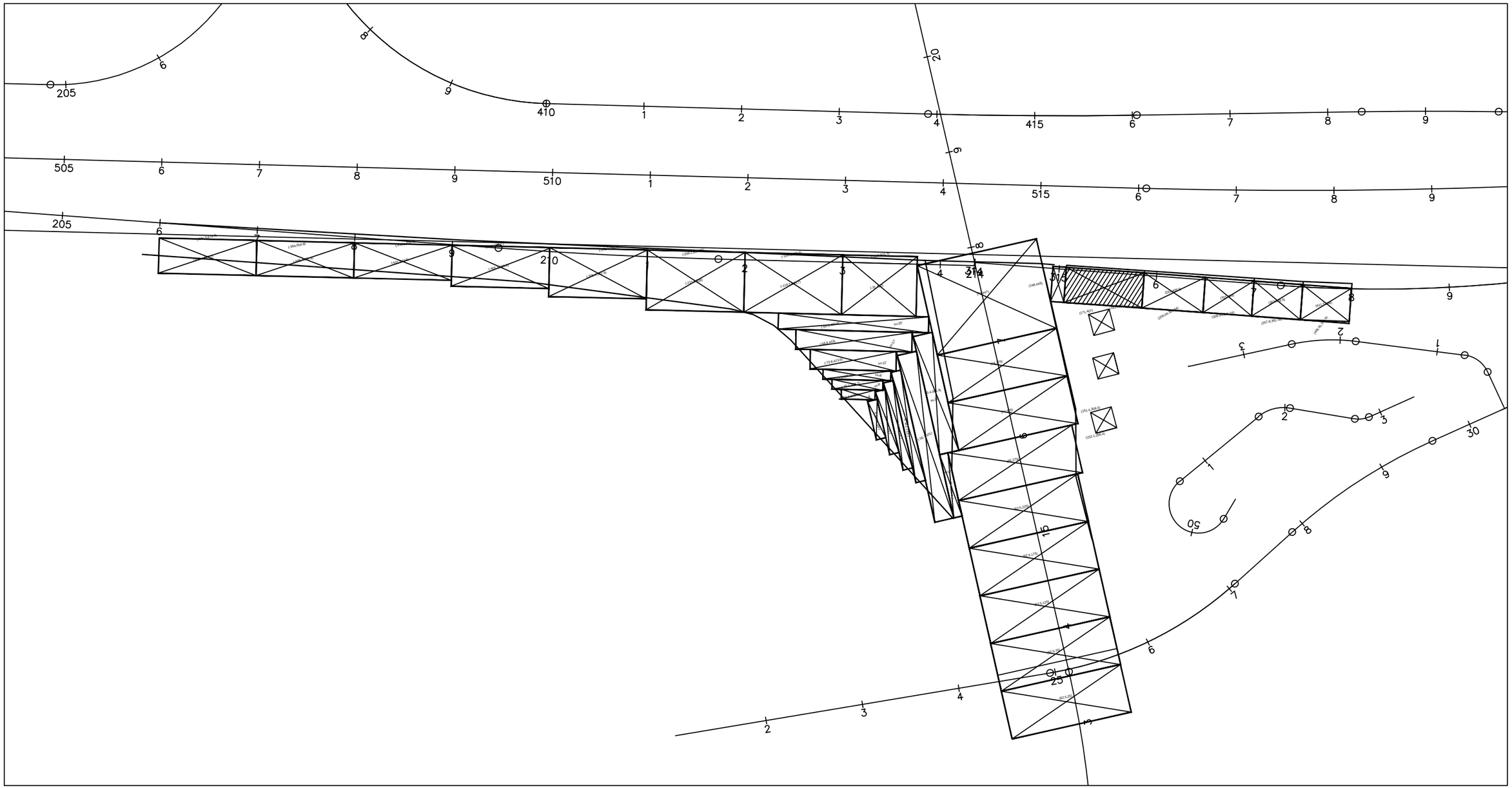


Figure 4. Excerpt from City of Burlingame FIRM

Source: Federal Emergency Management Agency

.



Embankment Load Estimates
West Approach Embankment &
Southbound On-/Off-Ramp
101 / Broadway (BWY and B2, B3)

URS

Page ____ of ____

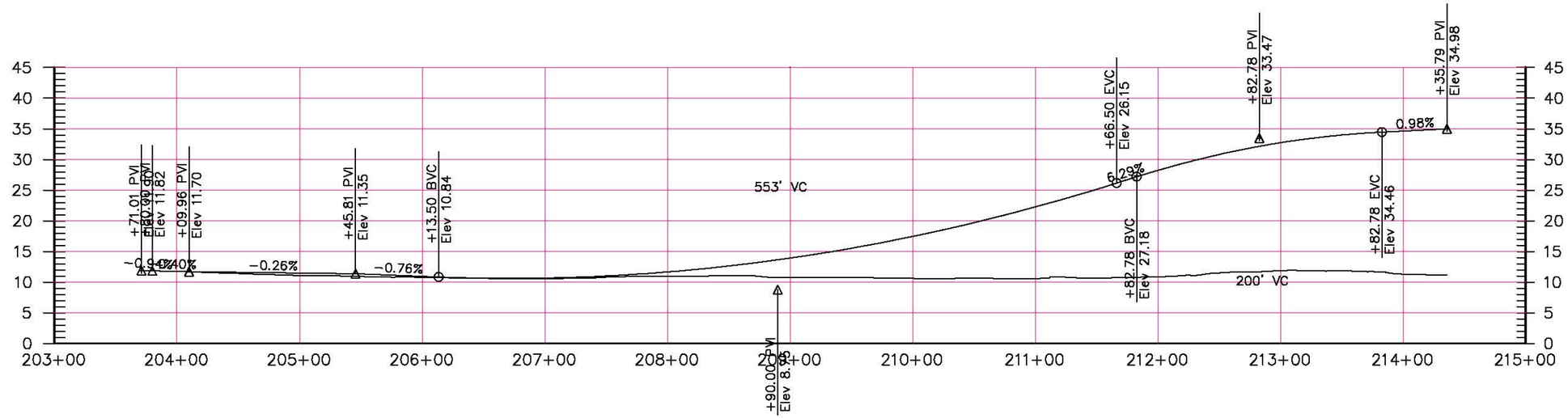
Job BROADWAY INTERCHANGE RECONSTRUCTION Project No. 9864529.86 Sheet ____ of ____

Description RAMP "B2" EMBANKMENT SETTLEMENT Computed by MT Date 12/18/11

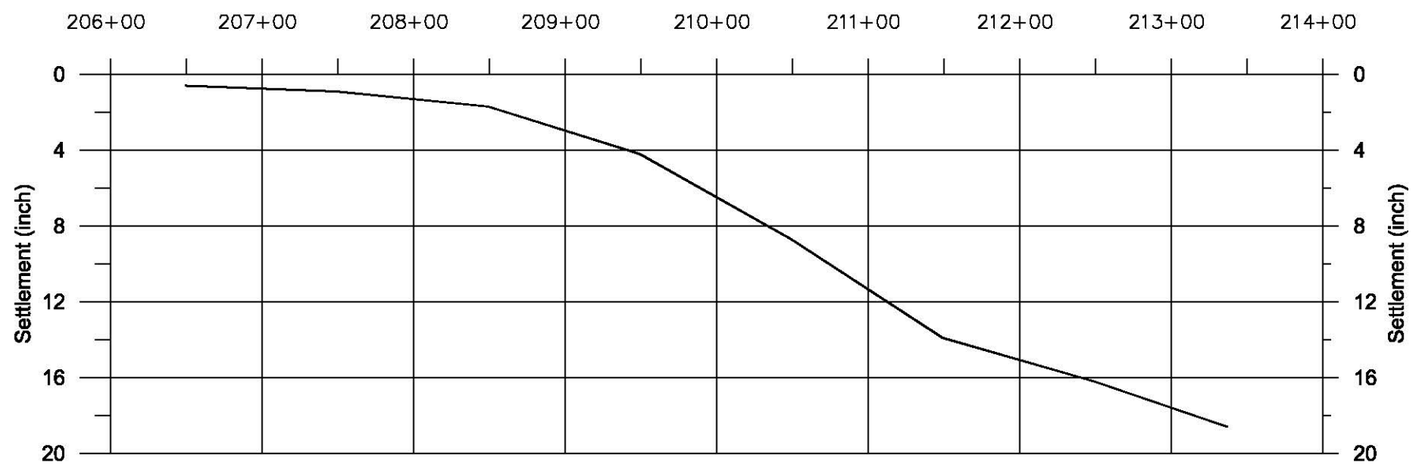
Checked by S. HUANG Date 1/20/12

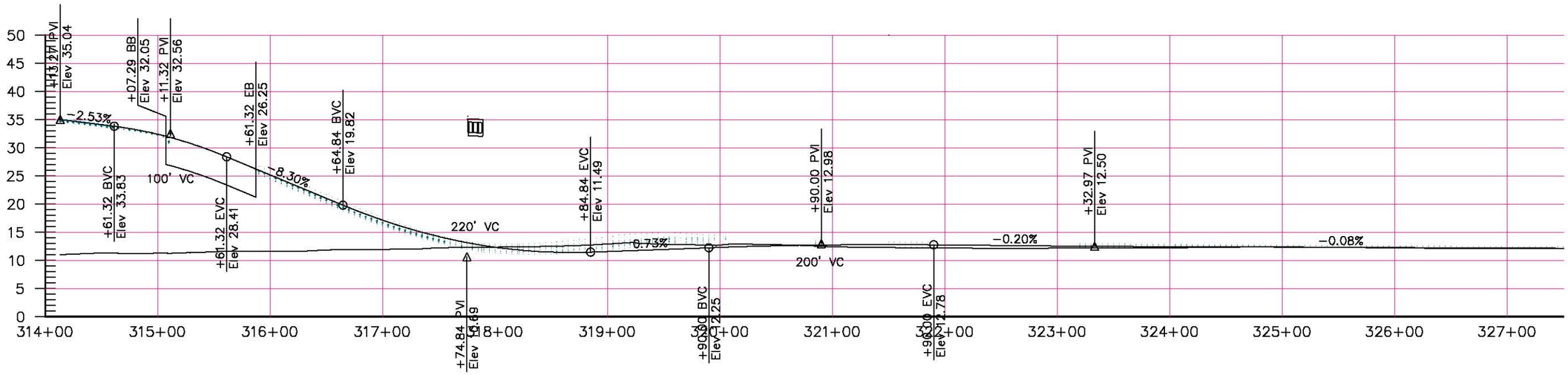
Reference

EL 11	DEPTH (ft) 0	STRESS (KSF) 5 10	γ' PCF	C_{CE}	$C_{\gamma E}$	P_p (KSF)	E $\times 10^6$ PSF	μ	C_α	A	t_{ZERO}	S_α / σ'_{VO}
	FILL		120	-	-		0.30	0.3	-	1	10	
EL 3												
EL 1	OH		27.6	0.30	0.03	1.3 / 1.8	0.03	0.5	0.015	1	10	
EL-7.5												
EL-9	CL		57.6	0.12	0.015	4.0	0.78	0.5	-	1	10	
EL-19												
EL-25.5												
EL-29	CL/SC		62.6	-	-	-	0.30	0.3	-	1	10	
EL-36												
EL-39	CH		52.6	0.19	0.02	5.5	(1000x 300) 0.30	0.5	-	1	10	
EL-49												
EL-49.5	ML											
EL-59	CL		72.6	0.05	0.005	7.0	(1600x600) ~1.0	0.5	-	1	10	
	GC											
EL-69	CL											

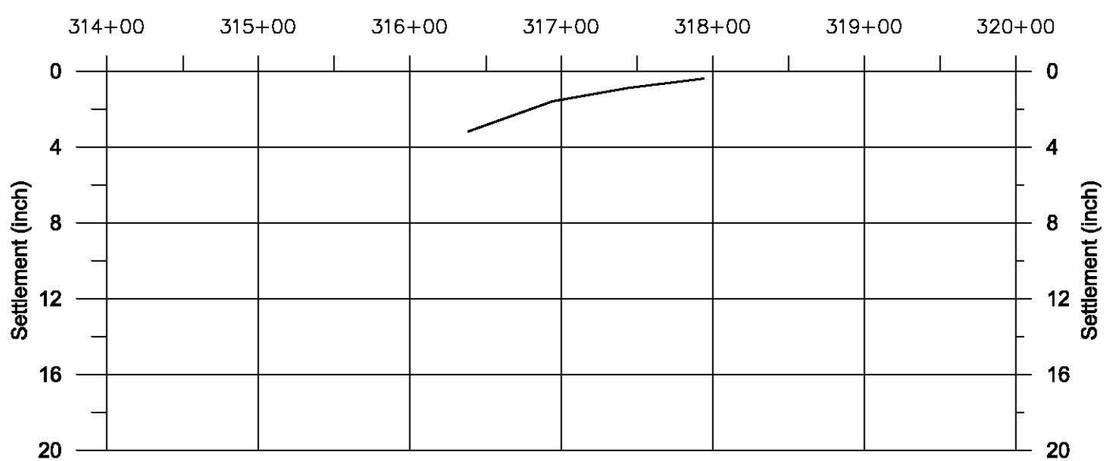

+71.01 PVI
Elev 11.82
+09.96 PVI
Elev 11.70
+45.81 PVI
Elev 11.35
+13.50 BVC
Elev 10.84
553' VC
+66.50 EVC
Elev 26.15
+82.78 BVC
Elev 27.18
+82.78 PVI
Elev 33.47
+82.78 EVC
Elev 34.46
+35.79 PVI
Elev 34.98
+90.00 PVI
Elev 8.45
−0.26%
−0.76%
0.98%
200' VC
203+00
204+00
205+00
206+00
207+00
208+00
209+00
210+00
211+00
212+00
213+00
214+00
215+00

"B2" LINE


206+00
207+00
208+00
209+00
210+00
211+00
212+00
213+00
214+00
Settlement (inch)
0
4
8
12
16
20


+13.27 PVI
Elev 35.04
+07.29 BB
Elev 32.05
+11.32 PVI
Elev 32.56
+61.32 EB
Elev 26.25
+64.84 BVC
Elev 19.82
+84.84 EVC
Elev 11.49
+90.00 PVI
Elev 12.98
+32.97 PVI
Elev 12.50
-2.53%
-8.30%
-0.73%
-0.20%
-0.08%
100' VC
220' VC
200' VC
+61.32 BVC
Elev 33.83
+61.32 EVC
Elev 28.41
+74.84 PVI
Elev 19.69
+90.00 BVC
Elev 12.25
+96.00 EVC
Elev 12.78
50
45
40
35
30
25
20
15
10
5
0
314+00
315+00
316+00
317+00
318+00
319+00
320+00
321+00
322+00
323+00
324+00
325+00
326+00
327+00

"B3" LINE


314+00
315+00
316+00
317+00
318+00
319+00
320+00
Settlement (inch)
0
4
8
12
16
20

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1
FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

b2ramp_2.dat
NUMBER OF SOIL LAYERS: 10

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	11.0	7.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	7.0	3.0	57.6	.000	.000	1200.0	.300	.30	.00000	1.000	5.00
3	3.0	-2.0	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
4	-2.0	-7.5	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
5	-7.5	-25.5	57.6	.120	.015	4000.0	.780	.50	.00000	1.000	5.00
6	-25.5	-36.0	62.6	.000	.000	8000.0	.300	.30	.00000	1.000	5.00
7	-36.0	-49.5	52.6	.190	.020	5500.0	.300	.50	.00000	1.000	5.00
8	-49.5	-69.0	72.6	.050	.005	7000.0	1.000	.50	.00000	1.000	5.00
9	-69.0	-79.0	72.6	.000	.000	9000.0	.300	.30	.00000	1.000	5.00
10	-79.0	-89.0	72.6	.050	.005	10000.0	1.000	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 36

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	62.50	25.00	.00	11.00	125.00	50.00	375.00
2	62.50	75.00	.00	11.00	125.00	50.00	625.00
3	62.50	125.00	.00	11.00	125.00	50.00	938.00
4	62.50	175.00	.00	11.00	125.00	50.00	1375.00
5	62.50	225.00	.00	11.00	125.00	50.00	1750.00
6	65.00	275.00	.00	11.00	130.00	50.00	2000.00
7	74.00	325.00	.00	11.00	125.00	50.00	2375.00
8	74.00	375.00	.00	11.00	125.00	50.00	2625.00
9	74.00	447.00	.00	11.00	125.00	93.80	3000.00
10	148.00	443.00	16.70	11.00	13.50	36.00	3000.00
11	193.00	430.00	16.70	11.00	80.00	36.00	.10
12	261.00	409.50	16.70	11.00	62.70	36.00	1625.00
13	315.00	393.00	16.70	11.00	50.00	36.00	1125.00
14	363.00	378.50	16.70	11.00	50.00	36.00	625.00
15	411.50	364.00	16.70	11.00	50.00	36.00	250.00
16	-31.00	482.00	14.10	11.00	76.40	61.10	3000.00
17	-116.50	503.70	14.10	11.00	100.00	61.10	2625.00
18	-213.50	528.00	14.10	11.00	100.00	61.10	2250.00
19	-309.10	557.60	14.10	11.00	100.00	50.00	1500.00
20	-405.10	585.50	14.10	11.00	100.00	42.00	1000.00
21	-501.50	613.00	14.10	11.00	100.00	36.00	625.00
22	-598.40	637.40	14.10	11.00	100.00	36.00	375.00
23	-695.40	661.70	14.10	11.00	100.00	36.00	250.00
24	-65.30	450.80	14.10	11.00	153.60	16.30	2500.00
25	-68.80	433.00	14.10	11.00	118.90	20.00	2125.00
26	-73.80	413.60	14.10	11.00	88.06	20.00	1500.00

27	-73.50	398.10	14.10	11.00	69.30	10.00	1000.00
28	-75.10	388.20	14.10	11.00	52.06	10.00	750.00
29	-76.60	378.20	14.10	11.00	34.43	10.00	500.00
30	-63.70	349.10	.00	11.00	10.00	40.12	500.00
31	-53.70	344.20	.00	11.00	10.00	66.10	750.00
32	-43.60	338.50	.00	11.00	10.00	91.39	1000.00
33	-33.10	335.20	.00	11.00	10.00	115.70	1500.00
34	-18.70	321.00	.00	11.00	19.98	174.87	2125.00
35	-4.40	266.90	.00	11.00	8.62	66.38	2125.00
36	.40	361.90	.00	11.00	20.00	123.84	2500.00

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TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5
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SETTLEMENT POINT : -31.0, 482.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2999.7	2877.6	2824.2	1.000	.003	.000	.206	.209
2	595.2	2993.5	2637.4	2482.8	1.000	.002	.000	.233	.236
3	779.4	2967.9	2382.4	2132.4	1.000	8.676	.722	1.421	10.819
4	924.3	2906.3	2115.2	1786.5	1.000	7.067	.795	2.102	9.964
5	1518.6	2674.6	1647.4	1255.1	1.000	1.894	.000	.339	2.232
6	2365.6	2353.4	1267.5	906.1	1.000	.000	.000	.715	.715
7	3049.3	2118.5	1043.2	732.9	1.000	.742	.000	.664	1.407
8	4112.3	1859.8	816.8	576.2	1.000	.190	.000	.272	.462
9	5183.1	1676.5	665.9	477.9	1.000	.000	.000	.533	.533
10	5909.1	1570.7	583.1	425.0	1.000	.061	.000	.128	.189
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						18.636	1.517	6.614	26.767

SETTLEMENT POINT : -23.5, 511.9

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1239.4	1325.3	1468.3	1.000	.002	.000	.064	.066
2	595.2	1411.5	1326.4	1409.9	1.000	.001	.000	.094	.096
3	779.4	1446.3	1253.1	1343.2	1.000	4.603	.722	.296	5.622
4	924.3	1455.9	1163.1	1267.0	1.000	2.976	.795	.530	4.300
5	1518.6	1439.7	989.3	1106.2	1.000	.938	.000	.109	1.047
6	2365.6	1394.0	829.2	934.6	1.000	.000	.000	.363	.363
7	3049.3	1348.5	721.3	811.2	1.000	.515	.000	.314	.830
8	4112.3	1282.7	598.0	670.3	1.000	.138	.000	.152	.290
9	5183.1	1222.0	506.3	568.2	1.000	.000	.000	.360	.360
10	5909.1	1180.4	452.5	509.5	1.000	.047	.000	.084	.131
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						9.221	1.517	2.367	13.105

SETTLEMENT POINT : -116.5, 503.7

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2624.8	2528.9	2447.8	1.000	.003	.000	.181	.184
2	595.2	2619.3	2339.4	2103.2	1.000	.002	.000	.206	.208
3	779.4	2596.9	2136.0	1748.9	1.000	7.861	.722	1.309	9.892
4	924.3	2542.4	1918.2	1398.3	1.000	6.209	.795	1.945	8.949
5	1518.6	2331.7	1520.0	863.5	1.000	1.309	.000	.316	1.625
6	2365.6	2025.3	1180.8	533.4	1.000	.000	.000	.635	.635
7	3049.3	1791.7	979.0	392.1	1.000	.650	.000	.597	1.248

8	4112.3	1530.8	779.1	288.3	1.000	.161	.000	.233	.394
9	5183.1	1349.4	649.0	236.8	1.000	.000	.000	.433	.434
10	5909.1	1248.3	578.4	212.9	1.000	.050	.000	.102	.152
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						16.246	1.517	5.958	23.721

SETTLEMENT POINT : -109.1, 533.3

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1345.2	1303.7	1273.2	1.000	.002	.000	.092	.093
2	595.2	1323.1	1242.6	1195.2	1.000	.001	.000	.095	.096
3	779.4	1317.1	1184.4	1109.2	1.000	4.136	.722	.341	5.199
4	924.3	1311.5	1119.6	1012.9	1.000	2.438	.795	.540	3.772
5	1518.6	1290.6	983.9	819.9	1.000	.866	.000	.108	.973
6	2365.6	1245.0	839.0	635.5	1.000	.000	.000	.337	.337
7	3049.3	1193.0	734.4	520.0	1.000	.465	.000	.306	.770
8	4112.3	1112.0	614.4	407.1	1.000	.122	.000	.141	.262
9	5183.1	1038.5	526.9	337.4	1.000	.000	.000	.312	.312
10	5909.1	990.6	476.4	301.5	1.000	.040	.000	.072	.113
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						8.069	1.517	2.341	11.927

SETTLEMENT POINT : -213.5, 528.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2249.7	2153.9	2064.1	1.000	.003	.000	.157	.160
2	595.2	2243.0	1965.1	1704.6	1.000	.002	.000	.183	.185
3	779.4	2215.6	1764.2	1341.3	1.000	6.924	.722	1.326	8.972
4	924.3	2150.0	1552.8	993.5	1.000	5.176	.795	1.929	7.900
5	1518.6	1906.4	1183.3	503.8	1.000	1.144	.000	.294	1.439
6	2365.6	1574.8	896.2	246.8	1.000	.000	.000	.517	.518
7	3049.3	1339.6	741.7	156.4	1.000	.512	.000	.481	.993
8	4112.3	1095.7	601.1	102.9	1.000	.120	.000	.174	.294
9	5183.1	938.7	514.8	82.7	1.000	.000	.000	.304	.304
10	5909.1	856.0	468.8	75.3	1.000	.035	.000	.070	.105
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						13.917	1.517	5.436	20.870

SETTLEMENT POINT : -206.2, 557.8

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1066.2	1070.2	1079.2	1.000	.001	.000	.067	.069
2	595.2	1104.9	1039.3	988.4	1.000	.001	.000	.079	.080

3	779.4	1111.2	987.9	889.1	1.000	3.328	.722	.345	4.395
4	924.3	1109.0	927.3	779.7	1.000	1.621	.795	.562	2.978
5	1518.6	1082.0	802.5	569.8	1.000	.757	.000	.110	.867
6	2365.6	1017.8	678.3	387.3	1.000	.000	.000	.293	.293
7	3049.3	949.4	595.5	286.2	1.000	.381	.000	.275	.656
8	4112.3	852.5	506.6	200.8	1.000	.096	.000	.117	.212
9	5183.1	773.1	444.7	156.6	1.000	.000	.000	.237	.237
10	5909.1	725.2	409.5	136.8	1.000	.030	.000	.054	.084
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						6.216	1.517	2.140	9.873

SETTLEMENT POINT : -309.1, 557.6

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1499.7	1429.3	1348.8	1.000	.002	.000	.107	.108
2	595.2	1491.9	1291.6	1061.2	1.000	.001	.000	.126	.127
3	779.4	1461.7	1148.6	784.2	1.000	4.657	.722	.991	6.370
4	924.3	1395.2	1003.9	539.5	1.000	2.754	.795	1.372	4.920
5	1518.6	1185.7	767.0	240.3	1.000	.812	.000	.189	1.001
6	2365.6	950.1	592.9	108.6	1.000	.000	.000	.311	.311
7	3049.3	802.0	499.9	66.8	1.000	.329	.000	.280	.609
8	4112.3	657.5	414.4	43.2	1.000	.075	.000	.100	.176
9	5183.1	566.8	361.9	34.7	1.000	.000	.000	.179	.179
10	5909.1	519.1	334.3	31.7	1.000	.022	.000	.040	.062
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						8.652	1.517	3.694	13.863

SETTLEMENT POINT : -303.1, 581.9

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	735.8	727.9	713.1	1.000	.001	.000	.049	.049
2	595.2	744.8	702.6	640.3	1.000	.000	.000	.055	.055
3	779.4	744.8	670.3	561.6	1.000	1.644	.722	.258	2.624
4	924.3	740.2	633.2	477.0	1.000	.506	.795	.407	1.708
5	1518.6	714.3	556.4	323.4	1.000	.542	.000	.076	.618
6	2365.6	661.7	478.4	202.9	1.000	.000	.000	.192	.192
7	3049.3	610.6	425.5	142.3	1.000	.257	.000	.176	.433
8	4112.3	543.2	368.6	94.9	1.000	.063	.000	.073	.136
9	5183.1	490.6	329.3	71.9	1.000	.000	.000	.148	.148
10	5909.1	459.6	307.2	62.1	1.000	.020	.000	.033	.053
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						3.033	1.517	1.467	6.016

SETTLEMENT POINT : -405.1, 585.5

SOIL	INITIAL	VERTICAL STRESS	HORIZ. X STRESS	HORIZ. Y STRESS	SKEMPTON BJERRUM	CONSOL.	SECOND. COMP.	ELASTIC	TOTAL

LAYER	STRESS (PSF)	INCREASE (PSF)	INCREASE (PSF)	INCREASE (PSF)	FACTOR	COMP. (IN.)	20. YR (IN.)	COMP. (IN.)	COMP. (IN.)
1	240.0	999.6	943.4	879.9	1.000	.001	.000	.072	.074
2	595.2	991.0	834.4	655.8	1.000	.001	.000	.087	.088
3	779.4	959.7	724.7	452.2	1.000	2.675	.722	.743	4.140
4	924.3	896.6	619.2	287.7	1.000	.673	.795	.975	2.442
5	1518.6	725.3	460.8	112.8	1.000	.549	.000	.121	.671
6	2365.6	559.7	356.5	47.3	1.000	.000	.000	.184	.184
7	3049.3	464.3	305.1	28.5	1.000	.199	.000	.161	.360
8	4112.3	376.1	260.5	18.6	1.000	.044	.000	.055	.100
9	5183.1	322.9	234.3	15.3	1.000	.000	.000	.099	.099
10	5909.1	295.6	220.8	14.3	1.000	.013	.000	.021	.034
						4.155	1.517	2.519	8.192

SETTLEMENT POINT : -400.0, 606.2

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	400.2	437.8	469.7	1.000	.000	.000	.020	.021
2	595.2	465.7	447.8	412.6	1.000	.000	.000	.033	.033
3	779.4	477.8	429.4	351.1	1.000	.374	.722	.175	1.271
4	924.3	478.3	404.2	286.7	1.000	.359	.795	.292	1.445
5	1518.6	456.8	351.8	177.8	1.000	.370	.000	.053	.423
6	2365.6	412.1	302.3	101.9	1.000	.000	.000	.122	.122
7	3049.3	372.3	271.3	67.7	1.000	.162	.000	.109	.272
8	4112.3	324.2	240.3	43.3	1.000	.039	.000	.043	.081
9	5183.1	289.4	220.0	32.4	1.000	.000	.000	.085	.086
10	5909.1	269.9	208.9	28.0	1.000	.012	.000	.018	.030
						1.315	1.517	.952	3.784

SETTLEMENT POINT : -501.5, 613.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	624.6	584.1	537.5	1.000	.000	.000	.046	.047
2	595.2	616.4	506.2	378.2	1.000	.000	.000	.056	.056
3	779.4	588.2	430.7	242.8	1.000	.796	.722	.503	2.022
4	924.3	536.7	361.9	143.3	1.000	.394	.795	.625	1.814
5	1518.6	415.3	266.7	50.7	1.000	.340	.000	.071	.411
6	2365.6	312.4	209.3	20.5	1.000	.000	.000	.102	.102
7	3049.3	257.1	182.4	12.5	1.000	.114	.000	.086	.200
8	4112.3	207.8	160.1	8.5	1.000	.025	.000	.029	.054
9	5183.1	178.7	147.7	7.3	1.000	.000	.000	.053	.053
10	5909.1	164.0	141.5	7.0	1.000	.007	.000	.011	.018
						1.677	1.517	1.583	4.777

SETTLEMENT POINT : -498.1, 630.7

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	313.5	304.4	290.7	1.000	.000	.000	.022	.022
2	595.2	312.3	287.2	248.3	1.000	.000	.000	.024	.024
3	779.4	309.8	269.0	204.1	1.000	.262	.722	.146	1.131
4	924.3	304.0	249.4	159.7	1.000	.244	.795	.219	1.258
5	1518.6	280.3	213.5	90.4	1.000	.238	.000	.036	.274
6	2365.6	244.0	183.6	47.9	1.000	.000	.000	.073	.073
7	3049.3	215.9	166.4	30.8	1.000	.096	.000	.063	.160
8	4112.3	184.9	150.4	19.5	1.000	.022	.000	.023	.046
9	5183.1	163.9	140.7	14.8	1.000	.000	.000	.047	.047
10	5909.1	152.5	135.6	13.0	1.000	.007	.000	.009	.016
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						.870	1.517	.663	3.050

SETTLEMENT POINT : -598.4, 637.4

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	374.8	350.3	322.5	1.000	.000	.000	.028	.028
2	595.2	369.8	303.4	226.8	1.000	.000	.000	.034	.034
3	779.4	352.9	258.0	145.4	1.000	.292	.722	.302	1.317
4	924.3	322.0	216.5	85.7	1.000	.257	.795	.376	1.428
5	1518.6	249.0	159.3	30.0	1.000	.214	.000	.043	.256
6	2365.6	186.8	125.2	11.8	1.000	.000	.000	.061	.061
7	3049.3	153.2	109.7	7.0	1.000	.069	.000	.051	.120
8	4112.3	123.1	97.7	4.7	1.000	.015	.000	.017	.032
9	5183.1	105.2	91.6	4.0	1.000	.000	.000	.031	.031
10	5909.1	96.2	88.8	3.9	1.000	.004	.000	.006	.010
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						.851	1.517	.948	3.317

SETTLEMENT POINT : -594.0, 654.8

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	193.7	185.6	174.4	1.000	.000	.000	.014	.014
2	595.2	189.2	173.7	148.7	1.000	.000	.000	.015	.015
3	779.4	187.0	162.6	122.1	1.000	.168	.722	.089	.980
4	924.3	183.1	150.9	95.3	1.000	.155	.795	.132	1.082
5	1518.6	168.7	129.6	53.4	1.000	.148	.000	.021	.170
6	2365.6	146.7	111.8	27.8	1.000	.000	.000	.044	.044
7	3049.3	129.6	101.9	17.6	1.000	.059	.000	.038	.096
8	4112.3	110.5	93.2	10.9	1.000	.013	.000	.014	.027
9	5183.1	97.4	88.5	8.1	1.000	.000	.000	.027	.027
10	5909.1	90.3	86.3	7.1	1.000	.004	.000	.005	.009

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						.548	1.517	.399	2.464

SETTLEMENT POINT : -695.4, 661.7

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	249.9	232.3	214.9	1.000	.000	.000	.019	.019
2	595.2	246.5	198.6	151.1	1.000	.000	.000	.023	.023
3	779.4	235.1	165.8	96.8	1.000	.206	.722	.208	1.136
4	924.3	214.2	135.7	56.9	1.000	.179	.795	.259	1.233
5	1518.6	164.1	94.2	19.7	1.000	.144	.000	.030	.174
6	2365.6	120.4	70.8	7.6	1.000	.000	.000	.041	.041
7	3049.3	96.3	61.6	4.4	1.000	.044	.000	.034	.078
8	4112.3	74.6	55.8	2.9	1.000	.009	.000	.011	.020
9	5183.1	61.9	53.9	2.4	1.000	.000	.000	.018	.018
10	5909.1	55.6	53.4	2.4	1.000	.002	.000	.003	.006
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						.585	1.517	.645	2.747

SETTLEMENT POINT : -691.5, 679.2

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	131.1	123.6	116.2	1.000	.000	.000	.009	.010
2	595.2	126.8	112.8	98.9	1.000	.000	.000	.010	.010
3	779.4	124.9	103.0	80.9	1.000	.116	.722	.066	.904
4	924.3	121.9	92.9	62.8	1.000	.107	.795	.097	.998
5	1518.6	110.9	75.5	34.7	1.000	.099	.000	.015	.115
6	2365.6	94.0	62.9	17.6	1.000	.000	.000	.029	.029
7	3049.3	80.9	57.1	10.8	1.000	.037	.000	.025	.062
8	4112.3	66.5	53.4	6.5	1.000	.008	.000	.009	.017
9	5183.1	57.0	52.2	4.8	1.000	.000	.000	.016	.016
10	5909.1	52.0	52.0	4.2	1.000	.002	.000	.003	.005
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						.369	1.517	.280	2.166

SETTLEMENT POINT : -65.3, 450.8

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2500.5	2428.0	2410.3	1.000	.003	.000	.168	.171
2	595.2	2506.6	2281.6	2215.1	1.000	.002	.000	.185	.187
3	779.4	2506.7	2118.2	1988.0	1.000	7.649	.722	.907	9.279
4	924.3	2487.0	1939.1	1743.5	1.000	6.071	.795	1.420	8.286
5	1518.6	2386.7	1596.6	1303.6	1.000	1.329	.000	.259	1.588

6	2365.6	2211.8	1280.8	936.3	1.000	.000	.000	.650	.650
7	3049.3	2051.1	1079.9	727.1	1.000	.724	.000	.620	1.343
8	4112.3	1838.9	869.8	535.3	1.000	.188	.000	.266	.454
9	5183.1	1669.4	725.9	422.6	1.000	.000	.000	.530	.530
10	5909.1	1566.8	645.1	366.1	1.000	.061	.000	.127	.189
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						16.027	1.517	5.133	22.677

SETTLEMENT POINT : -68.8, 433.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2124.6	2057.8	2034.0	1.000	.003	.000	.144	.146
2	595.2	2116.7	1928.4	1866.9	1.000	.002	.000	.157	.158
3	779.4	2097.4	1795.2	1707.2	1.000	6.609	.722	.692	8.024
4	924.3	2069.9	1656.2	1545.0	1.000	4.949	.795	1.033	6.777
5	1518.6	1997.3	1398.7	1238.0	1.000	1.181	.000	.188	1.369
6	2365.6	1887.3	1163.2	951.0	1.000	.000	.000	.526	.527
7	3049.3	1786.4	1009.2	768.4	1.000	.649	.000	.485	1.134
8	4112.3	1648.9	839.1	583.0	1.000	.171	.000	.219	.391
9	5183.1	1532.9	715.0	463.9	1.000	.000	.000	.472	.472
10	5909.1	1459.0	642.3	401.2	1.000	.058	.000	.112	.170
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						13.622	1.517	4.028	19.167

SETTLEMENT POINT : -73.8, 413.6

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1500.1	1468.7	1473.6	1.000	.002	.000	.099	.101
2	595.2	1501.9	1405.9	1416.1	1.000	.001	.000	.105	.106
3	779.4	1503.4	1336.6	1345.4	1.000	4.801	.722	.325	5.848
4	924.3	1499.1	1261.9	1264.0	1.000	3.130	.795	.519	4.444
5	1518.6	1472.0	1125.1	1097.7	1.000	.954	.000	.100	1.053
6	2365.6	1434.1	996.8	915.9	1.000	.000	.000	.361	.362
7	3049.3	1403.1	902.6	778.6	1.000	.533	.000	.304	.836
8	4112.3	1356.6	783.2	618.2	1.000	.145	.000	.153	.298
9	5183.1	1308.3	685.2	502.9	1.000	.000	.000	.381	.381
10	5909.1	1272.1	624.0	438.4	1.000	.051	.000	.089	.140
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						9.617	1.517	2.436	13.570

SETTLEMENT POINT : -73.5, 398.1

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)

1	240.0	1003.1	1014.0	1046.3	1.000	.001	.000	.062	.063
2	595.2	1030.4	1021.1	1072.3	1.000	.001	.000	.064	.065
3	779.4	1051.7	1010.3	1063.4	1.000	3.078	.722	.030	3.830
4	924.3	1061.1	994.8	1047.5	1.000	1.416	.795	.088	2.298
5	1518.6	1078.1	962.0	990.2	1.000	.755	.000	.028	.783
6	2365.6	1113.7	907.5	880.8	1.000	.000	.000	.242	.243
7	3049.3	1141.7	846.9	775.6	1.000	.447	.000	.178	.626
8	4112.3	1161.9	752.5	636.5	1.000	.126	.000	.109	.236
9	5183.1	1159.4	666.7	528.2	1.000	.000	.000	.320	.320
10	5909.1	1148.2	610.8	464.8	1.000	.046	.000	.073	.120
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						5.871	1.517	1.195	8.584

SETTLEMENT POINT : -75.1, 388.2

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	749.9	757.6	774.5	1.000	.001	.000	.046	.047
2	595.2	750.1	774.9	822.2	1.000	.000	.000	.043	.044
3	779.4	754.4	797.2	865.3	1.000	1.693	.722	-.154	2.262
4	924.3	766.6	823.2	897.0	1.000	.519	.795	-.206	1.108
5	1518.6	820.5	858.9	903.3	1.000	.608	.000	-.017	.591
6	2365.6	905.1	848.0	836.0	1.000	.000	.000	.168	.168
7	3049.3	967.4	806.9	752.9	1.000	.388	.000	.101	.489
8	4112.3	1024.9	728.2	632.2	1.000	.113	.000	.081	.194
9	5183.1	1048.8	650.8	532.6	1.000	.000	.000	.277	.278
10	5909.1	1052.4	598.9	472.5	1.000	.043	.000	.062	.105
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						3.365	1.517	.403	5.285

SETTLEMENT POINT : -76.6, 378.2

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	497.2	513.0	508.5	1.000	.000	.000	.031	.031
2	595.2	475.0	557.7	581.2	1.000	.000	.000	.021	.021
3	779.4	469.5	621.6	675.1	1.000	.369	.722	-.358	.733
4	924.3	493.4	688.8	750.4	1.000	.368	.795	-.498	.665
5	1518.6	593.8	779.7	810.8	1.000	.464	.000	-.056	.409
6	2365.6	723.4	799.9	781.0	1.000	.000	.000	.105	.105
7	3049.3	813.3	772.9	719.6	1.000	.333	.000	.036	.369
8	4112.3	900.2	705.9	619.0	1.000	.101	.000	.056	.156
9	5183.1	945.0	635.3	530.2	1.000	.000	.000	.238	.238
10	5909.1	960.9	586.8	474.6	1.000	.039	.000	.052	.091
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						1.674	1.517	-.373	2.818

SETTLEMENT POINT : 148.0, 443.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2972.6	2224.6	2458.5	1.000	.003	.000	.251	.254
2	595.2	2612.1	1423.8	1639.9	1.000	.002	.000	.271	.273
3	779.4	2127.0	1249.3	1149.8	1.000	6.689	.722	1.855	9.267
4	924.3	1768.1	1208.3	880.3	1.000	4.035	.795	1.592	6.422
5	1518.6	1411.3	1107.9	654.0	1.000	.925	.000	.147	1.072
6	2365.6	1250.7	966.8	531.1	1.000	.000	.000	.337	.337
7	3049.3	1176.1	857.4	458.1	1.000	.459	.000	.280	.739
8	4112.3	1099.1	726.7	381.2	1.000	.120	.000	.128	.248
9	5183.1	1040.4	627.8	327.6	1.000	.000	.000	.302	.302
10	5909.1	1003.5	569.1	297.0	1.000	.041	.000	.068	.109
						12.275	1.517	5.230	19.022

SETTLEMENT POINT : 261.0, 409.5

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1624.0	1489.4	1397.4	1.000	.002	.000	.121	.123
2	595.2	1600.9	1232.3	983.2	1.000	.001	.000	.150	.151
3	779.4	1521.2	986.4	631.7	1.000	4.862	.722	1.424	7.009
4	924.3	1372.4	771.2	375.1	1.000	2.669	.795	1.758	5.222
5	1518.6	1009.0	515.6	142.1	1.000	.717	.000	.188	.905
6	2365.6	695.8	420.9	75.0	1.000	.000	.000	.230	.230
7	3049.3	536.7	403.6	62.4	1.000	.228	.000	.164	.392
8	4112.3	413.2	401.3	59.9	1.000	.049	.000	.043	.091
9	5183.1	356.6	399.0	60.7	1.000	.000	.000	.087	.087
10	5909.1	335.0	394.3	61.2	1.000	.014	.000	.013	.027
						8.542	1.517	4.179	14.238

SETTLEMENT POINT : 256.0, 392.1

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	784.9	757.3	754.0	1.000	.001	.000	.053	.054
2	595.2	800.6	686.6	640.2	1.000	.000	.000	.064	.065
3	779.4	793.9	608.6	522.6	1.000	1.892	.722	.457	3.071
4	924.3	769.8	534.8	405.8	1.000	.521	.795	.659	1.975
5	1518.6	673.1	440.7	230.6	1.000	.516	.000	.093	.610
6	2365.6	541.5	410.2	133.3	1.000	.000	.000	.159	.159
7	3049.3	455.0	411.3	99.8	1.000	.196	.000	.108	.303
8	4112.3	379.2	418.1	81.7	1.000	.045	.000	.030	.075
9	5183.1	343.3	417.8	75.4	1.000	.000	.000	.078	.078
10	5909.1	330.4	413.0	72.8	1.000	.014	.000	.010	.025
						3.185	1.517	1.712	6.414

SETTLEMENT POINT : 315.0, 393.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1124.4	1047.4	967.8	1.000	.001	.000	.083	.085
2	595.2	1109.3	899.7	681.7	1.000	.001	.000	.102	.102
3	779.4	1058.1	756.5	438.7	1.000	3.105	.722	.921	4.749
4	924.3	964.1	626.0	260.7	1.000	.985	.795	1.146	2.926
5	1518.6	740.4	447.5	96.6	1.000	.559	.000	.130	.689
6	2365.6	546.6	348.1	45.6	1.000	.000	.000	.180	.180
7	3049.3	440.1	310.3	33.8	1.000	.190	.000	.145	.334
8	4112.3	344.7	288.8	29.7	1.000	.041	.000	.043	.084
9	5183.1	290.6	282.5	29.5	1.000	.000	.000	.079	.079
10	5909.1	265.1	280.5	29.8	1.000	.011	.000	.013	.025
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						4.894	1.517	2.841	9.252

SETTLEMENT POINT : 310.0, 375.7

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	568.5	547.8	523.4	1.000	.000	.000	.040	.040
2	595.2	563.3	511.0	447.2	1.000	.000	.000	.044	.044
3	779.4	557.8	473.8	368.0	1.000	.621	.722	.274	1.617
4	924.3	545.9	435.2	288.6	1.000	.399	.795	.405	1.599
5	1518.6	499.0	369.0	165.7	1.000	.400	.000	.064	.464
6	2365.6	427.1	322.1	92.2	1.000	.000	.000	.127	.127
7	3049.3	371.1	302.6	64.0	1.000	.162	.000	.101	.263
8	4112.3	310.2	292.4	46.9	1.000	.037	.000	.033	.070
9	5183.1	271.7	290.2	40.7	1.000	.000	.000	.069	.069
10	5909.1	252.8	289.7	38.5	1.000	.011	.000	.011	.022
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						1.630	1.517	1.168	4.314

SETTLEMENT POINT : 363.0, 378.5

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	624.6	587.1	537.8	1.000	.000	.000	.046	.046
2	595.2	616.5	514.9	379.1	1.000	.000	.000	.056	.056
3	779.4	588.8	445.1	244.3	1.000	.800	.722	.488	2.010
4	924.3	538.2	381.7	145.5	1.000	.395	.795	.604	1.793
5	1518.6	418.9	295.3	54.1	1.000	.343	.000	.068	.410
6	2365.6	316.9	247.4	25.4	1.000	.000	.000	.099	.099
7	3049.3	261.5	229.3	18.6	1.000	.116	.000	.074	.190
8	4112.3	212.2	219.1	16.1	1.000	.026	.000	.022	.048

9	5183.1	184.0	216.5	16.1	1.000	.000	.000	.046	.046
10	5909.1	170.5	216.2	16.4	1.000	.007	.000	.007	.014
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						1.686	1.517	1.509	4.712

SETTLEMENT POINT : 357.8, 361.2

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	295.8	298.8	291.2	1.000	.000	.000	.019	.019
2	595.2	306.5	293.7	249.6	1.000	.000	.000	.023	.023
3	779.4	306.9	283.2	206.3	1.000	.260	.722	.124	1.106
4	924.3	302.9	270.7	162.7	1.000	.244	.795	.190	1.228
5	1518.6	282.4	247.1	94.5	1.000	.240	.000	.031	.271
6	2365.6	248.4	229.3	53.1	1.000	.000	.000	.069	.069
7	3049.3	221.2	222.1	36.9	1.000	.099	.000	.049	.148
8	4112.3	191.2	219.1	26.9	1.000	.023	.000	.016	.039
9	5183.1	171.7	219.7	23.2	1.000	.000	.000	.040	.040
10	5909.1	161.9	220.7	22.0	1.000	.007	.000	.005	.012
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						.872	1.517	.565	2.955

SETTLEMENT POINT : 411.5, 364.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	249.9	238.8	215.3	1.000	.000	.000	.018	.018
2	595.2	246.7	217.8	152.0	1.000	.000	.000	.022	.022
3	779.4	235.9	198.1	98.3	1.000	.207	.722	.175	1.105
4	924.3	216.5	181.3	59.1	1.000	.181	.795	.212	1.188
5	1518.6	171.5	161.4	22.9	1.000	.151	.000	.022	.173
6	2365.6	134.5	154.6	11.7	1.000	.000	.000	.036	.036
7	3049.3	115.3	154.9	9.2	1.000	.052	.000	.018	.070
8	4112.3	99.4	158.4	8.5	1.000	.012	.000	.004	.016
9	5183.1	91.2	162.3	8.8	1.000	.000	.000	.016	.016
10	5909.1	87.6	164.9	9.1	1.000	.004	.000	.000	.004
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						.607	1.517	.522	2.646

SETTLEMENT POINT : 405.6, 346.6

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	97.0	112.9	116.6	1.000	.000	.000	.005	.005
2	595.2	115.4	126.0	101.0	1.000	.000	.000	.008	.008
3	779.4	119.2	131.5	84.4	1.000	.111	.722	.022	.856

4	924.3	120.0	135.6	67.6	1.000	.105	.795	.041	.940
5	1518.6	116.1	141.1	40.9	1.000	.104	.000	.007	.111
6	2365.6	106.9	146.8	24.4	1.000	.000	.000	.023	.023
7	3049.3	99.2	151.9	17.9	1.000	.045	.000	.008	.053
8	4112.3	91.0	158.8	14.0	1.000	.011	.000	.001	.012
9	5183.1	86.3	164.4	12.6	1.000	.000	.000	.013	.013
10	5909.1	84.3	167.7	12.3	1.000	.004	.000	-.001	.003
						---	---	---	---
						.380	1.517	.127	2.024

SETTLEMENT POINT : 171.0, 407.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.2	102.3	34.5	1.000	.000	.000	-.007	-.007
2	595.2	4.5	299.0	101.2	1.000	.000	.000	-.018	-.018
3	779.4	22.0	494.3	168.8	1.000	.022	.722	-.619	.125
4	924.3	63.7	673.4	233.3	1.000	.057	.795	-.857	-.005
5	1518.6	216.4	887.3	318.7	1.000	.187	.000	-.107	.080
6	2365.6	415.3	926.2	344.3	1.000	.000	.000	.014	.014
7	3049.3	545.2	880.0	332.8	1.000	.231	.000	-.033	.198
8	4112.3	661.3	781.5	299.1	1.000	.076	.000	.028	.104
9	5183.1	718.2	689.4	264.8	1.000	.000	.000	.173	.173
10	5909.1	738.9	630.4	242.4	1.000	.031	.000	.036	.067
						---	---	---	---
						.605	1.517	-1.390	.732

SETTLEMENT POINT : 193.0, 407.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.1	65.0	14.8	1.000	.000	.000	-.004	-.004
2	595.2	1.6	192.1	43.7	1.000	.000	.000	-.011	-.011
3	779.4	8.0	324.8	74.4	1.000	.008	.722	-.383	.347
4	924.3	24.4	458.7	106.2	1.000	.022	.795	-.568	.249
5	1518.6	95.3	663.0	159.0	1.000	.086	.000	-.087	-.002
6	2365.6	214.3	760.9	191.4	1.000	.000	.000	-.030	-.030
7	3049.3	312.3	765.3	200.0	1.000	.137	.000	-.092	.045
8	4112.3	421.3	716.8	195.7	1.000	.050	.000	-.008	.041
9	5183.1	489.9	653.1	184.0	1.000	.000	.000	.096	.096
10	5909.1	522.7	607.4	174.1	1.000	.022	.000	.016	.038
						---	---	---	---
						.325	1.517	-1.072	.770

URS

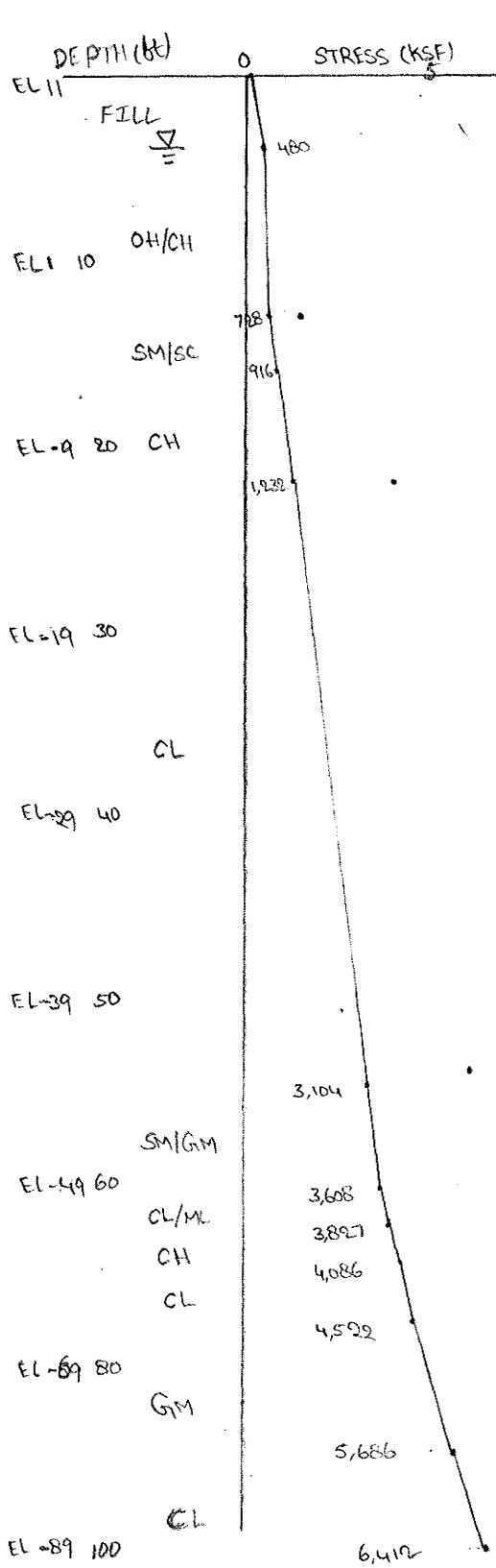
Page ____ of ____

Job BROADWAY INTERCHANGE RECONSTRUCTION Project No. 28645286 Sheet ____ of ____

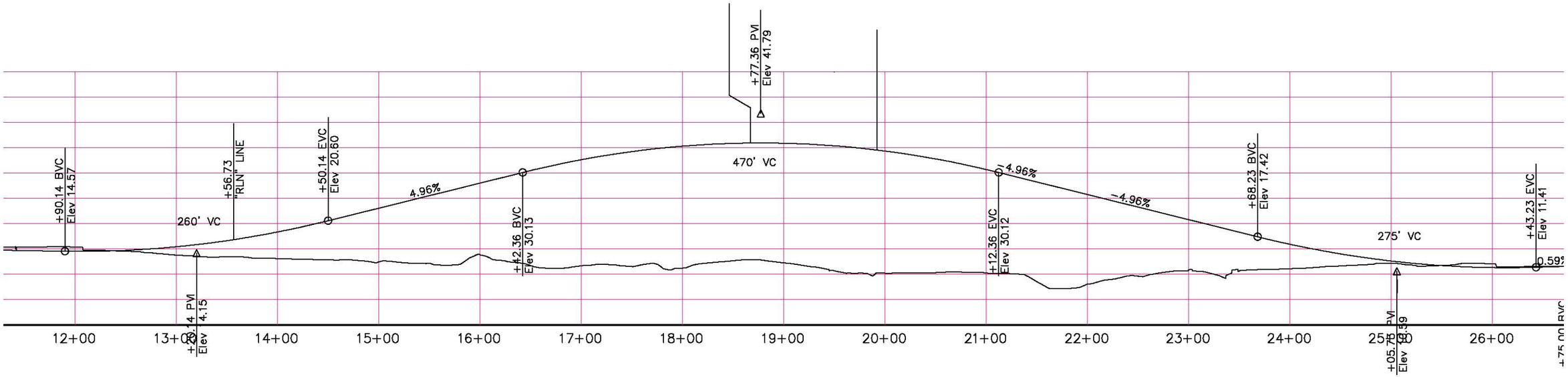
Description BROADWAY WEST APPROACH EMBANKMENT SETTLEMENT Computed by MT Date 12/8/11

Checked by SHUANG Date 1/20/12

Reference



	γ' PCF	C_{CE}	$C_{\gamma E}$	P_p (KSF)	E $\times 10^6$ PSF	μ	C_α	A	t_{ZERO}	S_u/σ_{vo}
FILL	120	-	-		0.30	0.3	-	1	10	
OH/CH	27.6	0.30	0.03	1.3 / 1.8	0.03	0.5	0.015	1	10	
SM/SC	62.6	-	-	-	0.23	0.3	-	1	10	
CH	52.6	0.19	0.02	3.5	0.26	0.5	-	1	10	
CL	57.6	0.12	0.015	4.5 / 5.5	0.78	0.5	-	1	10	
SM/GM	77.6	-	-		0.80	0.4	-	1	10	
CL/ML	62.6	0.12	0.015	7.0	0.70	0.5	-	1	10	
CH	57.6	0.19	0.02		1.00	0.5	-	1	10	
CL	72.6	0.05	0.005		1.00	0.5	-	1	10	
GM	77.6	-	-		1.65	0.4	-	1	10	
CL	72.6	0.05	0.005		1.00	0.5	-	1	10	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Elev 41.79
+90.14 BVC
Elev 14.57
+56.73
"RLN" LINE
+50.14 EVC
Elev 20.60
470' VC
4.96%
-4.96%
+68.23 BVC
Elev 17.42
+43.23 EVC
Elev 11.41
260' VC
275' VC
+42.36 BVC
Elev 30.13
+12.36 EVC
Elev 30.12
+29.14 PVI
Elev 4.15
+05.75 PVI
Elev 19.59
12+00
13+00
14+00
15+00
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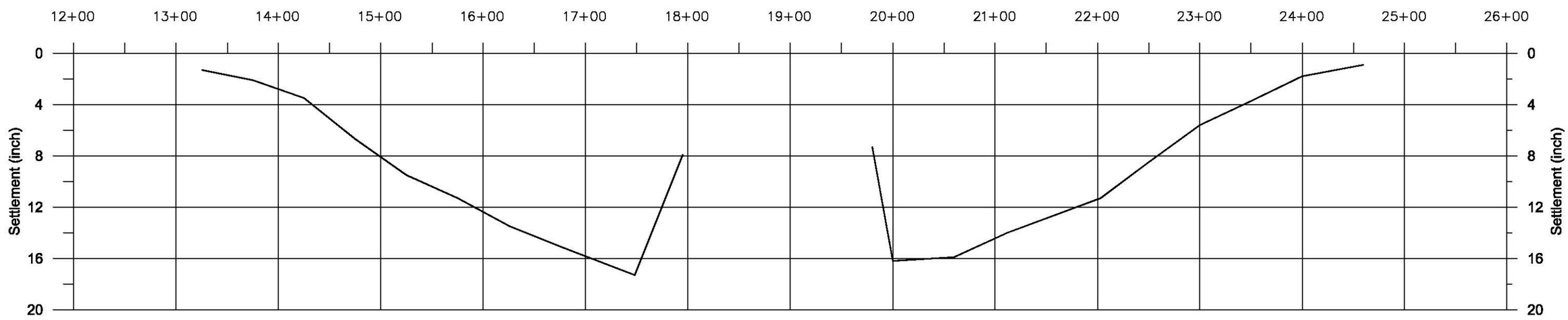
26+00

"BWY" LINE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15+00
16+00
17+00
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19+00
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21+00
22+00
23+00
24+00
25+00
26+00
Settlement (inch)
0
4
8
12
16
20

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1
FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

bwy_2.dat
NUMBER OF SOIL LAYERS: 13

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	11.0	7.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	7.0	3.0	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
3	3.0	-2.0	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
4	-2.0	-5.0	62.6	.000	.000	3000.0	.230	.30	.00000	1.000	5.00
5	-5.0	-11.0	52.6	.190	.020	3500.0	.260	.50	.00000	1.000	5.00
6	-11.0	-27.0	57.6	.120	.015	4500.0	.780	.50	.00000	1.000	5.00
7	-27.0	-43.5	57.6	.120	.015	5500.0	.780	.50	.00000	1.000	5.00
8	-43.5	-50.0	77.6	.000	.000	6500.0	.800	.40	.00000	1.000	5.00
9	-50.0	-53.5	62.6	.120	.015	7000.0	.700	.50	.00000	1.000	5.00
10	-53.5	-58.0	57.6	.190	.020	7500.0	1.000	.50	.00000	1.000	5.00
11	-58.0	-64.0	72.6	.050	.005	8000.0	1.000	.50	.00000	1.000	5.00
12	-64.0	-79.0	77.6	.000	.000	9000.0	1.700	.40	.00000	1.000	5.00
13	-79.0	-89.0	72.6	.050	.005	10000.0	1.000	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 36

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	62.50	25.00	.00	11.00	125.00	50.00	375.00
2	62.50	75.00	.00	11.00	125.00	50.00	625.00
3	62.50	125.00	.00	11.00	125.00	50.00	938.00
4	62.50	175.00	.00	11.00	125.00	50.00	1375.00
5	62.50	225.00	.00	11.00	125.00	50.00	1750.00
6	65.00	275.00	.00	11.00	130.00	50.00	2000.00
7	74.00	325.00	.00	11.00	125.00	50.00	2375.00
8	74.00	375.00	.00	11.00	125.00	50.00	2625.00
9	74.00	447.00	.00	11.00	125.00	93.80	3000.00
10	148.00	443.00	16.70	11.00	13.50	36.00	3000.00
11	193.00	430.00	16.70	11.00	80.00	36.00	.10
12	261.00	409.50	16.70	11.00	62.70	36.00	1625.00
13	315.00	393.00	16.70	11.00	50.00	36.00	1125.00
14	363.00	378.50	16.70	11.00	50.00	36.00	625.00
15	411.50	364.00	16.70	11.00	50.00	36.00	250.00
16	-31.00	482.00	14.10	11.00	76.40	61.10	3000.00
17	-116.50	503.70	14.10	11.00	100.00	61.10	2625.00
18	-213.50	528.00	14.10	11.00	100.00	61.10	2250.00
19	-309.10	557.60	14.10	11.00	100.00	50.00	1500.00
20	-405.10	585.50	14.10	11.00	100.00	42.00	1000.00
21	-501.50	613.00	14.10	11.00	100.00	36.00	625.00
22	-598.40	637.40	14.10	11.00	100.00	36.00	375.00
23	-695.40	661.70	14.10	11.00	100.00	36.00	250.00

24	-65.30	450.80	14.10	11.00	153.60	16.30	2500.00
25	-68.80	433.00	14.10	11.00	118.90	20.00	2125.00
26	-73.80	413.60	14.10	11.00	88.06	20.00	1500.00
27	-73.50	398.10	14.10	11.00	69.30	10.00	1000.00
28	-75.10	388.20	14.10	11.00	52.06	10.00	750.00
29	-76.60	378.20	14.10	11.00	34.43	10.00	500.00
30	-63.70	349.10	.00	11.00	10.00	40.12	500.00
31	-53.70	344.20	.00	11.00	10.00	66.10	750.00
32	-43.60	338.50	.00	11.00	10.00	91.39	1000.00
33	-33.10	335.20	.00	11.00	10.00	115.70	1500.00
34	-18.70	321.00	.00	11.00	19.98	174.87	2125.00
35	-4.40	266.90	.00	11.00	8.62	66.38	2125.00
36	.40	361.90	.00	11.00	20.00	123.84	2500.00

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TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5
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SETTLEMENT POINT : 74.0, 493.8

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1595.3	1507.8	1472.5	1.000	.002	.000	.112	.114
2	535.2	1531.5	1396.8	1417.5	1.000	3.454	.578	.199	4.231
3	659.4	1516.7	1302.5	1356.2	1.000	2.268	.722	.375	3.365
4	822.3	1509.3	1224.8	1302.5	1.000	.000	.000	.118	.118
5	1074.0	1501.8	1142.4	1243.2	1.000	.547	.000	.086	.633
6	1692.6	1477.7	963.0	1105.2	1.000	.785	.000	.109	.894
7	2628.6	1422.6	755.0	923.3	1.000	.558	.000	.148	.706
8	3356.0	1373.0	642.6	811.8	1.000	.000	.000	.077	.077
9	3717.7	1349.8	601.0	767.7	1.000	.085	.000	.040	.125
10	3956.9	1330.8	570.3	734.3	1.000	.136	.000	.037	.173
11	4304.3	1305.6	533.3	692.7	1.000	.041	.000	.050	.091
12	5104.1	1254.4	468.7	617.1	1.000	.000	.000	.087	.087
13	6049.1	1193.9	405.0	538.9	1.000	.047	.000	.087	.134
						7.924	1.300	1.523	10.748

SETTLEMENT POINT : 74.0, 447.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2999.9	2898.5	2881.3	1.000	.003	.000	.203	.206
2	535.2	2998.0	2697.0	2646.6	1.000	6.808	.578	.522	7.908
3	659.4	2989.7	2476.2	2392.6	1.000	6.309	.722	1.111	8.142
4	822.3	2974.0	2288.1	2180.4	1.000	.000	.000	.256	.256
5	1074.0	2945.4	2088.3	1960.8	1.000	1.561	.000	.255	1.816
6	1692.6	2826.0	1663.3	1517.7	1.000	1.264	.000	.304	1.568
7	2628.6	2565.0	1200.8	1075.9	1.000	.878	.000	.362	1.240
8	3356.0	2362.4	970.4	869.5	1.000	.000	.000	.159	.159
9	3717.7	2276.2	889.1	798.2	1.000	.131	.000	.086	.217
10	3956.9	2209.0	830.8	747.3	1.000	.208	.000	.077	.285
11	4304.3	2123.8	762.2	687.7	1.000	.063	.000	.101	.163
12	5104.1	1964.4	647.3	587.8	1.000	.000	.000	.156	.156
13	6049.1	1794.7	540.1	494.1	1.000	.068	.000	.153	.221
						17.294	1.300	3.743	22.337

SETTLEMENT POINT : 74.0, 375.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2625.0	2545.6	2565.1	1.000	.003	.000	.175	.178

2	535.2	2624.6	2387.9	2445.2	1.000	6.109	.578	.333	7.020
3	659.4	2622.6	2214.0	2310.6	1.000	5.480	.722	.721	6.924
4	822.3	2618.4	2064.4	2191.6	1.000	.000	.000	.210	.210
5	1074.0	2610.0	1903.6	2059.6	1.000	1.043	.000	.174	1.217
6	1692.6	2567.7	1552.4	1751.9	1.000	1.155	.000	.225	1.380
7	2628.6	2447.3	1151.1	1357.3	1.000	.849	.000	.303	1.152
8	3356.0	2332.1	941.5	1127.4	1.000	.000	.000	.147	.147
9	3717.7	2277.5	865.8	1039.8	1.000	.131	.000	.079	.210
10	3956.9	2232.7	811.0	974.8	1.000	.210	.000	.072	.282
11	4304.3	2172.8	745.9	895.8	1.000	.064	.000	.097	.161
12	5104.1	2052.1	635.5	757.8	1.000	.000	.000	.158	.159
13	6049.1	1910.9	531.2	623.5	1.000	.072	.000	.160	.232
						---	---	---	---
						15.116	1.300	2.855	19.271

SETTLEMENT POINT : 136.5, 375.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1312.5	1295.3	1293.0	1.000	.002	.000	.086	.087
2	535.2	1312.7	1260.8	1253.5	1.000	2.754	.578	.089	3.421
3	659.4	1313.4	1222.0	1207.9	1.000	1.501	.722	.197	2.421
4	822.3	1314.5	1187.3	1165.9	1.000	.000	.000	.095	.095
5	1074.0	1316.1	1148.3	1117.0	1.000	.500	.000	.051	.551
6	1692.6	1319.8	1053.4	992.8	1.000	.721	.000	.073	.794
7	2628.6	1315.1	917.6	812.9	1.000	.523	.000	.114	.637
8	3356.0	1300.6	827.3	698.4	1.000	.000	.000	.067	.067
9	3717.7	1291.5	789.9	652.9	1.000	.082	.000	.034	.116
10	3956.9	1282.9	760.9	618.6	1.000	.132	.000	.032	.164
11	4304.3	1270.3	724.1	576.1	1.000	.040	.000	.045	.085
12	5104.1	1240.9	654.8	499.9	1.000	.000	.000	.082	.083
13	6049.1	1200.1	580.1	422.9	1.000	.047	.000	.084	.131
						---	---	---	---
						6.303	1.300	1.049	8.653

SETTLEMENT POINT : .4, 361.9

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2499.5	2380.7	2414.5	1.000	.003	.000	.170	.173
2	535.2	2487.5	2164.2	2250.3	1.000	5.832	.578	.448	6.858
3	659.4	2455.0	1969.8	2084.3	1.000	5.071	.722	.856	6.649
4	822.3	2420.6	1827.1	1952.8	1.000	.000	.000	.201	.202
5	1074.0	2381.0	1687.6	1819.2	1.000	.731	.000	.174	.904
6	1692.6	2281.6	1411.8	1540.5	1.000	1.068	.000	.198	1.266
7	2628.6	2133.9	1112.5	1218.3	1.000	.767	.000	.246	1.012
8	3356.0	2033.6	947.8	1036.6	1.000	.000	.000	.121	.121
9	3717.7	1991.1	885.0	967.0	1.000	.117	.000	.064	.181
10	3956.9	1957.6	838.0	914.9	1.000	.189	.000	.058	.247
11	4304.3	1914.1	780.3	851.0	1.000	.058	.000	.079	.137
12	5104.1	1828.5	677.4	736.9	1.000	.000	.000	.134	.134
13	6049.1	1729.0	573.7	622.1	1.000	.066	.000	.136	.201

13.900	1.300	2.885	18.085

SETTLEMENT POINT : 74.0, 325.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2375.0	2299.0	2319.5	1.000	.003	.000	.158	.161
2	535.2	2374.1	2148.0	2209.4	1.000	5.593	.578	.313	6.483
3	659.4	2370.4	1982.3	2088.6	1.000	4.856	.722	.670	6.248
4	822.3	2363.7	1840.5	1985.0	1.000	.000	.000	.190	.190
5	1074.0	2351.7	1689.1	1873.2	1.000	.725	.000	.158	.883
6	1692.6	2302.3	1362.0	1621.4	1.000	1.074	.000	.200	1.274
7	2628.6	2185.8	994.1	1302.9	1.000	.781	.000	.263	1.044
8	3356.0	2083.3	804.9	1113.6	1.000	.000	.000	.128	.128
9	3717.7	2036.1	737.2	1039.8	1.000	.119	.000	.069	.188
10	3956.9	1997.6	688.4	984.3	1.000	.192	.000	.063	.254
11	4304.3	1946.7	630.8	916.0	1.000	.058	.000	.084	.143
12	5104.1	1844.8	534.2	793.7	1.000	.000	.000	.139	.139
13	6049.1	1726.3	444.2	670.1	1.000	.065	.000	.140	.206
						13.467	1.300	2.576	17.343

SETTLEMENT POINT : 136.5, 325.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1187.5	1170.0	1158.4	1.000	.001	.000	.078	.080
2	535.2	1186.5	1135.0	1102.1	1.000	2.312	.578	.109	2.999
3	659.4	1183.2	1096.2	1045.0	1.000	.968	.722	.225	1.915
4	822.3	1178.1	1062.2	1000.7	1.000	.000	.000	.088	.088
5	1074.0	1171.1	1024.7	957.1	1.000	.461	.000	.050	.511
6	1692.6	1153.7	936.2	867.5	1.000	.650	.000	.062	.712
7	2628.6	1133.6	814.3	751.2	1.000	.462	.000	.089	.552
8	3356.0	1120.4	734.7	674.1	1.000	.000	.000	.054	.054
9	3717.7	1114.1	701.9	641.8	1.000	.072	.000	.027	.098
10	3956.9	1108.8	676.6	616.7	1.000	.116	.000	.025	.141
11	4304.3	1101.2	644.4	584.6	1.000	.036	.000	.035	.071
12	5104.1	1083.9	583.9	523.9	1.000	.000	.000	.068	.068
13	6049.1	1059.6	518.7	457.9	1.000	.042	.000	.069	.111
						5.121	1.300	.978	7.399

SETTLEMENT POINT : 65.0, 275.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)

1	240.0	2000.0	1937.7	1964.8	1.000	.002	.000	.133	.135
2	535.2	1999.9	1813.8	1894.1	1.000	4.732	.578	.233	5.543
3	659.4	1999.2	1676.6	1813.6	1.000	3.834	.722	.508	5.064
4	822.3	1997.3	1558.1	1741.1	1.000	.000	.000	.158	.158
5	1074.0	1993.0	1430.0	1659.4	1.000	.656	.000	.124	.780
6	1692.6	1967.2	1147.5	1464.3	1.000	.965	.000	.163	1.127
7	2628.6	1886.3	821.3	1204.9	1.000	.698	.000	.222	.919
8	3356.0	1805.6	652.1	1047.6	1.000	.000	.000	.110	.110
9	3717.7	1766.9	591.9	985.9	1.000	.106	.000	.059	.165
10	3956.9	1734.9	548.7	939.3	1.000	.171	.000	.054	.224
11	4304.3	1692.1	498.2	881.7	1.000	.052	.000	.072	.124
12	5104.1	1605.4	414.6	777.8	1.000	.000	.000	.119	.120
13	6049.1	1503.8	339.0	671.3	1.000	.058	.000	.120	.178
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						11.273	1.300	2.074	14.648

SETTLEMENT POINT : 130.0, 275.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1000.0	986.0	994.5	1.000	.001	.000	.065	.066
2	535.2	1000.5	958.0	982.3	1.000	1.597	.578	.049	2.224
3	659.4	1002.4	926.4	965.1	1.000	.723	.722	.113	1.558
4	822.3	1005.1	898.1	946.3	1.000	.000	.000	.071	.071
5	1074.0	1008.7	866.2	921.6	1.000	.414	.000	.032	.446
6	1692.6	1015.9	788.8	852.9	1.000	.588	.000	.048	.636
7	2628.6	1016.3	679.9	748.3	1.000	.422	.000	.077	.498
8	3356.0	1009.3	608.9	678.1	1.000	.000	.000	.048	.048
9	3717.7	1004.6	579.9	649.0	1.000	.065	.000	.023	.089
10	3956.9	1000.3	557.5	626.3	1.000	.106	.000	.022	.128
11	4304.3	993.8	529.3	597.5	1.000	.032	.000	.031	.063
12	5104.1	978.4	476.9	542.8	1.000	.000	.000	.060	.061
13	6049.1	956.4	421.3	483.1	1.000	.038	.000	.061	.099
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						3.987	1.300	.700	5.987

SETTLEMENT POINT : 62.5, 225.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1750.0	1685.6	1711.9	1.000	.002	.000	.117	.119
2	535.2	1749.2	1558.0	1636.4	1.000	4.080	.578	.243	4.902
3	659.4	1745.8	1418.2	1554.2	1.000	3.051	.722	.519	4.292
4	822.3	1739.6	1299.2	1484.4	1.000	.000	.000	.142	.142
5	1074.0	1728.8	1173.0	1409.8	1.000	.600	.000	.121	.721
6	1692.6	1685.0	904.9	1244.2	1.000	.864	.000	.150	1.014
7	2628.6	1584.7	615.8	1037.5	1.000	.609	.000	.192	.801
8	3356.0	1499.5	475.7	914.9	1.000	.000	.000	.092	.092
9	3717.7	1461.1	427.6	866.9	1.000	.091	.000	.049	.140
10	3956.9	1430.4	393.7	830.7	1.000	.145	.000	.044	.189
11	4304.3	1390.2	354.7	785.9	1.000	.044	.000	.059	.103

12	5104.1	1311.7	291.8	704.6	1.000	.000	.000	.097	.097
13	6049.1	1223.7	236.7	620.6	1.000	.048	.000	.095	.143
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						9.533	1.300	1.921	12.754

SETTLEMENT POINT : 125.0, 225.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	875.0	859.2	870.7	1.000	.001	.000	.057	.058
2	535.2	875.4	827.8	861.1	1.000	1.066	.578	.050	1.693
3	659.4	876.7	792.8	847.2	1.000	.661	.722	.114	1.497
4	822.3	878.6	762.2	831.8	1.000	.000	.000	.063	.063
5	1074.0	880.7	728.6	811.7	1.000	.375	.000	.031	.405
6	1692.6	883.1	650.6	756.9	1.000	.525	.000	.044	.569
7	2628.6	876.8	547.0	675.3	1.000	.371	.000	.067	.439
8	3356.0	866.9	482.7	620.7	1.000	.000	.000	.041	.042
9	3717.7	861.5	457.0	598.0	1.000	.057	.000	.020	.077
10	3956.9	856.6	437.4	580.2	1.000	.092	.000	.019	.111
11	4304.3	849.8	413.1	557.4	1.000	.028	.000	.026	.054
12	5104.1	834.4	368.7	513.9	1.000	.000	.000	.051	.051
13	6049.1	813.8	322.8	465.8	1.000	.033	.000	.050	.083
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						3.209	1.300	.633	5.142

SETTLEMENT POINT : 62.5, 175.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1375.0	1320.6	1347.1	1.000	.002	.000	.092	.094
2	535.2	1374.4	1212.8	1291.8	1.000	2.960	.578	.195	3.733
3	659.4	1371.7	1095.0	1231.2	1.000	1.729	.722	.417	2.869
4	822.3	1366.8	994.9	1179.3	1.000	.000	.000	.112	.112
5	1074.0	1358.0	889.3	1123.7	1.000	.511	.000	.097	.608
6	1692.6	1320.9	667.6	999.7	1.000	.722	.000	.120	.841
7	2628.6	1234.5	436.3	845.9	1.000	.497	.000	.151	.647
8	3356.0	1161.8	328.9	755.7	1.000	.000	.000	.071	.071
9	3717.7	1129.5	293.1	720.5	1.000	.073	.000	.037	.110
10	3956.9	1103.9	268.2	694.1	1.000	.115	.000	.034	.149
11	4304.3	1070.8	240.0	661.3	1.000	.035	.000	.045	.079
12	5104.1	1007.2	195.5	601.8	1.000	.000	.000	.073	.073
13	6049.1	937.7	157.8	540.0	1.000	.038	.000	.071	.108
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						6.680	1.300	1.514	9.495

SETTLEMENT POINT : 125.0, 175.0

SOIL	INITIAL	VERTICAL STRESS	HORIZ. X STRESS	HORIZ. Y STRESS	SKEMPTON BJERRUM	CONSOL.	SECOND. COMP.	ELASTIC	TOTAL

LAYER	STRESS (PSF)	INCREASE (PSF)	INCREASE (PSF)	INCREASE (PSF)	FACTOR	COMP. (IN.)	20. YR (IN.)	COMP. (IN.)	COMP. (IN.)
1	240.0	687.5	674.6	680.4	1.000	.001	.000	.045	.046
2	535.2	687.4	648.9	666.3	1.000	.517	.578	.048	1.142
3	659.4	687.0	620.3	650.9	1.000	.558	.722	.103	1.383
4	822.3	686.3	595.3	637.7	1.000	.000	.000	.050	.050
5	1074.0	685.3	567.7	623.4	1.000	.309	.000	.025	.333
6	1692.6	681.5	503.6	589.9	1.000	.423	.000	.033	.456
7	2628.6	673.3	418.9	542.1	1.000	.294	.000	.049	.343
8	3356.0	665.3	366.9	509.0	1.000	.000	.000	.031	.031
9	3717.7	661.2	346.3	494.8	1.000	.045	.000	.014	.059
10	3956.9	657.7	330.7	483.5	1.000	.072	.000	.014	.086
11	4304.3	652.7	311.5	469.0	1.000	.022	.000	.019	.041
12	5104.1	641.7	276.7	440.5	1.000	.000	.000	.038	.038
13	6049.1	627.0	241.3	407.9	1.000	.026	.000	.036	.062
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						2.266	1.300	.503	4.070

SETTLEMENT POINT : 62.5, 125.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	938.0	902.0	927.1	1.000	.001	.000	.062	.063
2	535.2	938.0	830.6	904.8	1.000	1.337	.578	.112	2.028
3	659.4	937.8	752.0	878.2	1.000	.692	.722	.245	1.659
4	822.3	937.0	684.8	853.2	1.000	.000	.000	.074	.074
5	1074.0	934.7	613.1	823.7	1.000	.392	.000	.060	.451
6	1692.6	919.4	460.4	750.3	1.000	.543	.000	.077	.620
7	2628.6	870.7	298.6	650.9	1.000	.369	.000	.101	.470
8	3356.0	824.9	223.2	590.8	1.000	.000	.000	.049	.049
9	3717.7	803.8	198.0	567.3	1.000	.054	.000	.025	.079
10	3956.9	786.8	180.6	549.6	1.000	.085	.000	.023	.108
11	4304.3	764.7	161.0	527.6	1.000	.026	.000	.030	.056
12	5104.1	721.8	130.2	487.6	1.000	.000	.000	.050	.050
13	6049.1	674.5	104.5	446.0	1.000	.028	.000	.048	.075
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						3.525	1.300	.957	5.783

SETTLEMENT POINT : 125.0, 125.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	469.0	461.5	469.1	1.000	.000	.000	.030	.031
2	535.2	469.2	446.5	468.9	1.000	.394	.578	.018	.990
3	659.4	469.7	429.4	467.7	1.000	.420	.722	.042	1.185
4	822.3	470.6	414.1	465.5	1.000	.000	.000	.032	.032
5	1074.0	471.9	396.9	461.8	1.000	.228	.000	.012	.240
6	1692.6	475.0	355.0	448.8	1.000	.309	.000	.018	.327
7	2628.6	476.6	297.0	424.4	1.000	.215	.000	.029	.244
8	3356.0	474.7	260.4	405.6	1.000	.000	.000	.020	.020
9	3717.7	473.2	245.9	397.3	1.000	.033	.000	.009	.042

10	3956.9	471.7	234.8	390.6	1.000	.053	.000	.009	.061
11	4304.3	469.4	221.2	381.9	1.000	.016	.000	.012	.028
12	5104.1	463.7	196.5	364.4	1.000	.000	.000	.025	.025
13	6049.1	455.4	171.5	343.9	1.000	.019	.000	.024	.043
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						1.687	1.300	.282	3.270

SETTLEMENT POINT : 62.5, 75.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	625.0	600.7	618.5	1.000	.000	.000	.041	.042
2	535.2	624.9	552.5	605.4	1.000	.484	.578	.074	1.135
3	659.4	624.6	499.6	589.9	1.000	.521	.722	.160	1.403
4	822.3	623.8	454.3	575.4	1.000	.000	.000	.049	.049
5	1074.0	621.9	406.1	558.6	1.000	.286	.000	.039	.324
6	1692.6	610.6	303.9	517.5	1.000	.385	.000	.049	.434
7	2628.6	577.5	195.9	462.9	1.000	.256	.000	.063	.319
8	3356.0	547.2	145.8	430.3	1.000	.000	.000	.031	.031
9	3717.7	533.4	129.2	417.6	1.000	.037	.000	.016	.052
10	3956.9	522.4	117.7	407.9	1.000	.058	.000	.014	.072
11	4304.3	508.1	104.7	396.0	1.000	.017	.000	.019	.036
12	5104.1	480.8	84.5	374.1	1.000	.000	.000	.031	.032
13	6049.1	451.1	67.8	350.8	1.000	.019	.000	.029	.048
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						2.063	1.300	.615	3.978

SETTLEMENT POINT : 125.0, 75.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	312.5	307.4	313.6	1.000	.000	.000	.020	.020
2	535.2	312.6	297.1	315.6	1.000	.288	.578	.010	.876
3	659.4	312.9	285.5	317.3	1.000	.304	.722	.023	1.049
4	822.3	313.3	275.1	318.2	1.000	.000	.000	.021	.021
5	1074.0	314.0	263.5	318.6	1.000	.160	.000	.006	.167
6	1692.6	315.6	235.5	317.1	1.000	.214	.000	.010	.224
7	2628.6	316.5	197.2	311.0	1.000	.147	.000	.016	.163
8	3356.0	315.8	173.2	304.9	1.000	.000	.000	.012	.012
9	3717.7	315.1	163.7	301.9	1.000	.022	.000	.005	.027
10	3956.9	314.4	156.5	299.3	1.000	.036	.000	.005	.041
11	4304.3	313.3	147.5	295.8	1.000	.011	.000	.007	.018
12	5104.1	310.7	131.5	288.3	1.000	.000	.000	.015	.015
13	6049.1	306.9	115.3	278.6	1.000	.013	.000	.013	.026
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						1.194	1.300	.163	2.658

SETTLEMENT POINT : 62.5, 25.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	375.0	358.9	368.3	1.000	.000	.000	.025	.025
2	535.2	374.6	327.1	355.4	1.000	.332	.578	.053	.963
3	659.4	372.9	292.6	342.9	1.000	.350	.722	.110	1.183
4	822.3	370.1	263.8	333.8	1.000	.000	.000	.030	.030
5	1074.0	365.6	233.7	325.9	1.000	.183	.000	.024	.207
6	1692.6	350.7	172.2	313.2	1.000	.236	.000	.027	.262
7	2628.6	324.9	110.4	301.7	1.000	.150	.000	.030	.180
8	3356.0	307.0	82.5	294.6	1.000	.000	.000	.015	.015
9	3717.7	299.7	73.4	291.5	1.000	.021	.000	.007	.028
10	3956.9	294.1	67.2	288.9	1.000	.034	.000	.006	.040
11	4304.3	287.1	60.1	285.5	1.000	.010	.000	.008	.018
12	5104.1	274.4	49.2	278.5	1.000	.000	.000	.015	.015
13	6049.1	261.5	40.3	269.7	1.000	.011	.000	.013	.024
						1.328	1.300	.364	2.992

SETTLEMENT POINT : 125.0, 25.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	187.5	183.5	187.4	1.000	.000	.000	.012	.012
2	535.2	187.3	175.5	187.4	1.000	.188	.578	.009	.775
3	659.4	186.8	166.9	188.2	1.000	.195	.722	.018	.936
4	822.3	185.9	159.5	189.8	1.000	.000	.000	.013	.013
5	1074.0	184.6	151.7	192.5	1.000	.099	.000	.003	.103
6	1692.6	181.3	134.6	201.1	1.000	.127	.000	.003	.131
7	2628.6	178.5	113.3	212.8	1.000	.085	.000	.004	.089
8	3356.0	178.1	100.6	218.3	1.000	.000	.000	.005	.005
9	3717.7	178.2	95.7	219.9	1.000	.013	.000	.001	.014
10	3956.9	178.4	91.9	220.9	1.000	.021	.000	.001	.022
11	4304.3	178.7	87.3	221.8	1.000	.006	.000	.002	.008
12	5104.1	179.4	78.9	222.2	1.000	.000	.000	.006	.006
13	6049.1	180.3	70.5	220.8	1.000	.008	.000	.004	.012
						.742	1.300	.083	2.125

SETTLEMENT POINT : 148.0, 443.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2972.6	2224.6	2458.5	1.000	.003	.000	.251	.254
2	535.2	2612.1	1423.8	1639.9	1.000	6.085	.578	1.728	8.391
3	659.4	2127.0	1249.3	1149.8	1.000	4.201	.722	1.855	6.778
4	822.3	1836.1	1216.5	927.1	1.000	.000	.000	.187	.187
5	1074.0	1627.4	1184.9	788.8	1.000	.577	.000	.177	.754
6	1692.6	1371.7	1083.1	627.3	1.000	.742	.000	.127	.870
7	2628.6	1219.5	924.4	501.6	1.000	.492	.000	.129	.620

8	3356.0	1155.7	823.6	437.4	1.000	.000	.000	.064	.064
9	3717.7	1132.0	783.3	413.5	1.000	.073	.000	.032	.105
10	3956.9	1114.1	752.5	395.8	1.000	.116	.000	.029	.146
11	4304.3	1091.8	714.1	374.2	1.000	.035	.000	.039	.075
12	5104.1	1049.9	643.4	335.9	1.000	.000	.000	.070	.070
13	6049.1	1003.5	569.1	297.0	1.000	.040	.000	.068	.108
						---	---	---	---
						12.364	1.300	4.756	18.421

SETTLEMENT POINT : -31.0, 482.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2999.7	2877.6	2824.2	1.000	.003	.000	.206	.209
2	535.2	2993.5	2637.4	2482.8	1.000	6.800	.578	.693	8.071
3	659.4	2967.9	2382.4	2132.4	1.000	6.263	.722	1.421	8.406
4	822.3	2924.0	2175.5	1862.2	1.000	.000	.000	.268	.268
5	1074.0	2852.3	1968.2	1608.3	1.000	1.422	.000	.295	1.716
6	1692.6	2617.4	1568.4	1176.4	1.000	1.169	.000	.306	1.476
7	2628.6	2260.4	1175.7	832.6	1.000	.800	.000	.319	1.119
8	3356.0	2049.4	981.2	688.5	1.000	.000	.000	.135	.135
9	3717.7	1969.1	910.6	639.4	1.000	.116	.000	.072	.188
10	3956.9	1909.3	858.9	604.3	1.000	.185	.000	.064	.248
11	4304.3	1836.1	796.8	562.9	1.000	.056	.000	.083	.139
12	5104.1	1705.1	688.8	492.7	1.000	.000	.000	.130	.131
13	6049.1	1570.7	583.1	425.0	1.000	.060	.000	.128	.188
						---	---	---	---
						16.874	1.300	4.121	22.295

SETTLEMENT POINT : -23.5, 511.9

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1239.4	1325.3	1468.3	1.000	.002	.000	.064	.066
2	535.2	1411.5	1326.4	1409.9	1.000	3.080	.578	.069	3.727
3	659.4	1446.3	1253.1	1343.2	1.000	2.011	.722	.296	3.030
4	822.3	1455.1	1184.1	1284.9	1.000	.000	.000	.112	.112
5	1074.0	1455.0	1110.6	1221.0	1.000	.536	.000	.080	.616
6	1692.6	1432.9	957.8	1074.1	1.000	.767	.000	.103	.870
7	2628.6	1377.3	786.5	886.1	1.000	.543	.000	.137	.681
8	3356.0	1332.8	689.1	774.2	1.000	.000	.000	.073	.073
9	3717.7	1313.0	651.0	730.6	1.000	.083	.000	.037	.120
10	3956.9	1296.9	622.1	697.7	1.000	.133	.000	.034	.167
11	4304.3	1275.6	586.3	657.1	1.000	.041	.000	.047	.088
12	5104.1	1232.4	520.7	584.1	1.000	.000	.000	.084	.084
13	6049.1	1180.4	452.5	509.5	1.000	.046	.000	.084	.130
						---	---	---	---
						7.242	1.300	1.221	9.764

SETTLEMENT POINT : 151.4, 308.3

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1.0	166.8	68.4	1.000	.000	.000	-.011	-.011
2	535.2	23.4	455.5	195.9	1.000	.027	.578	-.484	.121
3	659.4	91.5	668.9	312.7	1.000	.102	.722	-.799	.025
4	822.3	173.5	772.6	390.3	1.000	.000	.000	-.027	-.027
5	1074.0	268.1	828.6	452.4	1.000	.139	.000	-.103	.036
6	1692.6	457.9	844.2	528.6	1.000	.299	.000	-.056	.243
7	2628.6	630.2	773.8	540.3	1.000	.277	.000	-.007	.270
8	3356.0	702.9	710.5	517.3	1.000	.000	.000	.021	.021
9	3717.7	726.1	682.7	503.4	1.000	.049	.000	.008	.057
10	3956.9	741.7	660.7	491.3	1.000	.081	.000	.009	.090
11	4304.3	758.9	632.4	474.3	1.000	.025	.000	.015	.040
12	5104.1	783.6	577.9	438.6	1.000	.000	.000	.040	.040
13	6049.1	799.8	517.7	395.2	1.000	.032	.000	.041	.074
						---	---	---	---
						1.032	1.300	-1.354	.978

SETTLEMENT POINT : 152.1, 286.4

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.4	111.2	58.0	1.000	.000	.000	-.008	-.008
2	535.2	9.7	317.5	168.2	1.000	.011	.578	-.373	.216
3	659.4	43.9	501.0	273.8	1.000	.050	.722	-.687	.086
4	822.3	94.7	613.9	347.4	1.000	.000	.000	-.030	-.030
5	1074.0	165.2	692.4	408.8	1.000	.089	.000	-.107	-.017
6	1692.6	339.7	752.4	488.5	1.000	.229	.000	-.069	.160
7	2628.6	524.1	710.0	509.7	1.000	.235	.000	-.022	.213
8	3356.0	605.9	656.1	494.1	1.000	.000	.000	.014	.014
9	3717.7	632.5	631.5	483.4	1.000	.043	.000	.005	.047
10	3956.9	650.7	611.7	473.6	1.000	.071	.000	.006	.077
11	4304.3	670.9	586.0	459.7	1.000	.023	.000	.011	.033
12	5104.1	701.0	536.2	429.5	1.000	.000	.000	.033	.033
13	6049.1	722.8	480.9	391.8	1.000	.029	.000	.034	.064
						---	---	---	---
						.781	1.300	-1.193	.888

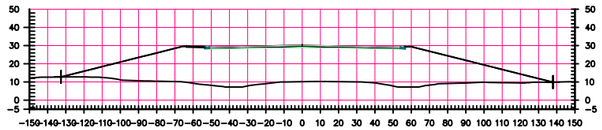
SETTLEMENT POINT : 171.0, 407.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.2	102.3	34.5	1.000	.000	.000	-.007	-.007
2	535.2	4.5	299.0	101.2	1.000	.005	.578	-.313	.270
3	659.4	22.0	494.3	168.8	1.000	.026	.722	-.619	.129
4	822.3	51.7	635.9	219.5	1.000	.000	.000	-.032	-.032
5	1074.0	99.8	756.5	264.7	1.000	.056	.000	-.114	-.058

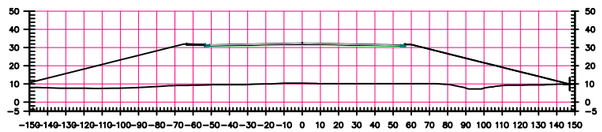
6	1692.6	253.1	906.7	328.0	1.000	.174	.000	-.090	.085
7	2628.6	468.8	913.6	342.2	1.000	.212	.000	-.040	.171
8	3356.0	579.5	858.0	325.8	1.000	.000	.000	.010	.010
9	3717.7	616.6	828.3	315.7	1.000	.042	.000	.003	.045
10	3956.9	641.9	803.5	307.0	1.000	.071	.000	.005	.075
11	4304.3	670.0	770.4	295.1	1.000	.023	.000	.010	.033
12	5104.1	711.0	704.7	270.6	1.000	.000	.000	.034	.034
13	6049.1	738.9	630.4	242.4	1.000	.030	.000	.036	.066
						---	---	---	---
						.638	1.300	-1.117	.821

SETTLEMENT POINT : 193.0, 407.0

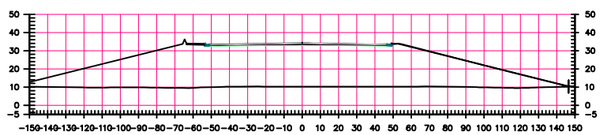
SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	.1	65.0	14.8	1.000	.000	.000	-.004	-.004
2	535.2	1.6	192.1	43.7	1.000	.002	.578	-.186	.394
3	659.4	8.0	324.8	74.4	1.000	.009	.722	-.383	.349
4	822.3	19.5	429.1	99.1	1.000	.000	.000	-.022	-.022
5	1074.0	39.6	528.5	123.5	1.000	.023	.000	-.079	-.057
6	1692.6	114.8	690.4	166.9	1.000	.082	.000	-.077	.005
7	2628.6	252.4	768.5	196.2	1.000	.118	.000	-.058	.060
8	3356.0	341.9	757.5	200.3	1.000	.000	.000	-.004	-.004
9	3717.7	376.1	743.6	199.3	1.000	.026	.000	-.006	.021
10	3956.9	401.1	730.0	197.7	1.000	.045	.000	-.003	.042
11	4304.3	430.8	709.8	194.6	1.000	.015	.000	-.002	.013
12	5104.1	480.0	664.4	186.3	1.000	.000	.000	.015	.015
13	6049.1	522.7	607.4	174.1	1.000	.022	.000	.016	.037
						---	---	---	---
						.343	1.300	-.794	.849



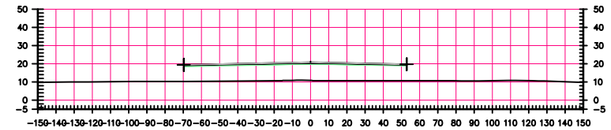
21+12
(x,y) = (-2.5, 145); H=20 ft



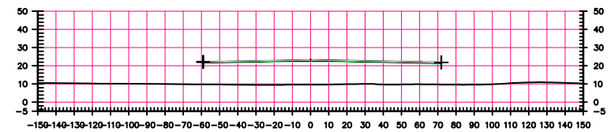
20+60
(x,y) = (-2.5, 75); H=22 ft



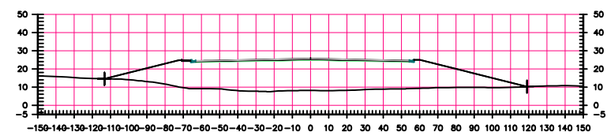
20+10
(x,y) = (-5, 25); H=24 ft



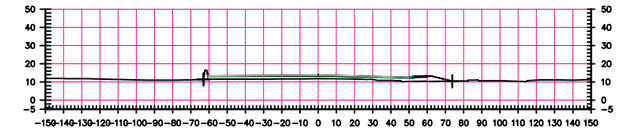
23+00
(x,y) = (-7.5, 315); H=10 ft



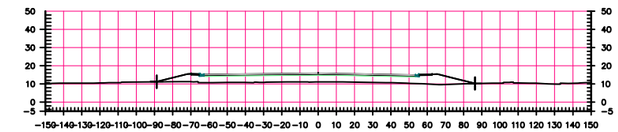
22+50
(x,y) = (5, 265); H=13.5 ft



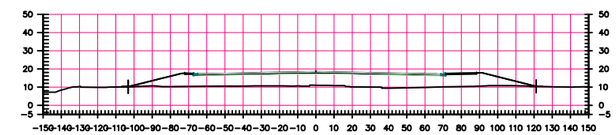
22+03
(x,y) = (-5, 215); H=17.5 ft



24+60
(x,y) = (5, 470); H=2 ft



24+00
(x,y) = (-2.5, 420); H=5 ft



23+48
(x,y) = (10, 365); H=8 ft

Legend:

(x,y) = local coordinates;
0,0 at BWY Station 20+10, 0 offset.
H = height of rectangular block of fill simulating embankment load

Embankment Load Estimates
Cross-sections
East Approach Embankment
Broadway (BWY)

URS

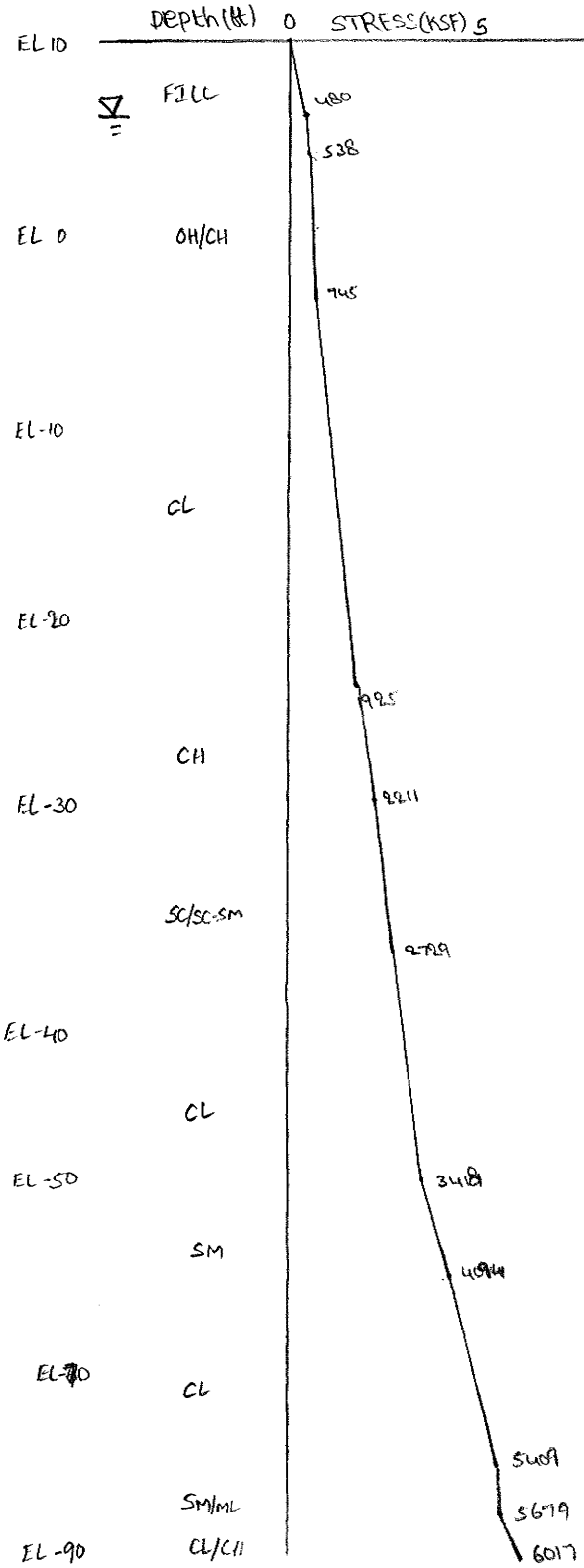
Page ____ of ____

Job BROADWAY INTERCHANGE RECONSTRUCTION Project No. 28645286 Sheet ____ of ____

Description BROADWAY EAST APPROACH EMBANKMENT SETTLEMENT Computed by MT Date 01/07/12

Checked by SHUANG Date 1/20/12

Reference



	γ' PCF	C_{CE}	$C_{\gamma E}$	P_p (KSF)	E $\times 10^6$ PSF	μ	C_α	A	t_{ZERO}	S_u/σ_{VO}
FILL	120	-	-	-	0.30	0.30	-	1	10	-
OH/CH (4 – 3.5)	27.6	0.30	0.03	1.3 / 1.5	0.03	0.5	0.015	1	10	
CL (3.5 – 24)	57.6	0.12	0.015	3.5	1.5	0.5	-	1	10	
CH (24 – 30)	47.6	0.19	0.02	4.5	0.30	0.5	-	1	10	
SC/SC-SM (30 – 39)	57.6	-	-	-	0.40	0.4	-	1	10	
CL (39 – 50)	62.6	0.12	0.015	5.5	0.40	0.5	-	1	10	
SM (50 – 60)	67.6	-	-	-	0.55	0.4	-	1	10	
CL (60 – 81)	62.6	0.12	0.015	7.0	1.0	0.5	-	1	10	
SM/ML (81 – 85)	67.6	-	-	-	0.65	0.4	-	1	10	
CL/CH (85 – 90)	67.6	0.12	0.015	8.0	1.4	0.5	-	1	10	

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1
FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

bwyeapp2.dat
NUMBER OF SOIL LAYERS: 12

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	10.0	6.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	6.0	4.0	57.6	.000	.000	1000.0	.300	.30	.00000	1.000	5.00
3	4.0	.5	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
4	.5	-3.5	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
5	-3.5	-24.0	57.6	.120	.015	3500.0	1.500	.50	.00000	1.000	5.00
6	-24.0	-30.0	47.6	.190	.020	4500.0	.300	.50	.00000	1.000	5.00
7	-30.0	-39.0	57.6	.000	.000	5000.0	.400	.40	.00000	1.000	5.00
8	-39.0	-50.0	62.6	.120	.015	55000.0	.400	.50	.00000	1.000	5.00
9	-50.0	-60.0	67.6	.000	.000	6000.0	.550	.40	.00000	1.000	5.00
10	-60.0	-81.0	62.6	.120	.015	7000.0	1.000	.50	.00000	1.000	5.00
11	-81.0	-85.0	67.6	.000	.000	7500.0	.650	.40	.00000	1.000	5.00
12	-85.0	-90.0	67.6	.120	.015	8000.0	1.400	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 50

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	-5.00	25.00	.00	10.00	120.00	50.00	3000.00
2	102.50	25.00	.00	10.00	95.00	50.00	625.00
3	87.50	25.00	.00	10.00	65.00	50.00	625.00
4	77.50	25.00	.00	10.00	45.00	50.00	625.00
5	67.50	25.00	.00	10.00	25.00	50.00	625.00
6	60.00	25.00	.00	10.00	10.00	50.00	500.00
7	-112.50	25.00	.00	10.00	95.00	50.00	625.00
8	-97.50	25.00	.00	10.00	65.00	50.00	625.00
9	-87.50	25.00	.00	10.00	45.00	50.00	625.00
10	-77.50	25.00	.00	10.00	25.00	50.00	625.00
11	-70.00	25.00	.00	10.00	10.00	50.00	500.00
12	-2.50	75.00	.00	10.00	125.00	50.00	2750.00
13	105.00	75.00	.00	10.00	90.00	50.00	625.00
14	90.00	75.00	.00	10.00	60.00	50.00	625.00
15	80.00	75.00	.00	10.00	40.00	50.00	625.00
16	70.00	75.00	.00	10.00	20.00	50.00	625.00
17	62.50	75.00	.00	10.00	5.00	50.00	250.00
18	-110.00	75.00	.00	10.00	90.00	50.00	625.00
19	-95.00	75.00	.00	10.00	60.00	50.00	625.00
20	-85.00	75.00	.00	10.00	40.00	50.00	625.00
21	-75.00	75.00	.00	10.00	20.00	50.00	625.00
22	-67.50	75.00	.00	10.00	5.00	50.00	250.00
23	-2.50	145.00	.00	10.00	125.00	90.00	2500.00
24	100.00	145.00	.00	10.00	80.00	90.00	625.00

25	85.00	145.00	.00	10.00	50.00	90.00	625.00
26	75.00	145.00	.00	10.00	30.00	90.00	625.00
27	67.50	145.00	.00	10.00	15.00	90.00	625.00
28	-97.50	145.00	.00	10.00	65.00	90.00	625.00
29	-90.00	145.00	.00	10.00	50.00	90.00	625.00
30	-82.50	145.00	.00	10.00	35.00	90.00	625.00
31	-72.50	145.00	.00	10.00	15.00	90.00	625.00
32	-5.00	215.00	.00	10.00	130.00	50.00	2188.00
33	90.00	215.00	.00	10.00	60.00	50.00	625.00
34	80.00	125.00	.00	10.00	40.00	50.00	625.00
35	67.50	215.00	.00	10.00	15.00	50.00	938.00
36	-90.00	215.00	.00	10.00	40.00	50.00	625.00
37	-80.00	215.00	.00	10.00	20.00	50.00	625.00
38	5.00	265.00	.00	10.00	130.00	50.00	1688.00
39	-7.50	315.00	.00	10.00	125.00	50.00	1250.00
40	10.00	365.00	.00	10.00	160.00	50.00	1000.00
41	105.00	365.00	.00	10.00	30.00	50.00	625.00
42	95.00	365.00	.00	10.00	10.00	50.00	375.00
43	-85.00	365.00	.00	10.00	30.00	50.00	375.00
44	-77.50	365.00	.00	10.00	15.00	50.00	625.00
45	-2.50	420.00	.00	10.00	135.00	60.00	625.00
46	75.00	420.00	.00	10.00	20.00	60.00	313.00
47	70.00	420.00	.00	10.00	10.00	60.00	313.00
48	-80.00	420.00	.00	10.00	20.00	60.00	250.00
49	-75.00	420.00	.00	10.00	10.00	60.00	250.00
50	5.00	470.00	.00	10.00	130.00	40.00	250.00

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TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5
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SETTLEMENT POINT : -5.0, .0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1500.0	1461.0	1471.1	1.000	.002	.000	.099	.101
2	537.6	1499.9	1402.6	1428.0	1.000	.001	.000	.052	.053
3	643.5	1499.5	1349.5	1388.8	1.000	3.120	.506	.182	3.808
4	747.0	1498.3	1278.0	1336.0	1.000	1.932	.578	.306	2.816
5	1392.6	1486.3	1057.0	1172.6	1.000	1.164	.000	.061	1.225
6	2125.8	1456.2	848.2	1015.9	1.000	.326	.000	.126	.452
7	2527.8	1431.7	746.0	936.8	1.000	.000	.000	.205	.205
8	3131.3	1392.4	627.5	841.3	1.000	.316	.000	.217	.533
9	3813.6	1345.0	523.1	752.2	1.000	.000	.000	.182	.182
10	4808.9	1268.3	400.9	638.9	1.000	.384	.000	.189	.573
11	5601.4	1204.0	324.8	561.2	1.000	.000	.000	.063	.063
12	5905.6	1180.8	301.4	535.8	1.000	.071	.000	.033	.104
						7.317	1.084	1.715	10.116

SETTLEMENT POINT : -5.0, 25.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2999.6	2874.7	2810.9	1.000	.003	.000	.207	.210
2	537.6	2994.6	2689.2	2536.3	1.000	.001	.000	.114	.116
3	643.5	2981.1	2524.4	2302.8	1.000	5.996	.506	.795	7.296
4	747.0	2945.2	2311.3	2022.8	1.000	5.043	.578	1.245	6.866
5	1392.6	2718.0	1731.3	1417.3	1.000	3.539	.000	.188	3.726
6	2125.8	2428.1	1283.7	1088.4	1.000	.540	.000	.298	.838
7	2527.8	2280.4	1091.2	968.1	1.000	.000	.000	.393	.394
8	3131.3	2106.0	884.5	843.2	1.000	.442	.000	.410	.852
9	3813.6	1946.4	714.4	738.6	1.000	.000	.000	.298	.298
10	4808.9	1744.4	527.6	615.0	1.000	.508	.000	.296	.804
11	5601.4	1603.6	417.1	533.8	1.000	.000	.000	.090	.090
12	5905.6	1556.9	384.1	507.8	1.000	.091	.000	.048	.139
						16.164	1.084	4.381	21.629

SETTLEMENT POINT : 55.0, 25.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2998.8	2802.1	2787.4	1.000	.003	.000	.212	.215
2	537.6	2983.9	2526.7	2481.9	1.000	.001	.000	.119	.120
3	643.5	2951.1	2307.1	2227.4	1.000	5.950	.506	.957	7.414

4	747.0	2881.9	2053.5	1929.2	1.000	4.935	.578	1.425	6.938
5	1392.6	2561.3	1468.0	1307.7	1.000	3.040	.000	.192	3.233
6	2125.8	2216.2	1081.6	984.8	1.000	.447	.000	.284	.731
7	2527.8	2052.8	927.5	870.6	1.000	.000	.000	.360	.360
8	3131.3	1869.8	767.3	754.8	1.000	.403	.000	.366	.768
9	3813.6	1711.6	637.6	659.9	1.000	.000	.000	.260	.260
10	4808.9	1523.6	494.0	549.8	1.000	.452	.000	.252	.704
11	5601.4	1399.5	406.8	478.4	1.000	.000	.000	.077	.077
12	5905.6	1359.3	380.0	455.6	1.000	.081	.000	.040	.121
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						15.313	1.084	4.545	20.941

SETTLEMENT POINT : -2.5, 75.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2750.0	2675.8	2675.3	1.000	.003	.000	.183	.186
2	537.6	2749.7	2564.9	2563.7	1.000	.001	.000	.097	.098
3	643.5	2748.8	2463.9	2462.2	1.000	5.633	.506	.400	6.539
4	747.0	2746.1	2327.8	2325.8	1.000	4.696	.578	.671	5.945
5	1392.6	2718.5	1906.1	1907.0	1.000	3.540	.000	.133	3.673
6	2125.8	2646.0	1506.4	1518.6	1.000	.817	.000	.272	1.089
7	2527.8	2585.1	1310.7	1332.4	1.000	.000	.000	.413	.413
8	3131.3	2485.7	1084.6	1120.2	1.000	.502	.000	.457	.959
9	3813.6	2365.5	886.9	937.2	1.000	.000	.000	.357	.357
10	4808.9	2173.1	659.1	727.6	1.000	.612	.000	.373	.985
11	5601.4	2015.6	520.4	599.2	1.000	.000	.000	.116	.116
12	5905.6	1959.9	478.4	560.0	1.000	.112	.000	.062	.174
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						15.919	1.084	3.533	20.535

SETTLEMENT POINT : 60.0, 75.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2747.0	2583.5	2638.5	1.000	.003	.000	.189	.192
2	537.6	2725.2	2379.6	2485.0	1.000	.001	.000	.101	.103
3	643.5	2699.6	2227.8	2358.2	1.000	5.553	.506	.569	6.628
4	747.0	2666.1	2048.6	2198.7	1.000	4.552	.578	.868	5.998
5	1392.6	2552.1	1596.7	1743.5	1.000	3.010	.000	.145	3.155
6	2125.8	2407.1	1251.0	1350.7	1.000	.512	.000	.265	.778
7	2527.8	2317.2	1097.4	1171.2	1.000	.000	.000	.381	.381
8	3131.3	2192.7	927.0	973.3	1.000	.456	.000	.410	.866
9	3813.6	2061.1	781.0	808.1	1.000	.000	.000	.311	.311
10	4808.9	1873.0	611.6	624.6	1.000	.540	.000	.316	.856
11	5601.4	1731.1	505.4	514.9	1.000	.000	.000	.098	.098
12	5905.6	1682.6	472.4	481.8	1.000	.098	.000	.052	.150
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						14.727	1.084	3.705	19.515

SETTLEMENT POINT : -2.5, 145.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2500.0	2434.9	2447.0	1.000	.003	.000	.166	.168
2	537.6	2499.8	2337.5	2367.6	1.000	.001	.000	.087	.088
3	643.5	2499.3	2248.8	2295.2	1.000	5.215	.506	.318	6.039
4	747.0	2497.7	2129.1	2197.3	1.000	4.235	.578	.535	5.348
5	1392.6	2481.2	1756.0	1889.3	1.000	2.778	.000	.108	2.886
6	2125.8	2436.2	1398.2	1585.2	1.000	.550	.000	.227	.777
7	2527.8	2396.8	1221.3	1429.4	1.000	.000	.000	.361	.361
8	3131.3	2329.8	1015.3	1241.0	1.000	.478	.000	.397	.875
9	3813.6	2244.7	834.0	1066.9	1.000	.000	.000	.324	.324
10	4808.9	2100.2	623.6	851.6	1.000	.595	.000	.343	.938
11	5601.4	1975.0	494.6	710.1	1.000	.000	.000	.110	.110
12	5905.6	1929.3	455.5	665.4	1.000	.110	.000	.059	.169
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						13.967	1.084	3.034	18.085

SETTLEMENT POINT : 60.0, 145.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2808.6	2636.1	2645.1	1.000	.003	.000	.196	.199
2	537.6	2778.7	2397.0	2449.2	1.000	.001	.000	.106	.107
3	643.5	2740.8	2209.9	2309.2	1.000	5.620	.506	.674	6.800
4	747.0	2687.2	1996.4	2144.4	1.000	4.590	.578	.987	6.155
5	1392.6	2508.2	1509.9	1713.6	1.000	2.867	.000	.147	3.014
6	2125.8	2320.5	1175.1	1371.2	1.000	.461	.000	.251	.713
7	2527.8	2220.7	1033.4	1216.9	1.000	.000	.000	.357	.357
8	3131.3	2096.1	878.9	1043.5	1.000	.441	.000	.375	.815
9	3813.6	1975.2	747.2	892.1	1.000	.000	.000	.288	.288
10	4808.9	1812.6	593.3	712.5	1.000	.525	.000	.292	.817
11	5601.4	1693.0	495.2	597.0	1.000	.000	.000	.093	.093
12	5905.6	1652.0	464.4	560.7	1.000	.096	.000	.049	.145
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						14.606	1.084	3.814	19.503

SETTLEMENT POINT : -5.0, 215.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	2188.0	2117.5	2137.1	1.000	.003	.000	.146	.148
2	537.6	2187.4	2012.2	2061.5	1.000	.001	.000	.077	.078
3	643.5	2186.0	1916.9	1993.5	1.000	4.641	.506	.323	5.469
4	747.0	2181.8	1789.8	1903.8	1.000	3.594	.578	.536	4.708
5	1392.6	2147.4	1409.4	1638.7	1.000	1.623	.000	.102	1.725
6	2125.8	2077.3	1073.1	1395.5	1.000	.426	.000	.202	.629

7	2527.8	2025.7	918.1	1274.7	1.000	.000	.000	.310	.310
8	3131.3	1947.7	746.9	1130.2	1.000	.416	.000	.333	.749
9	3813.6	1858.9	604.2	996.9	1.000	.000	.000	.266	.266
10	4808.9	1723.8	446.9	829.4	1.000	.503	.000	.274	.776
11	5601.4	1616.6	354.3	715.8	1.000	.000	.000	.088	.088
12	5905.6	1579.0	326.7	679.1	1.000	.093	.000	.046	.139
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						11.299	1.084	2.703	15.086

SETTLEMENT POINT : 60.0, 215.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1875.0	1763.6	1817.7	1.000	.002	.000	.128	.130
2	537.6	1869.2	1606.9	1733.5	1.000	.001	.000	.069	.070
3	643.5	1855.4	1483.1	1660.8	1.000	3.961	.506	.397	4.863
4	747.0	1825.6	1346.9	1570.2	1.000	2.783	.578	.587	3.949
5	1392.6	1709.7	1063.1	1331.0	1.000	1.284	.000	.084	1.368
6	2125.8	1609.1	864.6	1133.4	1.000	.352	.000	.146	.499
7	2527.8	1560.6	774.0	1039.1	1.000	.000	.000	.226	.226
8	3131.3	1500.8	669.9	928.1	1.000	.337	.000	.232	.568
9	3813.6	1441.4	577.3	826.1	1.000	.000	.000	.192	.192
10	4808.9	1357.7	465.2	697.0	1.000	.408	.000	.196	.604
11	5601.4	1292.8	392.1	608.3	1.000	.000	.000	.066	.066
12	5905.6	1270.0	368.9	579.3	1.000	.076	.000	.034	.110
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						9.205	1.084	2.357	12.645

SETTLEMENT POINT : 5.0, 265.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1688.0	1628.8	1661.0	1.000	.002	.000	.112	.114
2	537.6	1687.8	1540.4	1620.5	1.000	.001	.000	.059	.060
3	643.5	1687.3	1460.4	1583.3	1.000	3.580	.506	.232	4.317
4	747.0	1685.7	1353.7	1532.3	1.000	2.434	.578	.388	3.400
5	1392.6	1667.1	1037.1	1367.1	1.000	1.261	.000	.076	1.338
6	2125.8	1617.9	766.3	1199.3	1.000	.354	.000	.152	.506
7	2527.8	1578.4	646.6	1112.0	1.000	.000	.000	.236	.236
8	3131.3	1517.7	519.0	1004.8	1.000	.340	.000	.249	.589
9	3813.6	1449.1	416.7	903.0	1.000	.000	.000	.201	.201
10	4808.9	1347.1	308.1	771.2	1.000	.405	.000	.203	.609
11	5601.4	1268.2	245.9	679.2	1.000	.000	.000	.066	.066
12	5905.6	1240.9	227.5	648.8	1.000	.075	.000	.034	.109
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						8.452	1.084	2.011	11.546

SETTLEMENT POINT : 70.0, 265.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	844.0	832.5	841.2	1.000	.001	.000	.055	.056
2	537.6	843.9	815.1	837.3	1.000	.000	.000	.028	.028
3	643.5	843.8	799.0	834.1	1.000	1.121	.506	.038	1.665
4	747.0	843.7	776.6	830.3	1.000	.473	.578	.064	1.115
5	1392.6	846.8	699.5	816.7	1.000	.761	.000	.015	.776
6	2125.8	857.5	613.1	786.4	1.000	.212	.000	.038	.250
7	2527.8	864.5	565.5	761.1	1.000	.000	.000	.090	.090
8	3131.3	872.1	505.4	720.6	1.000	.211	.000	.086	.297
9	3813.6	876.3	447.5	673.2	1.000	.000	.000	.093	.094
10	4808.9	874.0	372.3	600.1	1.000	.274	.000	.098	.372
11	5601.4	864.9	320.4	542.3	1.000	.000	.000	.038	.038
12	5905.6	860.3	303.6	522.2	1.000	.053	.000	.019	.072
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						3.108	1.084	.662	4.853

SETTLEMENT POINT : -7.5, 315.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1250.0	1206.5	1237.6	1.000	.002	.000	.083	.084
2	537.6	1250.1	1141.4	1218.5	1.000	.001	.000	.043	.044
3	643.5	1250.2	1082.4	1200.1	1.000	2.443	.506	.153	3.102
4	747.0	1250.4	1003.6	1173.3	1.000	1.201	.578	.259	2.038
5	1392.6	1244.6	767.9	1073.2	1.000	1.023	.000	.053	1.076
6	2125.8	1216.3	565.2	959.3	1.000	.283	.000	.109	.392
7	2527.8	1190.4	475.6	897.9	1.000	.000	.000	.173	.173
8	3131.3	1148.5	380.4	821.4	1.000	.269	.000	.181	.449
9	3813.6	1099.9	304.4	748.2	1.000	.000	.000	.148	.148
10	4808.9	1026.6	224.2	652.6	1.000	.318	.000	.148	.466
11	5601.4	969.6	178.6	585.1	1.000	.000	.000	.049	.049
12	5905.6	949.9	165.2	562.7	1.000	.058	.000	.025	.083
						---	---	---	---
						5.597	1.084	1.424	8.105

SETTLEMENT POINT : 55.0, 315.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	625.1	620.4	660.1	1.000	.000	.000	.039	.039
2	537.6	626.7	613.2	709.7	1.000	.000	.000	.018	.019
3	643.5	630.8	605.7	748.9	1.000	.374	.506	-.065	.815
4	747.0	641.5	593.6	789.2	1.000	.388	.578	-.080	.886
5	1392.6	700.8	539.2	823.5	1.000	.653	.000	.003	.656
6	2125.8	756.1	467.1	775.3	1.000	.190	.000	.032	.223
7	2527.8	774.3	426.3	737.6	1.000	.000	.000	.083	.083
8	3131.3	786.2	375.0	686.2	1.000	.193	.000	.084	.277
9	3813.6	787.4	326.4	634.2	1.000	.000	.000	.088	.088

10	4808.9	775.8	265.4	563.6	1.000	.246	.000	.091	.337
11	5601.4	759.2	224.8	512.0	1.000	.000	.000	.034	.034
12	5905.6	752.3	211.9	494.5	1.000	.047	.000	.017	.064
						---	---	---	---
						2.091	1.084	.346	3.520

SETTLEMENT POINT : 10.0, 365.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1000.0	966.2	979.1	1.000	.001	.000	.067	.068
2	537.6	999.7	915.9	948.2	1.000	.001	.000	.035	.036
3	643.5	998.8	870.3	920.7	1.000	1.664	.506	.145	2.314
4	747.0	996.5	809.7	885.0	1.000	.530	.578	.239	1.347
5	1392.6	978.0	629.6	784.4	1.000	.852	.000	.044	.897
6	2125.8	943.1	472.0	697.7	1.000	.230	.000	.086	.316
7	2527.8	918.7	400.0	655.7	1.000	.000	.000	.134	.134
8	3131.3	883.0	321.0	605.8	1.000	.214	.000	.138	.352
9	3813.6	843.4	255.9	559.6	1.000	.000	.000	.113	.113
10	4808.9	784.7	185.5	500.5	1.000	.248	.000	.111	.359
11	5601.4	739.4	145.2	459.1	1.000	.000	.000	.037	.037
12	5905.6	723.7	133.4	445.3	1.000	.045	.000	.019	.064
						---	---	---	---
						3.785	1.084	1.168	6.036

SETTLEMENT POINT : 90.0, 365.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	999.2	912.5	909.7	1.000	.001	.000	.072	.074
2	537.6	989.6	796.0	782.3	1.000	.001	.000	.041	.042
3	643.5	969.2	711.0	680.2	1.000	1.564	.506	.383	2.453
4	747.0	928.7	623.0	568.1	1.000	.505	.578	.533	1.616
5	1392.6	765.8	457.7	382.5	1.000	.702	.000	.057	.759
6	2125.8	622.9	371.8	335.8	1.000	.161	.000	.065	.225
7	2527.8	567.7	339.7	330.5	1.000	.000	.000	.081	.081
8	3131.3	516.9	304.9	328.8	1.000	.131	.000	.066	.197
9	3813.6	482.7	273.8	327.0	1.000	.000	.000	.053	.053
10	4808.9	453.0	234.2	320.3	1.000	.148	.000	.044	.192
11	5601.4	438.6	206.4	311.3	1.000	.000	.000	.017	.017
12	5905.6	434.6	197.2	307.4	1.000	.028	.000	.008	.036
						---	---	---	---
						3.241	1.084	1.420	5.745

SETTLEMENT POINT : -2.5, 420.0

SOIL LAYER	INITIAL STRESS	VERTICAL STRESS INCREASE	HORIZ. X STRESS INCREASE	HORIZ. Y STRESS INCREASE	SKEMPTON BJERRUM FACTOR	CONSOL. COMP.	SECOND. COMP. 20. YR	ELASTIC COMP.	TOTAL COMP.

	(PSF)	(PSF)	(PSF)	(PSF)		(IN.)	(IN.)	(IN.)	(IN.)
1	240.0	625.0	605.7	616.7	1.000	.000	.000	.041	.042
2	537.6	624.9	576.8	604.2	1.000	.000	.000	.022	.022
3	643.5	624.8	550.6	592.9	1.000	.371	.506	.074	.951
4	747.0	624.2	515.5	577.7	1.000	.380	.578	.124	1.082
5	1392.6	618.6	408.2	530.3	1.000	.589	.000	.024	.614
6	2125.8	604.2	310.5	484.9	1.000	.156	.000	.050	.206
7	2527.8	592.4	264.6	462.1	1.000	.000	.000	.081	.082
8	3131.3	573.6	213.5	434.8	1.000	.145	.000	.082	.227
9	3813.6	551.4	170.8	409.5	1.000	.000	.000	.070	.070
10	4808.9	517.2	124.3	376.9	1.000	.168	.000	.067	.235
11	5601.4	490.3	97.5	353.9	1.000	.000	.000	.023	.023
12	5905.6	481.0	89.6	346.1	1.000	.031	.000	.011	.042
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						1.840	1.084	.670	3.594

SETTLEMENT POINT : 65.0, 420.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	624.9	563.7	598.3	1.000	.000	.000	.044	.045
2	537.6	618.3	483.5	560.6	1.000	.000	.000	.024	.025
3	643.5	605.3	428.4	531.4	1.000	.363	.506	.176	1.044
4	747.0	582.1	376.3	499.4	1.000	.360	.578	.231	1.169
5	1392.6	514.9	291.1	433.4	1.000	.504	.000	.025	.529
6	2125.8	471.5	242.3	389.4	1.000	.125	.000	.037	.163
7	2527.8	454.5	220.1	370.5	1.000	.000	.000	.059	.059
8	3131.3	435.8	194.1	349.8	1.000	.112	.000	.054	.166
9	3813.6	418.8	170.2	332.3	1.000	.000	.000	.048	.048
10	4808.9	396.9	140.5	311.5	1.000	.130	.000	.043	.173
11	5601.4	381.4	120.7	297.2	1.000	.000	.000	.016	.016
12	5905.6	376.3	114.3	292.4	1.000	.024	.000	.007	.032
						---	---	---	---
						1.620	1.084	.764	3.468

SETTLEMENT POINT : 5.0, 470.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	250.0	244.4	258.7	1.000	.000	.000	.016	.016
2	537.6	250.4	236.0	271.2	1.000	.000	.000	.008	.008
3	643.5	251.2	228.0	281.3	1.000	.180	.506	-.005	.681
4	747.0	253.3	216.8	292.5	1.000	.183	.578	-.002	.759
5	1392.6	263.2	178.7	311.8	1.000	.277	.000	.003	.280
6	2125.8	270.4	140.5	316.7	1.000	.075	.000	.010	.085
7	2527.8	272.1	122.1	315.9	1.000	.000	.000	.026	.026
8	3131.3	272.3	101.3	312.5	1.000	.072	.000	.022	.093
9	3813.6	270.9	83.7	306.6	1.000	.000	.000	.025	.025
10	4808.9	267.0	64.0	295.3	1.000	.089	.000	.022	.111
11	5601.4	263.0	52.3	284.8	1.000	.000	.000	.009	.009
12	5905.6	261.4	48.7	280.9	1.000	.017	.000	.004	.021

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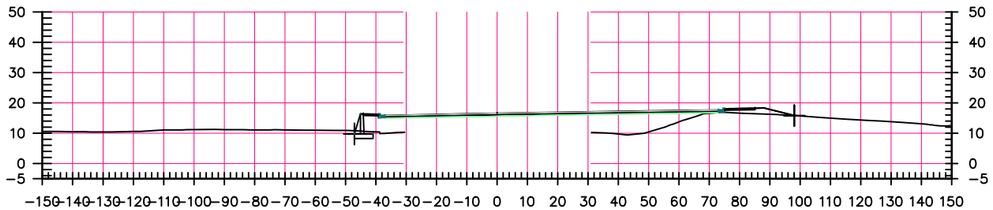
.893	1.084	.138	2.115	

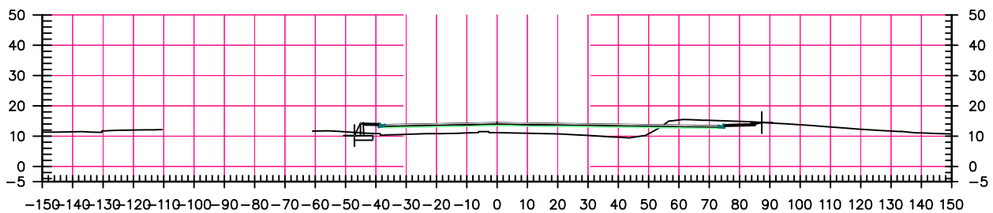
SETTLEMENT POINT : 70.0, 470.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	125.0	125.5	139.4	1.000	.000	.000	.007	.007
2	537.6	125.7	126.1	159.8	1.000	.000	.000	.003	.003
3	643.5	127.2	126.3	176.1	1.000	.099	.506	-.034	.571
4	747.0	130.8	126.1	193.9	1.000	.101	.578	-.047	.632
5	1392.6	147.0	121.5	225.2	1.000	.161	.000	-.004	.156
6	2125.8	160.6	112.9	239.1	1.000	.046	.000	-.004	.042
7	2527.8	166.4	107.3	243.4	1.000	.000	.000	.007	.007
8	3131.3	173.0	99.6	246.5	1.000	.046	.000	.000	.046
9	3813.6	178.9	91.5	247.0	1.000	.000	.000	.009	.010
10	4808.9	186.0	80.2	244.2	1.000	.062	.000	.006	.068
11	5601.4	190.5	71.7	239.7	1.000	.000	.000	.005	.005
12	5905.6	191.8	68.9	237.7	1.000	.012	.000	.002	.014
						---	---	---	---
						.527	1.084	-.049	1.562



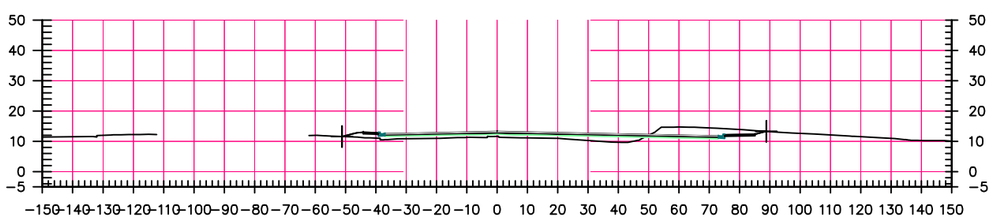
38+94

(x,y) = (0, 120); H=5.5 ft



38+40

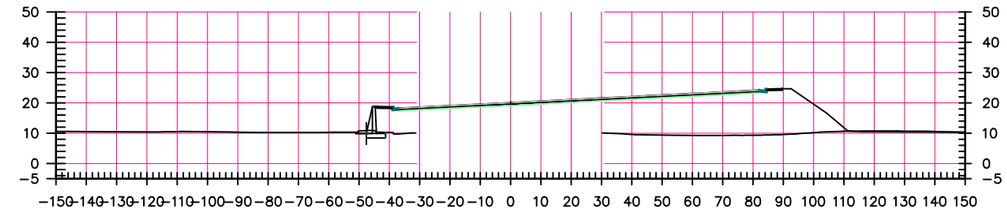
(x,y) = (0, 70); H=4 ft



38+00

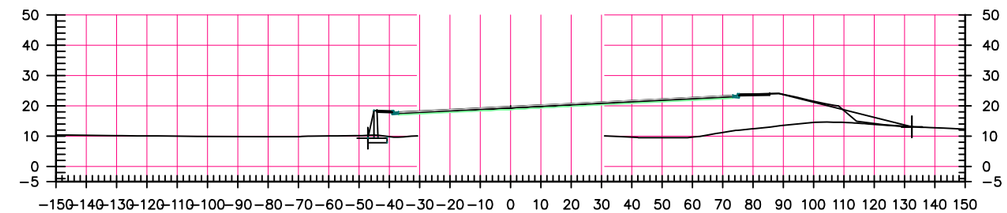
(x,y) = (0, 30); H=3 ft

(x,y) = (0, 10); H=2 ft



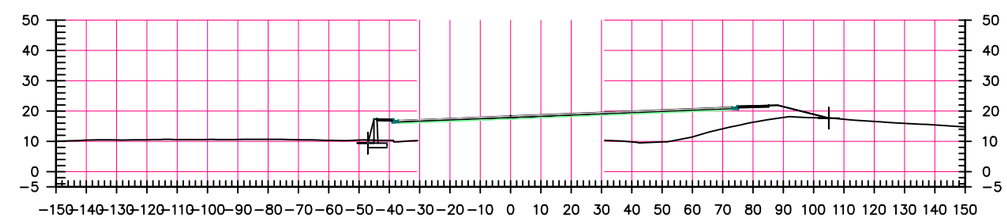
40+20

(x,y) = (-7.5, 270); H=9.5 ft (x,y) = (50, 270); H=13 ft (x,y) = (8.5, 270); H=15 ft



40+00

(x,y) = (-7.5, 210); H=8.5 ft (x,y) = (45, 210); H=11 ft (x,y) = (75, 170); H=10 ft



39+40

(x,y) = (-7, 170); H=7 ft (x,y) = (45, 170); H=10 ft (x,y) = (7.5, 170); H=5 ft

Legend:

(x,y) = local coordinates;
0,0 at BSHY Station 38+00, 0 offset.
H = height of rectangular block of fill simulating embankment load

Embankment Load Estimates
Cross-sections
Bayshore Blvd (BYSH)

URS

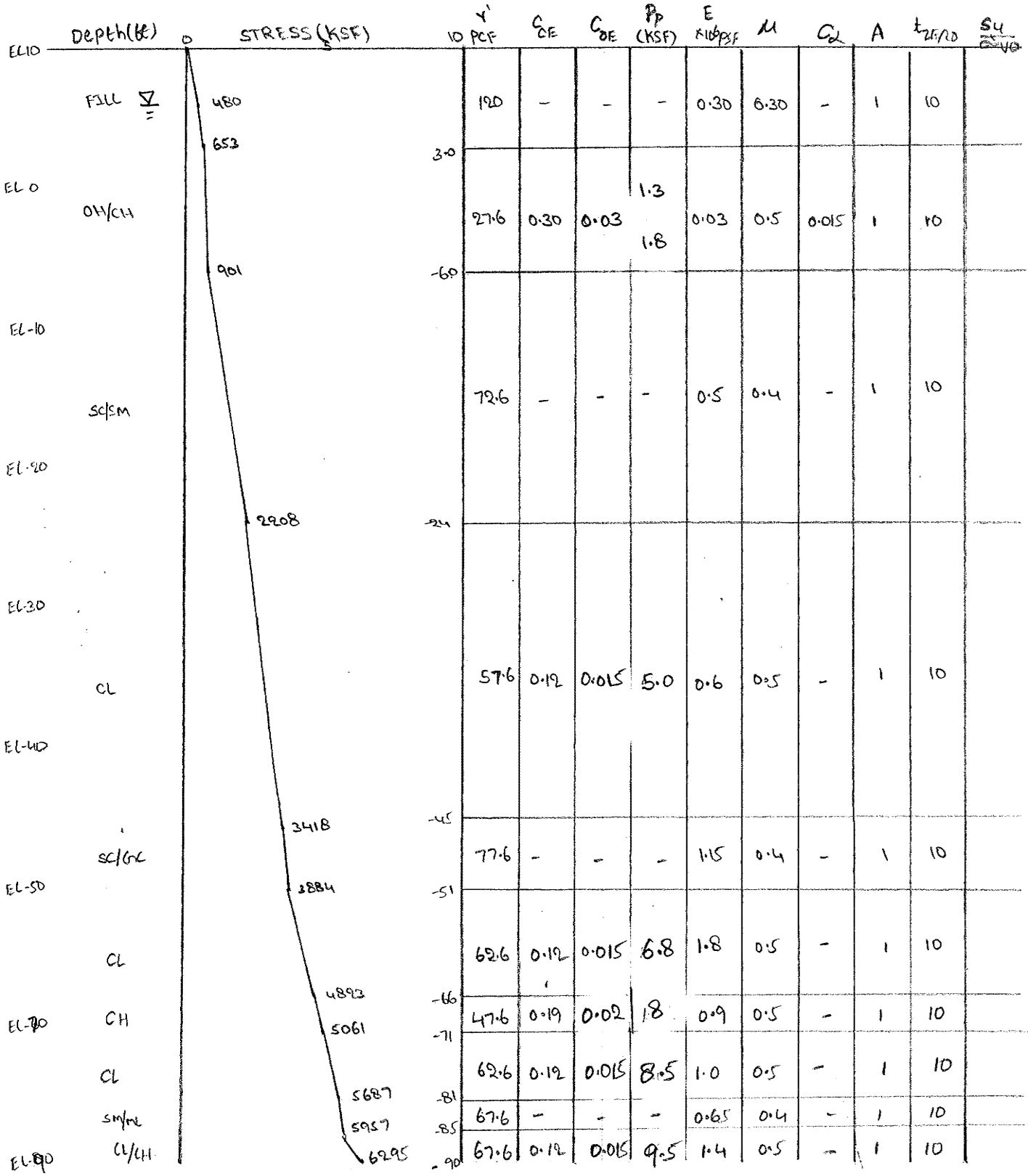
Page ____ of ____

Job BROADWAY INTERCHANGE RECONSTRUCTION Project No. 28645286 Sheet ____ of ____

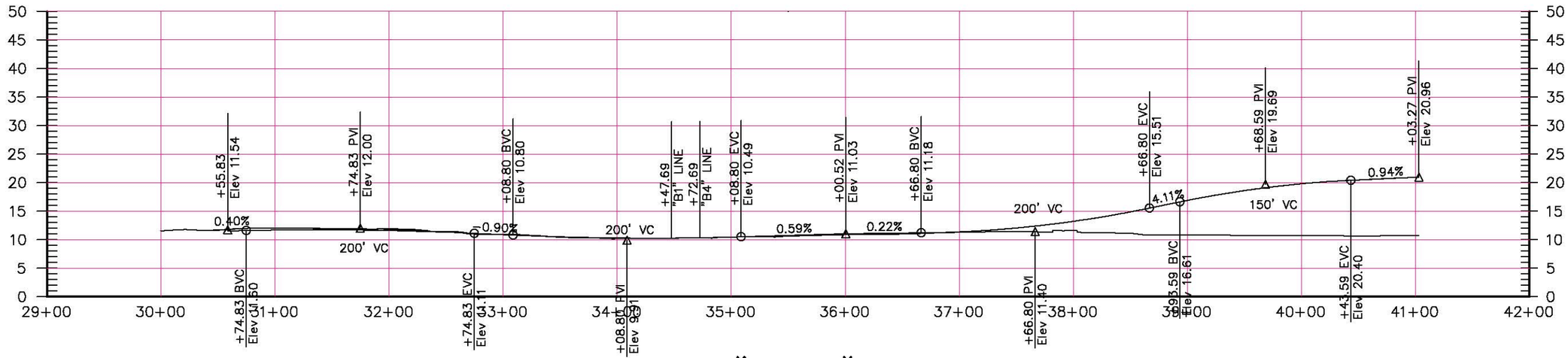
Description BAYSHORE HIGHWAY SETTLEMENT Computed by MT Date 01/07/12

Checked by S. HUANG Date 1/20/12

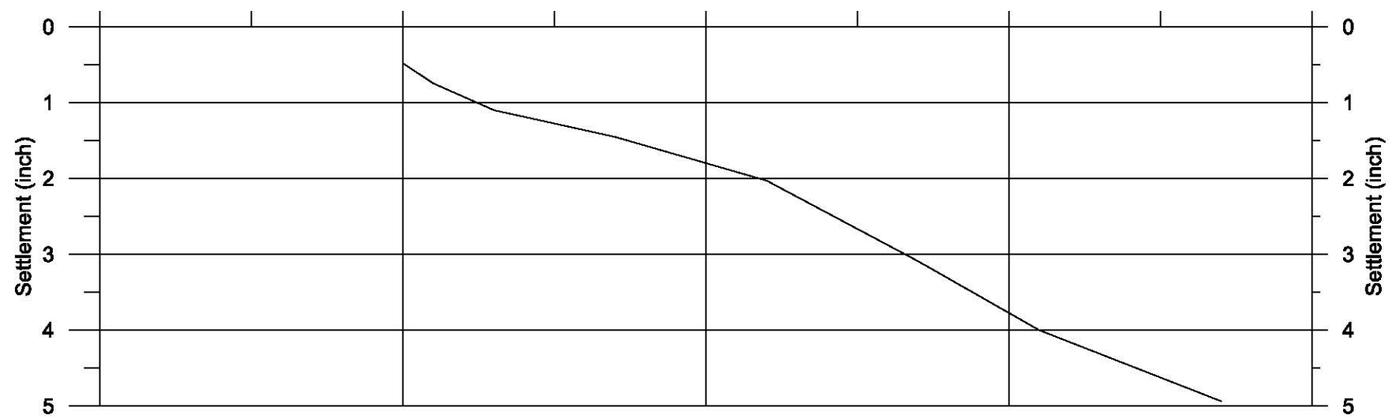
Reference



γ' PCF	C_{cE}	$C_{\alpha E}$	P_p (KSF)	E KIPS/FT²	μ	C_α	A	$t_{2/10}$	S_u / σ'vo
120	–	–	–	0.30	0.30	–	1	10	
27.6	0.30	0.03	1.3 1.8	0.03	0.5	0.015	1	10	
72.6	–	–	–	0.5	0.4	–	1	10	
57.6	0.12	0.015	5.0	0.6	0.5	–	1	10	
77.6	–	–	–	1.15	0.4	–	1	10	
62.6	0.12	0.015	6.8	1.8	0.5	–	1	10	
47.6	0.19	0.02	18	0.9	0.5	–	1	10	
62.6	0.12	0.015	8.5	1.0	0.5	–	1	10	
67.6	–	–	–	0.65	0.4	–	1	10	
67.6	0.12	0.015	9.5	1.4	0.5	–	1	10	


+55.83
Elev 11.54
+74.83 PVI
Elev 12.00
+08.80 BVC
Elev 10.80
+47.69
"B1" LINE
+72.69
"B4" LINE
+08.80 EVC
Elev 10.49
+00.52 PVI
Elev 11.03
+66.80 BVC
Elev 11.18
+66.80 EVC
Elev 15.51
+68.59 PVI
Elev 19.69
+03.27 PVI
Elev 20.96
0.40%
0.90%
0.59%
0.22%
4.11%
0.94%
200' VC
200' VC
200' VC
150' VC
+74.83 BVC
Elev 11.60
+74.83 EVC
Elev 11.11
+08.80 PVI
Elev 9.91
+66.80 PVI
Elev 11.40
+93.59 BVC
Elev 16.61
+43.59 EVC
Elev 20.40
29+00
30+00
31+00
32+00
33+00
34+00
35+00
36+00
37+00
38+00
39+00
40+00
41+00
42+00

"BYSH" LINE


Settlement (inch)
0
1
2
3
4
5

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1
FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

bysh_2.dat
NUMBER OF SOIL LAYERS: 12

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	10.0	6.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	6.0	4.0	57.6	.000	.000	800.0	.300	.30	.00000	1.000	5.00
3	4.0	.5	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
4	.5	-3.5	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
5	-3.5	-24.0	57.6	.120	.015	5000.0	1.500	.50	.00000	1.000	5.00
6	-24.0	-30.0	47.6	.190	.020	5500.0	.300	.50	.00000	1.000	5.00
7	-30.0	-39.0	57.6	.000	.000	6000.0	.400	.40	.00000	1.000	5.00
8	-39.0	-50.0	62.6	.120	.015	6800.0	.400	.50	.00000	1.000	5.00
9	-50.0	-60.0	67.6	.000	.000	7000.0	.550	.40	.00000	1.000	5.00
10	-60.0	-81.0	62.6	.120	.015	8000.0	1.000	.50	.00000	1.000	5.00
11	-81.0	-85.0	67.6	.000	.000	9000.0	.650	.40	.00000	1.000	5.00
12	-85.0	-90.0	67.6	.120	.015	9500.0	1.400	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 13

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	.00	10.00	.00	10.00	100.00	20.00	250.00
2	.00	30.00	.00	10.00	100.00	20.00	375.00
3	.00	70.00	.00	10.00	90.00	60.00	500.00
4	.00	120.00	.00	10.00	90.00	40.00	688.00
5	-7.50	170.00	.00	10.00	75.00	60.00	875.00
6	45.00	170.00	.00	10.00	30.00	60.00	1250.00
7	75.00	170.00	.00	10.00	30.00	60.00	625.00
8	-7.50	210.00	.00	10.00	75.00	20.00	1063.00
9	45.00	210.00	.00	10.00	30.00	20.00	1375.00
10	75.00	210.00	.00	10.00	30.00	20.00	1250.00
11	-7.50	270.00	.00	10.00	75.00	100.00	1188.00
12	50.00	270.00	.00	10.00	40.00	100.00	1625.00
13	85.00	270.00	.00	10.00	30.00	100.00	1875.00

TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5

DEFORM.FOR - VERSION 2.4, DEC 1988

FOR SETTLEMENT OPTION INPUT 1

FOR STRESS DISTRIBUTION ONLY INPUT 2

1
IF DATA ON DISK FILE TYPE 1
IF DATA AT TERMINAL TYPE 2

1
TYPE FILE NAME:

bysh_2.dat
NUMBER OF SOIL LAYERS: 12

SOIL	TOP	BOTTOM	GAMMA	CC	CR	PC	E*10**6	MU	CA	A	TZERO
1	10.0	6.0	120.0	.000	.000	800.0	.300	.30	.00000	1.000	5.00
2	6.0	4.0	57.6	.000	.000	800.0	.300	.30	.00000	1.000	5.00
3	4.0	.5	27.6	.300	.030	1300.0	.030	.50	.02000	1.000	5.00
4	.5	-3.5	27.6	.300	.030	1800.0	.030	.50	.02000	1.000	5.00
5	-3.5	-24.0	57.6	.120	.015	5000.0	1.500	.50	.00000	1.000	5.00
6	-24.0	-30.0	47.6	.190	.020	5500.0	.300	.50	.00000	1.000	5.00
7	-30.0	-39.0	57.6	.000	.000	6000.0	.400	.40	.00000	1.000	5.00
8	-39.0	-50.0	62.6	.120	.015	6800.0	.400	.50	.00000	1.000	5.00
9	-50.0	-60.0	67.6	.000	.000	7000.0	.550	.40	.00000	1.000	5.00
10	-60.0	-81.0	62.6	.120	.015	8000.0	1.000	.50	.00000	1.000	5.00
11	-81.0	-85.0	67.6	.000	.000	9000.0	.650	.40	.00000	1.000	5.00
12	-85.0	-90.0	67.6	.120	.015	9500.0	1.400	.50	.00000	1.000	5.00

PROJECT LIFE: 20.0

NUMBER OF INITIAL LOADED AREAS: 0

NUMBER OF LOADED AREAS: 13

AREA	CX	CY	ANGLE	ELEV	WIDTH	LENGTH	LOAD
1	.00	10.00	.00	10.00	100.00	20.00	500.00
2	.00	30.00	.00	10.00	100.00	20.00	375.00
3	.00	70.00	.00	10.00	90.00	60.00	500.00
4	.00	120.00	.00	10.00	90.00	40.00	688.00
5	-7.50	170.00	.00	10.00	75.00	60.00	875.00
6	45.00	170.00	.00	10.00	30.00	60.00	1250.00
7	75.00	170.00	.00	10.00	30.00	60.00	625.00
8	-7.50	210.00	.00	10.00	75.00	20.00	1063.00
9	45.00	210.00	.00	10.00	30.00	20.00	1375.00
10	75.00	210.00	.00	10.00	30.00	20.00	1250.00
11	-7.50	270.00	.00	10.00	75.00	100.00	1188.00
12	50.00	270.00	.00	10.00	40.00	100.00	1625.00
13	85.00	270.00	.00	10.00	30.00	100.00	1875.00

TO BEGIN EXECUTION, TYPE 1
TO PRINT INPUT DATA, TYPE 2
TO CHANGE SOIL DATA, TYPE 3
TO CHANGE LOAD DATA, TYPE 4
TO STOP, TYPE 5

SETTLEMENT POINT : .0, .0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	250.0	235.8	241.2	1.000	.000	.000	.017	.017
2	537.6	249.6	214.9	228.6	1.000	.000	.000	.009	.009
3	643.5	248.5	196.4	218.1	1.000	.179	.506	.058	.742
4	747.0	245.9	172.7	206.2	1.000	.178	.578	.090	.846
5	1392.6	230.4	110.1	181.0	1.000	.245	.000	.014	.259
6	2125.8	210.0	67.0	164.2	1.000	.059	.000	.023	.082
7	2527.8	198.7	51.2	156.4	1.000	.000	.000	.031	.031
8	3131.3	184.4	36.5	147.2	1.000	.049	.000	.031	.080
9	3813.6	171.0	26.5	138.6	1.000	.000	.000	.023	.023
10	4808.9	154.7	17.7	127.2	1.000	.052	.000	.021	.073
11	5601.4	144.2	13.4	118.8	1.000	.000	.000	.007	.007
12	5905.6	141.0	12.3	115.9	1.000	.009	.000	.003	.013
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						.771	1.084	.326	2.182

SETTLEMENT POINT : .0, 10.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	499.0	449.4	423.1	1.000	.000	.000	.038	.038
2	537.6	487.3	379.5	329.5	1.000	.000	.000	.022	.022
3	643.5	465.1	325.4	274.2	1.000	.298	.506	.231	1.035
4	747.0	428.2	266.7	232.9	1.000	.283	.578	.285	1.147
5	1392.6	335.0	149.7	190.6	1.000	.345	.000	.027	.372
6	2125.8	277.9	85.5	172.6	1.000	.077	.000	.036	.113
7	2527.8	254.5	63.7	164.3	1.000	.000	.000	.044	.044
8	3131.3	228.8	44.4	154.6	1.000	.061	.000	.043	.103
9	3813.6	207.1	31.7	145.4	1.000	.000	.000	.030	.030
10	4808.9	182.4	20.7	133.1	1.000	.061	.000	.027	.088
11	5601.4	167.4	15.6	124.0	1.000	.000	.000	.008	.008
12	5905.6	162.9	14.2	120.8	1.000	.011	.000	.004	.015
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						1.136	1.084	.795	3.015

SETTLEMENT POINT : -50.0, 10.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	249.5	228.6	212.5	1.000	.000	.000	.019	.019
2	537.6	243.7	199.5	167.2	1.000	.000	.000	.011	.011
3	643.5	232.6	177.6	141.0	1.000	.169	.506	.103	.777

4	747.0	214.4	154.8	122.6	1.000	.158	.578	.121	.857
5	1392.6	170.1	111.7	110.5	1.000	.185	.000	.010	.194
6	2125.8	148.0	85.9	110.7	1.000	.042	.000	.012	.054
7	2527.8	141.0	75.1	110.5	1.000	.000	.000	.018	.018
8	3131.3	134.4	63.4	109.5	1.000	.036	.000	.016	.052
9	3813.6	129.4	53.4	107.4	1.000	.000	.000	.014	.014
10	4808.9	123.8	42.2	102.8	1.000	.042	.000	.013	.055
11	5601.4	120.1	35.3	98.3	1.000	.000	.000	.005	.005
12	5905.6	118.9	33.3	96.5	1.000	.008	.000	.002	.010
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						.639	1.084	.343	2.066

SETTLEMENT POINT : .0, 30.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	375.4	362.6	380.8	1.000	.000	.000	.024	.025
2	537.6	379.4	342.2	381.5	1.000	.000	.000	.013	.013
3	643.5	386.6	320.7	371.6	1.000	.257	.506	.057	.820
4	747.0	396.7	288.4	348.2	1.000	.266	.578	.125	.970
5	1392.6	397.3	186.1	268.8	1.000	.402	.000	.028	.430
6	2125.8	359.4	110.2	217.4	1.000	.098	.000	.047	.145
7	2527.8	333.4	82.5	199.1	1.000	.000	.000	.060	.060
8	3131.3	300.4	57.6	181.1	1.000	.079	.000	.060	.139
9	3813.6	270.2	41.0	166.5	1.000	.000	.000	.041	.041
10	4808.9	234.9	26.7	149.0	1.000	.078	.000	.037	.115
11	5601.4	213.2	20.0	136.7	1.000	.000	.000	.011	.011
12	5905.6	206.6	18.3	132.6	1.000	.013	.000	.006	.019
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						1.195	1.084	.508	2.787

SETTLEMENT POINT : -50.0, 30.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	187.5	186.3	182.5	1.000	.000	.000	.012	.012
2	537.6	187.5	183.8	175.9	1.000	.000	.000	.006	.006
3	643.5	187.8	180.0	170.8	1.000	.140	.506	.017	.663
4	747.0	189.0	172.8	164.1	1.000	.141	.578	.033	.752
5	1392.6	190.6	142.6	144.8	1.000	.206	.000	.008	.213
6	2125.8	184.1	112.4	133.1	1.000	.052	.000	.015	.067
7	2527.8	179.0	98.2	128.9	1.000	.000	.000	.024	.024
8	3131.3	172.2	82.4	124.2	1.000	.046	.000	.023	.069
9	3813.6	165.6	69.0	119.6	1.000	.000	.000	.020	.020
10	4808.9	156.9	53.9	112.3	1.000	.053	.000	.019	.071
11	5601.4	150.8	44.8	105.9	1.000	.000	.000	.007	.007
12	5905.6	148.7	42.0	103.6	1.000	.010	.000	.003	.013
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						.647	1.084	.186	1.917

SETTLEMENT POINT : .0, 70.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	500.0	473.0	489.6	1.000	.000	.000	.034	.034
2	537.6	499.8	433.1	474.0	1.000	.000	.000	.018	.019
3	643.5	499.2	397.4	459.7	1.000	.314	.506	.099	.919
4	747.0	497.6	351.0	440.2	1.000	.319	.578	.163	1.060
5	1392.6	481.9	226.2	378.4	1.000	.476	.000	.029	.506
6	2125.8	448.9	139.6	319.5	1.000	.120	.000	.053	.172
7	2527.8	426.5	107.9	291.0	1.000	.000	.000	.072	.072
8	3131.3	396.0	78.7	258.2	1.000	.102	.000	.075	.178
9	3813.6	365.9	58.5	229.2	1.000	.000	.000	.055	.055
10	4808.9	326.9	40.1	194.1	1.000	.108	.000	.053	.161
11	5601.4	300.3	30.9	170.7	1.000	.000	.000	.016	.016
12	5905.6	291.8	28.3	163.2	1.000	.019	.000	.008	.027
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						1.459	1.084	.676	3.219

SETTLEMENT POINT : -45.0, 70.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	250.0	244.1	248.8	1.000	.000	.000	.016	.016
2	537.6	250.1	235.2	246.8	1.000	.000	.000	.008	.008
3	643.5	250.2	227.1	244.8	1.000	.180	.506	.020	.705
4	747.0	250.5	216.1	241.5	1.000	.181	.578	.035	.794
5	1392.6	252.2	181.5	226.4	1.000	.267	.000	.008	.275
6	2125.8	252.1	147.7	205.9	1.000	.070	.000	.018	.088
7	2527.8	250.5	131.0	194.2	1.000	.000	.000	.033	.033
8	3131.3	246.6	111.4	179.3	1.000	.065	.000	.033	.099
9	3813.6	240.8	94.1	164.8	1.000	.000	.000	.030	.030
10	4808.9	230.5	74.0	145.4	1.000	.077	.000	.030	.107
11	5601.4	221.5	61.5	131.4	1.000	.000	.000	.011	.011
12	5905.6	218.3	57.7	126.6	1.000	.014	.000	.005	.020
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						.854	1.084	.248	2.185

SETTLEMENT POINT : .0, 120.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	688.0	653.9	672.3	1.000	.001	.000	.046	.047
2	537.6	687.7	603.3	648.9	1.000	.000	.000	.025	.025
3	643.5	687.0	558.0	627.7	1.000	.512	.506	.132	1.149
4	747.0	684.7	499.0	599.0	1.000	.407	.578	.217	1.202
5	1392.6	664.6	337.7	510.7	1.000	.625	.000	.039	.665
6	2125.8	623.5	221.2	427.3	1.000	.161	.000	.072	.233

7	2527.8	595.9	176.5	386.1	1.000	.000	.000	.100	.100
8	3131.3	558.1	133.4	337.5	1.000	.141	.000	.106	.248
9	3813.6	519.9	101.9	293.4	1.000	.000	.000	.079	.079
10	4808.9	468.7	71.3	239.0	1.000	.153	.000	.079	.232
11	5601.4	432.1	55.0	202.8	1.000	.000	.000	.024	.024
12	5905.6	419.9	50.3	191.2	1.000	.027	.000	.013	.040
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						2.026	1.084	.933	4.043

SETTLEMENT POINT : -45.0, 120.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	344.0	336.5	339.4	1.000	.000	.000	.023	.023
2	537.6	344.0	325.3	332.4	1.000	.000	.000	.012	.012
3	643.5	344.0	315.1	326.1	1.000	.234	.506	.033	.773
4	747.0	343.9	301.3	317.4	1.000	.237	.578	.055	.870
5	1392.6	342.9	257.9	289.2	1.000	.353	.000	.011	.364
6	2125.8	340.0	215.2	259.2	1.000	.093	.000	.025	.117
7	2527.8	337.4	193.5	242.5	1.000	.000	.000	.044	.044
8	3131.3	332.7	167.4	221.0	1.000	.087	.000	.046	.133
9	3813.6	326.4	143.6	199.5	1.000	.000	.000	.041	.041
10	4808.9	314.7	114.5	170.1	1.000	.104	.000	.043	.147
11	5601.4	303.7	95.6	148.9	1.000	.000	.000	.015	.015
12	5905.6	299.5	89.6	141.8	1.000	.019	.000	.008	.027
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						1.127	1.084	.356	2.567

SETTLEMENT POINT : -7.5, 170.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	875.0	837.4	851.6	1.000	.001	.000	.059	.060
2	537.6	874.7	781.5	816.7	1.000	.001	.000	.032	.032
3	643.5	873.8	731.4	785.0	1.000	1.231	.506	.162	1.898
4	747.0	871.2	666.1	742.5	1.000	.483	.578	.267	1.328
5	1392.6	848.4	484.2	613.7	1.000	.762	.000	.049	.812
6	2125.8	803.0	343.9	495.4	1.000	.200	.000	.092	.292
7	2527.8	772.0	285.4	438.3	1.000	.000	.000	.130	.130
8	3131.3	728.2	224.5	372.2	1.000	.180	.000	.142	.322
9	3813.6	681.9	176.5	313.6	1.000	.000	.000	.106	.106
10	4808.9	616.0	125.9	243.8	1.000	.198	.000	.109	.306
11	5601.4	566.3	97.3	199.4	1.000	.000	.000	.033	.033
12	5905.6	549.3	88.9	185.6	1.000	.035	.000	.018	.052
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						3.091	1.084	1.198	5.372

SETTLEMENT POINT : -45.0, 170.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	437.5	429.9	430.1	1.000	.000	.000	.029	.029
2	537.6	437.5	418.4	418.9	1.000	.000	.000	.015	.015
3	643.5	437.5	407.9	408.7	1.000	.284	.506	.041	.830
4	747.0	437.5	393.6	394.8	1.000	.288	.578	.069	.936
5	1392.6	437.2	347.1	349.5	1.000	.438	.000	.015	.452
6	2125.8	435.5	298.0	302.1	1.000	.117	.000	.033	.149
7	2527.8	433.3	271.4	276.5	1.000	.000	.000	.058	.058
8	3131.3	428.5	238.0	244.6	1.000	.110	.000	.062	.172
9	3813.6	421.1	205.9	213.9	1.000	.000	.000	.055	.055
10	4808.9	405.8	164.9	174.2	1.000	.133	.000	.060	.193
11	5601.4	390.5	137.2	147.1	1.000	.000	.000	.020	.020
12	5905.6	384.5	128.4	138.3	1.000	.025	.000	.011	.035
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						1.395	1.084	.466	2.945

SETTLEMENT POINT : -7.5, 210.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1062.9	1016.7	1024.2	1.000	.001	.000	.072	.073
2	537.6	1061.3	948.5	968.4	1.000	.001	.000	.039	.040
3	643.5	1058.0	888.3	920.8	1.000	1.858	.506	.215	2.578
4	747.0	1051.2	811.0	860.6	1.000	.549	.578	.345	1.472
5	1392.6	1015.0	600.0	687.7	1.000	.877	.000	.061	.938
6	2125.8	956.9	436.8	534.3	1.000	.232	.000	.113	.346
7	2527.8	918.8	366.9	461.9	1.000	.000	.000	.159	.159
8	3131.3	865.4	292.2	380.0	1.000	.210	.000	.175	.384
9	3813.6	808.3	231.2	309.7	1.000	.000	.000	.129	.129
10	4808.9	725.6	165.0	229.8	1.000	.231	.000	.133	.364
11	5601.4	662.4	126.6	181.5	1.000	.000	.000	.040	.040
12	5905.6	640.6	115.3	167.0	1.000	.040	.000	.021	.062
						---	---	---	---
						4.000	1.084	1.501	6.584

SETTLEMENT POINT : -45.0, 210.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	531.4	520.9	516.0	1.000	.000	.000	.035	.036
2	537.6	530.8	505.4	493.9	1.000	.000	.000	.018	.019
3	643.5	529.7	491.6	475.3	1.000	.329	.506	.065	.899
4	747.0	527.7	473.5	451.9	1.000	.334	.578	.104	1.016
5	1392.6	521.7	417.5	382.8	1.000	.510	.000	.020	.530
6	2125.8	514.9	359.6	316.5	1.000	.136	.000	.042	.178
7	2527.8	509.8	328.1	282.8	1.000	.000	.000	.072	.072
8	3131.3	500.9	288.1	242.4	1.000	.128	.000	.078	.205
9	3813.6	488.9	249.3	205.6	1.000	.000	.000	.067	.067

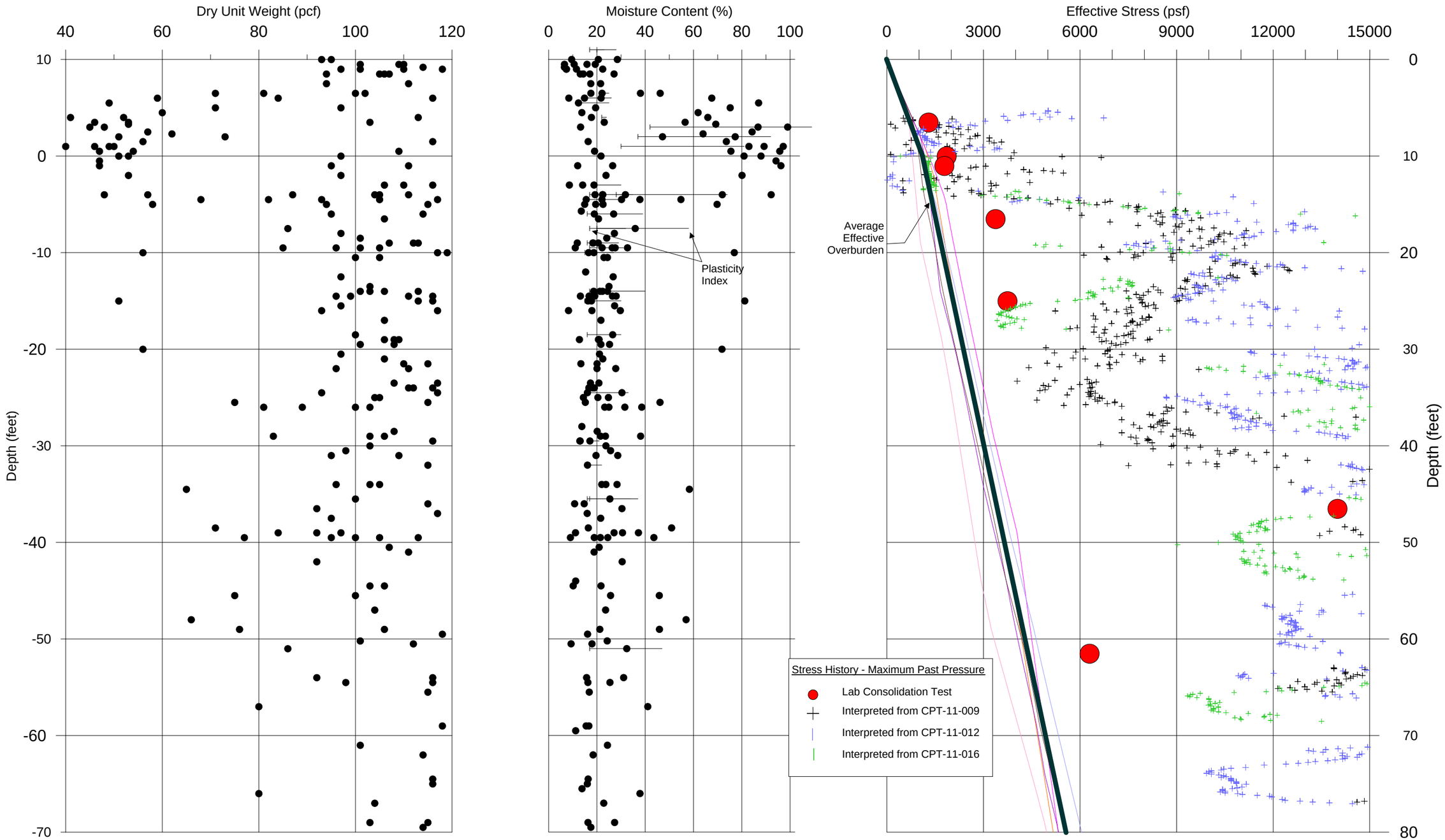
10	4808.9	466.5	199.1	160.8	1.000	.152	.000	.072	.224
11	5601.4	445.1	165.0	131.9	1.000	.000	.000	.024	.024
12	5905.6	437.0	154.0	122.8	1.000	.028	.000	.013	.041
						---	---	---	---
						1.617	1.084	.610	3.311

SETTLEMENT POINT : -7.5, 270.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	1188.0	1138.4	1138.3	1.000	.001	.000	.081	.082
2	537.6	1187.3	1064.8	1064.3	1.000	.001	.000	.044	.045
3	643.5	1185.6	999.0	997.9	1.000	2.253	.506	.262	3.021
4	747.0	1180.6	913.0	910.6	1.000	.978	.578	.430	1.986
5	1392.6	1136.8	673.6	663.6	1.000	.956	.000	.077	1.033
6	2125.8	1051.0	486.8	471.3	1.000	.251	.000	.137	.388
7	2527.8	994.2	407.1	392.0	1.000	.000	.000	.182	.182
8	3131.3	917.0	322.3	311.0	1.000	.221	.000	.198	.419
9	3813.6	838.9	253.5	248.0	1.000	.000	.000	.139	.139
10	4808.9	733.8	179.2	182.7	1.000	.233	.000	.139	.372
11	5601.4	658.9	136.5	145.5	1.000	.000	.000	.040	.040
12	5905.6	634.0	124.0	134.6	1.000	.040	.000	.022	.061
						---	---	---	---
						4.935	1.084	1.752	7.771

SETTLEMENT POINT : -45.0, 270.0

SOIL LAYER	INITIAL STRESS (PSF)	VERTICAL STRESS INCREASE (PSF)	HORIZ. X STRESS INCREASE (PSF)	HORIZ. Y STRESS INCREASE (PSF)	SKEMPTON BJERRUM FACTOR	CONSOL. COMP. (IN.)	SECOND. COMP. 20. YR (IN.)	ELASTIC COMP. (IN.)	TOTAL COMP. (IN.)
1	240.0	594.0	581.6	572.3	1.000	.000	.000	.040	.040
2	537.6	593.9	563.1	540.1	1.000	.000	.000	.021	.021
3	643.5	593.5	546.2	511.0	1.000	.358	.506	.091	.954
4	747.0	592.4	523.4	472.7	1.000	.365	.578	.151	1.094
5	1392.6	582.4	451.6	362.9	1.000	.560	.000	.029	.589
6	2125.8	560.7	380.4	274.7	1.000	.146	.000	.056	.202
7	2527.8	545.1	343.5	237.0	1.000	.000	.000	.084	.084
8	3131.3	522.5	298.4	197.1	1.000	.133	.000	.091	.223
9	3813.6	498.0	256.1	164.8	1.000	.000	.000	.072	.072
10	4808.9	461.9	202.7	129.0	1.000	.151	.000	.075	.225
11	5601.4	433.6	167.2	107.3	1.000	.000	.000	.024	.024
12	5905.6	423.6	155.9	100.6	1.000	.027	.000	.013	.040
						---	---	---	---
						1.740	1.084	.745	3.569



Index Properties and Stress History
U.S. 101 / Broadway Interchange Reconstruction
Burlingame, California
URS Project 28645286

Summary of Laboratory Consolidation Parameters
US 101/Broadway Interchange Reconstruction
Burlingame, California

Boring	Sample Depth (ft)	Elev (ft)	N_{60}	Water Content (%)	Dry Density (pcf)	Liquid Limit	Platicity Index	Liquidity Index	Soil Classification	C_{ce}	C_{re}	Existing Overburden Pressure (psf)	Max Past Pressure (psf)	OCR	C_v (ft^2/day)	C_v from PI (ft2/day)	e_0	Cc	Cr
B-31	14.5	-3	3	90	49	99	63	0.86	OH	0.31	0.040	1100	1100	1.0	0.22	0.01 to 0.04	na	na	na
BRO-1	9.5	0.5	1	89	51	110	72	0.71	OH	0.26	0.040	600	700	1.2	0.032	0.007 to 0.03	na	na	na
BRO-2	14.5	-3	3	82	55	98	63	0.75	OH	0.27	0.035	1200	1400	1.2	0.033	0.01 to 0.04	na	na	na
R-11-005	10	1	300 psi	83	50	81	51	1.04	OH/CH	0.30	0.020	1200	1860	1.6	0.03	0.04	2.34	1.00	0.067
											0.044					0.1			0.147
											0.053								0.177
R-11-011	6.5	3	250 psi	87	48	109	67	0.67	OH/CH	0.29	0.026	700	1,300	1.9	0.03	0.015	2.88	1.11	0.101
											-					0.025			
											0.059								0.229
R-11-013	11	2	200 psi	77	51	92	55	0.73	OH/CH	0.34	0.029	1300	1790	1.4	0.05	0.025	2.92	1.33	0.114
											-					0.05			
											0.057								0.223
R-11-015	61.5	-51	350 psi	32	86	47	30	0.50	CL/CH	0.19	0.017	4417	6300	1.4	0.05	0.18	0.86	0.34	0.032
											0.035					0.8			0.065
											0.035								0.065
R-11-014	25	-14	350 psi	22	103	40	23	0.22	CL	0.12	0.01	1813	3750	2.1	0.05	0.26	0.72	0.21	0.02
											-					1.5			
											0.04								0.07
R-11-006	16.5	-5.5	120 psi	27	95	39	23	0.48	CL	0.12	0.02	1814	3380	1.9	0.06	0.26	0.68	0.20	0.03
											0.02					1.5			0.04
											0.03								0.04
R-11-017	46.5	-35.5	250 psi	25	100	37	20	0.40	CL	0.17	0.02	3691	14000	3.8	0.4	0.3	0.73	0.29	0.03
											-					2			
											0.03								0.05

US 101/BROADWAY
INTERCHANGE RECONSTRUCTION PROJECT

PROPOSED EASTON CREEK BOX CULVERT, DRAINAGE CULVERTS, AND BOX GIRDER

MATERIALS REPORT

Prepared for

URS

Prepared by

V&A

January 2012

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Appendix A: Soil Sample Laboratory Chemical Analysis Results
Appendix B: Caltrans AltPipe Version 6.08 Alternative Pipes for Culverts

EXECUTIVE SUMMARY

V&A was retained by URS Corporation to perform a soil corrosivity investigation for the proposed US 101/Broadway Interchange Replacement Project in the City of Burlingame, San Mateo County. This project extends from Toyon Drive at the south to Mills Creek at the north, along US 101 from Post Mile 16.30 to Post Mile 17.06. The project objectives include reconstruction improvements to US 101 on-ramps and off-ramps at Rollins Road, the Bayshore Highway, Airport Boulevard, and the Crowne Plaza Hotel access road. Retaining walls, concrete barriers, a new Broadway overcrossing bridge, a single-span box girder structure over PG&E high-voltage tower foundations, and modifications to the existing US 101 pedestrian overcrossing approach structures will be constructed to accommodate the proposed US 101 mainline and Broadway interchange improvements.

This report provides recommendations for corrosion control of materials under consideration for the Easton Creek box culvert extension, drainage culverts to be replaced or installed as part of the project, and the reinforced concrete box girder over the PG&E high-voltage tower foundations. The structures being considered as part of this investigation are buried reinforced concrete and various standard culvert pipe alternatives. The investigation was conducted in accordance with California Department of Transportation's Division of Engineering Services, Materials Engineering and Testing Services, Corrosion Technology Branch *Corrosion Guidelines*, Version 1.0, dated September 2003. These Guidelines consider representative soil or water samples to be corrosive to metallic or reinforced concrete structural elements if one or more of the following conditions exist:

- **The chloride concentration is 500 ppm or greater**
- **The sulfate concentration is 2,000 ppm or greater**
- **The pH is 5.5 or less**

Evaluation of the soil environment was made in terms of potential corrosion damage to the proposed box culvert, drainage culvert, and reinforced concrete box girder materials to a depth of 15 feet below grade. Soil resistivity measurements were conducted by V&A in the field during the initial stages of the work. Soil resistivity was determined to a depth of 15 feet at the location of the proposed retaining walls and three PG&E high-voltage towers, as well as to a depth of 100 feet at the proposed Broadway overcrossing bridge abutment sites. In addition, 14 soil samples taken during a geotechnical investigation by URS were sent to Cooper Testing Laboratory in Palo Alto, California, for chemical analysis. The soil samples were analyzed for as-received and minimum (saturated) resistivity, for pH, and for water-soluble chloride and sulfate ion concentrations. All of these chemical properties affect the corrosion rate of buried reinforced concrete structures. A previously reported soil sample from Rajappan & Meyers for Job No. 201191.GDR, December 22, 2005, page 72, is included with the current analyses to provide information along a portion of the northbound US 101 on-ramp. A water sample from Easton Creek was sent to XENCO Laboratories in Houston, Texas, to be analyzed for specific conductance (conductivity), pH, and chloride, sulfate, and bicarbonate ion concentration. The water sample analysis is pertinent to the proposed box culvert widening where the reconstructed northbound US 101 on-ramp will cross Easton Creek.

Fourteen soil samples from selected points throughout the Broadway interchange site, and the previous sample B-31, had minimum (saturated) resistivities that ranged from 61 to 3,566 ohm-cm. The soil pH values varied from 7.6 to 8.8. Water-soluble chlorides ranged from less than 2 to 8,325 mg/kg (ppm), and the water-soluble sulfate concentrations were from 6 to 5,391 mg/kg (ppm). Six borehole soil samples (A-11-004, A-11-023, A-11-030-2-4, A-11-031-2-3, R-11-018-2-2, and B-31) are considered *corrosive* based on their chloride contents. Two borehole sites (A-11-030-2-4 and R-11-010-1-3) are *corrosive* based on their sulfate ion concentrations as defined by the Caltrans *Corrosion Guidelines*. The other soil samples are *non-corrosive* based on the Caltrans *Corrosion Guidelines*.

The water sample taken from Easton Creek has a chloride content of 11,600 mg/kg (ppm) and a sulfate content of 2,030 mg/kg (ppm). The water is *corrosive* to reinforced concrete structures based on the Caltrans *Corrosion Guidelines* criteria.

Alternative pipe materials were selected using Caltrans AltPipe software, version 6.08, which calculates maintenance-free service design estimates for various service life expectancies. Values are entered into the program for pipe diameter in inches, soil pH, minimum soil resistivity (ohm-cm), sulfate concentration (ppm), chloride concentration (ppm), abrasion level, 2- to 5-year-storm maximum flow velocity (feet per second), height of cover over the culvert (feet), and the service design life in years. The software calculates the permissible culvert material alternatives from a list that includes corrugated steel pipe, corrugated aluminum pipe, plastic pipe, and reinforced concrete pipe. The pipe diameters that were selected for the AltPipe calculations were 12, 18, 24, and 30 inches. Other parameters selected for the analyses were abrasion level 1, a 2-to 5-year maximum flow velocity of 5 feet per second, 5 feet of cover over the culverts, and a 50-year design service life.

For each proposed drainage system, the minimum resistivity and chemical values of the closest URS core boring sample were used in AltPipe to represent the harshest soil conditions in the drainage system. Where more than one URS soil sample was taken near the drainage system, the values of the most corrosive sample were used.

Conclusions

- Six soil boring samples (A-11-004, A-11-023, A-11-030-2-4, A-11-031-2-3, R-11-018-2-2, and B-31) had soluble chloride concentrations greater than 500 mg/kg. Two soil boring samples (A-11-030-2-4 and R-11-010-1-3) had soluble sulfate concentrations greater than 2,000 mg/kg. According to the Caltrans *Corrosion Guidelines*, these soils are *corrosive* to buried reinforced concrete structures.
- The Easton Creek water has a chloride content of 11,600 mg/kg (ppm) and a sulfate concentration of 2,030 mg/kg (ppm). This water is considered to be *corrosive* to buried reinforced concrete structures according to the Caltrans *Corrosion Guidelines*.
- Three soil samples were taken within about 75 feet of the proposed box girder structure over the PG&E high-voltage tower foundations at the US 101 southbound on-ramp. Of these three, one (R-11-018-2-2) had a water-soluble chloride content of 4,965 mg/kg (ppm), which

is considered *corrosive* to buried reinforced concrete structures per the Caltrans *Corrosion Guidelines*.

- The project site is within 1,000 feet of salt water or brackish water.

Recommendations

General

- Corrosion protection against a marine atmosphere is required by the *Corrosion Guidelines* for above-ground reinforced concrete structures at the proposed box culvert and box girder locations.
- Design of structures installed in these locations should include corrosion mitigation measures as detailed below.

Buried Reinforced Concrete Structures and Driven Concrete Piles

Buried concrete structures and driven reinforced concrete piles should be constructed of durable concrete as described in ACI Standards 201.2R and 222R and Chapter 850.3, "Corrosion," of the Caltrans *Highway Design Manual* (last updated September 28, 2011). Criteria for protecting reinforced concrete structures under corrosive conditions discussed in Caltrans Standard Special Provision (SSP) S8-C04, "Corrosion Control for Portland Cement Concrete" (a modification of Bridge Design Specifications, Section 8, "Reinforced Concrete"), should be followed for the Easton Creek box culvert and the box girder structure at the proposed US 101 southbound on-ramp. These recommendations include, but are not limited to, the following for reinforced concrete in corrosive soil or exposed to corrosive water:

- The following concrete compositional requirements are recommended per the Caltrans Standard Specifications updated July 28, 2011, Section 90-1.02H, "Concrete in Corrosive Environments":
  - The cementitious material used in the concrete must be a combination of Type II or Type V Portland cement and SCM (supplementary cementitious materials).
  - The concrete must contain at least 675 pounds of cementitious material per cubic yard.
  - The reduction of cementitious material content specified in Section 90-1.02E(2) is not allowed.
  - The specifications for SCM content in Section 90-1.02B(3) do not apply.
  - The cementitious material must be composed of one of the following by weight:
    - 25% natural pozzolan or fly ash with a CaO content of up to 10%, and 75% Portland cement.
    - 20% natural pozzolan or fly ash with a CaO content of up to 10%, 5% silica fume, and 75% Portland cement.
    - 12% silica fume, metakaolin, or UFFA (ultra-fine fly ash) and 88% Portland cement.
    - 50% GGBFS (ground granular blast furnace slag) and 50% Portland cement.

- A maximum water-to-cementitious material ratio of 0.40 shall be used in the concrete.

- Concrete sealant (silane) shall not be allowed as an option for concrete in a corrosive environment.
- A minimum concrete cover of 3 inches for a 50-year design life, and 4 inches for a 75-year design life, shall be applied over all steel reinforcement. This is based on a soil water-soluble chloride concentration of 5,000 to 10,000 mg/kg (ppm) for buried reinforced concrete above the groundwater table.

  This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete Cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.
- Sand and water used in concrete mixtures should contain a maximum of 100 mg/kg (ppm) of water-soluble chloride ions and water-soluble sulfate ions. Sand and water pH shall be between 6.5 and 8.0. Potable water should be used in all concrete mixtures.

Reinforced Concrete Exposed to Marine Atmosphere

- Above-ground reinforced concrete structures within 1,000 feet of brackish or salt water are exposed to a corrosive marine atmosphere. The following minimum concrete cover over unprotected reinforcing steel is recommended for the concrete structures listed below:
  - 3 inches concrete cover for the following:
    - Footings and pile caps
    - Walls, columns, and cast-in-place piles
    - Cast-in-place "I" and "T" girders, box-girder webs, bent caps, diaphragms, and hinged joints
  - 2.5 inches concrete cover for the top surface of deck slabs
  - 2 inches concrete cover for precast piles and pile extensions
  - 1.5 inches concrete cover for the following:
    - Bottom surface of deck slab
    - Box-girder bottom slabs
- This recommendation is taken from *California Amendments to AASHTO LRFD Bridge Design Specifications*, Fourth Edition, November 2011, Table 5.12.3-1, "Minimum Concrete Cover for 75-Year Design Life"; and from the Caltrans *Highway Design Manual*, Chapter 850, Physical Standards, Table 855.4B, page 850-35, August 1, 2011.

Culvert, Mechanically Stabilized Embankment, and Metallic Soil Reinforcement Backfill

Non-corrosive backfill for mechanically stabilized embankments with metallic soil reinforcement, such as tieback and tiedown anchors or soil nails, and reinforced concrete structures, shall meet the following requirements, in accordance with the *Corrosion Guidelines*:

- Minimum resistivity greater than 2,000 ohm-cm as determined by California Test Method (CTM) 643.

- Chloride concentration less than 250 ppm as determined by CTM 422.
- Sulfate concentration less than 500 ppm as determined by CTM 417.
- A pH value between 5.5 and 10.0 as determined by CTM 643.
- Slag aggregate should not be used as a backfill due to high water-soluble sulfate concentrations.

Fast-setting concrete backfill may need to be used when placing culverts in existing roadways. When using an admixture to decrease concrete curing times, only non-chloride admixtures should be considered.

If soil nails, tieback anchors, or tiedown anchors are used for any of the reinforced concrete structures proposed for the project, the following shall apply:

- Corrosion mitigation is required for soil nails, tieback anchors, and tiedown anchors due to the critical nature of their application.
  - Soil nails
    - Soil nails shall be either a reinforcing bar encapsulated for its full length in a grouted corrugated plastic sheathing or an epoxy-coated reinforcing bar partially encapsulated in a grouted corrugated plastic sheathing.
    - Soil nails shall be constructed in conformance with Structure Reference Specification 19-660, section 10-1.
    - The bar shall be centered in the sheathing and the space between the sheathing and the bar shall be filled with grout
    - The epoxy coating shall have a minimum thickness of 12 mils.
  - Tieback anchors
    - Tieback anchors shall be constructed in conformance with Structure Reference Specification 50-560, section 10-1.
    - Grouting procedures shall follow guidelines discussed in Section 50, “Prestressing Concrete,” in the Caltrans Standard Specifications.
    - The tieback anchorage assembly and anchor steel shall be protected against rust, corrosion, and physical damage prior to completing enclosure grouting or concrete encasement per Section 50 of the Caltrans Standard Specifications.
    - Strand-type tendons shall be encapsulated in corrosion-inhibiting grease per Structure Reference Specification 50-560.
  - Tiedown anchors
    - Tiedown anchors shall be constructed in conformance with Structure Reference Specification 50-570, Section 10-1.
    - Grouting procedures shall follow guidelines discussed in Section 50, “Prestressing Concrete,” in the Caltrans Standard Specifications.
    - Tieback anchor steel shall be protected prior to completion of all grouting against rust, corrosion, and physical damage per Section 50 of the Caltrans Standard Specifications.

- ◊ Strand-type tendons shall be encapsulated in corrosion-inhibiting grease per Structure Reference Specification 50-560.

Alternative Pipe Material Selection

Culvert materials were selected for the 22 selected drainage systems using Caltrans AltPipe web-based software, version 6.08. Alternative pipe material recommendations for each of the 22 drainage systems under consideration are presented in Appendix B and summarized as follows:

- Refer to the table in Appendix B for permissible steel pipe types, coatings, and minimum thicknesses for each drainage system.
- Use of aluminum pipe (corrugated and spiral-rib) and Type 2 aluminized steel pipe is highly restricted at the project site. Aluminum pipe and aluminum-coated steel pipe can only be used where the soil pH range is 5.5 to 8.5, the minimum soil resistivity is greater than 1,500 ohm-cm, and the abrasion level is 1 to 3 (non-abrasive).
- Corrugated PVC pipe can be used in all of the drainage systems at the specified pipe diameters. Other PVC and HDPE (high-density polyethylene) pipes are permissible with size restrictions.
- Reinforced concrete pipes can be used in all of the drainage systems with the specified minimum concrete cover over the reinforcing steel.

TESTING OVERVIEW

Figures 1 and 2 show the overall project location.

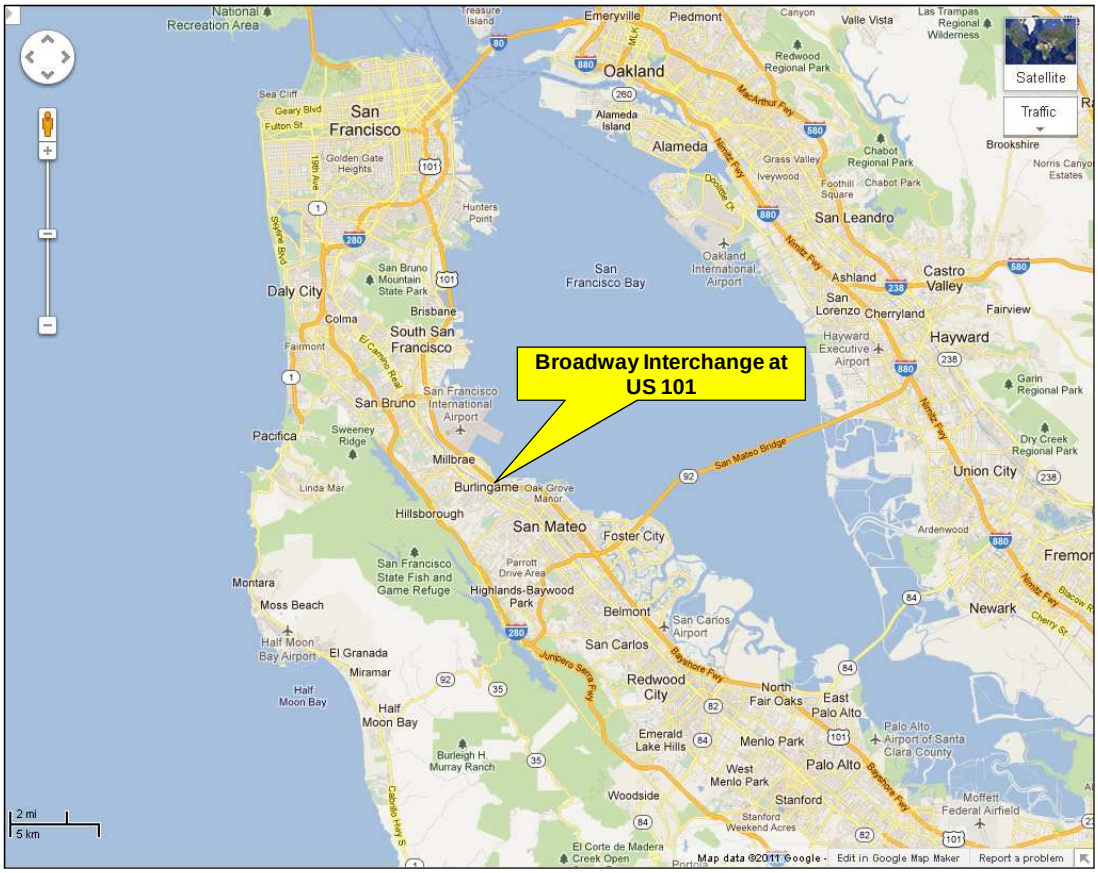


Figure 1. Vicinity and Project Site Map

Figure 2. Aerial View of Project Site (Red Box)

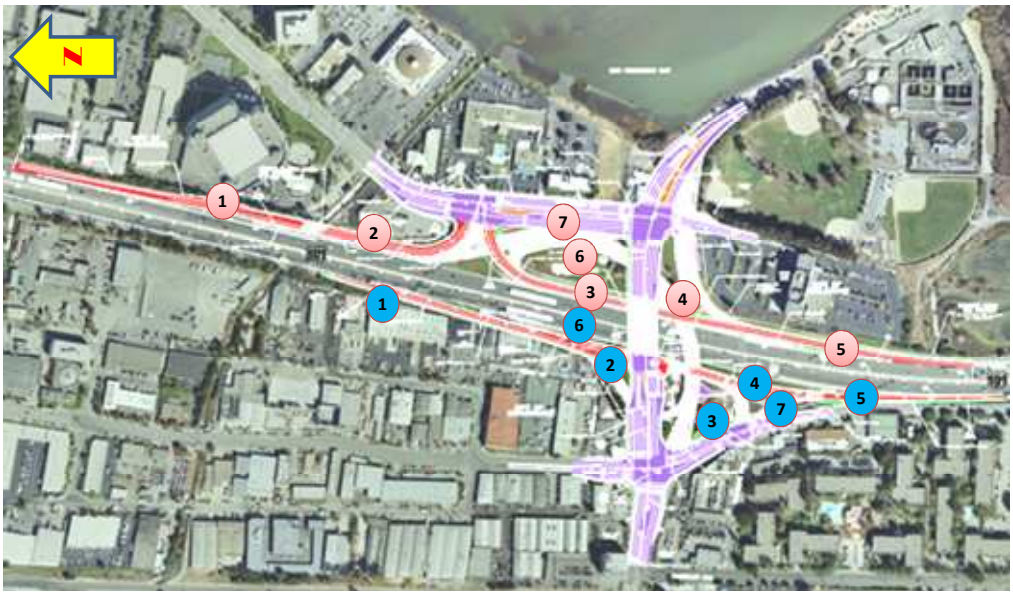
Proposed box girder and box culvert locations are shown in Figure 3.

Figure 3. Proposed Box Girder and Easton Creek Box Culvert Locations

To predict corrosion problems associated with a particular type of structure prior to installation, it is necessary to investigate the soil conditions the structure will encounter. Since corrosion is an electrochemical process accompanied by current flow, the electrochemical characteristics of a soil are of primary importance when evaluating corrosivity. Test methods utilized during this investigation reflect the most practical methods of determining soil corrosivity. This investigation was based on field measurements of soil resistivity and laboratory analysis of soil samples from the project site. The field resistivity tests have been conducted for comparison with laboratory soil boring sample analyses.

Resistivity is a measure of the ability of a soil to conduct an electric current. Soil resistivity is primarily dependent on the chemical and moisture content of the soil. As the concentrations of soluble chemical constituents increases, the soil resistivity will decrease. Lower soil resistivity is associated with higher corrosivity to buried metal and reinforced concrete structures.

At 14 sites the soil resistivity was measured to a depth of 15 feet below grade. Soil resistivities at four sites located near the abutments for the proposed Broadway overcrossing bridge (NB-6, NB-7, SB-6, and SB-7) were also measured to depths of 25, 50, 75 and 100 feet below grade. Figure 4 shows the soil resistivity test sites at the US 101/Broadway interchange project site.



Legend

1 Northbound (NB) soil resistivity test location

1 Southbound (SB) soil resistivity test location

Figure 4. Soil Resistivity Test Sites

A wide variety of water-soluble salts is typically found in soils. Two soils having the same resistivity may have significantly different corrosion characteristics, depending on the specific ions available. The major constituents that accelerate corrosion are chlorides, sulfates, and the acidity (pH) of the soil. Also, concentrations of bicarbonates tend to decrease soil resistivities. Bicarbonates are not

directly aggressive to buried metallic or concrete structures, but the lower soil resistivity can promote corrosion activity.

Chloride ions break down otherwise protective surface deposits and can facilitate corrosion of buried metallic structures. Sulfates in soil can be highly aggressive to Portland cement by combining chemically with certain constituents of the concrete, principally tricalcium aluminate. This reaction is accompanied by expansion and eventual disruption of the concrete matrix. Sulfate ions reduce the soil resistivity, which also promotes corrosion activity on buried metallic structures.

Acidity, as indicated by the pH value, is another important factor of soil with respect to corrosivity. Lower pH (more acidic) will result in a greater degree of corrosivity with respect to buried metallic structures. When pH increases above 7.0 (the neutral value) the conditions become increasingly more alkaline. In alkaline environments, iron forms a protective layer on its surface. This is referred to as passivation. When the soil pH drops below about 9.0, the passive layer may break down.

Figure 5 shows the URS soil boring sites that provided soil samples for laboratory analysis.

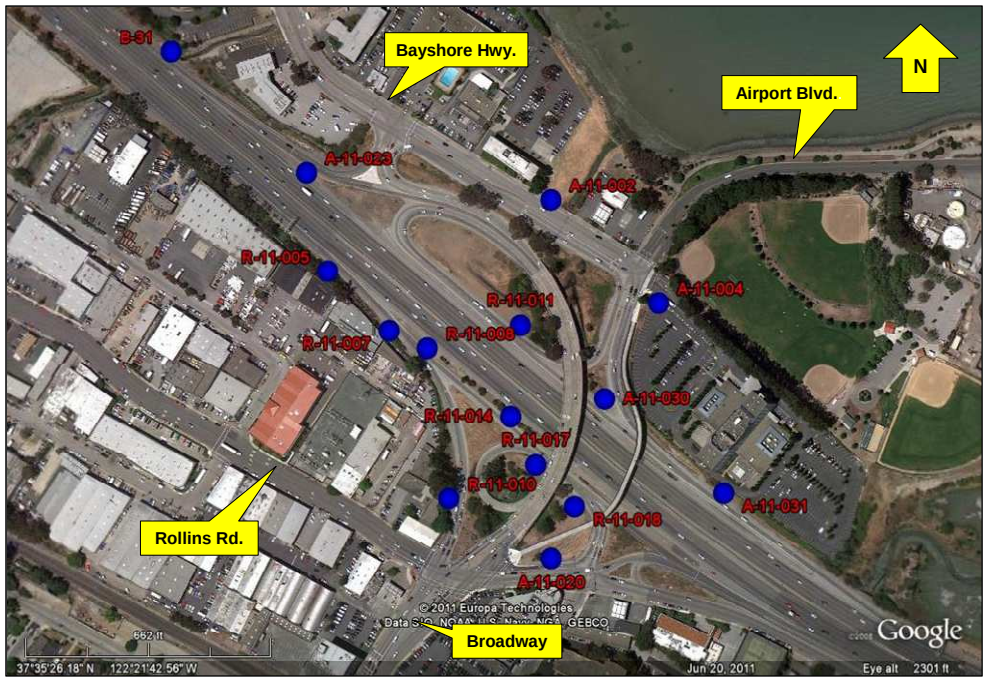


Figure 5. Soil Borehole Locations

TESTING METHODS

Field Soil Resistivity

Field soil resistivity measurements were taken using the Wenner four-electrode method (ASTM G57), utilizing an AEMC Instruments Model 4500 soil resistance meter. The Wenner method uses four

metal pins or electrodes, driven into the ground along a straight line, equidistant from each other, as shown in Figure 6. Soil resistivity measurements were conducted at electrode spacings of 2.5, 5, 7.5, 10, and 15 feet; and where applicable 25, 50, 75, and 100 feet.

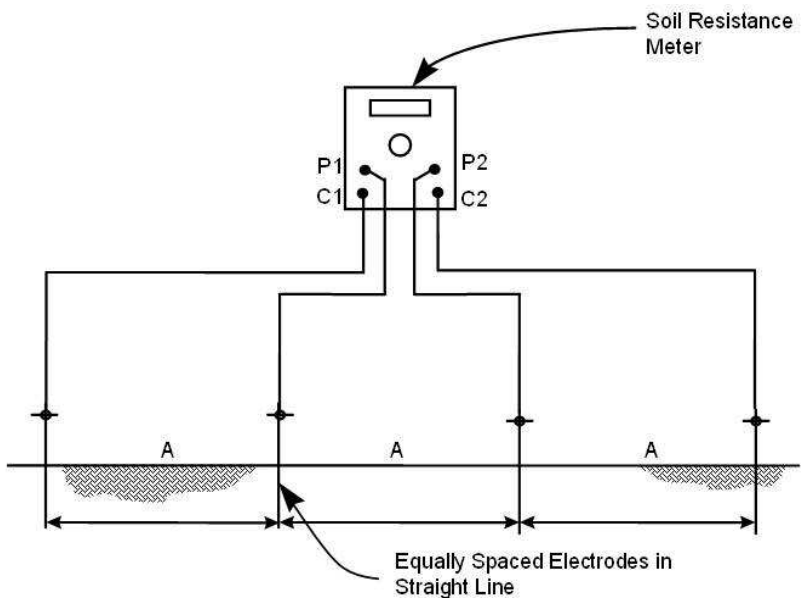


Figure 6. Soil Resistivity Measurement

An alternating current from the soil resistance meter causes a current to flow through the soil between the outer electrodes, C1 and C2. The current creates a voltage gradient in the soil, which is proportional to the average resistance of the soil mass to a depth equal to the electrode spacing. The voltage drop is then measured across pins P1 and P2. Resistivity of the soil is then computed from the instrument reading according to the formula

$$\rho = 2\pi AR$$

where ρ = soil resistivity (ohm-cm)
A = distance between electrodes (cm)
R = soil resistance, instrument reading (ohms)
π = 3.14 (approximate).

To calculate the resistivity of a soil layer, the Barnes layer method is used based on the results of the Wenner four-electrode tests. The Wenner method measures soil resistivity from the surface to various depths below grade. The Barnes layer method is used to calculate the resistivity of a soil layer between two depths below grade from the surface-to-depth resistivity measurements. The Barnes layer method assumes the soil layers are a uniform thickness and that the upper and lower boundaries are parallel to the surface.

The Barnes layer resistivity of each layer of soil was calculated using the equations

$$\rho_{b-a} = KR_{(b-a)}$$

and

$$\frac{1}{R_{b-a}} = \frac{1}{R_a} - \frac{1}{R_b}$$

where

ρ_{b-a}	=	resistivity of soil layer from depth *a* to *b* (ohm-cm)
a	=	soil depth to top of layer (cm)
b	=	soil depth to bottom of layer (cm)
R_a	=	soil resistance read at depth *a* (ohms)
R_b	=	soil resistance read at depth *b* (ohms)
R_{b-a}	=	resistance of soil layer from depth *a* to *b* (ohms)
K	=	layer constant (cm)
	=	$2\pi(b–a)$.

Laboratory Soil Analysis

For the purposes of this analysis, 14 soil samples were obtained from 14 URS soil boreholes (Figure 5) for laboratory soil resistivity analysis. A soil box was used in accordance with California Test Method 643. The test apparatus is shown in Figure 7. It consists of a small plastic box with metal end plates for passing current through a tightly packed soil sample. Electric current flowing through the sample causes a voltage drop between pins P1 and P2. The soil resistivity is measured with a soil resistance meter. The soil box is designed so that the meter resistance reading is also the sample resistivity in ohm-cm. The soil resistivity is first measured in the "as-received" state. Distilled water is then added in increments to the soil sample. The soil resistivity is measured after each water addition. As the soil sample becomes more saturated, the resistivity decreases until the minimum soil resistivity is reached. Adding more water increases the resistivity as the soil electrolyte solution is diluted. The minimum observed resistivity is recorded.

The soil samples from the URS boreholes were forwarded to Cooper Testing Laboratory in Palo Alto, California, for minimum resistivity measurement, pH analysis, and analysis of water-soluble chloride and sulfate ion concentrations. The analytical procedures followed California Test Methods 417, 422, 643, and 644.

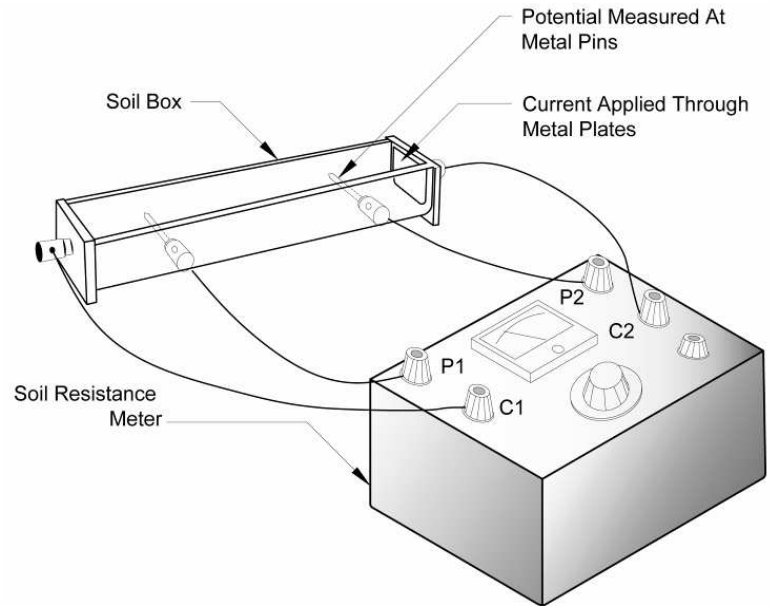


Figure 7. Soil Resistivity Measurement Using the Soil Box Method

TEST RESULTS

Field Soil Resistivity Results

Data obtained during this investigation has been tabulated for analysis and presentation. Table 1 lists the results of the Wenner soil resistivity measurements and Barnes layer calculations conducted at the US 101/Broadway interchange project site.

Table 1. Field Soil Resistivity Measurements

Site	Depth (feet)	Resistivity (Ohm-cm)	Layer Depth (feet)	Layer Resistivity (ohm-cm)	Site	Depth (feet)	Resistivity (Ohm-cm)	Layer Depth (feet)	Layer Resistivity (ohm-cm)
NB-1	2.5	2,298	0 - 2.5	2,298	SB-1	2.5	2,557	0 - 2.5	2,557
	5	852	2.5 - 5	523		5	1,274	2.5 - 5	848
	7.5	417	5 - 7.5	206		7.5	603	5 - 7.5	294
	10	402	7.5 - 10	364		10	306	7.5 - 10	124
	15	259	10 - 15	151		15	259	10 - 15	197
NB-2	2.5	1,197	0 - 2.5	1,197	SB-2	2.5	2,427	0 - 2.5	2,427
	5	259	2.5 - 5	145		5	1,455	2.5 - 5	1,039
	7.5	172	5 - 7.5	103		7.5	1,508	5 - 7.5	1,626
	10	96	7.5 - 10	41		10	1,111	7.5 - 10	620
	15	29	10 - 15	12		15	1,207	10 - 15	1,458
NB-3	2.5	1,647	0 - 2.5	1,647	SB-3	2.5	5,042	0 - 2.5	5,042
	5	929	2.5 - 5	647		5	3,074	2.5 - 5	2,211
	7.5	632	5 - 7.5	386		7.5	1,566	5 - 7.5	790
	10	249	7.5 - 10	88		10	900	7.5 - 10	396
	15	172	10 - 15	107		15	373	10 - 15	172
NB-4	2.5	1,666	0 - 2.5	1,666	SB-4	2.5	1,628	0 - 2.5	1,628
	5	1,676	2.5 - 5	1,685		5	1,302	2.5 - 5	1,085
	7.5	632	5 - 7.5	281		7.5	747	5 - 7.5	403
	10	345	7.5 - 10	146		10	594	7.5 - 10	368
	15	201	10 - 15	110		15	402	10 - 15	244
NB-5	2.5	6,334	0 - 2.5	6,334	SB-5	2.5	6,195	0 - 2.5	6,195
	5	3,447	2.5 - 5	2,368		5	3,371	2.5 - 5	2,315
	7.5	4,252	5 - 7.5	7,972		7.5	1,566	5 - 7.5	756
	10	1,666	7.5 - 10	590		10	900	7.5 - 10	396
	15	431	10 - 15	174		15	718	10 - 15	511
NB-6	2.5	12,448	0 - 2.5	12,448	SB-6	2.5	3,332	0 - 2.5	3,332
	5	1,609	2.5 - 5	860		5	3,074	2.5 - 5	2,852
	7.5	862	5 - 7.5	447		7.5	1,566	5 - 7.5	790
	10	218	7.5 - 10	67		10	1,072	7.5 - 10	551
	15	204	10 - 15	180		15	172	10 - 15	64
	25	321	15 - 25	2,278		25	48	15 - 25	23
	50	278	25 - 50	245		50	**ND**	25 - 50	**ND**
	75	373	50 - 75	1,203		75	**ND**	50 - 75	**ND**
	100	315,036	75 - 100	11,031		100	**ND**	75 - 100	**ND**
NB-7	2.5	1,254	0 - 2.5	1,254	SB-7	2.5	6,464	0 - 2.5	6,464
	5	1,072	2.5 - 5	937		5	4,376	2.5 - 5	3,308
	7.5	282	5 - 7.5	114		7.5	975	5 - 7.5	382
	10	170	7.5 - 10	78		10	515	7.5 - 10	213
	15	359	10 - 15	296		15	290	10 - 15	155
	25	737	15 - 25	1,271		25	326	15 - 25	399
	50	517	25 - 50	398		50	354	25 - 50	389
	75	876	50 - 75	2,253		75	733	50 - 75	645
	100	102,267	75 - 100	1,093		100	**ND**	75 - 100	**ND**

ND: not determined. Insufficient space to set up the Wenner four-electrode test array for the indicated soil depth.

Laboratory Soil Analysis Results

Table 2 lists the minimum soil resistivity and chemical analyses of the 14 soil samples retrieved from URS soil borings taken at the project site and analyzed at the Cooper Testing Laboratory.

An additional sample from a previous soil boring (B-31) was included to provide additional information along the proposed northbound US 101 on-ramp concrete barrier alignment. The results for B-31 were reported in Rajappan & Meyer Job No. 201191.GDR (GDMR for US 101 Auxiliary Lane Project), December 22, 2005, Table 8B, page 72.

Table 2. Laboratory Soil Resistivity and Chemical Data

Sample No.	Depth (feet)	Minimum Resistivity (ohm-cm)	Chemical Data		
			pH	Chloride (mg/kg)	Sulfate (mg/kg)
A-11-002	2.5 - 5	1,236	8.8	92	434
A-11-004	2.5 - 5	622	8.3	528	900
A-11-020-2-3	5 - 6.5	3,566	8.3	<2	6
A-11-023	2 - 5	198	8.2	2,034	447
A-11-030-2-4	3 - 6.5	114	7.8	6,739	2,606
A-11-031-2-3	3 - 6.5	90	7.7	3,284	425
R-11-005	3.5 - 5	1,151	7.9	90	542
R-11-007-1-3	5 - 7	1,952	7.9	13	6
R-11-008-1-3	5 - 7	2,517	8.0	<2	132
R-11-010-1-3	5 - 7	1,768	7.7	24	5,391
R-11-011	0 - 6	1,252	8.0	246	9
R-11-014-1	5 - 6.5	1,328	7.6	181	8
R-11-017-1-2	5 - 7	561	7.7	451	272
R-11-018-2-2	10 - 11.5	131	8.0	4,965	786
B-31*	9.5 - 19.5	61	8.1	8,325	1,094
Easton Creek Water		26	7.3	11,600	2,030

* Soil sample B-31 was previously reported in Rajappan & Meyer Job No. 201191.GDR, 12/22/05, page 72
mg/kg – milligrams per kilogram (ppm)
Minimum resistivity by Caltrans Method 643
pH by Caltrans Method 644
Chloride by Caltrans Method 422-modified
Sulfate by Caltrans Method 417-modified

Based on the *Corrosion Guidelines*, six of the analyzed soil samples and Rajappan & Meyer soil sample B-31 are considered corrosive to buried metallic objects and reinforced concrete structures with regards to chloride or sulfate contents. These samples are color-highlighted in Table 2 above.

APPENDIX A: SOIL SAMPLE LABORATORY CHEMICAL ANALYSIS RESULTS

COOPER TESTING LABORATORY

Corrosivity Test Summary

CTL #	632-011		**Date:**	12/19/2011		**Tested By:**	PJ		**Checked:**	PJ	
Client:	V&A Consulting Engineers		**Project:**	URS Hwy 101 Broadway Interchange					**Proj. No:**	11-0149	
Remarks:											

Sample Location or ID			**Resistivity @ 15.5 °C (Ohm-cm)**			**Chloride**	**Sulfate**		**pH**	**ORP**	**Moisture**	
Boring	**Sample, No.**	**Depth, ft.**	**As Rec.**	**Minimum**	**Saturated**	**mg/kg**	**mg/kg**	**%**		(Redox)	At Test	**Soil Visual Description**
						Dry Wt.	Dry Wt.	Dry Wt.		mV	%	
			ASTM G57	Cal 643	ASTM G57	Cal 422-mod.	Cal 417-mod.	Cal 417-mod.	Cal 643	SM 2580B	ASTM D2216	
A-11-002	-	2.5-5	29,118	1,236	-	92	434	0.0434	8.8	-	8.3	Olive Silty SAND (Slightly Plastic)
A-11-004	-	2.5-5	1,308	622	-	528	900	0.0900	8.3	-	16.8	Dark Olive Gray Clayey SAND w/ Gravel
A-11-020-2-3	-	5-6.5	3,566	3,566	-	<2	6	0.0006	8.3	-	20.4	Olive Brown Silty SAND
A-11-023	-	2-5	5,591	198	-	2,034	447	0.0447	8.2	-	7.8	Olive Gray Clayey SAND w/ Gravel
A-11-030-2-4	-	3-6.5	129	114	-	6,739	2,606	0.2606	7.8	-	95.7	Olive Gray CLAY w/ Organics
A-11-031-2-3	-	3-6.5	104	90	-	3,284	425	0.0425	7.7	-	77.0	Dark Greenish Gray CLAY
R-11-005	-	3.5-5	149,040	1,151	-	90	542	0.0542	7.9	-	4.8	Olive Brown Clayey SAND w/ Gravel
R-11-007-1-3	-	5-7	6,381	1,952	-	13	6	0.0006	7.9	-	12.5	Gray Clayey SAND changing to Sandy CLAY
R-11-008-1-3	-	5-7	2,904	2,517	-	<2	132	0.0132	8.0	-	7.4	Gray Clayey SAND w/ Gravel
R-11-010-1-3	-	5-7	5,515	1,768	-	24	5,391	0.5391	7.7	-	20.8	Olive Brown Clayey SAND
R-11-011	-	0-6	600,080	1,252	-	246	9	0.0009	8.0	-	3.9	Olive Brown Clayey SAND w/ Gravel
R-11-011-13-3	-	55-60	821	719	-	341	9	0.0009	7.7	-	23.6	Olive Brown Clayey SAND
R-11-014-1	-	5-6.5	1,605	1,328	-	181	8	0.0008	7.6	-	24.9	Brown Clayey SAND w/ Gravel
R-11-014-13-4	-	57-58	3,214	2,829	-	43	<5	<0.0005	8.0	-	16.1	Olive Brown Clayey SAND
R-11-017-1-2	-	5-7	561	561	-	451	272	0.0272	7.7	-	15.4	Olive Brown Sandy CLAY w/ Gravel
R-11-018-2-2	-	10-11.5	146	131	-	4965	786	0.0786	8.0	-	80.3	Gray CLAY

APPENDIX B: CALTRANS ALTPIPE VERSION 6.08
ALTERNATIVE PIPES FOR CULVERTS

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	1	1	1	1	2	2	2	2	3	3	3	3
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PA (Polymerized Asphalt)	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
	PS (Polymeric Sheet)	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	`	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	1	1	1	1	2	2	2	2	3	3	3	3
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Plastic Pipes

	Drainage System	1	1	1	1	2	2	2	2	3	3	3	3
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Availability				Availability				Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	1	1	1	1	2	2	2	2	3	3	3	3
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Steel Cover (in)		1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	1	1	1	1	2	2	2	2	3	3	3	3
	Soil Bore Sample I.D.	B-31				B-31				B-31			
Soil pH		8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
Minimum Soil Resistivity (ohm-cm)		61	61	61	61	61	61	61	61	61	61	61	61
Sulfate Concentration (ppm)		1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,094	1,094
Chloride Concentration (ppm)		8,325	8,325	8,325	8,325	8,325	8,325	8,325	8,325	8,325	8,325	8,325	8,325
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	4	4	4	4	5	5	5	5	6	6	6	6
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Pipe Type	**Coating**	**Minimum Thickness (in)**				**Minimum Thickness (in)**				**Minimum Thickness (in)**			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	0.109	NA	NA	NA	0.109
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	0.064	0.064	0.064	0.064	NA	NA	0.079	0.079
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.064	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	NA	0.079	0.079
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.109	0.109	NA	NA	0.109	0.109
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.079	0.079
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.109	0.109	NA	NA	0.109	0.109
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.079	0.079
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.109	0.109	NA	NA	0.109	0.109
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.079	0.079
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	4	4	4	4	5	5	5	5	6	6	6	6
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Pipe Type		**Minimum Thickness (in)**				**Minimum Thickness (in)**				**Minimum Thickness (in)**			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Plastic Pipes

	Drainage System	4	4	4	4	5	5	5	5	6	6	6	6
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Pipe Type		**Availability**				**Availability**				**Availability**			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	4	4	4	4	5	5	5	5	6	6	6	6
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Steel Cover (in)		0.75	0.75	1	1	0.75	0.75	1	1	0.75	0.75	1	1
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	4	4	4	4	5	5	5	5	6	6	6	6
	Soil Bore Sample I.D.	**A-11-023**				**A-11-002**				**R-11-005**			
Soil pH		8.2	8.2	8.2	8.2	8.8	8.8	8.8	8.8	7.9	7.9	7.9	7.9
Minimum Soil Resistivity (ohm-cm)		198	198	198	198	1,236	1,236	1,236	1,236	1,151	1,151	1,151	1,151
Sulfate Concentration (ppm)		447	447	447	447	434	434	434	434	542	542	542	542
Chloride Concentration (ppm)		2,034	2,034	2,034	2,034	92	92	92	92	90	90	90	90
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	7	7	7	7	8	8	8	8	9	9	9	9
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	0.109	NA	NA	NA	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.079	0.079	0.064	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.079	0.079	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.079	0.079	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.079	0.079	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.079	0.079	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	7	7	7	7	8	8	8	8	9	9	9	9
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Plastic Pipes

	Drainage System	7	7	7	7	8	8	8	8	9	9	9	9
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Availability				Availability				Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	7	7	7	7	8	8	8	8	9	9	9	9
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Steel Cover (in)		0.75	0.75	1	1	0.75	0.75	1	1	1.25	1.25	1.25	1.25
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	7	7	7	7	8	8	8	8	9	9	9	9
	Soil Bore Sample I.D.	R-11-005				R-11-011				A-11-030-2-4			
Soil pH		7.9	7.9	7.9	7.9	8.0	8.0	8.0	8.0	7.8	7.8	7.8	7.8
Minimum Soil Resistivity (ohm-cm)		1,151	1,151	1,151	1,151	1,252	1,252	1,252	1,252	114	114	114	114
Sulfate Concentration (ppm)		542	542	542	542	9	9	9	9	2,606	2,606	2,606	2,606
Chloride Concentration (ppm)		90	90	90	90	246	246	246	246	6,739	6,739	6,739	6,739
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	10	10	10	10	11	11	11	11	12	12	12	12
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079			0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	NA	0.079	0.079	NA	NA	0.079	0.079
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	10	10	10	10	11	11	11	11	12	12	12	12
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA				0.060				0.060
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	0.060	0.060	0.060	0.075	0.060	0.060	0.060	0.075
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA				0.060				0.060
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA			0.060	0.060			0.060	0.060
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA			0.060	0.060			0.060	0.060

Plastic Pipes

	Drainage System	10	10	10	10	11	11	11	11	12	12	12	12
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Availability				Availability				Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	10	10	10	10	11	11	11	11	12	12	12	12
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Steel Cover (in)		1.25	1.25	1.25	1.25	0.75	0.75	1	1	0.75	0.75	1	1
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	10	10	10	10	11	11	11	11	12	12	12	12
	Soil Bore Sample I.D.	A-11-030-2-4				R-11-010-1-3				R-11-010-1-3			
Soil pH		7.8	7.8	7.8	7.8	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Minimum Soil Resistivity (ohm-cm)		114	114	114	114	1,768	1,768	1,768	1,768	1,768	1,768	1,768	1,768
Sulfate Concentration (ppm)		2,606	2,606	2,606	2,606	5,391	5,391	5,391	5,391	5,391	5,391	5,391	5,391
Chloride Concentration (ppm)		6,739	6,739	6,739	6,739	24	24	24	24	24	24	24	24
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	**13**	**13**	**13**	**13**	**14**	**14**	**14**	**14**	**15**	**15**	**15**	**15**
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**18**	**18**
Pipe Type	**Coating**	**Minimum Thickness (in)**				**Minimum Thickness (in)**				**Minimum Thickness (in)**			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	BC (Bituminous Coating)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	BCI (BC+paved invert)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	**13**	**13**	**13**	**13**	**14**	**14**	**14**	**14**	**15**	**15**	**15**	**15**
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Pipe Type		**Minimum Thickness (in)**				**Minimum Thickness (in)**				**Minimum Thickness (in)**			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		0.060	0.060	0.060	0.075	0.060	0.060	0.060	0.075	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations					0.060				0.060	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		0.060	0.060	0.060	0.075	0.060	0.060	0.060	0.075	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations					0.060				0.060	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch				0.060	0.060			0.060	0.060	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch				0.060	0.060			0.060	0.060	NA	NA	NA	NA

Plastic Pipes

	Drainage System	**13**	**13**	**13**	**13**	**14**	**14**	**14**	**14**	**15**	**15**	**15**	**15**
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Pipe Type		**Availability**				**Availability**				**Availability**			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	**13**	**13**	**13**	**13**	**14**	**14**	**14**	**14**	**15**	**15**	**15**	**15**
	Pipe Diameter (in)	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**	**12**	**18**	**24**	**30**
Steel Cover (in)		0.75	0.75	1	1	0.75	0.75	1	1	0.75	0.75	1	1
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	**13**	**13**	**13**	**13**	**14**	**14**	**14**	**14**	**15**	**15**	**15**	**15**
	Soil Bore Sample I.D.	**A-11-020-2-3**				**A-11-020-2-3**				**A-11-023**			
Soil pH		8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.2	8.2	8.2	8.2
Minimum Soil Resistivity (ohm-cm)		3,566	3,566	3,566	3,566	3,566	3,566	3,566	3,566	198	198	198	198
Sulfate Concentration (ppm)		6	6	6	6	6	6	6	6	447	447	447	447
Chloride Concentration (ppm)		2	2	2	2	2	2	2	2	2,034	2,034	2,034	2,034
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	16	16	16	16	17	17	17	17	18	18	18	18
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	0.109	NA	NA	NA	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	0.109
	BCI (BC+paved invert)	0.064	0.064	0.064	0.064	0.064	0.064	0.064	0.064	NA	NA	NA	0.109
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	0.109	0.109	NA	NA	0.109	0.109	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.079	0.079	NA	NA	0.079	0.079	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	16	16	16	16	17	17	17	17	18	18	18	18
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Plastic Pipes

	Drainage System	16	16	16	16	17	17	17	17	18	18	18	18
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Availability				Availability				Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	16	16	16	16	17	17	17	17	18	18	18	18
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Steel Cover (in)		0.75	0.75	1	1	0.75	0.75	1	1	0.75	0.75	1	1
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	16	16	16	16	17	17	17	17	18	18	18	18
	Soil Bore Sample I.D.	A-11-002				A-11-002				A-11-004			
Soil pH		8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.8	8.3	8.3	8.3	8.3
Minimum Soil Resistivity (ohm-cm)		1,236	1,236	1,236	1,236	1,236	1,236	1,236	1,236	622	622	622	622
Sulfate Concentration (ppm)		434	434	434	434	434	434	434	434	900	900	900	900
Chloride Concentration (ppm)		92	92	92	92	92	92	92	92	528	528	528	528
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	19	19	19	19	20	20	20	20	21	21	21	21
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	0.064	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	0.109	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	0.109	0.052	0.052	0.052	0.052	NA	NA	NA	NA
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA	NA	0.064	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA	NA	NA	0.064	0.064	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	0.109	0.109	NA	NA	0.064	0.064	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064	NA	NA	0.064	0.064	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064	NA	NA	NA	0.064	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	19	19	19	19	20	20	20	20	21	21	21	21
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Minimum Thickness (in)				Minimum Thickness (in)				Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	0.060	0.060	0.060	0.075	NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA				0.060	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA	0.060	0.060	0.060	0.075	NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA				0.060	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA			0.060	0.060	NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA			0.060	0.060	NA	NA	NA	NA

Plastic Pipes

	Drainage System	19	19	19	19	20	20	20	20	21	21	21	21
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Pipe Type		Availability				Availability				Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable	NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA	NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	19	19	19	19	20	20	20	20	21	21	21	21
	Pipe Diameter (in)	12	18	24	30	12	18	24	30	12	18	24	30
Steel Cover (in)		0.75	0.75	1	1	0.75	0.75	1	1	1.25	1.25	1.25	1.25
Sacks of Cement		5	5	5	5	5	5	5	5	5	5	5	5
Percentage Water		10	10	10	10	10	10	10	10	10	10	10	10

Other Information

	Drainage System	19	19	19	19	20	20	20	20	21	21	21	21
	Soil Bore Sample I.D.	A-11-004				A-11-020-2-3				R-11-018-2-2			
Soil pH		8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.0	8.0	8.0	8.0
Minimum Soil Resistivity (ohm-cm)		622	622	622	622	3,566	3,566	3,566	3,566	131	131	131	131
Sulfate Concentration (ppm)		900	900	900	900	6	6	6	6	786	786	786	786
Chloride Concentration (ppm)		528	528	528	528	2	2	2	2	4,965	4,965	4,965	4,965
Abrasion Level		1	1	1	1	1	1	1	1	1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5	5	5	5	5	5	5	5	5
Design Service Life (years)		50	50	50	50	50	50	50	50	50	50	50	50
Height of Cover (ft)		5	5	5	5	5	5	5	5	5	5	5	5

Caltrans AltPipe

Project EA: 235841
Project Engineer: Madhu Thummaluru, URS
Location: Burlingame
Description: US 101-Broadway Interchange

Note: NA indicates Not Allowable

Steel Pipes

	Drainage System	22	22	22	22
	Pipe Diameter (in)	12	18	24	30
Pipe Type	Coating	Minimum Thickness (in)			
Corrugated Steel Pipe - Helical Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA
	PA (Polymerized Asphalt)	0.052	0.052	0.052	0.052
	PS (Polymeric Sheet)	0.052	0.052	0.052	0.052
Corrugated Steel Pipe - Annular Corrugations - 2⅔" X ½" Corrugations	GAL (Galvanized)	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	NA	NA
	BCI (BC+paved invert)	NA	NA	NA	NA
	PA (Polymerized Asphalt)	NA	0.064	0.064	0.064
	PS (Polymeric Sheet)	NA	0.064	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch	GAL (Galvanized)	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X 1" Ribs At 8½" Pitch	GAL (Galvanized)	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064
Steel Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch	GAL (Galvanized)	NA	NA	NA	NA
	AL2 (Aluminum Type 2)	NA	NA	NA	NA
	BC (Bituminous Coating)	NA	NA	0.109	0.109
	BCI (BC+paved invert)	NA	NA	0.109	0.109
	PA (Polymerized Asphalt)	NA	NA	0.064	0.064
	PS (Polymeric Sheet)	NA	NA	0.064	0.064
	CSS (Composite Steel Spiral)	NA	NA	NA	0.064

Aluminum Pipes

	Drainage System	22	22	22	22
	Pipe Diameter (in)	12	18	24	30
Pipe Type		Minimum Thickness (in)			
Corrugated Aluminum Pipe - Annular Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA
Corrugated Aluminum Pipe - Annular Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 2⅔" X ½" Corrugations		NA	NA	NA	NA
Corrugated Aluminum Pipe - Helical Corrugations - 3" X 1" Corrugations		NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X 1" Ribs At 11½" Pitch		NA	NA	NA	NA
Aluminum Spiral Rib Pipe - ¾" X ¾" Ribs At 7½" Pitch		NA	NA	NA	NA

Plastic Pipes

	Drainage System	22	22	22	22
	Pipe Diameter (in)	12	18	24	30
Pipe Type		Availability			
PVC Corrugated		Allowable	Allowable	Allowable	Allowable
PVC Ribbed		NA	Allowable	Allowable	Allowable
HDPE Corrugated - Type S		NA	Allowable	Allowable	Allowable
HDPE Ribbed		NA	Allowable	Allowable	NA
HDPE Corrugated - Type C		NA	Allowable	Allowable	NA

Reinforced Concrete Pipes

	Drainage System	22	22	22	22
	Pipe Diameter (in)	12	18	24	30
Steel Cover (in)		0.75	0.75	1	1
Sacks of Cement		5	5	5	5
Percentage Water		10	10	10	10

Other Information

	Drainage System	22	22	22	22
	Soil Bore Sample I.D.	A-11-004			
Soil pH		8.3	8.3	8.3	8.3
Minimum Soil Resistivity (ohm-cm)		622	622	622	622
Sulfate Concentration (ppm)		900	900	900	900
Chloride Concentration (ppm)		528	528	528	528
Abrasion Level		1	1	1	1
2–5 Year Flow Velocity (ft/sec)		5	5	5	5
Design Service Life (years)		50	50	50	50
Height of Cover (ft)		5	5	5	5

Replace "Reserved" in section 24-3 with:

24-3 SOIL-CEMENT

24-3.01 GENERAL

24-3.01A Summary

Section 24-3 includes specifications for constructing soil-cement elements for ground improvement.

24-3.01B Definitions

soil-cement element: a soil-cement element is constructed by mixing in-situ soils with cement grout by way of deep soil cement mixing technology.

mixing shaft: a component of the mixing rig driven by a power source sufficient to provide torque for the range of expected drilling/augering conditions, indicated by the available boring and/or cone penetration test logs and other test data included in the Geotechnical Design and Materials Report. The mixing shafts are positioned so as to overlap one another to form continuously mixed overlapping columns.

grout: a water-based Portland cement material added to the blended in situ soils. The purposes of the grout are to assist in loosening the soils for penetration and optimum mixing, and upon setting, to strengthen the in-situ soils. Grout must be premixed in a mixing plant which combines dry materials and water in predetermined proportions.

24-3.02 Submittals

From 30 to 180 days before use, submit a statement of the previous work experience similar to that described in these special provisions, signed by a California Registered Professional Civil Engineer. The statement must include at least 10 successful soil cement mixing projects within the past five years. This statement must include a written description of each project, owner's contact name and current phone number, the dates and the extent of the work, the manner of its execution, and any other information that supports your ability to carry out the work described in these special provisions.

Submit a Pre-Production (PPC) Program for review and approval by the Engineer prior to commencing soil-cement mixing to establish production parameters, procedures, and materials to be used during the production phase.

If you provide an alternative soil treatment scheme meeting the minimum performance requirement specified herein, the alternative plan must be submitted as an attachment to the pre-construction submittal for approval by the Engineer.

24-3.03 Quality Control and Assurance

24-3.03A General

Perform QC testing in the presence of the Engineer to verify that the average 28-day and 56-day unconfined compressive strengths of soil-cement elements is greater than 200 psi.

Control vertical alignment of mixing shafts.

24-3.03B Pre-Production (PPC) Program

Conduct a Pre-Production (PPC) Program within the limits of soil-cement treatment areas shown on the plans prior to commencing production phase soil-cement mixing to establish production parameters, procedures, and materials to be used during the production phase.

You must conduct a load test to verify the effectiveness of the PPC Program. A minimum plan dimension of 28 feet by 32 feet of soil-cement treated area must be provided for the load test. The load test area must be surcharged and settlement must be monitored by complying with California Test Method 112. The surcharge load in the test area must be constructed at or above the grading plane at the location specified in the following table.

Bridge Number	Abutment Number	Surcharge Height (feet)	Settlement Period (days)	Maximum Settlement (inch)
35-0351	3	24	60	1.0

The PPC Program must produce soil-cement mix design and procedures for production mixing based upon the information provided from the PPC Program including: estimated in-situ 28-day and 56-day unconfined compressive strength of the soil-cement, cement-grout injection pressure and rates, mixing rotational speeds, penetration and withdrawal rates of the mixing tools, and mixing times at bottom of the soil-cement element when there is no vertical movement of the mixing tools. The approval of the PPC Program must be based on the results of the load test such that the rate and total settlement within the settlement period are satisfactory.

24-3.03B(1) Pre-construction Submittals

At least 28 days prior to commencement of any mobilization of deep soil-cement mixing equipment for production mixing, you must submit the following to the Engineer:

1. Names and qualifications of the soil-cement mixing personnel and surveyors, including project experience, resumes and other documentation that demonstrate the experience qualifications of the project engineers, each field superintendent, rig operators, and batch plant operators for the deep soil-cement mixing.
2. A list of contractors, responsible engineers, project descriptions and personnel responsibilities from soil-cement mixing projects completed by the soil-cement mixing Project Engineers and Field Superintendents during the past ten years. Contractors' names, addresses and telephone numbers must be included for these projects representing the individual's comparable experience. The projects listed to demonstrate personnel qualifications must have employed equipment using similar auger configuration(s) as proposed for the work of this Contract.
3. Submit data on equipment to be used for the deep soil-cement mixing, proportioning, pumping, injecting and mixing soil-cement, as well as all other ancillary equipment, including equipment capable of remixing non-conforming soil-cement elements.
4. Spoil containment (sheet piling or other) structures and methods to be used to prevent the migration or leakage of spoil return, disturbed in-situ soils or other spoil material beyond the immediate limits of soil-cement mixing operations. You must demonstrate that the containment structure is stable under loads applied by soil cement, water, in-situ soils, overlying fill materials, construction equipment, other surcharge loads and loads applied by the subsequent deep mixing operations. Include also details and methods to be used to collect and dispose of the spoil return and other spoil materials.
5. Sequence and time schedule of all operations including plan location and sequence of all deep soil-cement mixing. You must submit a soil-cement element Layout Plan based on the limits shown on the Plans to achieve the required plan area configurations and coverages, necessary overlaps, auger re-penetrations over the depths, and limits shown on the Plans. Plan locations of all proposed soil-cement mixing must be shown on Layout Plans of suitable scale to clearly show the details of the layout. Soil-cement elements on the Layout Plans must be numbered and dimensioned.
6. Cement grout mix design including: cement type, cement source, cement compound composition, water-cement ratio by weight and other pertinent details. Limit water-cement ratio to 1:1 (maximum), unless otherwise demonstrated in the Pre-Production (PPC) Program specified in these special provisions.
7. The results of the PPC Program including, but not limited to: estimated in-situ 28-day and 56-day unconfined compressive strengths of the soil-cement elements, cement-grout injection pressure and rates, mixing rotational speeds, penetration and withdrawal rates of the mixing tools, and mixing times at bottom of the soil-cement element when there is no vertical movement of the mixing tools, and complete description of all mixing operations.
8. Description of Quality Control Plan for deep soil-cement mixing including, but not limited to, the following:.

    8.1. A detailed description of the Quality Control Plan to be undertaken each day during soil-cement mixing, including the plan area coverage over the required depths and limits, and required horizontal and vertical alignments, to confirm that the installed soil-cement conforms to the required unconfined compressive strengths.

8.2. Details of procedures to obtain soil-cement samples, catalog cuts of the soil-cement sampling device and curing boxes.
8.3. Measures to be implemented each day during soil-cement mixing to continuously monitor, modify and control: water-cement ratios; cement-grout injection pressures and quantities; mixing rotational speeds; penetration and withdrawal rates of the mixing equipment; horizontal and vertical alignments of the soil cement elements, and other related aspects of the soil-cement mixing process.
8.4. Example formats of Daily Production Reports conforming to the requirements stated herein.
8.5. Names, certifications and licenses of the laboratories and/or companies responsible for performing quality control tests.
8.6. Proposed details and formats of all required tabular and graphical data presentations to be submitted to the Engineer during the course of the Work.

24-3.03B(2) Construction Report

Within two working days after the completion of each soil-cement element, submit the following:

1. Deviations of the center coordinates from the layout plan to the nearest 3 inches at the top of the element.
2. Vertical alignment profiles at every 6 inches or higher frequency over the measurement length, and to the nearest 0.5 inch along axes parallel and perpendicular to the line of longitudinal progression; the elevation must be measured to the nearest 2 inches of the top and bottom of the element.
3. The Daily Quality Control Reports must include, as a minimum, the results of the following QC parameter monitoring for each element:

3.1. Rig number
3.2. Type of mixing tool
3.3. Date and time (start and finish) of column construction
3.4. Column number and reference drawing number
3.5. Column diameter
3.6. Column top and bottom elevations
3.7. Grout mix design designation
3.8. Grout specific gravity measurements
3.9. Description of obstructions, interruptions, or other difficulties during installation and how they were resolved
3.10. The Daily Quality Control Reports must also include the following parameters recorded automatically or manually for each element at intervals no greater than and submitted in the form of either tables or figures (as agreed to by the Engineer):

3.10.1. Elevation in feet vs. real time
3.10.2. Shaft rotation speed in RPM vs. real time
3.10.3. Penetration and withdrawal rates in feet per minute vs. real time
3.10.4. Grout injection rate in gpm vs. real time
3.10.5. The average quantity of grout in gallons per foot injected per vertical foot of column vs. depth

24-3.03C Soil-Cement Strength

You must verify that the installed soil-cement elements conform to the minimum unconfined compressive strength specified in these special provisions.

You must obtain soil-cement samples, including fluid and core samples, and provide them to the laboratory for testing specified in these special provisions. The Laboratory must form, preserve, cure, transport, and test the samples and report the test results to the Engineer. The test results must be signed by a California licensed Civil Engineer from the laboratory. You must coordinate sampling and testing activities with the Engineer and the laboratory. You must supply incidental items, access, inside storage space, curing boxes and electrical power to the curing boxes. You must supply molds for use in forming the samples.

24-3.03C(1) Wet Grab Soil-Cement Samples

A minimum of two in-situ sampling rounds must be performed daily during the PPC Program at locations selected by the Engineer. You must obtain sampling rounds at the same soil-cement element, which must consist of non-cured soil-cement samples from three depths selected by the Engineer. Separate soil-cement samples must be retrieved within 60 minutes of the completion of the soil-cement element. The device used to retrieve the wet grab soil-cement samples must be capable of obtaining a discrete fluid sample of soil-cement at a depth determined by the Engineer and must be capable of accepting particles not thoroughly mixed that are up to 6 inches in maximum dimension. The sampler must be lowered empty, air only, to the required depth in the soil-cement element and then opened. Once filled with the soil-cement, the sampler must be closed to exclude entry or loss of soil-cement and must be expeditiously raised to ground surface.

Each retrieved soil-cement sample must be of sufficient volume to produce a minimum of six full cylinders, each 3 inches in diameter by 6 inches high. You must separate and retain all soil-cement retrieved from each depth. You must then cut all retrieved particles of soil larger than 1 inch into smaller pieces that will pass a 1 inch sieve, and then immediately form the six cylinders with material passing through a 1 inch sieve, including particles of soil that were cut up.

Soil-cement samples must be formed, cured and preserved by complying with AASHTO T 23 and protected from extreme weather conditions which could have deleterious effects, at all times.

If you cannot obtain all of the required wet grab samples of the soil-cement in the designated soil-cement element, you must obtain a full round of wet grab samples from the next soil-cement element installed by that rig.

Continue taking wet grab samples in subsequent soil-cement elements until a full round is obtained. From each sampling round, one cylinder from each sampling depth must be used to determine the cement factor based on the cement content as defined by AASHTO Specification T 144 (or ASTM D 806), unless otherwise directed by the Engineer,

For each soil-cement element, the Laboratory must test one cylinder at 7 days, one cylinder at 14 days, two cylinders at 28 days, and two cylinders at 56 days for unconfined compressive strength as defined by ASTM D 2166. The Laboratory must submit the laboratory test results to the Engineer in accordance with these special provisions.

24-3.03C(2) Soil-Cement Core Samples

At locations designated by the Engineer, you must conduct continuous coring, vibra-coring or double tube sampling for the full depth of the soil-cement elements and retain an Engineer approved independent laboratory to conduct unconfined compressive strength testing.

Each core run must be at least 4 feet in length and contain at least four test specimens with a length to diameter ratio of 2, or greater. A minimum recovery of 85 percent for each 4-foot-long core run must be achieved. During coring, the elevation of the bottom of the hole must be measured after each core run to calculate the core recovery. You must determine the time interval between column installation and coring except that the time interval must not be longer than required to conduct 28-day strength testing. Upon retrieval, the full-depth samples must be given to the Engineer for logging and test specimen selection.

The Laboratory must store each core sample in a moist room complying with ASTM G192 until the test date.

Testing for 28-day unconfined compressive strength must comply with ASTM D2166.

You must store the remaining portions of the full-depth samples that are not tested, in a moist room complying with ASTM G192, until completion and acceptance of all CDSM elements, for possible inspection and confirmation testing by the Engineer.

24-3.03D Acceptance Criteria

The basis for acceptance of soil-cement elements must be determined from the results of the PPC.

24-3.03D(1) Horizontal Alignment

You must accurately stake the locations of the soil-cement elements shown on the Plans based on controls established by a surveyor, licensed in the State of California, before beginning installation.

The elements must be constructed within six (6) inches of the horizontal locations shown on the Plans for the top of soil-cement elements. In addition, the minimum 20 percent overlap of adjacent element must be achieved at all depths.

You must provide an adequate method to allow the Engineer to verify the as-built locations of the elements during construction.

If an obstruction preventing drilling advancement is encountered, you must investigate the location and extent of the obstruction using methods approved by the Engineer. You must propose remedial measures to clear the obstruction for approval by the Engineer.

During investigation for an obstruction, you must continue to install soil-cement elements in areas away from the obstruction location.

If the Engineer determines that misaligned soil-cement elements will interfere with the driven pile foundation, you must correct the alignment by re-drilling the misaligned elements and remixing the elements to a strength that is approximately equal to that of the unimproved soil.

24-3.03D(2) Vertical Alignment

Your equipment operator must control vertical alignment of the mixing shaft. Two measures of verticality must be monitored: longitudinal and transverse to the element alignment. The inclination of each soil-cement element must not deviate more than 1 to 100 (horizontal to vertical) from vertical at any point.

24-3.03D(3) Depth of Soil-Cement Element

Depths of soil-cement elements must extend to the line and grades shown on the Plans.

The total depth of penetration must be measured either by observing the length of the mixing shaft inserted below a reference point on the mast, or by subtraction of the exposed length of shaft above the reference point from the total shaft length.

You must note and record the final depth of the stroke on the Daily Quality Control Report. The equipment must be adequately marked to allow the Engineer to confirm the penetration depth during construction.

The bottom elevations of soil-cement elements indicated on the Plans are estimates of required minimum penetration of the elements into competent soils underlying the site. When the elevations of the top of competent soils are found to be different from the Plans, the Engineer will direct the Contractor to shorten or deepen the soil-cement elements. You will be compensated based on the decreased or increased volume of the elements.

24-3.04 MATERIALS

24-3.04A Cement Grout

24-3.04A(1) Cement

Cement must conform to ASTM C150, Type II, and must be as specified in the submitted cement grout mix design approved by the Engineer.

Measure, handle, transport and store bulk cement following the manufacturer's recommendations. Cement packaged in cloth or paper bags must be sealed within plastic or rubber vapor barriers.

Store cement to prevent damage by moisture. Material that has become caked due to moisture absorption must not be used. Bags of cement must be stacked no more than ten bags high to avoid compaction. Cement containing lumps or foreign matter of a nature and in amounts that are deleterious to the grouting operations must not be used.

24-3.04A(2) Water

Water used in soil-cement and cement grout mixing must comply with Section 90-1.02D.

24-3.05 PAYMENT

Payment for furnishing soil-cement elements includes:

1. Furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in mixing soil-cement, complete-in-place, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.
2. Furnishing containment of spoils during excavation and mixing.
3. Disposing of materials resulting from mixing of soil-cement elements.

Table 1
Sampling Plan - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH
Stage 1														
S-01-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-03-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0			X									X
		6.0	X											
S-05-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-08-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
		6.0		X										
		9.0	X											
		12.0	X											
S-12-A	Geoprobe	0.5		X										
		1.0			X	X	X		X	X			X	X
		1.5		X										
		2.0		X										
		3.0		X										
		6.0		X										
		9.0		X										
		12.0		X										
S-14-C	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
		6.0	X											
S-19-A	Geoprobe	0.5		X										
		1.0			X								X	X
		1.5		X										
		2.0		X										
		3.0			X	X	X		X	X			X	X

Table 1
Sampling Plan - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH
S-21-B	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
N-01-A	Geoprobe	0.5		X							X	X		
		1.0		X										
		1.5		X										
		2.0		X										
		3.0			X									X
N-01-A (Duplicate)	Geoprobe	0.5		X							X	X		
		1.0		X										
		1.5		X										
		2.0		X										
		3.0			X									X
N-01-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0			X								X	X
N-02-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
N-02-B	Hand	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
N-03-A	Geoprobe	0.5		X										
		1.0			X	X	X		X	X				X
		1.5		X										
		2.0		X										
		3.0		X										
		6.0	X											
		9.0	X											
		12.0	X											
N-04-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										

Table 1
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Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH
N-06-A	Hand Auger	0.5		X										
		1.0		X										
N-06-B	Hand Auger	0.5			X									
		1.0		X										
		1.5		X										
N-07-A	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
N-09-A	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0			X									
		3.0		X										
N-09-B	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
N-16-B	Geoprobe	0.5		X										
		1.0			X									
		1.5		X										
		2.0		X										
		3.0		X										
N-17-A	Geoprobe	0.5		X										
		1.0		X		X	X		X					
		1.5		X										
		2.0		X										
		3.0		X										
		6.0		X										
		9.0		X										
		12.0		X										
N-18-A	Geoprobe	0.5		X										
		1.0			X									
		1.5		X										
		2.0		X										
		3.0		X										
Stage 2														
N-08-A	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0			X									
		3.0		X										

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Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH
S-01-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X		X	X		X	X				
		5.0	X											
S-02-A	Geoprobe	0.5			X								X	X
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
		6.0	X											
S-02-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
		6.0	X											
S-03-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X							X			
		6.0									X			
S-04-A	Geoprobe	0.5		X										
		1.0			X									X
		1.5		X										
		2.0		X										
		3.0			X	X	X	X					X	
		6.0			X[1]									
S-05-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-05-C	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-06-A	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										

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Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH
S-06-B	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-07-A	Geoprobe	0.5		X										
		1.0			X	X	X	X	X	X				X
		1.5		X										
		2.0		X										
		3.0			X	X	X	X	X	X			X	X
		6.0	X											
		9.0	X											
		12.0	X											
S-09-A	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-10-A	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
		5.0		X										
S-10-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0			X								X	X
		6.0		X[2]	X[2]									
S-10-B (Duplicate)	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0			X								X	X
		6.0			X[3]									
S-14-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
		6.0		X										

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Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH
S-14-B	Geoprobe	0.5		X										
		1.0			X									X
		1.5		X										
		2.0		X										
		3.0		X										
		6.0		X										
S-23-A	Hand Auger	0.5		X										
		1.0			X								X	X
		1.5		X										
		2.0		X										
		3.0		X										
Stage 3														
S-11-A	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-11-B	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-13-A	Hand Auger	0.5		X										
		1.0		X		X	X		X	X				
		1.5		X										
		2.0		X										
		3.0			X									X
S-13-A (Duplicate)	Hand Auger	0.5		X										
		1.0		X		X	X		X	X				
		1.5		X										
		2.0		X										
		3.0			X									X
S-15-A	Hand Auger	0.5		X							X	X		
		1.0		X		X	X	X	X	X				
		1.5		X										
		2.0		X										
		3.0		X										
S-15-A (Duplicate)	Hand Auger	0.5		X							X	X		
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										

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Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH
S-15-B	Hand Auger	0.5		X							X	X		
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-15-C	Hand Auger	0.5		X							X	X		
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-16-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0			X								X	X
		3.0		X										
		6.0	X											
S-17-A	Geoprobe	0.5		X										
		1.0		X		X	X		X	X				
		1.5		X										
		2.0		X										
		3.0		X										
		6.0	X											
S-18-A	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0			X									X
		3.0		X										
S-19-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
		6.0			X									
S-20-A	Hand Auger	0.5		X										
		1.0			X								X	X
		1.5		X										
		2.0		X										
		3.0			X	X	X		X	X	X	X		X
S-20-B	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										

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Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH
S-20-C	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-21-A	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
S-22-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0			X									
		3.0		X										
N-05-A	Hand	0.5		X										
		1.0		X										
		1.5		X										
		2.0			X									
		3.0		X										
N-11-A	Hand	0.5			X									
		1.0			X									
		1.5		X										
		2.0		X										
		3.0		X										
N-12-A	Hand	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
N-15A	Hand Auger	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
N-22-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0			X									X
N-22-C	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										

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Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH
Stage 4														
N-19-A	Geoprobe	0.5		X										
		1.0			X									X
		1.5		X										
		2.0		X										
		3.0			X	X	X		X	X			X	X
N-20-A	Hand Auger	0.5		X										
		1.0			X								X	X
		1.5		X										
		2.0		X										
		3.0			X	X	X	X	X	X	X	X		
N-04-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0			X								X	X
		3.0		X										
N-10-A	Hand	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0			X									
N-14-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
		6.0	X											
Stage 5														
N-13-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0			X									
		3.0		X										
N-13-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
N-16-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										

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Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH
N-16-A (Duplicate)	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
N-21-A	Geoprobe	0.5		X										
		1.0			X									X
		1.5		X										
		2.0		X										
		3.0		X										
		6.0		X										
N-21-A (Duplicate)	Geoprobe	0.5		X										
		1.0			X									X
		1.5		X										
		2.0		X										
		3.0		X										
		6.0		X										
N-22-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0			X								X	X
N-23-A	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0			X									X
N-23-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										
N-24-A	Geoprobe	0.5		X										
		1.0		X		X	X		X	X				
		1.5		X										
		2.0		X										
		3.0		X										
N-24-B	Geoprobe	0.5		X										
		1.0		X										
		1.5		X										
		2.0		X										
		3.0		X										

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Boring Location	Sample Collection System*	Sample Depth (ft)	Hold	Lead	Cam 17 Metals	5 Gas OXygenates	BTEX	Other VOCs	TPH-G	TPH-d/mo	PCBs	Pesticides	Asbestos	pH

Notes:

X^1 = This sample was originally held, and later analyzed for Chromium only.
X^2 = This sample was originally held, and later analyzed for Chromium, Lead & Nickel only.
X^3 = This sample was originally held, and later analyzed for Chromium & Nickel only.

Table 2
Total Metals - Hazardous Material Investigation
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Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
		ESLs - Direct Exposure		310	15	2,600	98	39	1,200,000#	94	310,000	750	58	3,900	260	3,900	3,900	62	770	230,000	NE
		ESLs - Residential		6.3	0.39	750	4	1.7	750#	40	230	200	1.3	40	150	10	20	1.3	16	600	NE
		ESLs - Comm/Ind		40	1.6	1,500	8	7.4	750#	80	230	750	10	40	150	10	40	16	200	600	NE
Stage 1																					
S-01-A	0.50	1109210-001A	9/29/2011	--	--	--	--	--	--	--	--	**480**	--	--	--	--	--	--	--	--	--
	1.00	1109210-002A	9/29/2011	--	--	--	--	--	--	--	--	**610**	--	--	--	--	--	--	--	--	--
	1.50	1109210-003A	9/29/2011	--	--	--	--	--	--	--	--	17	--	--	--	--	--	--	--	--	--
	2.00	1109210-004A	9/29/2011	--	--	--	--	--	--	--	--	19	--	--	--	--	--	--	--	--	--
	3.00	1109210-005A	9/29/2011	--	--	--	--	--	--	--	--	35	--	--	--	--	--	--	--	--	--
S-03-A	0.50	1109210-018A	9/29/2011	--	--	--	--	--	--	--	--	260	--	--	--	--	--	--	--	--	--
	1.00	1109210-019A	9/29/2011	--	--	--	--	--	--	--	--	830	--	--	--	--	--	--	--	--	--
	1.50	1109210-020A	9/29/2011	--	--	--	--	--	--	--	--	5.2	--	--	--	--	--	--	--	--	--
	2.00	1109210-021A	9/29/2011	--	--	--	--	--	--	--	--	3.5	--	--	--	--	--	--	--	--	--
	3.00	1109210-022A	9/29/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
S-05-A	0.50	1110098-011A	10/13/2011	--	--	--	--	--	--	--	--	15	--	--	--	--	--	--	--	--	--
	1.00	1110098-012A	10/13/2011	--	--	--	--	--	--	--	--	15	--	--	--	--	--	--	--	--	--
	1.50	1110098-013A	10/13/2011	--	--	--	--	--	--	--	--	**110**	--	--	--	--	--	--	--	--	--
	2.00	1110098-014A	10/13/2011	--	--	--	--	--	--	--	--	3.3	--	--	--	--	--	--	--	--	--
	3.00	1110098-015A	10/13/2011	--	--	--	--	--	--	--	--	3.4	--	--	--	--	--	--	--	--	--
S-08-A	0.50	1109210-024A	9/29/2011	--	--	--	--	--	--	--	--	**610**	--	--	--	--	--	--	--	--	--
	1.00	1109210-025A	9/29/2011	--	--	--	--	--	--	--	--	**260**	--	--	--	--	--	--	--	--	--
	1.50	1109210-026A	9/29/2011	--	--	--	--	--	--	--	--	**220**	--	--	--	--	--	--	--	--	--
	2.00	1109210-027A	9/29/2011	--	--	--	--	--	--	--	--	**160**	--	--	--	--	--	--	--	--	--
	3.00	1109210-028A	9/29/2011	--	--	--	--	--	--	--	--	36	--	--	--	--	--	--	--	--	--
	6.00	1109210-029A	9/29/2011	--	--	--	--	--	--	--	--	8.1	--	--	--	--	--	--	--	--	--
	9.00	HELD	9/29/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	12.00	HELD	9/29/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-12-A	0.50	1109210-032A	9/30/2011	--	--	--	--	--	--	--	--	280	--	--	--	--	--	--	--	--	--
	1.00	1109210-033A	9/30/2011	<5.0	4.5	63	<2.0	<1.0	42	8.2	26	**290**	0.16	<5.0	48	<5.0	<1.0	<5.0	28	120	7.4
	1.50	1109210-034A	9/30/2011	--	--	--	--	--	--	--	--	**65**	--	--	--	--	--	--	--	--	--
	2.00	1109210-035A	9/30/2011	--	--	--	--	--	--	--	--	**53**	--	--	--	--	--	--	--	--	--
	3.00	1109210-036A	9/30/2011	--	--	--	--	--	--	--	--	**78**	--	--	--	--	--	--	--	--	--
	6.00	1109210-037A	9/30/2011	--	--	--	--	--	--	--	--	20	--	--	--	--	--	--	--	--	--
	9.00	1109210-038A	9/30/2011	--	--	--	--	--	--	--	--	**2,600**	--	--	--	--	--	--	--	--	--
	12.00	1109210-039A	9/30/2011	--	--	--	--	--	--	--	--	6.1	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
S-14-C	0.50	1110075-013A	10/12/2011	--	--	--	--	--	--	--	--	**100**	--	--	--	--	--	--	--	--	--
	1.00	1110075-014A	10/12/2011	--	--	--	--	--	--	--	--	**79**	--	--	--	--	--	--	--	--	--
	1.50	1110075-015A	10/12/2011	--	--	--	--	--	--	--	--	**60**	--	--	--	--	--	--	--	--	--
	2.00	1110075-016A	10/12/2011	--	--	--	--	--	--	--	--	23	--	--	--	--	--	--	--	--	--
	3.00	1110075-017A	10/12/2011	--	--	--	--	--	--	--	--	20	--	--	--	--	--	--	--	--	
	6.00	HELD	10/12/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-19-A	0.50	1110078-014A	10/12/2011	--	--	--	--	--	--	--	--	**260**	--	--	--	--	--	--	--	--	--
	1.00	1110078-015A	10/12/2011	<5.0	2.4	74	<2.0	<1.0	45	9.4	13	**58**	<0.50	<5.0	25	<5.0	<1.0	<5.0	35	34	5.93
	1.50	1110078-016A	10/12/2011	--	--	--	--	--	--	--	--	2.7	--	--	--	--	--	--	--	--	--
	2.00	1110078-017A	10/12/2011	--	--	--	--	--	--	--	--	4.9	--	--	--	--	--	--	--	--	--
	3.00	1110078-018A	10/12/2011	<5.0	2.7	17	<2.0	<1.0	22	<5.0	<5.0	2.2	<0.50	<5.0	23	<5.0	1.2	<5.0	17	16	5.51
S-21-B	0.50	1109207-020A	9/30/2011	--	--	--	--	--	--	--	--	**95**	--	--	--	--	--	--	--	--	--
	1.00	1109207-021A	9/30/2011	--	--	--	--	--	--	--	--	**180**	--	--	--	--	--	--	--	--	--
	1.50	1109207-022A	9/30/2011	--	--	--	--	--	--	--	--	**140**	--	--	--	--	--	--	--	--	--
	2.00	1109207-023A	9/30/2011	--	--	--	--	--	--	--	--	**150**	--	--	--	--	--	--	--	--	--
	3.00	1109207-024A	9/30/2011	--	--	--	--	--	--	--	--	42	--	--	--	--	--	--	--	--	--
N-01-A	0.50	1111146-025A	11/18/2011	--	--	--	--	--	--	--	--	**600**	--	--	--	--	--	--	--	--	--
	1.00	1111146-026A	11/18/2011	--	--	--	--	--	--	--	--	**1,600**	--	--	--	--	--	--	--	--	--
	1.50	1111146-027A	11/18/2011	--	--	--	--	--	--	--	--	**130**	--	--	--	--	--	--	--	--	--
	2.00	1111146-028A	11/18/2011	--	--	--	--	--	--	--	--	**74**	--	--	--	--	--	--	--	--	--
	3.00	1111146-029A	11/18/2011	<5.0	5	41	<2.0	<1.0	28	<5.0	6.4	3.3	<0.50	<5.0	39	<5.0	<1.0	<5.0	15	21	7.53
N-01-A (Duplicate)	0.50	1111146-030A	11/18/2011	--	--	--	--	--	--	--	--	**1,800**	--	--	--	--	--	--	--	--	--
	1.00	1111146-031A	11/18/2011	--	--	--	--	--	--	--	--	**390**	--	--	--	--	--	--	--	--	--
	1.50	1111146-032A	11/18/2011	--	--	--	--	--	--	--	--	18	--	--	--	--	--	--	--	--	--
	2.00	1111146-033A	11/18/2011	--	--	--	--	--	--	--	--	28	--	--	--	--	--	--	--	--	--
	3.00	1111146-034A	11/18/2011	<5.0	3.5	37	<2.0	<1.0	26	<5.0	5.7	3.2	<0.50	<5.0	42	<5.0	<1.0	<5.0	15	21	7.7
N-01-B	0.50	1111146-035A	11/18/2011	--	--	--	--	--	--	--	--	**900**	--	--	--	--	--	--	--	--	--
	1.00	1111146-036A	11/18/2011	--	--	--	--	--	--	--	--	**90**	--	--	--	--	--	--	--	--	--
	1.50	1111146-037A	11/18/2011	--	--	--	--	--	--	--	--	18	--	--	--	--	--	--	--	--	--
	2.00	1111146-038A	11/18/2011	--	--	--	--	--	--	--	--	4.9	--	--	--	--	--	--	--	--	--
	3.00	1111146-039A	11/18/2011	<5.0	4.2	30	<2.0	<1.0	32	5.4	7.7	4.0	<0.50	<5.0	47	<5.0	<1.0	<5.0	16	24	8.3
N-02-A	0.50	1111146-015A	11/18/2011	--	--	--	--	--	--	--	--	**450**	--	--	--	--	--	--	--	--	--
	1.00	1111146-016A	11/18/2011	--	--	--	--	--	--	--	--	**2,600**	--	--	--	--	--	--	--	--	--
	1.50	1111146-017A	11/18/2011	--	--	--	--	--	--	--	--	**1,700**	--	--	--	--	--	--	--	--	--
	2.00	1111146-018A	11/18/2011	--	--	--	--	--	--	--	--	**460**	--	--	--	--	--	--	--	--	--
	3.00	1111146-019A	11/18/2011	--	--	--	--	--	--	--	--	**89**	--	--	--	--	--	--	--	--	--
N-02-B	0.50	1111146-020A	11/18/2011	--	--	--	--	--	--	--	--	**740**	--	--	--	--	--	--	--	--	--
	1.00	1111146-021A	11/18/2011	--	--	--	--	--	--	--	--	**120**	--	--	--	--	--	--	--	--	--
	1.50	1111146-022A	11/18/2011	--	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	--	--
	2.00	1111146-023A	11/18/2011	--	--	--	--	--	--	--	--	3.7	--	--	--	--	--	--	--	--	--
	3.00	1111146-024A	11/18/2011	--	--	--	--	--	--	--	--	2.4	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
N-03-A	0.50	1111146-007A	11/18/2011	--	--	--	--	--	--	--	--	27	--	--	--	--	--	--	--	--	--
	1.00	1111146-008A	11/18/2011	<5.0	3.4	100	<2.0	<1.0	18	6.2	23	18	<0.50	<5.0	24	<5.0	1.5	<5.0	35	35	10.8
	1.50	1111146-009A	11/18/2011	--	--	--	--	--	--	--	--	18	--	--	--	--	--	--	--	--	--
	2.00	1111146-010A	11/18/2011	--	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	--	--
	3.00	1111146-011A	11/18/2011	--	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	--	--
	6.00	HELD	11/18/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9.00	HELD	11/18/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	12.00	HELD	11/18/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-04-B	0.50	1111146-002A	11/18/2011	--	--	--	--	--	--	--	--	**210**	--	--	--	--	--	--	--	--	--
	1.00	1111146-003A	11/18/2011	--	--	--	--	--	--	--	--	**300**	--	--	--	--	--	--	--	--	--
	1.50	1111146-004A	11/18/2011	--	--	--	--	--	--	--	--	**120**	--	--	--	--	--	--	--	--	--
	2.00	1111146-005A	11/18/2011	--	--	--	--	--	--	--	--	18	--	--	--	--	--	--	--	--	--
	3.00	1111146-006A	11/18/2011	--	--	--	--	--	--	--	--	5.8	--	--	--	--	--	--	--	--	--
N-06-A	0.50	1111145-032A	11/18/2011	--	--	--	--	--	--	--	--	**130**	--	--	--	--	--	--	--	--	--
	1.00	1111145-033A	11/18/2011	--	--	--	--	--	--	--	--	30	--	--	--	--	--	--	--	--	--
N-06-B	0.50	1111145-034A	11/18/2011	<5.0	5	58	<2.0	<1.0	32	7.9	22	**250**	<0.50	<5.0	43	<5.0	2.1	<5.0	27	74	--
	1.00	1111145-035A	11/18/2011	--	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	--	--
	1.50	1111145-036A	11/18/2011	--	--	--	--	--	--	--	--	17	--	--	--	--	--	--	--	--	--
N-07-A	0.50	1111145-027A	11/18/2011	--	--	--	--	--	--	--	--	**210**	--	--	--	--	--	--	--	--	--
	1.00	1111145-028A	11/18/2011	--	--	--	--	--	--	--	--	**110**	--	--	--	--	--	--	--	--	--
	1.50	1111145-029A	11/18/2011	--	--	--	--	--	--	--	--	9.2	--	--	--	--	--	--	--	--	--
	2.00	1111145-030A	11/18/2011	--	--	--	--	--	--	--	--	5.2	--	--	--	--	--	--	--	--	--
	3.00	1111145-031A	11/18/2011	--	--	--	--	--	--	--	--	3.4	--	--	--	--	--	--	--	--	--
N-08-A	0.50	1110100-011A	10/13/2011	--	--	--	--	--	--	--	--	19	--	--	--	--	--	--	--	--	--
	1.00	1110100-012A	10/13/2011	--	--	--	--	--	--	--	--	27	--	--	--	--	--	--	--	--	--
	1.50	1110100-013A	10/13/2011	--	--	--	--	--	--	--	--	45	--	--	--	--	--	--	--	--	--
	2.00	1110100-014A	10/13/2011	<5.0	5.8	54	<2.0	<1.0	36	5.8	10	**58**	<0.50	<5.0	36	<5.0	1	<5.0	24	43	--
	3.00	1110100-015A	10/13/2011	--	--	--	--	--	--	--	--	4.3	--	--	--	--	--	--	--	--	--
N-09-A	0.50	1110099-011A	10/13/2011	--	--	--	--	--	--	--	--	41	--	--	--	--	--	--	--	--	--
	1.00	1110099-012A	10/13/2011	--	--	--	--	--	--	--	--	32	--	--	--	--	--	--	--	--	--
	1.50	1110099-013A	10/13/2011	--	--	--	--	--	--	--	--	33	--	--	--	--	--	--	--	--	--
	2.00	1110099-014A	10/13/2011	<5.0	7.8	79	<2.0	<1.0	35	13	40	**53**	<0.50	<5.0	37	<5.0	<1.0	<5.0	38	63	--
	3.00	1110099-015A	10/13/2011	--	--	--	--	--	--	--	--	10	--	--	--	--	--	--	--	--	--
N-09-B	0.50	1110099-016A	10/13/2011	--	--	--	--	--	--	--	--	**540**	--	--	--	--	--	--	--	--	--
	1.00	1110099-017A	10/13/2011	--	--	--	--	--	--	--	--	**240**	--	--	--	--	--	--	--	--	--
	1.50	1110099-018A	10/13/2011	--	--	--	--	--	--	--	--	8.8	--	--	--	--	--	--	--	--	--
	2.00	1110099-019A	10/13/2011	--	--	--	--	--	--	--	--	4.7	--	--	--	--	--	--	--	--	--
	3.00	1110099-020A	10/13/2011	--	--	--	--	--	--	--	--	4.2	--	--	--	--	--	--	--	--	--
N-16-B	0.50	1110097-019A	10/13/2011	--	--	--	--	--	--	--	--	**65**	--	--	--	--	--	--	--	--	--
	1.00	1110097-020A	10/13/2011	<5.0	4.7	61	<2.0	<1.0	29	5.8	37	**560**	<0.50	<5.0	31	<5.0	<1.0	<5.0	21	160	--
	1.50	1110098-001A	10/13/2011	--	--	--	--	--	--	--	--	27	--	--	--	--	--	--	--	--	--
	2.00	1110098-002A	10/13/2011	--	--	--	--	--	--	--	--	**50**	--	--	--	--	--	--	--	--	--
	3.00	1110098-003A	10/13/2011	--	--	--	--	--	--	--	--	**120**	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
N-17-A	0.50	1110097-001A	10/13/2011	--	--	--	--	--	--	--	--	**290**	--	--	--	--	--	--	--	--	--
	1.00	1110097-002A	10/13/2011	--	--	--	--	--	--	--	--	**300**	--	--	--	--	--	--	--	--	--
	1.50	1110097-003A	10/13/2011	--	--	--	--	--	--	--	--	9.5	--	--	--	--	--	--	--	--	--
	2.00	1110097-004A	10/13/2011	--	--	--	--	--	--	--	--	**670**	--	--	--	--	--	--	--	--	--
	3.00	1110097-005A	10/13/2011	--	--	--	--	--	--	--	--	18	--	--	--	--	--	--	--	--	--
	6.00	1110097-006A	10/13/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
	9.00	1110097-007A	10/13/2011	--	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	--	--
	12.00	1110097-008A	10/13/2011	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--	--	--	--	--
N-18-A	0.50	1110096-004A	10/13/2011	--	--	--	--	--	--	--	--	**190**	--	--	--	--	--	--	--	--	--
	1.00	1110096-005A	10/13/2011	<5.0	5	100	<2.0	<1.0	47	12	28	**210**	<0.50	<5.0	47	<5.0	2.1	<5.0	43	75	--
	1.50	1110096-006A	10/13/2011	--	--	--	--	--	--	--	--	**320**	--	--	--	--	--	--	--	--	--
	2.00	1110096-007A	10/13/2011	--	--	--	--	--	--	--	--	**200**	--	--	--	--	--	--	--	--	--
	3.00	1110096-008A	10/13/2011	--	--	--	--	--	--	--	--	**74**	--	--	--	--	--	--	--	--	--
N-19-A	0.50	1111145-006A	11/18/2011	--	--	--	--	--	--	--	--	**75**	--	--	--	--	--	--	--	--	--
	1.00	1111145-007A	11/18/2011	<5.0	5.9	100	<2.0	<1.0	47	12	30	**66**	<0.50	<5.0	46	<5.0	<1.0	<5.0	35	74	7.2
	1.50	1111145-008A	11/18/2011	--	--	--	--	--	--	--	--	19	--	--	--	--	--	--	--	--	--
	2.00	1111145-009A	11/18/2011	--	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	--	--
	3.00	1111145-010A	11/18/2011	<5.0	2.6	89	<2.0	<1.0	28	<5.0	8.2	33	<0.50	<5.0	15	<5.0	<1.0	<5.0	26	67	8.34
Stage 2																					
S-01-B	0.50	1109170-001A	9/27/2011	--	--	--	--	--	--	--	--	**270**	--	--	--	--	--	--	--	--	--
	1.00	1109170-002A	9/27/2011	--	--	--	--	--	--	--	--	7.7	--	--	--	--	--	--	--	--	--
	1.50	1109170-003A	9/27/2011	--	--	--	--	--	--	--	--	4	--	--	--	--	--	--	--	--	--
	2.00	1109170-004A	9/27/2011	--	--	--	--	--	--	--	--	20	--	--	--	--	--	--	--	--	--
	3.00	1109170-005A	9/27/2011	--	--	--	--	--	--	--	--	5.1	--	--	--	--	--	--	--	--	--
	5.00	HELD	9/27/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-02-A	0.50	1109170-007A	9/27/2011	<5.0	4.5	60	<2.0	<1.0	38	6.7	24	**140**	0.13	<5.0	47	<5.0	<1.0	<5.0	24	110	7.45
	1.00	1109170-008A	9/27/2011	--	--	--	--	--	--	--	--	**80**	--	--	--	--	--	--	--	--	--
	1.50	1109170-009A	9/27/2011	--	--	--	--	--	--	--	--	**600**	--	--	--	--	--	--	--	--	--
	2.00	1109170-010A	9/27/2011	--	--	--	--	--	--	--	--	4.3	--	--	--	--	--	--	--	--	--
	3.00	1109170-011A	9/27/2011	--	--	--	--	--	--	--	--	3.3	--	--	--	--	--	--	--	--	--
	6.00	HELD	9/27/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-02-B	0.50	1109170-013A	9/27/2011	--	--	--	--	--	--	--	--	**110**	--	--	--	--	--	--	--	--	--
	1.00	1109170-014A	9/27/2011	--	--	--	--	--	--	--	--	48	--	--	--	--	--	--	--	--	--
	1.50	1109170-015A	9/27/2011	--	--	--	--	--	--	--	--	36	--	--	--	--	--	--	--	--	--
	2.00	1109170-016A	9/27/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
	3.00	1109170-017A	9/27/2011	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--	--	--	--	--
	6.00	HELD	9/27/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
S-03-B	0.50	1109210-006A	9/29/2011	--	--	--	--	--	--	--	--	**280**	--	--	--	--	--	--	--	--	--
	1.00	1109210-007A	9/29/2011	--	--	--	--	--	--	--	--	**110**	--	--	--	--	--	--	--	--	--
	1.50	1109210-008A	9/29/2011	--	--	--	--	--	--	--	--	**60**	--	--	--	--	--	--	--	--	--
	2.00	1109210-009A	9/29/2011	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--	--	--	--	--
	3.00	1109210-010A	9/29/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
	6.00	HELD	9/29/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-04-A	0.50	1109210-012A	9/30/2011	--	--	--	--	--	--	--	--	**120**	--	--	--	--	--	--	--	--	--
	1.00	1109210-013A	9/30/2011	<5.0	3.6	50	<2.0	<1.0	33	5.7	14	**84**	0.11	<5.0	42	<5.0	<1.0	<5.0	21	53	7.28
	1.50	1109210-014A	9/30/2011	--	--	--	--	--	--	--	--	45	--	--	--	--	--	--	--	--	--
	2.00	1109210-015A	9/30/2011	--	--	--	--	--	--	--	--	**48**	--	--	--	--	--	--	--	--	--
	3.00	1109210-016A	9/30/2011	<5.0	2.2	180	<2.0	<1.0	**60**	21	62	7.7	<0.10	<5.0	69	<5.0	1.6	<5.0	56	48	--
	6.00	1109210-017A	9/30/2011	--	--	--	--	--	16	--	--	--	--	--	--	--	--	--	--	--	--
S-05-B	0.50	1110099-006A	10/13/2011	--	--	--	--	--	--	--	--	**140**	--	--	--	--	--	--	--	--	--
	1.00	1110099-007A	10/13/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
	1.50	1110099-008A	10/13/2011	--	--	--	--	--	--	--	--	10	--	--	--	--	--	--	--	--	--
	2.00	1110099-009A	10/13/2011	--	--	--	--	--	--	--	--	47	--	--	--	--	--	--	--	--	--
	3.00	1110099-010A	10/13/2011	--	--	--	--	--	--	--	--	3.9	--	--	--	--	--	--	--	--	--
S-05-C	0.50	1110099-001A	10/13/2011	--	--	--	--	--	--	--	--	**130**	--	--	--	--	--	--	--	--	--
	1.00	1110099-002A	10/13/2011	--	--	--	--	--	--	--	--	**90**	--	--	--	--	--	--	--	--	--
	1.50	1110099-003A	10/13/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
	2.00	1110099-004A	10/13/2011	--	--	--	--	--	--	--	--	25	--	--	--	--	--	--	--	--	--
	3.00	1110099-005A	10/13/2011	--	--	--	--	--	--	--	--	4.3	--	--	--	--	--	--	--	--	--
S-06-A	0.50	1110098-021A	10/13/2011	--	--	--	--	--	--	--	--	**84**	--	--	--	--	--	--	--	--	--
	1.00	1110098-022A	10/13/2011	--	--	--	--	--	--	--	--	5.8	--	--	--	--	--	--	--	--	--
	1.50	1110098-023A	10/13/2011	--	--	--	--	--	--	--	--	19	--	--	--	--	--	--	--	--	--
	2.00	1110098-024A	10/13/2011	--	--	--	--	--	--	--	--	5.6	--	--	--	--	--	--	--	--	--
	3.00	1110098-025A	10/13/2011	--	--	--	--	--	--	--	--	6.5	--	--	--	--	--	--	--	--	--
S-06-B	0.50	1110098-016A	10/13/2011	--	--	--	--	--	--	--	--	**130**	--	--	--	--	--	--	--	--	--
	1.00	1110098-017A	10/13/2011	--	--	--	--	--	--	--	--	**76**	--	--	--	--	--	--	--	--	--
	1.50	1110098-018A	10/13/2011	--	--	--	--	--	--	--	--	19	--	--	--	--	--	--	--	--	--
	2.00	1110098-019A	10/13/2011	--	--	--	--	--	--	--	--	**60**	--	--	--	--	--	--	--	--	--
	3.00	1110098-020A	10/13/2011	--	--	--	--	--	--	--	--	3.6	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
S-07-A	0.50	1111097-001A	11/15/2011	--	--	--	--	--	--	--	--	**60**	--	--	--	--	--	--	--	--	--
	1.00	1111097-002A	11/15/2011	<5.0	4.2	160	<2.0	<1.0	47	10	42	**320**	<0.50	<5.0	50	<5.0	<1.0	<5.0	34	140	7.58
	1.50	1111097-003A	11/15/2011	--	--	--	--	--	--	--	--	**310**	--	--	--	--	--	--	--	--	--
	2.00	1111097-004A	11/15/2011	--	--	--	--	--	--	--	--	7.2	--	--	--	--	--	--	--	--	--
	3.00	1111097-005A	11/15/2011	<5.0	2.6	190	<2.0	<1.0	**110**	20	19	9.1	<0.50	<5.0	110	<5.0	<1.0	<5.0	59	30	7.67
	6.00	HELD	11/15/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	9.00	HELD	11/15/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	12.00	HELD	11/15/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-09-A	0.50	1110079-004A	10/12/2011	--	--	--	--	--	--	--	--	**73**	--	--	--	--	--	--	--	--	--
	1.00	1110079-005A	10/12/2011	--	--	--	--	--	--	--	--	**180**	--	--	--	--	--	--	--	--	--
	1.50	1110079-006A	10/12/2011	--	--	--	--	--	--	--	--	19	--	--	--	--	--	--	--	--	--
	2.00	1110079-007A	10/12/2011	--	--	--	--	--	--	--	--	8.6	--	--	--	--	--	--	--	--	--
	3.00	1110079-008A	10/12/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
S-10-A	0.50	1110075-019A	10/12/2011	--	--	--	--	--	--	--	--	**160**	--	--	--	--	--	--	--	--	--
	1.00	1110075-020A	10/12/2011	--	--	--	--	--	--	--	--	**320**	--	--	--	--	--	--	--	--	--
	1.50	1110076-001A	10/12/2011	--	--	--	--	--	--	--	--	**360**	--	--	--	--	--	--	--	--	--
	2.00	1110076-002A	10/12/2011	--	--	--	--	--	--	--	--	**210**	--	--	--	--	--	--	--	--	--
	3.00	1110076-003A	10/12/2011	--	--	--	--	--	--	--	--	48	--	--	--	--	--	--	--	--	--
	5.00	1110076-004A	10/12/2011	--	--	--	--	--	--	--	--	27	--	--	--	--	--	--	--	--	--
S-10-B	0.50	1110077-017A	10/12/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
	1.00	1110077-018A	10/12/2011	--	--	--	--	--	--	--	--	6.6	--	--	--	--	--	--	--	--	--
	1.50	1110077-019A	10/12/2011	--	--	--	--	--	--	--	--	30	--	--	--	--	--	--	--	--	--
	2.00	1110077-020A	10/12/2011	--	--	--	--	--	--	--	--	**95**	--	--	--	--	--	--	--	--	--
	3.00	1110078-001A	10/12/2011	<5.0	3	250	<2.0	<1.0	**120**	26	29	10	<0.50	<5.0	**230**	<5.0	<1.0	<5.0	56	40	7.66
	6.00	1110078-002A	10/12/2011	--	--	--	--	--	**110**	--	--	9.0	--	--	130	--	--	--	--	--	--
S-10-B (Duplicate)	0.50	1110078-003A	10/12/2011	--	--	--	--	--	--	--	--	34	--	--	--	--	--	--	--	--	--
	1.00	1110078-004A	10/12/2011	--	--	--	--	--	--	--	--	16	--	--	--	--	--	--	--	--	--
	1.50	1110078-005A	10/12/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
	2.00	1110078-006A	10/12/2011	--	--	--	--	--	--	--	--	8.2	--	--	--	--	--	--	--	--	--
	3.00	1110078-007A	10/12/2011	5.4	2.8	200	<2.0	<1.0	**130**	28	30	12	<0.50	<5.0	**230**	<5.0	<1.0	<5.0	57	46	8.1
	6.00	1110078-008A	10/12/2011	--	--	--	--	--	**130**	--	--	--	--	--	**210**	--	--	--	--	--	--
S-14-A	0.50	1110075-001A	10/12/2011	--	--	--	--	--	--	--	--	**63**	--	--	--	--	--	--	--	--	
	1.00	1110075-002A	10/12/2011	--	--	--	--	--	--	--	--	**96**	--	--	--	--	--	--	--	--	--
	1.50	1110075-003A	10/12/2011	--	--	--	--	--	--	--	--	**82**	--	--	--	--	--	--	--	--	--
	2.00	1110075-004A	10/12/2011	--	--	--	--	--	--	--	--	33	--	--	--	--	--	--	--	--	--
	3.00	1110075-005A	10/12/2011	--	--	--	--	--	--	--	--	**180**	--	--	--	--	--	--	--	--	--
	6.00	1110075-006A	10/12/2011	--	--	--	--	--	--	--	--	2.6	--	--	--	--	--	--	--	--	--
S-14-B	0.50	1110075-007A	10/12/2011	--	--	--	--	--	--	--	--	**54**	--	--	--	--	--	--	--	--	--
	1.00	1110075-008A	10/12/2011	<5.0	4.4	53	<2.0	<1.0	39	5.8	15	**140**	<0.50	<5.0	41	<5.0	<1.0	<5.0	22	78	7.98
	1.50	1110075-009A	10/12/2011	--	--	--	--	--	--	--	--	**110**	--	--	--	--	--	--	--	--	--
	2.00	1110075-010A	10/12/2011	--	--	--	--	--	--	--	--	**150**	--	--	--	--	--	--	--	--	--
	3.00	1110075-011A	10/12/2011	--	--	--	--	--	--	--	--	**180**	--	--	--	--	--	--	--	--	--
	6.00	1110075-012A	10/12/2011	--	--	--	--	--	--	--	--	3.2	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
S-23-A	0.50	1111097-009A	11/15/2011	--	--	--	--	--	--	--	--	**550**	--	--	--	--	--	--	--	--	--
	1.00	1111097-010A	11/15/2011	<5.0	5.6	100	<2.0	1.4	44	8.3	49	**880**	<0.50	<5.0	45	<5.0	<1.0	<5.0	31	230	8.41
	1.50	1111097-011A	11/15/2011	--	--	--	--	--	--	--	--	**260**	--	--	--	--	--	--	--	--	--
	2.00	1111097-012A	11/15/2011	--	--	--	--	--	--	--	--	34	--	--	--	--	--	--	--	--	--
	3.00	1111097-013A	11/15/2011	--	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	--	--
Stage 3																					
S-11-A	0.50	1110076-005A	10/12/2011	--	--	--	--	--	--	--	--	**200**	--	--	--	--	--	--	--	--	--
	1.00	1110076-006A	10/12/2011	--	--	--	--	--	--	--	--	**450**	--	--	--	--	--	--	--	--	--
	1.50	1110076-007A	10/12/2011	--	--	--	--	--	--	--	--	**77**	--	--	--	--	--	--	--	--	--
	2.00	1110076-008A	10/12/2011	--	--	--	--	--	--	--	--	**75**	--	--	--	--	--	--	--	--	--
	3.00	1110076-09A	10/12/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
S-11-B	0.50	1110076-10A	10/12/2011	--	--	--	--	--	--	--	--	**130**	--	--	--	--	--	--	--	--	--
	1.00	1110076-11A	10/12/2011	--	--	--	--	--	--	--	--	**63**	--	--	--	--	--	--	--	--	--
	1.50	1110076-12A	10/12/2011	--	--	--	--	--	--	--	--	48	--	--	--	--	--	--	--	--	--
	2.00	1110076-13A	10/12/2011	--	--	--	--	--	--	--	--	9	--	--	--	--	--	--	--	--	--
	3.00	1110076-14A	10/12/2011	--	--	--	--	--	--	--	--	7.3	--	--	--	--	--	--	--	--	--
S-13-A	0.50	1110077-001A	10/12/2011	--	--	--	--	--	--	--	--	**1,800**	--	--	--	--	--	--	--	--	--
	1.00	1110077-002A	10/12/2011	--	--	--	--	--	--	--	--	**430**	--	--	--	--	--	--	--	--	--
	1.50	1110077-003A	10/12/2011	--	--	--	--	--	--	--	--	22	--	--	--	--	--	--	--	--	--
	2.00	1110077-004A	10/12/2011	--	--	--	--	--	--	--	--	6.9	--	--	--	--	--	--	--	--	--
	3.00	1110077-005A	10/12/2011	<5.0	2.4	51	<2.0	<1.0	35	5.4	6.7	3.2	<0.50	<5.0	45	<5.0	<1.0	<5.0	20	23	7.35
S-13-A (Duplicate)	0.50	1110077-006A	10/12/2011	--	--	--	--	--	--	--	--	**270**	--	--	--	--	--	--	--	--	--
	1.00	1110077-007A	10/12/2011	--	--	--	--	--	--	--	--	**400**	--	--	--	--	--	--	--	--	--
	1.50	1110077-008A	10/12/2011	--	--	--	--	--	--	--	--	8.7	--	--	--	--	--	--	--	--	--
	2.00	1110077-009A	10/12/2011	--	--	--	--	--	--	--	--	8.3	--	--	--	--	--	--	--	--	--
	3.00	1110077-010A	10/12/2011	<5.0	2.4	54	<2.0	<1.0	32	<0.50	6.5	2.6	<0.50	<5.0	39	<5.0	<1.0	<5.0	19	21	7.41
S-15-A	0.50	1109210-040A	9/30/2011	--	--	--	--	--	--	--	--	**510**	--	--	--	--	--	--	--	--	--
	1.00	1109207-001A	9/30/2011	--	--	--	--	--	--	--	--	**530**	--	--	--	--	--	--	--	--	--
	1.50	1109207-002A	9/30/2011	--	--	--	--	--	--	--	--	**160**	--	--	--	--	--	--	--	--	--
	2.00	1109207-003A	9/30/2011	--	--	--	--	--	--	--	--	5.6	--	--	--	--	--	--	--	--	--
	3.00	1109207-004A	9/30/2011	--	--	--	--	--	--	--	--	5.6	--	--	--	--	--	--	--	--	--
S-15-A (Duplicate)	0.50	1109207-025A	9/30/2011	--	--	--	--	--	--	--	--	**690**	--	--	--	--	--	--	--	--	--
	1.00	1109207-026A	9/30/2011	--	--	--	--	--	--	--	--	**1,900**	--	--	--	--	--	--	--	--	--
	1.50	1109207-027A	9/30/2011	--	--	--	--	--	--	--	--	8.9	--	--	--	--	--	--	--	--	--
	2.00	1109207-028A	9/30/2011	--	--	--	--	--	--	--	--	6.7	--	--	--	--	--	--	--	--	--
	3.00	1109207-029A	9/30/2011	--	--	--	--	--	--	--	--	6.4	--	--	--	--	--	--	--	--	--
S-15-B	0.50	1109207-005A	9/30/2011	--	--	--	--	--	--	--	--	**390**	--	--	--	--	--	--	--	--	--
	1.00	1109207-006A	9/30/2011	--	--	--	--	--	--	--	--	**380**	--	--	--	--	--	--	--	--	--
	1.50	1109207-007A	9/30/2011	--	--	--	--	--	--	--	--	**880**	--	--	--	--	--	--	--	--	--
	2.00	1109207-008A	9/30/2011	--	--	--	--	--	--	--	--	**72**	--	--	--	--	--	--	--	--	--
	3.00	1109207-009A	9/30/2011	--	--	--	--	--	--	--	--	7.9	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
S-15-C	0.50	1109207-010A	9/30/2011	--	--	--	--	--	--	--	--	**430**	--	--	--	--	--	--	--	--	--
	1.00	1109207-011A	9/30/2011	--	--	--	--	--	--	--	--	**480**	--	--	--	--	--	--	--	--	--
	1.50	1109207-012A	9/30/2011	--	--	--	--	--	--	--	--	30	--	--	--	--	--	--	--	--	--
	2.00	1109207-013A	9/30/2011	--	--	--	--	--	--	--	--	3.5	--	--	--	--	--	--	--	--	--
	3.00	1109207-014A	9/30/2011	--	--	--	--	--	--	--	--	3.1	--	--	--	--	--	--	--	--	--
S-16-A	0.50	1110076-015A	10/12/2011	--	--	--	--	--	--	--	--	**270**	--	--	--	--	--	--	--	--	--
	1.00	1110076-016A	10/12/2011	--	--	--	--	--	--	--	--	44	--	--	--	--	--	--	--	--	--
	1.50	1110076-017A	10/12/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
	2.00	1110076-018A	10/12/2011	<5.0	6.9	90	<2.0	<1.0	25	7.7	21	7.6	<0.50	<5.0	31	<5.0	<1.0	<5.0	22	41	7.77
	3.00	1110076-019A	10/12/2011	--	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	--	--
	6.00	HELD	10/12/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-17-A	0.50	1110077-011A	10/12/2011	--	--	--	--	--	--	--	--	**91**	--	--	--	--	--	--	--	--	--
	1.00	1110077-012A	10/12/2011	--	--	--	--	--	--	--	--	**260**	--	--	--	--	--	--	--	--	--
	1.50	1110077-013A	10/12/2011	--	--	--	--	--	--	--	--	**150**	--	--	--	--	--	--	--	--	--
	2.00	1110077-014A	10/12/2011	--	--	--	--	--	--	--	--	26	--	--	--	--	--	--	--	--	--
	3.00	1110077-015A	10/12/2011	--	--	--	--	--	--	--	--	9.1	--	--	--	--	--	--	--	--	--
	6.00	HELD	10/12/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
S-18-A	0.50	1110078-009A	10/12/2011	--	--	--	--	--	--	--	--	**150**	--	--	--	--	--	--	--	--	--
	1.00	1110078-010A	10/12/2011	--	--	--	--	--	--	--	--	21	--	--	--	--	--	--	--	--	--
	1.50	1110078-011A	10/12/2011	--	--	--	--	--	--	--	--	26	--	--	--	--	--	--	--	--	--
	2.00	1110078-012A	10/12/2011	<5.0	4.6	53	<2.0	<1.0	36	6.7	10	30	<0.50	<5.0	43	<5.0	<1.0	<5.0	23	40	7.27
	3.00	1110078-013A	10/12/2011	--	--	--	--	--	--	--	--	6.2	--	--	--	--	--	--	--	--	--
S-19-B	0.50	1110079-019A	10/12/2011	--	--	--	--	--	--	--	--	**570**	--	--	--	--	--	--	--	--	--
	1.00	1110079-020A	10/12/2011	--	--	--	--	--	--	--	--	**290**	--	--	--	--	--	--	--	--	--
	1.50	1110079-021A	10/12/2011	--	--	--	--	--	--	--	--	**100**	--	--	--	--	--	--	--	--	--
	2.00	1110079-022A	10/12/2011	--	--	--	--	--	--	--	--	37	--	--	--	--	--	--	--	--	--
	3.00	1110079-023A	10/12/2011	--	--	--	--	--	--	--	--	5.5	--	--	--	--	--	--	--	--	--
	6.00	1110079-024A	10/12/2011	<5.0	4.4	150	<2.0	<1.0	16	10	15	7.6	<0.50	<5.0	21	<5.0	2.6	<5.0	33	36	--
S-20-A	0.50	1110078-019A	10/12/2011	--	--	--	--	--	--	--	--	**150**	--	--	--	--	--	--	--	--	--
	1.00	1110078-020A	10/12/2011	<5.0	3.9	79	<2.0	<1.0	**72**	8.3	17	**110**	<0.50	<5.0	33	<5.0	<1.0	<5.0	45	76	6.74
	1.50	1110079-001A	10/12/2011	--	--	--	--	--	--	--	--	**280**	--	--	--	--	--	--	--	--	--
	2.00	1110079-002A	10/12/2011	--	--	--	--	--	--	--	--	**230**	--	--	--	--	--	--	--	--	--
	3.00	1110079-003A	10/12/2011	<5.0	4.3	89	<2.0	<1.0	40	8.2	23	**58**	<0.50	<5.0	37	<5.0	<1.0	<5.0	30	68	5.64
S-20-B	0.50	1110079-009A	10/12/2011	--	--	--	--	--	--	--	--	**210**	--	--	--	--	--	--	--	--	--
	1.00	1110079-010A	10/12/2011	--	--	--	--	--	--	--	--	**210**	--	--	--	--	--	--	--	--	--
	1.50	1110079-011A	10/12/2011	--	--	--	--	--	--	--	--	**280**	--	--	--	--	--	--	--	--	--
	2.00	1110079-012A	10/12/2011	--	--	--	--	--	--	--	--	9.4	--	--	--	--	--	--	--	--	--
	3.00	1110079-013A	10/12/2011	--	--	--	--	--	--	--	--	3.6	--	--	--	--	--	--	--	--	--
S-20-C	0.50	1110079-014A	10/12/2011	--	--	--	--	--	--	--	--	**350**	--	--	--	--	--	--	--	--	--
	1.00	1110079-015A	10/12/2011	--	--	--	--	--	--	--	--	**390**	--	--	--	--	--	--	--	--	--
	1.50	1110079-016A	10/12/2011	--	--	--	--	--	--	--	--	**370**	--	--	--	--	--	--	--	--	--
	2.00	1110079-017A	10/12/2011	--	--	--	--	--	--	--	--	**370**	--	--	--	--	--	--	--	--	--
	3.00	1110079-018A	10/12/2011	--	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
S-21-A	0.50	1109207-015A	9/30/2011	--	--	--	--	--	--	--	--	**170**	--	--	--	--	--	--	--	--	--
	1.00	1109207-016A	9/30/2011	--	--	--	--	--	--	--	--	**380**	--	--	--	--	--	--	--	--	--
	1.50	1109207-017A	9/30/2011	--	--	--	--	--	--	--	--	**110**	--	--	--	--	--	--	--	--	--
	2.00	1109207-018A	9/30/2011	--	--	--	--	--	--	--	--	**100**	--	--	--	--	--	--	--	--	--
	3.00	1109207-019A	9/30/2011	--	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	--	--
S-22-A	0.50	1110079-025A	10/12/2011	--	--	--	--	--	--	--	--	**290**	--	--	--	--	--	--	--	--	--
	1.00	1110079-026A	10/12/2011	--	--	--	--	--	--	--	--	**290**	--	--	--	--	--	--	--	--	--
	1.50	1110079-027A	10/12/2011	--	--	--	--	--	--	--	--	**280**	--	--	--	--	--	--	--	--	--
	2.00	1110079-028A	10/12/2011	<5.0	2.7	150	<2.0	<1.0	**69**	9.5	17	12	<0.50	<5.0	36	<5.0	<1.0	<5.0	51	34	--
	3.00	1110079-029A	10/12/2011	--	--	--	--	--	--	--	--	4.5	--	--	--	--	--	--	--	--	--
N-05-A	0.50	1111145-022A	11/18/2011	--	--	--	--	--	--	--	--	**130**	--	--	--	--	--	--	--	--	--
	1.00	1111145-023A	11/18/2011	--	--	--	--	--	--	--	--	**480**	--	--	--	--	--	--	--	--	--
	1.50	1111145-024A	11/18/2011	--	--	--	--	--	--	--	--	**110**	--	--	--	--	--	--	--	--	--
	2.00	1111145-025A	11/18/2011	<5.0	4.5	190	<2.0	<1.0	**62**	13	16	**120**	<0.50	<5.0	37	<5.0	<1.0	<5.0	42	96	--
	3.00	1111145-026A	11/18/2011	--	--	--	--	--	--	--	--	**95**	--	--	--	--	--	--	--	--	--
N-11-A	0.50	1110100-016A	10/13/2011	<5.0	3.1	91	<2.0	<1.0	30	6.1	27	**61**	<0.50	<5.0	34	<5.0	<1.0	<5.0	27	150	--
	1.00	1110100-017A	10/13/2011	<5.0	5.8	100	<2.0	<1.0	38	7.6	18	**130**	<0.50	<5.0	46	<5.0	<1.0	<5.0	29	85	--
	1.50	1110100-018A	10/13/2011	--	--	--	--	--	--	--	--	**53**	--	--	--	--	--	--	--	--	--
	2.00	1110100-019A	10/13/2011	--	--	--	--	--	--	--	--	35	--	--	--	--	--	--	--	--	--
	3.00	1110100-020A	10/13/2011	--	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	--	--
N-12-A	0.50	1110100-001A	10/13/2011	--	--	--	--	--	--	--	--	**130**	--	--	--	--	--	--	--	--	--
	1.00	1110100-002A	10/13/2011	--	--	--	--	--	--	--	--	**110**	--	--	--	--	--	--	--	--	--
	1.50	1110100-003A	10/13/2011	--	--	--	--	--	--	--	--	46	--	--	--	--	--	--	--	--	--
	2.00	1110100-004A	10/13/2011	--	--	--	--	--	--	--	--	69	--	--	--	--	--	--	--	--	--
	3.00	1110100-005A	10/13/2011	--	--	--	--	--	--	--	--	4.3	--	--	--	--	--	--	--	--	--
N-15-A	0.50	1110100-006A	10/13/2011	--	--	--	--	--	--	--	--	**490**	--	--	--	--	--	--	--	--	--
	1.00	1110100-007A	10/13/2011	--	--	--	--	--	--	--	--	**140**	--	--	--	--	--	--	--	--	--
	1.50	1110100-008A	10/13/2011	--	--	--	--	--	--	--	--	41	--	--	--	--	--	--	--	--	--
	2.00	1110100-009A	10/13/2011	--	--	--	--	--	--	--	--	5.3	--	--	--	--	--	--	--	--	--
	3.00	1110100-010A	10/13/2011	--	--	--	--	--	--	--	--	3.6	--	--	--	--	--	--	--	--	--
N-22-B	0.50	1111147-025A	11/18/2011	--	--	--	--	--	--	--	--	**1,600**	--	--	--	--	--	--	--	--	--
	1.00	1111147-026A	11/18/2011	--	--	--	--	--	--	--	--	**350**	--	--	--	--	--	--	--	--	--
	1.50	1111147-027A	11/18/2011	--	--	--	--	--	--	--	--	**65**	--	--	--	--	--	--	--	--	--
	2.00	1111147-028A	11/18/2011	--	--	--	--	--	--	--	--	**80**	--	--	--	--	--	--	--	--	--
	3.00	1111147-029A	11/18/2011	<5.0	2.4	17	<2.0	<1.0	47	6.5	16	9.2	<0.50	<5.0	36	<5.0	<1.0	<5.0	36	40	7.88
N-22-C	0.50	1111147-030A	11/18/2011	--	--	--	--	--	--	--	--	**770**	--	--	--	--	--	--	--	--	--
	1.00	1111147-031A	11/18/2011	--	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	--	--
	1.50	1111147-032A	11/18/2011	--	--	--	--	--	--	--	--	**58**	--	--	--	--	--	--	--	--	--
	2.00	1111147-033A	11/18/2011	--	--	--	--	--	--	--	--	15	--	--	--	--	--	--	--	--	--
	3.00	1111147-034A	11/18/2011	--	--	--	--	--	--	--	--	**66**	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
Stage 4																					
N-04-A	0.50	1111145-037A	11/18/2011	--	--	--	--	--	--	--	--	**190**	--	--	--	--	--	--	--	--	--
	1.00	1111145-038A	11/18/2011	--	--	--	--	--	--	--	--	**120**	--	--	--	--	--	--	--	--	--
	1.50	1111145-039A	11/18/2011	--	--	--	--	--	--	--	--	4.0	--	--	--	--	--	--	--	--	--
	2.00	1111145-040A	11/18/2011	<5.0	3.9	37	<2.0	<1.0	30	<5.0	6.7	3.7	<0.50	<5.0	37	<5.0	<1.0	<5.0	16	21	7.73
	3.00	1111146-001A	11/18/2011	--	--	--	--	--	--	--	--	3.1	--	--	--	--	--	--	--	--	--
N-10-A	0.50	1111145-017A	11/18/2011	--	--	--	--	--	--	--	--	35	--	--	--	--	--	--	--	--	--
	1.00	1111145-018A	11/18/2011	--	--	--	--	--	--	--	--	**79**	--	--	--	--	--	--	--	--	--
	1.50	1111145-019A	11/18/2011	--	--	--	--	--	--	--	--	**52**	--	--	--	--	--	--	--	--	--
	2.00	1111145-020A	11/18/2011	--	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	--	--
	3.00	1111145-021A	11/18/2011	<5.0	3	190	<2.0	<1.0	**67**	15	24	26	<0.50	<5.0	88	<5.0	<1.0	<5.0	52	56	--
N-14-A	0.50	1111145-011A	11/18/2011	--	--	--	--	--	--	--	--	**140**	--	--	--	--	--	--	--	--	--
	1.00	1111145-012A	11/18/2011	--	--	--	--	--	--	--	--	**150**	--	--	--	--	--	--	--	--	--
	1.50	1111145-013A	11/18/2011	--	--	--	--	--	--	--	--	11	--	--	--	--	--	--	--	--	--
	2.00	1111145-014A	11/18/2011	--	--	--	--	--	--	--	--	6.8	--	--	--	--	--	--	--	--	--
	3.00	1111145-015A	11/18/2011	--	--	--	--	--	--	--	--	4.6	--	--	--	--	--	--	--	--	--
	6.00	HELD	11/18/2011	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
N-20-A	0.50	1111145-001A	11/18/2011	--	--	--	--	--	--	--	--	**57**	--	--	--	--	--	--	--	--	--
	1.00	1111145-002A	11/18/2011	<5.0	3.7	27	<2.0	<1.0	33	5.5	11	**130**	<0.50	<5.0	21	<5.0	1.5	<5.0	30	54	7.72
	1.50	1111145-003A	11/18/2011	--	--	--	--	--	--	--	--	**150**	--	--	--	--	--	--	--	--	--
	2.00	1111145-004A	11/18/2011	--	--	--	--	--	--	--	--	**230**	--	--	--	--	--	--	--	--	--
	3.00	1111145-005A	11/18/2011	<5.0	5.5	38	<2.0	<1.0	31	5.0	27	**340**	<0.50	<5.0	20	<5.0	1.6	<5.0	26	96	--
Stage 5																					
N-13-A	0.50	1110098-004A	10/13/2011	--	--	--	--	--	--	--	--	**140**	--	--	--	--	--	--	--	--	--
	1.00	1110098-005A	10/13/2011	--	--	--	--	--	--	--	--	15	--	--	--	--	--	--	--	--	--
	1.50	1110098-006A	10/13/2011	--	--	--	--	--	--	--	--	15	--	--	--	--	--	--	--	--	--
	2.00	1110098-007A	10/13/2011	<5.0	8.5	41	<2.0	<1.0	**87**	18	37	11	<0.50	<5.0	150	<5.0	<1.0	<5.0	42	66	--
	3.00	1110098-008A	10/13/2011	--	--	--	--	--	--	--	--	44	--	--	--	--	--	--	--	--	--
N-13-B	0.50	1110098-009A	10/13/2011	--	--	--	--	--	--	--	--	29	--	--	--	--	--	--	--	--	--
	1.00	1110098-010A	10/13/2011	--	--	--	--	--	--	--	--	29	--	--	--	--	--	--	--	--	--
	1.50	1110096-001A	10/13/2011	--	--	--	--	--	--	--	--	17	--	--	--	--	--	--	--	--	--
	2.00	1110096-002A	10/13/2011	--	--	--	--	--	--	--	--	14	--	--	--	--	--	--	--	--	--
	3.00	1110096-003A	10/13/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--
N-16-A	0.50	1110097-009A	10/13/2011	--	--	--	--	--	--	--	--	**64**	--	--	--	--	--	--	--	--	--
	1.00	1110097-010A	10/13/2011	--	--	--	--	--	--	--	--	**420**	--	--	--	--	--	--	--	--	--
	1.50	1110097-011A	10/13/2011	--	--	--	--	--	--	--	--	**370**	--	--	--	--	--	--	--	--	--
	2.00	1110097-012A	10/13/2011	--	--	--	--	--	--	--	--	38	--	--	--	--	--	--	--	--	--
	3.00	1110097-013A	10/13/2011	--	--	--	--	--	--	--	--	28	--	--	--	--	--	--	--	--	--
N-16-A (Duplicate)	0.50	1110097-014	10/13/2011	--	--	--	--	--	--	--	--	**190**	--	--	--	--	--	--	--	--	--
	1.00	1110097-015	10/13/2011	--	--	--	--	--	--	--	--	**190**	--	--	--	--	--	--	--	--	--
	1.50	1110097-016	10/13/2011	--	--	--	--	--	--	--	--	**75**	--	--	--	--	--	--	--	--	--
	2.00	1110097-017	10/13/2011	--	--	--	--	--	--	--	--	**420**	--	--	--	--	--	--	--	--	--
	3.00	1110097-018	10/13/2011	--	--	--	--	--	--	--	--	5.9	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
N-21-A	0.50	1111147-035A	11/18/2011	--	--	--	--	--	--	--	--	**52**	--	--	--	--	--	--	--	--	--
	1.00	1111147-036A	11/18/2011	<5.0	4.1	150	<2.0	<1.0	46	12	78	**200**	<0.50	<5.0	47	<5.0	3.2	<5.0	37	180	7.28
	1.50	1111147-037A	11/18/2011	--	--	--	--	--	--	--	--	**150**	--	--	--	--	--	--	--	--	--
	2.00	1111147-038A	11/18/2011	--	--	--	--	--	--	--	--	**52**	--	--	--	--	--	--	--	--	--
	3.00	1111147-039A	11/18/2011	--	--	--	--	--	--	--	--	**1,100**	--	--	--	--	--	--	--	--	--
	6.00	1111147-040A	11/18/2011	--	--	--	--	--	--	--	--	**560**	--	--	--	--	--	--	--	--	--
N-21-A (Duplicate)	0.50	1111147-041A	11/18/2011	--	--	--	--	--	--	--	--	**69**	--	--	--	--	--	--	--	--	--
	1.00	1111147-042A	11/18/2011	5	5.6	140	<2.0	<1.0	**58**	12	60	**240**	<0.50	<5.0	50	<5.0	2.8	<5.0	42	190	6.85
	1.50	1111147-043A	11/18/2011	--	--	--	--	--	--	--	--	**190**	--	--	--	--	--	--	--	--	--
	2.00	1111147-044A	11/18/2011	--	--	--	--	--	--	--	--	**120**	--	--	--	--	--	--	--	--	--
	3.00	1111147-045A	11/18/2011	--	--	--	--	--	--	--	--	**1,700**	--	--	--	--	--	--	--	--	--
	6.00	1111147-046A	11/18/2011									**1,100**									
N-22-A	0.50	1111147-020A	11/18/2011	--	--	--	--	--	--	--	--	**820**	--	--	--	--	--	--	--	--	--
	1.00	1111147-021A	11/18/2011	--	--	--	--	--	--	--	--	**470**	--	--	--	--	--	--	--	--	--
	1.50	1111147-022A	11/18/2011	--	--	--	--	--	--	--	--	**78**	--	--	--	--	--	--	--	--	--
	2.00	1111147-023A	11/18/2011	--	--	--	--	--	--	--	--	4.6	--	--	--	--	--	--	--	--	--
	3.00	1111147-024A	11/18/2011	<5.0	7.5	48	<2.0	<1.0	30	11	16	40	<0.50	<5.0	34	<5.0	<1.0	<5.0	40	40	8.58
N-23-A	0.50	1111147-010A	11/18/2011	--	--	--	--	--	--	--	--	**370**	--	--	--	--	--	--	--	--	--
	1.00	1111147-011A	11/18/2011	--	--	--	--	--	--	--	--	**330**	--	--	--	--	--	--	--	--	--
	1.50	1111147-012A	11/18/2011	--	--	--	--	--	--	--	--	**1,600**	--	--	--	--	--	--	--	--	--
	2.00	1111147-013A	11/18/2011	--	--	--	--	--	--	--	--	**1,700**	--	--	--	--	--	--	--	--	--
	3.00	1111147-014A	11/18/2011	<5.0	5.5	71	<2.0	1.1	43	8.6	37	**700**	<0.50	<5.0	48	<5.0	<1.0	<5.0	29	120	7.79
N-23-B	0.50	1111147-015A	11/18/2011	--	--	--	--	--	--	--	--	**89**	--	--	--	--	--	--	--	--	--
	1.00	1111147-016A	11/18/2011	--	--	--	--	--	--	--	--	6.2	--	--	--	--	--	--	--	--	--
	1.50	1111147-017A	11/18/2011	--	--	--	--	--	--	--	--	9.3	--	--	--	--	--	--	--	--	--
	2.00	1111147-018A	11/18/2011	--	--	--	--	--	--	--	--	**89**	--	--	--	--	--	--	--	--	--
	3.00	1111147-019A	11/18/2011	--	--	--	--	--	--	--	--	**70**	--	--	--	--	--	--	--	--	--
N-24-A	0.50	1111146-040A	11/18/2011	--	--	--	--	--	--	--	--	**140**	--	--	--	--	--	--	--	--	--
	1.00	1111147-001A	11/18/2011	--	--	--	--	--	--	--	--	**210**	--	--	--	--	--	--	--	--	--
	1.50	1111147-002A	11/18/2011	--	--	--	--	--	--	--	--	**230**	--	--	--	--	--	--	--	--	--
	2.00	1111147-003A	11/18/2011	--	--	--	--	--	--	--	--	**190**	--	--	--	--	--	--	--	--	--
	3.00	1111147-004A	11/18/2011	--	--	--	--	--	--	--	--	**150**	--	--	--	--	--	--	--	--	--
N-24-B	0.50	1111147-005A	11/18/2011	--	--	--	--	--	--	--	--	**220**	--	--	--	--	--	--	--	--	--
	1.00	1111147-006A	11/18/2011	--	--	--	--	--	--	--	--	**330**	--	--	--	--	--	--	--	--	--
	1.50	1111147-007A	11/18/2011	--	--	--	--	--	--	--	--	**320**	--	--	--	--	--	--	--	--	--
	2.00	1111147-008A	11/18/2011	--	--	--	--	--	--	--	--	**140**	--	--	--	--	--	--	--	--	--
	3.00	1111147-009A	11/18/2011	--	--	--	--	--	--	--	--	**150**	--	--	--	--	--	--	--	--	--

Table 2
Total Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead (Total)	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	pH
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B	SW9045C
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	SU
		10 x STLC		150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	<2.5, >12.5*
		20 x TCLP		NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	<2.5, >12.5*
Samples on adjacent land (not to be included in main stats evaluation, just for retaining walls)																					
SB-06	0.50	1112070-009A	12/11/2011	--	--	--	--	--	--	--	--	**74**	--	--	--	--	--	--	--	--	--
	1.00	1112070-010A	12/11/2011	--	--	--	--	--	--	--	--	17	--	--	--	--	--	--	--	--	--
	1.50	1112070-011A	12/11/2011	--	--	--	--	--	--	--	--	3.4	--	--	--	--	--	--	--	--	--
	2.00	1112070-012A	12/11/2011	--	--	--	--	--	--	--	--	47	--	--	--	--	--	--	--	--	--
	3.00	1112070-013A	12/11/2011	--	--	--	--	--	--	--	--	4.8	--	--	--	--	--	--	--	--	--
SB-07	0.50	1112071-011A	12/11/2011	--	--	--	--	--	--	--	--	**440**	--	--	--	--	--	--	--	--	--
	1.00	1112071-012A	12/11/2011	--	--	--	--	--	--	--	--	**310**	--	--	--	--	--	--	--	--	--
	1.50	1112071-013A	12/11/2011	--	--	--	--	--	--	--	--	**210**	--	--	--	--	--	--	--	--	--
	2.00	1112071-014A	12/11/2011	--	--	--	--	--	--	--	--	**68**	--	--	--	--	--	--	--	--	--
	3.00	1112071-015A	12/11/2011	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	--

Notes:
EPA = US Environmental Protection Agency
mg/L = milligrams per liter
mg/Kg = milligrams per kilogram
ESL - Direct Exposure = RWQCB Direct Exposure Soil Screening Levels for Construction/Trench Workers (Table K-3)
ESL - Residential = RWCQB Environmental Screening Levels for shallow soils where groundwater is a current or potential source of drinking water (Table A) for residential land use
ESL - Comm/Ind = RWCQB Environmental Screening Levels for shallow soils where groundwater is a current or potential source of drinking water (Table A) for commercial or industrial land use only
STLC = Soluble Threshold Limits Concentrations
TCLP = Toxicity Characteristic Leaching Procedure
NE = Not Established
-- = sample not analyzed for specified analyte
Bold indicates value exceeds STLC.
Yellow highlighting indicates value exceeds ESL.
The symbol "<" (less than) indicates that the analyte was not detected at a concentration above the laboratory detection limit specified.
*: Values indicate lower, upper pH boundaries for non-hazardous waste.
#: Value is for Chromium III, as speciation testing on samples with high total Chromium indicated that no Chromium VI was present (see Table 3).
HELD Samples Held at Laboratory; not analyzed

Table 3
Leachate Speciation Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Lead (Total)	Nickel (Total)	Chromium (Total)	Chromium VI	Lead (STLC)	Lead (TCLP)	Lead (Di-STLC)	Nickel (STLC)
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/L	mg/L	mg/L	mg/L
		STLC		50	200	50	5.0	5.0	NE	5.0	20
		TCLP		100	NE	100	5.0	NE	5.0	NE	NE
Stage 1											
S-01-A	0.5	1109210-001A	9/29/2011	**480**	--	--	--	**13**	<0.10	0.084	--
	1.0	1109210-002A	9/29/2011	**610**	--	--	--	**13**	0.24	3.0	--
S-03-A	0.5	1109210-018A	9/29/2011	**260**	--	--	--	**22**	--	**6.6**	--
	1.0	1109210-019A	9/29/2011	**830**	--	--	--	**31**	<0.10	0.48	--
S-05-A	1.5	1110098-013A	10/13/2011	**110**	--	--	--	2.1	--	--	--
S-08-A	0.5	1109210-024A	9/29/2011	**610**	--	--	--	**28**	0.19	2	--
	1.0	1109210-025A	9/29/2011	**260**	--	--	--	**9.5**	--	0.56	--
	1.5	1109210-026A	9/29/2011	**220**	--	--	--	4.9	--	--	--
	2.0	1109210-027A	9/29/2011	**160**	--	--	--	**6.6**	--	0.28	--
S-12-A	0.5	1109210-032A	9/30/2011	**280**	--	--	--	**15**	--	3.9	--
	1.0	1109210-033A	9/30/2011	**290**	--	--	--	**17**	--	NE*	--
	1.5	1109210-034A	9/30/2011	65	--	--	--	3.0	--	--	--
	2.0	1109210-035A	9/30/2011	53	--	--	--	2.5	--	--	--
	3.0	1109210-036A	9/30/2011	78	--	--	--	1.8	--	--	--
	9.0	1109210-038A	9/30/2011	**2,600**	--	--	--	**28**	0.17	**5.7**	--
S-14-C	0.5	1110075-013A	10/12/2011	**100**	--	--	--	2.1	--	--	--
	1.0	1110075-014A	10/12/2011	79	--	--	--	**7.1**	--	0.47	--
	1.5	1110075-015A	10/12/2011	60	--	--	--	2.6	--	--	--
S-19-A	0.5	1110078-014A	10/12/2011	**260**	--	--	--	**12**	--	0.74	--
	1.0	1110078-015A	10/12/2011	58	--	--	--	3.9	--	--	--
S-21-B	0.5	1109207-020A	9/30/2011	95	--	--	--	3.0	--	--	--
	1.0	1109207-021A	9/30/2011	**180**	--	--	--	**6.8**	--	0.57	--
	1.5	1109207-022A	9/30/2011	**140**	--	--	--	**5.5**	--	0.023	--
	2.0	1109207-023A	9/30/2011	**150**	--	--	--	**7.9**	--	<0.010	--
N-01-A	0.5	1111146-025A	11/18/2011	**600**	--	--	--	**50**	--	**11**	--
	1.0	1111146-026A	11/18/2011	**1,600**	--	--	--	**100**	**15**	**59**	--
	1.5	1111146-027A	11/18/2011	**130**	--	--	--	**5.0**	--	0.23	--
	2.0	1111146-028A	11/18/2011	74	--	--	--	1.4	--	--	--
N-01-A DUP	0.5	1111146-030A	11/18/2011	**1,800**	--	--	--	**75**	3.4	**73**	--
	1.0	1111146-031A	11/18/2011	**390**	--	--	--	**24**	--	1.7	--
N-01-B	0.5	1111146-035A	11/18/2011	**900**	--	--	--	**42**	0.50	**24**	--
	1.0	1111146-036A	11/18/2011	90	--	--	--	**7.6**	--	3.2	--
N-02-A	0.5	1111146-015A	11/18/2011	**450**	--	--	--	**22**	--	**8.6**	--
	1.0	1111146-016A	11/18/2011	**2,600**	--	--	--	**150**	4.9	**15**	--
	1.5	1111146-017A	11/18/2011	**1,700**	--	--	--	**110**	4.1	**93**	--
	2.0	1111146-018A	11/18/2011	**460**	--	--	--	**19**	--	3.3	--
	3.0	1111146-019A	11/18/2011	89	--	--	--	1.8	--	--	--
N-02-B	0.5	1111146-020A	11/18/2011	**740**	--	--	--	**43**	0.32	--	--
	1.0	1111146-021A	11/18/2011	**120**	--	--	--	**12**	--	4.3	--
N-04-B	0.5	1111146-002A	11/18/2011	**210**	--	--	--	**6.5**	--	**11**	--
	1.0	1111146-003A	11/18/2011	**300**	--	--	--	**16**	--	**14**	--
	1.5	1111146-004A	11/18/2011	**120**	--	--	--	**6.2**	--	0.89	--
N-06-A	0.5	1111145-032A	11/18/2011	**130**	--	--	--	**7.8**	--	1.3	--
N-06-B	0.5	1111145-034A	11/18/2011	**250**	--	--	--	**10**	--	2.3	--
N-07-A	0.5	1111145-027A	11/18/2011	**210**	--	--	--	**7.5**	--	1.5	--
	1.0	1111145-028A	11/18/2011	**110**	--	--	--	2.8	--	--	--

Table 3
Leachate Speciation Metals - Hazardous Material Investigation
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Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Lead (Total)	Nickel (Total)	Chromium (Total)	Chromium VI	Lead (STLC)	Lead (TCLP)	Lead (Di-STLC)	Nickel (STLC)
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/L	mg/L	mg/L	mg/L
		STLC		50	200	50	5.0	5.0	NE	5.0	20
		TCLP		100	NE	100	5.0	NE	5.0	NE	NE
N-08-A	2.0	1110100-014A	10/13/2011	58	--	--	--	1.8	--	--	--
N-09-A	2.0	1110099-014A	10/13/2011	53	--	--	--	1.5	--	--	--
N-09-B	0.5	1110099-016A	10/13/2011	**540**	--	--	--	**23**	0.10	**19**	--
	1.0	1110099-017A	10/13/2011	**240**	--	--	--	**7.5**	--	1.1	--
N-16-B	0.5	1110097-019A	10/13/2011	65	--	--	--	1.6	--	--	--
	1.0	1110097-020A	10/13/2011	**560**	--	--	--	3.5	0.24	--	--
	2.0	1110098-002A	10/13/2011	50	--	--	--	3.6	--	--	--
	3.0	1110098-003A	10/13/2011	**120**	--	--	--	**10**	--	0.014	--
N-17-A	0.5	1110097-001A	10/13/2011	**290**	--	--	--	**7.0**	--	0.56	--
	1.0	1110097-002A	10/13/2011	**300**	--	--	--	**7.3**	--	0.87	--
	2.0	1110097-004A	10/13/2011	**670**	--	--	--	**33**	<0.10	0.27	--
N-18-A	0.5	1110096-004A	10/13/2011	**190**	--	--	--	4.8	--	--	--
	1.0	1110096-005A	10/13/2011	**210**	--	--	--	**9.8**	--	1.4	--
	1.5	1110096-006A	10/13/2011	**320**	--	--	--	**11**	--	1.1	--
	2.0	1110096-007A	10/13/2011	**200**	--	--	--	4.7	--	--	--
	3.0	1110096-008A	10/13/2011	74	--	--	--	1.6	--	--	--
Stage 2											
S-01-B	0.5	1109170-001A	9/27/2011	**270**	--	--	--	**9.0**	--	1.9	--
S-02-A	0.5	1109170-007A	9/27/2011	**140**	--	--	--	**8.4**	--	3.3	--
	1.0	1109170-008A	9/27/2011	80	--	--	--	4.3	--	--	--
	1.5	1109170-009A	9/27/2011	**600**	--	--	--	**30**	0.29	0.41	--
S-02-B	0.5	1109170-013A	9/27/2011	**110**	--	--	--	**6.6**	--	0.25	--
S-03-B	0.5	1109210-006A	9/29/2011	**280**	--	--	--	**17**	--	1.9	--
	1.0	1109210-007A	9/29/2011	**110**	--	--	--	**6.4**	--	2.4	--
	1.5	1109210-008A	9/29/2011	60	--	--	--	0.88	--	--	--
S-04-A	0.5	1109210-012A	9/29/2011	**120**	--	--	--	4.3	--	--	--
	1.0	1109210-013A	9/29/2011	84	--	--	--	1.1	--	--	--
	3.0	1109210-016A	9/29/2011	7.7	--	60	<0.10	--	--	--	--
S-05-B	0.5	1110099-006A	10/13/2011	**140**	--	--	--	2.8	--	--	--
S-05-C	0.5	1110099-001A	10/13/2011	**130**	--	--	--	**5.6**	--	0.034	--
	1.0	1110099-002A	10/13/2011	90	--	--	--	3.4	--	--	--
S-06-A	0.5	1110098-021A	10/13/2011	84	--	--	--	2.6	--	--	--
S-06-B	0.5	1110098-016A	10/13/2011	**130**	--	--	--	**5.4**	--	0.45	--
	1.0	1110098-017A	10/13/2011	76	--	--	--	2.5	--	--	--
	2.0	1110098-019A	10/13/2011	60	--	--	--	1.9	--	--	--
S-07-A	0.5	1111097-001A	11/15/2011	60	--	--	--	NE*	--	2.3	--
	1.0	1111097-002A	11/15/2011	**320**	--	--	--	**29**	--	**26**	--
	1.5	1111097-003A	11/15/2011	**310**	--	--	--	**16**	--	NE*	--
	3.0	1111097-005A	11/15/2011	--	--	**110**	<0.005	--	--	--	--
S-09-A	0.5	1110079-004A	10/12/2011	73	--	--	--	**5.7**	--	0.52	--
	1.0	1110079-005A	10/12/2011	**180**	--	--	--	**6.9**	--	1.5	--
S-10-B	2.0	1110077-020A	10/12/2011	95	--	--	--	1.5	--	--	--
	3.0	1110078-001A	10/12/2011	10	230	**120**	<0.10	--	--	--	4
	6.0	1110078-002A	10/12/2011	9.0	--	**110**	<0.10	--	--	--	--
S-10-B DUP	3.0	1110078-007A	10/12/2011	12	230	**130**	<0.10	--	--	--	3.7
	6.0	1110078-008A	10/12/2011	--	210	**130**	<0.10	--	--	--	3.8

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Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Lead (Total)	Nickel (Total)	Chromium (Total)	Chromium VI	Lead (STLC)	Lead (TCLP)	Lead (Di-STLC)	Nickel (STLC)
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/L	mg/L	mg/L	mg/L
		STLC		50	200	50	5.0	5.0	NE	5.0	20
		TCLP		100	NE	100	5.0	NE	5.0	NE	NE
S-14-A	0.5	1110075-001A	10/12/2011	63	--	--	--	2.6	--	--	--
	1.0	1110075-002A	10/12/2011	96	--	--	--	4.8	--	--	--
	1.5	1110075-003A	10/12/2011	82	--	--	--	2.7	--	--	--
	3.0	1110075-005A	10/12/2011	**180**	--	--	--	1.6	--	--	--
S-14-B	0.5	1110075-007A	10/12/2011	54	--	--	--	4.1	--	--	--
	1.0	1110075-008A	10/12/2011	**140**	--	--	--	**8.8**	--	1.2	--
	1.5	1110075-009A	10/12/2011	**110**	--	--	--	**6.2**	--	1.2	--
	2.0	1110075-010A	10/12/2011	**150**	--	--	--	**7.1**	--	0.98	--
	3.0	1110075-011A	10/12/2011	**180**	--	--	--	**15**	--	1.5	--
S-23-A	0.5	1111097-009A	11/15/2011	**550**	--	--	--	**34**	--	**9.6**	--
	1.0	1111097-010A	11/15/2011	**880**	--	--	--	**14**	0.33	**34**	--
	1.5	1111097-011A	11/15/2011	**260**	--	--	--	**22**	0.43	**13**	--
Stage 3											
S-11-A	0.5	1110076-005A	10/12/2011	**200**	--	--	--	**6.3**	--	0.64	--
	1.0	1110076-006A	10/12/2011	**450**	--	--	--	4.3	<0.10	--	--
	1.5	1110076-007A	10/12/2011	77	--	--	--	0.98	--	--	--
	2.0	1110076-008A	10/12/2011	75	--	--	--	0.4	--	--	--
S-11-B	0.5	1110076-010A	10/12/2011	**130**	--	--	--	**6.8**	--	0.25	--
	1.0	1110076-011A	10/12/2011	63	--	--	--	2.9	--	--	--
S-13-A	0.5	1110077-001A	10/12/2011	**1,800**	--	--	--	**75**	0.86	**7.9**	--
	1.0	1110077-002A	10/12/2011	**430**	--	--	--	**20**	0.61	**11**	--
S-13-A DUP	0.5	1110077-006A	10/12/2011	**270**	--	--	--	**11**	--	3.2	--
	1.0	1110077-007A	10/12/2011	**400**	--	--	--	**20**	1.0	**29**	--
S-15-A	0.5	1109210-040A	9/30/2011	**510**	--	--	--	**37**	0.34	3.5	--
	1.0	1109207-001A	9/30/2011	**530**	--	--	--	**100**	0.74	NE*	--
	1.5	1109207-002A	9/30/2011	**160**	--	--	--	**5.6**	--	0.079	--
S-15-A DUP	0.5	1109207-025A	9/30/2011	**690**	--	--	--	**36**	0.15	NE*	--
	1.0	1109207-026A	9/30/2011	**1,900**	--	--	--	**56**	0.59	**8.3**	--
S-15-B	0.5	1109207-005A	9/30/2011	**390**	--	--	--	**18**	0.14	3.1	--
	1.0	1109207-006A	9/30/2011	**380**	--	--	--	**15**	0.59	**21**	--
	1.5	1109207-007A	9/30/2011	**880**	--	--	--	**29**	0.98	0.98	--
	2.0	1109207-008A	9/30/2011	72	--	--	--	3.0	--	--	--
S-15-C	0.5	1109207-010A	9/30/2011	**430**	--	--	--	**22**	<0.10	1.5	--
	1.0	1109207-011A	9/30/2011	**480**	--	--	--	**120**	1.4	**7.5**	--
S-16-A	0.5	1110076-015A	10/12/2011	**270**	--	--	--	**16**	--	2.6	--
S-17-A	0.5	1110077-011A	10/12/2011	91	--	--	--	3.1	--	--	--
	1.0	1110077-012A	10/12/2011	**260**	--	--	--	**16**	--	**8.5**	--
	1.5	1110077-013A	10/12/2011	**150**	--	--	--	3.4	--	--	--
S-18-A	0.5	1110078-009A	10/12/2011	**150**	--	--	--	**5.0**	--	0.35	--
S-19-B	0.5	1110079-019A	10/12/2011	**570**	--	--	--	0.57	0.18	--	--
	1.0	1110079-020A	10/12/2011	**290**	--	--	--	**14**	--	2.5	--
	1.5	1110079-021A	10/12/2011	**100**	--	--	--	**5.8**	--	0.77	--
S-20-A	0.5	1110078-019A	10/12/2011	**150**	--	--	--	**7.9**	--	1.2	--
	1.0	1110078-020A	10/12/2011	**110**	--	72	<0.10	**9.0**	--	1.2	--
	1.5	1110079-001A	10/12/2011	**280**	--	--	--	**16**	--	1.8	--
	2.0	1110079-002A	10/12/2011	**230**	--	--	--	**7.2**	--	0.88	--
	3.0	1110079-003A	10/12/2011	58	--	--	--	1.5	--	--	--

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Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Lead (Total)	Nickel (Total)	Chromium (Total)	Chromium VI	Lead (STLC)	Lead (TCLP)	Lead (Di-STLC)	Nickel (STLC)
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/L	mg/L	mg/L	mg/L
		STLC		50	200	50	5.0	5.0	NE	5.0	20
		TCLP		100	NE	100	5.0	NE	5.0	NE	NE
S-20-B	0.5	1110079-009A	10/12/2011	**210**	--	--	--	**12**	--	2.2	--
	1.0	1110079-010A	10/12/2011	**210**	--	--	--	**12**	--	0.91	--
	1.5	1110079-011A	10/12/2011	**280**	--	--	--	**11**	--	1.1	--
S-20-C	0.5	1110079-014A	10/12/2011	**350**	--	--	--	**16**	0.11	4.5	--
	1.0	1110079-015A	10/12/2011	**390**	--	--	--	**15**	0.16	3.7	--
	1.5	1110079-016A	10/12/2011	**370**	--	--	--	**27**	--	2.6	--
	2.0	1110079-017A	10/12/2011	**370**	--	--	--	**18**	--	1.2	--
S-21-A	0.5	1109207-015A	9/30/2011	**170**	--	--	--	**7.9**	--	0.46	--
	1.0	1109207-016A	9/30/2011	**380**	--	--	--	**15**	0.13	1.7	--
	1.5	1109207-017A	9/30/2011	**110**	--	--	--	2.6	--	--	--
	2.0	1109207-018A	9/30/2011	**100**	--	--	--	2.7	--	--	--
S-22-A	0.5	1110079-025A	10/12/2011	**290**	--	--	--	**7.6**	--	1.3	--
	1.0	1110079-026A	10/12/2011	**290**	--	--	--	**12**	--	<0.010	--
	1.5	1110079-027A	10/12/2011	**280**	--	--	--	**18**	--	**6**	--
	2.0	1110079-028A	10/12/2011	12	--	69	<0.10	--	--	--	--
N-05-A	0.5	1111145-022A	11/18/2011	**130**	--	--	--	**8.7**	--	**7.4**	--
	1.0	1111145-023A	11/18/2011	**480**	--	--	--	**24**	--	**6.7**	--
	1.5	1111145-024A	11/18/2011	**110**	--	--	--	**5.5**	--	2.3	--
	2.0	1111145-025A	11/18/2011	**120**	--	62	<0.10	3.9	--	--	--
	3.0	1111145-026A	11/18/2011	95	--	--	--	3.4	--	--	--
N-11-A	0.5	1110100-016A	10/13/2011	61	--	--	--	3.2	--	--	--
	1.0	1110100-017A	10/13/2011	**130**	--	--	--	3.4	--	--	--
	1.5	1110100-018A	10/13/2011	53	--	--	--	3.5	--	--	--
N-12-A	0.5	1110100-001A	10/13/2011	**130**	--	--	--	**6.9**	--	0.97	--
	1.0	1110100-002A	10/13/2011	**110**	--	--	--	**8.9**	--	0.46	--
	2.0	1110100-004A	10/13/2011	69	--	--	--	0.76	--	--	--
N-15-A	0.5	1110100-006A	10/13/2011	**490**	--	--	--	**24**	0.11	NE*	--
	1.0	1110100-007A	10/13/2011	**140**	--	--	--	**5.5**	--	0.79	--
N-22-B	0.5	1111147-025A	11/18/2011	**1,600**	--	--	--	**100**	0.96	**65**	--
	1.0	1111147-026A	11/18/2011	**350**	--	--	--	**24**	--	**13**	--
	1.5	1111147-027A	11/18/2011	65	--	--	--	3.5	--	--	--
	2.0	1111147-028A	11/18/2011	80	--	--	--	4.1	--	--	--
N-22-C	0.5	1111147-030A	11/18/2011	**770**	--	--	--	**50**	1.1	**23**	--
	1.5	1111147-032A	11/18/2011	58	--	--	--	0.36	--	--	--
	3.0	1111147-034A	11/18/2011	66	--	--	--	0.99	--	--	--
Stage 4											
S-10-A	0.5	1110075-019A	10/12/2011	**160**	--	--	--	**7.7**	--	1.9	--
	1.0	1110075-020A	10/12/2011	**320**	--	--	--	**23**	--	0.48	--
	1.5	1110076-001A	10/12/2011	**360**	--	--	--	NE*	**36**	**130**	--
	2.0	1110076-002A	10/12/2011	**210**	--	--	--	**12**	--	0.31	--
N-04-A	0.5	1111145-037A	11/18/2011	**190**	--	--	--	4	--	--	--
	1.0	1111145-038A	11/18/2011	**120**	--	--	--	**5.2**	--	1.4	--
N-10-A	1.0	1111145-018A	11/18/2011	79	--	--	--	1.9	--	--	--
	1.5	1111145-019A	11/18/2011	52	--	--	--	3.1	--	--	--
	3.0	1111145-021A	11/18/2011	26	--	67	<0.10	--	--	--	--
N-14-A	0.5	1111145-011A	11/18/2011	**140**	--	--	--	**5.4**	--	0.17	--
	1.0	1111145-012A	11/18/2011	**150**	--	--	--	3.6	--	--	--

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Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Lead (Total)	Nickel (Total)	Chromium (Total)	Chromium VI	Lead (STLC)	Lead (TCLP)	Lead (Di-STLC)	Nickel (STLC)
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/L	mg/L	mg/L	mg/L
		STLC		50	200	50	5.0	5.0	NE	5.0	20
		TCLP		100	NE	100	5.0	NE	5.0	NE	NE
N-19-A	0.5	1111145-006A	11/18/2011	75	--	--	--	2.0	--	--	--
	1.0	1111145-007A	11/18/2011	66	--	--	--	1.9	--	--	--
N-20-A	0.5	1111145-001A	11/18/2011	57	--	--	--	2.2	--	--	--
	1.0	1111145-002A	11/18/2011	**130**	--	--	--	**18**	--	2.2	--
	1.5	1111145-003A	11/18/2011	**150**	--	--	--	**15**	--	3.9	--
	2.0	1111145-004A	11/18/2011	**230**	--	--	--	**12**	--	**6.2**	--
	3.0	1111145-005A	11/18/2011	**340**	--	--	--	**42**	--	**13**	--
Stage 5											
N-13-A	0.5	1110098-004A	10/13/2011	**140**	--	--	--	**6.0**	--	1.4	--
	2.0	1110098-007A	10/13/2011	11	--	87	<0.10	--	--	--	--
N-16-A	0.5	1110097-009A	10/13/2011	64	--	--	--	2.7	--	--	--
	1.0	1110097-010A	10/13/2011	**420**	--	--	--	**25**	0.76	**8.3**	--
	1.5	1110097-011A	10/13/2011	**370**	--	--	--	**14**	0.10	NE*	--
N-16-A DUP	0.5	1110097-014A	10/13/2011	**190**	--	--	--	**5.2**	--	0.44	--
	1.0	1110097-015A	10/13/2011	**190**	--	--	--	**26**	--	**6.2**	--
	1.5	1110097-016A	10/13/2011	75	--	--	--	3.8	--	--	--
	2.0	1110097-017A	10/13/2011	**420**	--	--	--	**17**	0.13	NE*	--
N-21-A	0.5	1111147-035A	11/18/2011	52	--	--	--	2.5	--	--	--
	1.0	1111147-036A	11/18/2011	**200**	--	--	--	**8.1**	--	0.31	--
	1.5	1111147-037A	11/18/2011	**150**	--	--	--	**8.5**	--	0.047	--
	2.0	1111147-038A	11/18/2011	52	--	--	--	3.1	--	--	--
	3.0	1111147-039A	11/18/2011	**1,100**	--	--	--	**29**	<0.10	0.31	--
	6.0	1111147-040A	11/18/2011	**560**	--	--	--	**37**	<0.10	0.76	--
N-21-A DUP	0.5	1111147-041A	11/18/2011	69	--	--	--	3.4	--	--	--
	1.0	1111147-042A	11/18/2011	**240**	--	--	--	**7.6**	--	0.32	--
	1.5	1111147-043A	11/18/2011	**190**	--	--	--	**8.9**	--	0.48	--
	2.0	1111147-044A	11/18/2011	**120**	--	--	--	**5.5**	--	1.1	--
	3.0	1111147-045A	11/18/2011	**1,700**	--	--	--	--*	0.24	1.1	--
	6.0	1111147-046A	11/18/2011	**1,100**	--	--	--	**58**	0.14	**10**	--
N-22-A	0.5	1111147-020A	11/18/2011	**820**	--	--	--	**150**	1.9	**24**	--
	1.0	1111147-021A	11/18/2011	**470**	--	--	--	**25**	--	**21**	--
	1.5	1111147-022A	11/18/2011	78	--	--	--	4.0	--	--	--
N-23-A	0.5	1111147-010A	11/18/2011	**370**	--	--	--	**24**	--	2.5	--
	1.0	1111147-011A	11/18/2011	**330**	--	--	--	**21**	--	1.0	--
	1.5	1111147-012A	11/18/2011	**1,600**	--	--	--	**48**	1.3	**18**	--
	2.0	1111147-013A	11/18/2011	**1,700**	--	--	--	**110**	**7.1**	**44**	--
	3.0	1111147-014A	11/18/2011	**700**	--	--	--	**44**	1.3	**16**	--
N-23-B	0.5	1111147-015A	11/18/2011	89	--	--	--	**5.0**	--	0.58	--
	2.0	1111147-018A	11/18/2011	89	--	--	--	2.4	--	--	--
	3.0	1111147-019A	11/18/2011	70	--	--	--	1.6	--	--	--
N-24-A	0.5	1111146-040A	11/18/2011	**140**	--	--	--	**27**	--	**9.4**	--
	1.0	1111147-001A	11/18/2011	**210**	--	--	--	**51**	--	**10**	--
	1.5	1111147-002A	11/18/2011	**230**	--	--	--	**6.9**	--	1.6	--
	2.0	1111147-003A	11/18/2011	**190**	--	--	--	**8.5**	--	1.1	--
	3.0	1111147-004A	11/18/2011	**150**	--	--	--	3.2	--	--	--

Table 3
Leachate Speciation Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	Lead (Total)	Nickel (Total)	Chromium (Total)	Chromium VI	Lead (STLC)	Lead (TCLP)	Lead (Di-STLC)	Nickel (STLC)
		EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B
		Units		mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/L	mg/L	mg/L	mg/L
		STLC		50	200	50	5.0	5.0	NE	5.0	20
		TCLP		100	NE	100	5.0	NE	5.0	NE	NE
N-24-B	0.5	1111147-005A	11/18/2011	**220**	--	--	--	**8.8**	--	3.2	--
	1.0	1111147-006A	11/18/2011	**330**	--	--	--	**9.4**	--	1.4	--
	1.5	1111147-007A	11/18/2011	**320**	--	--	--	4.3	--	--	--
	2.0	1111147-008A	11/18/2011	**140**	--	--	--	2.2	--	--	--
	3.0	1111147-009A	11/18/2011	**150**	--	--	--	3.7	--	--	--

Notes:
EPA = US Environmental Protection Agency
mg/L = milligrams per liter
mg/Kg = milligrams per kilogram
STLC = Soluble Threshold Limits Concentrations
TCLP = Toxicity Characteristic Leaching Procedure
NE = Not Established
-- = sample not analyzed for specified analyte (or in case of total lead, chromium and nickel, the result was less than the STLC criteria).
--* Sample was not analysed for specified analyte due to laboratory error
NE* Due to insufficient sample mass available, no extraction was performed on requested sample.
Bold indicates value exceeds TCLP criteria (or STLC/DI-STLC criteria, if TCLP not applicable)
The symbol "<" (less than) indicates that the analyte was not detected at a concentration above the laboratory detection limit specified.

Table 4
Other COPCs - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Sample Depth (feet)	Lab Sample ID	Sample Date	5 Gas Oxygenates	BTEX	Other VOCs	TPH as Gasoline	TPH as Diesel	TPS as Motor Oil	4,4' DDT	Other Pesticides	Aroclor 1260	Other PCBs	Asbestos
		EPA Method		8260B	8260B	8260B	8260TPH	8015B(M)	8015B(M)	8081A	8081A	SW8082	SW8082	600/R-93/116
		ESLs - Direct Exposure		varies	varies	varies	4,200,000	4,200	12,000	87,000	varies	6.7	6.7	NE
		ESLs - Residential		varies	varies	varies	83,000	83,000	370,000	1,700	varies	0.22	0.22	NE
		ESLs - Comm/Ind		varies	varies	varies	83,000	83,000	2,500,000	4,000	varies	0.74	0.74	NE
		Units		ug/Kg	ug/Kg	ug/Kg	ug/Kg	mg/Kg	mg/Kg	ug/Kg	ug/Kg	mg/Kg	mg/Kg	NE
Stage 1														
S-12-A	1.00	1109210-033A	9/30/2011	ND	ND	--	<100	<12	110	--		--		ND
S-19-A	1.00	1110078-015A	10/12/2011	--	--	--	--	--	--	--		--		ND
S-19-A	3.00	1110078-018A	10/12/2011	ND	ND	--	<100	<2.0	<4.0	--		--		ND
N-01-A	0.50	1111146-025A	11/18/2011	--	--	--	--	--	--	<80	ND	0.12	ND	--
N-01-A (Dup)	0.50	1111146-030A	11/18/2011	--	--	--	--	--	--	<80	ND	0.11	ND	--
N-01-B	3.00	1111146-039A	11/18/2011	--	--	--	--	--	--	--		--		ND
N-03-A	1.00	1111146-008A	11/18/2011	ND	ND	--	<100	<120	3,400	--		--		--
N-17-A	1.00	1110097-002A	10/13/2011	ND	ND		<100	--	--	--		--		--
Stage 2														
S-01-B	3.00	1109170-005A	9/27/2011	ND	ND	--	<100	<2.0	<4.0	--		--		--
S-02-A	0.50	1109170-007A	9/27/2011	--	--	--	--	--	--			--		ND
S-03-B	3.00	1109210-010A	9/30/2011	--	--	--	--	--	--	--		<0.10	ND	--
S-03-B	6.00	1109210-011A	9/30/2011	--	--	--	--	--	--	--		<0.10	ND	--
S-04-A	3.00	1109210-016A	9/30/2011	ND	ND	ND	--	--	--	--		--		ND
S-07-A	1.00	1111097-002A	11/15/2011	ND	ND	ND	100	17	530	--		--		--
S-07-A	3.00	1111097-005A	11/15/2011	ND	ND	ND	<100	<2.0	4.4	--		--		ND
S-10-B	3.00	1110078-001A	10/12/2011	--	--	--	--	--	--	--		--		ND
S-10-B (Duplicate)	3.00	1110078-007A	10/12/2011	--	--	--	--	--	--	--		--		ND
S-23-A	1.00	1111097-010A	11/15/2011	--	--	--	--	--	--	--		--		ND
Stage 3														
S-13-A	1.00	1110077-002A	10/12/2011	ND	ND	--	<100	<2.0	43	--		--		--
S-13-A (Duplicate)	1.00	1110077-007A	10/12/2011	ND	ND	--	<100	2.1	40	--		--		--
S-15-A	0.50	1109210-040A	9/30/2011	--	--	--	--	--	--	9.4	ND	<0.10	ND	--
S-15-A	1.00	1109207-001A	9/30/2011	ND	ND	ND	<100	<12	310	--		--		--
S-15-A (Duplicate)	0.50	1109207-025A	9/30/2011	--	--	--	--	--	--	15	ND	<0.10	ND	--
S-15-B	0.50	1109207-005A	9/30/2011	--	--	--	--	--	--	6.7	ND	<0.10	ND	--
S-15-C	0.50	1109207-010A	9/30/2011	--	--	--	--	--	--	9.7	ND	<0.10	ND	--
S-16-A	2.00	1110076-018A	10/12/2011	--	--	--	--	--	--	--		--		ND
S-17-A	1.00	1110077-012A	10/12/2011	ND	ND	--	<100	<2.0	34	--		--		--
S-20-A	1.00	1110078-020a	10/12/2011	--	--	--	--	--	--	--		--		ND
S-20-A	3.00	1110079-003A	10/12/2011	ND	ND	--	<100	<2.0	5.5	<2.0	ND	<0.10	ND	--
Stage 4														
N-04-A	2.00	1111145-040A	11/18/2011	--	--	--	--	--	--	--		--		ND
N-19-A	3.00	1111145-010A	11/18/2011	ND	ND		<100	<2.0	13	--		--		ND
N-20-A	1.00	1111145-002A	11/18/2011	--	--	--	--	--	--	--		--		ND
N-20-A	3.00	1111145-005A	11/18/2011	ND	ND	ND	<100	3.5	8.2	<2.0	ND	<0.10	ND	--
Stage 5														
N-22-A	3.00	1111147-024A	11/18/2011	--	--	--	--	--	--	--		--		ND
N-24-A	1.00	1111147-001A	11/18/2011	ND	ND	--	<100	<2.0	49	--		--		--

EPA = US Environmental Protection Agency
ESL - Direct Exposure = RWQCB Direct Exposure Soil Screening Levels for Construction/Trench Workers (Table K-3)
ESL - Residential = RWCQB Environmental Screening Levels for shallow soils where groundwater is a current or potential source of drinking water (Table A) for residential land use
ESL - Comm/Ind = RWCQB Environmental Screening Levels for shallow soils where groundwater is a current or potential source of drinking water (Table A) for commercial or industrial land use only
mg/Kg = milligrams per kilogram
ug/Kg = micrograms per kilogram
-- = sample not analyzed for specified analyte
The symbol "<" (less than) indicates that the analyte was not detected at a concentration above the laboratory detection limit specified.
* Asbestos samples with detections above reporting limits were further tested using EPA Method 600/R-93/116 with CARB 435 Prep (Milling) Level A for 0.25% Target Analyte Sensitivity
Yellow highlighting indicates value exceeds ESL.
ND = Not Detected; detection limits vary.

Table 5
Groundwater Metals - Hazardous Material Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
	EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B
	Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	ESL		0.006	0.036	1	0.00053	0.00025	0.05	0.003	0.0031	0.0025	0.000025	0.035	0.0082	0.005	0.00019	0.002	0.015	0.081
	Burlingame Municipal Code-Sanitary Sewer Limits		NE	0.08	NE	NE	0.138	2.532	NE	2	0.365	0.01	NE	0.445	0.106	0.2	NE	NE	0.386
Stage 1																			
N-03-A-GW	Groundwater encountered but not collected due to insufficient recharge.																		
N-17-A GW	1110096-009A	10/13/2011	0.011	0.023	0.61	<0.005	0.0054	0.16	0.038	0.18	**0.38**	0.00031	0.015	0.18	<0.020	<0.005	<0.010	0.088	**1.9**
S-08-A-GW	Groundwater encountered but not collected due to insufficient recharge.																		
Stage 2																			
S-01-B-GW	Groundwater not encountered within first 6 feet of drilling.																		
S-04-A-GW	Groundwater encountered but not collected due to insufficient recharge.																		
S-07-A-GW	1111097-008A	11/15/2011	0.021	0.077	2.5	<0.005	0.0082	0.58	0.16	0.30	0.29	0.00055	<0.010	**0.67**	0.020	<0.005	<0.010	0.50	**1.8**
Stage 3																			
S-19-B-GW	Groundwater not encountered within first 6 feet of drilling.																		
Stage 4																			
N-20-A-GW	Groundwater not encountered within first 3 feet of drilling.																		

Notes:
EPA = US Environmental Protection Agency
mg/L = milligrams per Liter
ESL = RWQCB Groundwater Screening Levels where groundwater is a drinking water source (Table F-1a)
NE = Not Established
-- = sample not analyzed for specified analyte
Bold indicates value exceeds Burlingame Municipal Code Sanitary Sewer Limits
Yellow highlighting indicates value exceeds ESL.
The symbol "<" (less than) indicates that the analyte was not detected at a concentration above the laboratory detection limit specified.

Table 6
Groundwater Other COPCs - Hazardous Materials Investigation
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Boring Sample Location ID	Lab Sample ID	Sample Date	MTBE	Tert-Butanol	Diisopropyl ether (DIPE)	TAME	ETBE	Chloroform	Benzene	Toluene	Ethyl Benzene	m,p-Xylene	o-Xylene	n-Butylbenzene	1,2,4-Trimethylbenzene	n-Propylbenzene	isopropyl benzene	Other VOCs	TPH as Gasoline	TPH as Diesel	TPH as Motor Oil
	EPA Method		8260B (TPH)	8015B	8015B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260TPH	SW8015B(M)	SW8015B(M)
	Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L
	ESL		5	NE	NE	NE	NE	70	1	40	30	20	20	NE	NE	NE	NE	varies	100	0.1	0.1
	Burlingame Municipal Code-Sanitary Sewer Limits		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	10 mg/L (aggregate TPH)		
Stage 1																					
N-03-A-GW	Groundwater encountered but not collected due to insufficient recharge.																				
N-17-A GW	11100096-009A	10/13/2011	<0.50	<5.0	<0.50	<0.50	<0.50	0.60	<0.50	<0.50	<0.50	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	ND	<50	<0.11	0.35
S-08-A-GW	Groundwater encountered but not collected due to insufficient recharge.																				
Stage 2																					
S-01-B-GW	Groundwater not encountered within first 6 feet of drilling.																				
S-04-A-GW	Groundwater encountered but not collected due to insufficient recharge.																				
S-07-A-GW	1111097-008A	11/15/2011	380	<44	<4.4	<4.4	<4.4	<4.4	110	24	<4.4	29	10	60	8.8	5.0	27	ND	**14,000**	2.0	<0.40
Stage 3																					
Stage 4																					
N-20-A-GW	Groundwater not encountered within first 3 feet of drilling.																				
Stage 5																					
S-19-B-GW	Groundwater not encountered within first 6 feet of drilling.																				

Notes:
EPA = US Environmental Protection Agency
ESL = Regional Water Quality Control Board Environmental Screening Limits for Groundwater that is a current or potential drinking water resource (Table F-1a).
mg/L = milligrams per liter
ug/L = micrograms per liter
NE = Not Established
ND = Not detected. See analytical report for reporting limits.
-- = sample not analyzed for specified analyte
Bold indicates value exceeds Burlingame Municipal Code Sanitary Sewer Limits
Yellow highlighting indicates value exceeds ESL.
[1] Sample chromatogram does not resemble typical diesel or motor oil pattern (discrete peaks present). Hydrocarbons and hydrocarbon peaks within the diesel range quantitated as diesel; hydrocarbon peaks within the motor oil range quantitated as motor oil.
The symbol "<" (less than) indicates that the analyte was not detected at a concentration above the laboratory detection limit specified.

Table 7
US-101 Broadway Project: Summary Statistics and 95% UCL Results - Roadway Construction
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

				Summary Statistics - Raw Data				Detected and Nondetect Values			Summary Statistics - Data Included Predicted Values from Regression			Goodness-of-Fit Test	Upper Confidence Limit (UCL)	
Parameter	Unit	Construction Stage	Depth Group	No. of Samples	Detection Rate	Mean	Std Dev	Min Detected	Max Detected	Reporting Limit of NDs	No. of Samples	Mean	Std Dev	Distribution	Method of UCL Calculation	Assessed 95% UCL
Lead (Total)	mg/kg	1	(1) 0 - 1.5 ft bgs	61	100%	289	446	2.7	2600	-	61	289	446	Gamma	95% Approximate Gamma UCL	387
Lead (Total)	mg/kg	1	(2) > 1.5 ft bgs	28	100%	39.5	88.7	2.2	460	-	28	39.5	88.7	Non-parametric	95% Chebyshev (Mean, Sd) UCL	113
Lead (Total)	mg/kg	1	(4) All Depths	89	100%	210	389	2.2	2600	-	89	210	389	Lognormal	95% H-UCL	491
Lead (Total)	mg/kg	2	(1) 0 - 1.5 ft bgs	38	100%	152	182	4	880	-	38	152	182	Gamma	95% Approximate Gamma UCL	207
Lead (Total)	mg/kg	2	(2) > 1.5 ft bgs	18	100%	38.1	61.7	2.6	180	-	18	38.1	61.7	Non-parametric	95% Chebyshev (Mean, Sd) UCL	101
Lead (Total)	mg/kg	2	(3) > 3 ft bgs	2	100%	-	-	2.6	3.2	-	2	-	-	-	-	-
Lead (Total)	mg/kg	2	(4) All Depths	56	100%	116	162	2.6	880	-	56	116	162	Gamma	95% Approximate Gamma UCL	156
Lead (Total)	mg/kg	3	(1) 0 - 1.5 ft bgs	56	100%	293	297	12	1600	-	56	293	297	Gamma	95% Approximate Gamma UCL	363
Lead (Total)	mg/kg	3	(2) > 1.5 ft bgs	29	100%	49.9	79.2	2.9	370	-	29	49.9	79.2	Lognormal	95% H-UCL	103
Lead (Total)	mg/kg	3	(3) > 3 ft bgs	1	100%	-	-	7.6	7.6	-	1	-	-	-	-	-
Lead (Total)	mg/kg	3	(4) All Depths	85	100%	210	271	2.9	1600	-	85	210	271	Gamma	95% Approximate Gamma UCL	264
Lead (Total)	mg/kg	4	(1) 0 - 1.5 ft bgs	17	100%	103	80	4	320	-	17	103	80	Normal	95% Student's-t UCL	137
Lead (Total)	mg/kg	4	(2) > 1.5 ft bgs	10	100%	67.5	117.9	3.1	340	-	10	67.5	117.9	Lognormal	99% Chebyshev (Mean, Sd) UCL	439
Lead (Total)	mg/kg	4	(4) All Depths	27	100%	90.1	95.2	3.1	340	-	27	90.1	95.2	Gamma	95% Approximate Gamma UCL	137
Lead (Total)	mg/kg	5	(1) 0 - 1.5 ft bgs	27	100%	243	325	6.2	1600	-	27	243	325	Gamma	95% Approximate Gamma UCL	369
Lead (Total)	mg/kg	5	(2) > 1.5 ft bgs	19	100%	309	494	4.6	1700	-	19	309	494	Gamma	95% Approximate Gamma UCL	591
Lead (Total)	mg/kg	5	(3) > 3 ft bgs	1	100%	-	-	830	830	-	1	-	-	-	-	-
Lead (Total)	mg/kg	5	(4) All Depths	46	100%	271	400	4.6	1700	-	46	271	400	Gamma	95% Approximate Gamma UCL	379
Lead (Total)	mg/kg	All	(1) 0 - 1.5 ft bgs	199	100%	242	332	2.7	2600	-	199	242	332	Non-parametric	95% Chebyshev (Mean, Sd) UCL	344
Lead (Total)	mg/kg	All	(2) > 1.5 ft bgs	104	100%	94.1	242.4	2.2	1700	-	104	94.1	242.4	Non-parametric	95% Chebyshev (Mean, Sd) UCL	198
Lead (Total)	mg/kg	All	(3) > 3 ft bgs	4	100%	-	-	2.6	830	-	4	-	-	-	-	-
Lead (Total)	mg/kg	All	(4) All Depths	303	100%	191	312	2.2	2600	-	303	191	312	Non-parametric	95% Chebyshev (Mean, Sd) UCL	269
Lead (Di-STLC)	mg/L	1	(1) 0 - 1.5 ft bgs	31	100%	10.7	19.4	0.023	93	-	61	5.73	14.66	Lognormal	95% Chebyshev (Mean, Sd) UCL	13.9
Lead (Di-STLC)	mg/L	1	(2) > 1.5 ft bgs	2	50%	-	-	3.3	3.3	0.01	28	0.214	0.607	Non-parametric	97.5% KM (Chebyshev) UCL	0.945
Lead (Di-STLC)	mg/L	1	(4) All Depths	33	97%	10.2	18.6	0.023	93	0.01	89	3.99	12.31	Lognormal	97.5% KM (Chebyshev) UCL	12.2
Lead (Di-STLC)	mg/L	2	(1) 0 - 1.5 ft bgs	17	100%	5.88	9.81	0.034	34	-	38	2.86	7.02	Lognormal	95% Chebyshev (Mean, Sd) UCL	7.83
Lead (Di-STLC)	mg/L	2	(2) > 1.5 ft bgs	2	100%	-	-	0.98	1.5	-	18	0.250	0.453	Non-parametric	99% Chebyshev (Mean, Sd) UCL	1.31
Lead (Di-STLC)	mg/L	2	(3) > 3 ft bgs	0	-	-	-	-	-	-	2	-	-	-	-	-
Lead (Di-STLC)	mg/L	2	(4) All Depths	19	100%	5.39	9.37	0.034	34	-	56	2.02	5.90	Lognormal	95% H-UCL	5.35
Lead (Di-STLC)	mg/L	3	(1) 0 - 1.5 ft bgs	38	97%	6.17	11.22	0.25	65	0.01	56	4.45	9.58	Gamma	95% KM (Chebyshev) UCL	10.1
Lead (Di-STLC)	mg/L	3	(2) > 1.5 ft bgs	2	100%	-	-	0.88	1.2	-	29	0.236	0.304	Lognormal	95% H-UCL	0.561
Lead (Di-STLC)	mg/L	3	(3) > 3 ft bgs	0	-	-	-	-	-	-	1	-	-	-	-	-
Lead (Di-STLC)	mg/L	3	(4) All Depths	40	98%	5.92	10.99	0.25	65	0.01	85	3.01	8.03	Lognormal	97.5% KM (Chebyshev) UCL	8.48
Lead (Di-STLC)	mg/L	4	(1) 0 - 1.5 ft bgs	6	100%	1.68	1.35	0.17	3.9	-	17	0.850	1.023	Gamma	95% Approximate Gamma UCL	1.47
Lead (Di-STLC)	mg/L	4	(2) > 1.5 ft bgs	2	100%	-	-	6.2	13	-	10	1.97	4.33	Non-parametric	99% Chebyshev (Mean, Sd) UCL	15.6
Lead (Di-STLC)	mg/L	4	(4) All Depths	8	100%	3.66	4.25	0.17	13	-	27	1.27	2.73	Lognormal	95% Chebyshev (Mean, Sd) UCL	3.55
Lead (Di-STLC)	mg/L	5	(1) 0 - 1.5 ft bgs	16	100%	6.40	7.97	0.2635	24	-	27	3.98	6.76	Gamma	95% Adjusted Gamma UCL	7.39
Lead (Di-STLC)	mg/L	5	(2) > 1.5 ft bgs	6	100%	11.4	17.0	0.705	44	-	19	3.89	10.39	Lognormal	99% Chebyshev (Mean, Sd) UCL	27.6
Lead (Di-STLC)	mg/L	5	(3) > 3 ft bgs	1	100%	-	-	5.38	5.38	-	1	-	-	-	-	-
Lead (Di-STLC)	mg/L	5	(4) All Depths	22	100%	7.76	10.93	0.2635	44	-	46	3.94	8.34	Lognormal	95% Chebyshev (Mean, Sd) UCL	9.30
Lead (Di-STLC)	mg/L	All	(1) 0 - 1.5 ft bgs	108	99%	7.21	13.34	0.023	93	0.01	199	4.17	10.38	Lognormal	97.5% KM (Chebyshev) UCL	8.77
Lead (Di-STLC)	mg/L	All	(2) > 1.5 ft bgs	14	93%	6.86	11.30	0.705	44	0.01	104	1.07	4.74	Non-parametric	97.5% KM (Chebyshev) UCL	3.99
Lead (Di-STLC)	mg/L	All	(3) > 3 ft bgs	1	100%	-	-	5.38	5.38	-	4	-	-	-	-	-
Lead (Di-STLC)	mg/L	All	(4) All Depths	122	98%	7.16	13.12	0.023	93	0.01	303	3.10	8.98	Non-parametric	97.5% KM (Chebyshev) UCL	6.33

Table 7
US-101 Broadway Project: Summary Statistics and 95% UCL Results - Roadway Construction
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				Summary Statistics - Raw Data				Detected and Nondetect Values			Summary Statistics - Data Included Predicted Values from Regression			Goodness-of-Fit Test	Upper Confidence Limit (UCL)	
Parameter	Unit	Construction Stage	Depth Group	No. of Samples	Detection Rate	Mean	Std Dev	Min Detected	Max Detected	Reporting Limit of NDs	No. of Samples	Mean	Std Dev	Distribution	Method of UCL Calculation	Assessed 95% UCL
Lead (STLC)	mg/L	1	(1) 0 - 1.5 ft bgs	41	100%	19.3	29.4	1.6	150	-	61	13.2	25.5	Lognormal	95% H-UCL	26.8
Lead (STLC)	mg/L	1	(2) > 1.5 ft bgs	6	100%	5.57	7.05	1.4	19	-	28	1.49	3.74	Non-parametric	95% Chebyshev (Mean, Sd) UCL	4.58
Lead (STLC)	mg/L	1	(4) All Depths	47	100%	17.5	27.9	1.4	150	-	89	9.49	21.88	Lognormal	95% H-UCL	22.3
Lead (STLC)	mg/L	2	(1) 0 - 1.5 ft bgs	28	100%	9.51	9.04	1.1	34	-	38	7.23	8.65	Gamma	95% Approximate Gamma UCL	10.1
Lead (STLC)	mg/L	2	(2) > 1.5 ft bgs	3	100%	-	-	1.6	15	-	18	1.66	3.70	Lognormal	95% Chebyshev (Mean, Sd) UCL	5.46
Lead (STLC)	mg/L	2	(3) > 3 ft bgs	0	-	-	-	-	-	-	2	-	-	-	-	-
Lead (STLC)	mg/L	2	(4) All Depths	31	100%	9.35	8.77	1.1	34	-	56	5.44	7.84	Gamma	95% Approximate Gamma UCL	7.51
Lead (STLC)	mg/L	3	(1) 0 - 1.5 ft bgs	50	100%	17.9	23.6	0.36	120	-	56	16.1	22.9	Gamma	95% Approximate Gamma UCL	21.1
Lead (STLC)	mg/L	3	(2) > 1.5 ft bgs	9	100%	4.73	5.35	0.76	18	-	29	1.78	3.51	Lognormal	95% H-UCL	3.32
Lead (STLC)	mg/L	3	(3) > 3 ft bgs	0	-	-	-	-	-	-	1	-	-	-	-	-
Lead (STLC)	mg/L	3	(4) All Depths	59	100%	15.9	22.3	0.36	120	-	85	11.2	19.9	Gamma	95% Approximate Gamma UCL	14.7
Lead (STLC)	mg/L	4	(1) 0 - 1.5 ft bgs	13	100%	7.15	6.97	1.9	23	-	17	5.62	6.68	Gamma	95% Approximate Gamma UCL	9.60
Lead (STLC)	mg/L	4	(2) > 1.5 ft bgs	2	100%	-	-	12	42	-	10	5.77	13.24	Lognormal	99% Chebyshev (Mean, Sd) UCL	47.4
Lead (STLC)	mg/L	4	(4) All Depths	15	100%	9.80	11.07	1.9	42	-	27	5.67	9.39	Gamma	95% Approximate Gamma UCL	9.52
Lead (STLC)	mg/L	5	(1) 0 - 1.5 ft bgs	20	100%	22.4	33.2	2.95	150	-	27	16.8	30.0	Gamma	95% Approximate Gamma UCL	27.7
Lead (STLC)	mg/L	5	(2) > 1.5 ft bgs	12	100%	22.8	32.1	1.6	110	-	19	15.6	28.7	Lognormal	99% Chebyshev (Mean, Sd) UCL	81.1
Lead (STLC)	mg/L	5	(3) > 3 ft bgs	1	100%	-	-	47.5	47.5	-	1	-	-	-	-	-
Lead (STLC)	mg/L	5	(4) All Depths	32	100%	22.6	32.3	1.6	150	-	46	16.3	29.2	Lognormal	95% Chebyshev (Mean, Sd) UCL	35.0
Lead (STLC)	mg/L	All	(1) 0 - 1.5 ft bgs	152	100%	16.4	24.3	0.36	150	-	199	12.7	22.2	Non-parametric	95% Chebyshev (Mean, Sd) UCL	19.6
Lead (STLC)	mg/L	All	(2) > 1.5 ft bgs	32	100%	13.4	21.9	0.76	110	-	104	4.59	14.05	Non-parametric	95% Chebyshev (Mean, Sd) UCL	10.6
Lead (STLC)	mg/L	All	(3) > 3 ft bgs	1	100%	-	-	47.5	47.5	-	4	-	-	-	-	-
Lead (STLC)	mg/L	All	(4) All Depths	184	100%	15.9	23.9	0.36	150	-	303	9.92	20.16	Non-parametric	95% Chebyshev (Mean, Sd) UCL	15.0
Lead (TCLP)	mg/L	1	(1) 0 - 1.5 ft bgs	12	83%	2.43	4.15	0.1	15	0.1	61	0.425	1.231	Non-parametric	95% KM (BCA) UCL	0.716
Lead (TCLP)	mg/L	1	(2) > 1.5 ft bgs	0	-	-	-	-	-	-	28	-	-	-	-	-
Lead (TCLP)	mg/L	1	(4) All Depths	12	83%	2.43	4.15	0.1	15	0.1	89	0.325	1.030	Non-parametric	95% KM (BCA) UCL	0.520
Lead (TCLP)	mg/L	2	(1) 0 - 1.5 ft bgs	3	100%	-	-	0.29	0.43	-	38	0.135	0.075	Normal	95% KM (t) UCL	0.157
Lead (TCLP)	mg/L	2	(2) > 1.5 ft bgs	0	-	-	-	-	-	-	18	-	-	-	-	-
Lead (TCLP)	mg/L	2	(3) > 3 ft bgs	0	-	-	-	-	-	-	2	-	-	-	-	-
Lead (TCLP)	mg/L	2	(4) All Depths	3	100%	-	-	0.29	0.43	-	56	0.125	0.063	Normal	95% KM (t) UCL	0.140
Lead (TCLP)	mg/L	3	(1) 0 - 1.5 ft bgs	16	88%	0.480	0.418	0.11	1.4	0.1	56	0.223	0.265	Non-parametric	95% KM (t) UCL	0.283
Lead (TCLP)	mg/L	3	(2) > 1.5 ft bgs	0	-	-	-	-	-	-	29	0.134	0.014	Non-parametric	95% KM (t) UCL	0.140
Lead (TCLP)	mg/L	3	(3) > 3 ft bgs	0	-	-	-	-	-	-	1	-	-	-	-	-
Lead (TCLP)	mg/L	3	(4) All Depths	16	88%	0.480	0.418	0.11	1.4	0.1	85	0.186	0.221	Non-parametric	95% KM (t) UCL	0.226
Lead (TCLP)	mg/L	4	(1) 0 - 1.5 ft bgs	0	-	-	-	-	-	-	17	0.113	0.017	Non-parametric	95% KM (t) UCL	0.123
Lead (TCLP)	mg/L	4	(2) > 1.5 ft bgs	0	-	-	-	-	-	-	10	0.137	0.018	Non-parametric	95% KM (t) UCL	0.152
Lead (TCLP)	mg/L	4	(4) All Depths	0	-	-	-	-	-	-	27	0.115	0.020	Normal	95% KM (t) UCL	0.123
Lead (TCLP)	mg/L	5	(1) 0 - 1.5 ft bgs	4	100%	-	-	0.1	1.9	-	27	0.247	0.398	Non-parametric	95% KM (t) UCL	0.382
Lead (TCLP)	mg/L	5	(2) > 1.5 ft bgs	5	100%	1.75	3.03	0.095	7.1	-	19	0.544	1.568	Non-parametric	97.5% KM (Chebyshev) UCL	3.00
Lead (TCLP)	mg/L	5	(3) > 3 ft bgs	1	100%	-	-	0.095	0.095	-	1	-	-	-	-	-
Lead (TCLP)	mg/L	5	(4) All Depths	9	100%	1.43	2.23	0.095	7.1	-	46	0.367	1.063	Non-parametric	95% KM (BCA) UCL	0.688
Lead (TCLP)	mg/L	All	(1) 0 - 1.5 ft bgs	35	89%	1.20	2.62	0.1	15	0.1	199	0.259	0.722	Non-parametric	95% KM (t) UCL	0.344
Lead (TCLP)	mg/L	All	(2) > 1.5 ft bgs	5	100%	1.75	3.03	0.095	7.1	-	104	0.187	0.691	Non-parametric	95% KM (BCA) UCL	0.314
Lead (TCLP)	mg/L	All	(3) > 3 ft bgs	1	100%	-	-	0.095	0.095	-	4	-	-	-	-	-
Lead (TCLP)	mg/L	All	(4) All Depths	40	90%	1.27	2.64	0.095	15	0.1	303	0.234	0.713	Non-parametric	95% KM (t) UCL	0.301

Table 7
US-101 Broadway Project: Summary Statistics and 95% UCL Results - Roadway Construction
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				Summary Statistics - Raw Data				Detected and Nondetect Values			Summary Statistics - Data Included Predicted Values from Regression			Goodness-of-Fit Test	Upper Confidence Limit (UCL)	
Parameter	Unit	Construction Stage	Depth Group	No. of Samples	Detection Rate	Mean	Std Dev	Min Detected	Max Detected	Reporting Limit of NDs	No. of Samples	Mean	Std Dev	Distribution	Method of UCL Calculation	Assessed 95% UCL
Notes:																

(1) If duplicates exist, the average of the duplicate results is used as a single data point.
(2) All samples collected at various depths at the same location are considered independent data points.
(3) Goodness-of-Fit Test at 5% significance level is used to test for distributional assumption.
(4) The distributional assumption from (3) is used to select the appropriate UCL calculation method. For normal distribution, the UCL is based on the t-statistics. For lognormal distribution, gamma distribution, and non-parametric assumption, the UCL is based on the recommendations from USEPA (2002) and Singh (2010).
(5) References:
USEPA. 2002. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Report No. OSWER 9285.6-10.
Singh, A., R. Maichle, and N. Armbya. 2010a. ProUCL Version 4.1 User Guide. Office of Research and Development, U.S. Environmental Protection Agency, Report No. EPA/600/R-07/038.
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USEPA. 2011. ProUCL Version 4.1.01 (Software). Retrieved from http://www.epa.gov/osp/hstl/tsc/software.htm. July.
(6) Locations designated as CDSM and deeper than 1 ft bgs are excluded from UCL calculation.

Table 8
US-101 Broadway Project: Summary Statistics and 95% UCL Results - Retaining Wall Construction
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

				Summary Statistics - Raw Data				Detected and Nondetect Values			Summary Statistics - Data Included Predicted Values from Regression			Goodness-of-Fit Test	Upper Confidence Limit (UCL)	
Parameter	Unit	Retaining Wall	Depth Group	No. of Samples	Detection Rate	Mean	Std Dev	Min Detected	Max Detected	Reporting Limit of NDs	No. of Samples	Mean	Std Dev	Distribution	Method of UCL Calculation	Assessed 95% UCL
Lead (Total)	mg/kg	RW15	(1) 0 - 3 ft bgs	15	100%	98.3	115.4	7.3	360	-	15	98.28	115.4	Gamma	95% Approximate Gamma UCL	**178**
Lead (Total)	mg/kg	RW15	(2) All Depths	17	100%	88.8	111.2	7.3	360	-	17	88.84	111.2	Gamma	95% Approximate Gamma UCL	**155**
Lead (Total)	mg/kg	RW205	(1) 0 - 3 ft bgs	15	100%	65.9	71.2	6.7	280	-	15	65.87	71.21	Gamma	95% Approximate Gamma UCL	**111**
Lead (Total)	mg/kg	RW205	(2) All Depths	15	100%	65.9	71.2	6.7	280	-	15	65.87	71.21	Gamma	95% Approximate Gamma UCL	**111**
Lead (Total)	mg/kg	RW209	(1) 0 - 3 ft bgs	15	100%	215	262	3.3	830	-	15	215	262.4	Gamma	95% Approximate Gamma UCL	**463**
Lead (Total)	mg/kg	RW209	(2) All Depths	16	100%	202	259	3.3	830	-	16	202.1	258.8	Gamma	95% Adjusted Gamma UCL	**469**
Lead (Total)	mg/kg	RW314	(1) 0 - 3 ft bgs	5	100%	153	121	53	290	-	5	153.2	120.7	Gamma	95% Approximate Gamma UCL	**405**
Lead (Total)	mg/kg	RW314	(2) All Depths	8	100%	424	886	6.1	2600	-	8	424	886.2	Gamma	95% Adjusted Gamma UCL	**2393**
Lead (Total)	mg/kg	RW315	(1) 0 - 3 ft bgs	15	100%	306	372	3.1	1215	-	15	305.9	371.5	Gamma	95% Adjusted Gamma UCL	**774**
Lead (Total)	mg/kg	RW315	(2) All Depths	15	100%	306	372	3.1	1215	-	15	305.9	371.5	Gamma	95% Adjusted Gamma UCL	**774**
Lead (Total)	mg/kg	RW316	(1) 0 - 3 ft bgs	15	100%	113	130	7.6	450	-	15	113.3	129.8	Gamma	95% Approximate Gamma UCL	**207**
Lead (Total)	mg/kg	RW316	(2) All Depths	15	100%	113	130	7.6	450	-	15	113.3	129.8	Gamma	95% Approximate Gamma UCL	**207**
Lead (Total)	mg/kg	RW38/39	(1) 0 - 3 ft bgs	15	100%	100.0	130.6	3.4	440	-	15	99.97	130.6	Gamma	95% Approximate Gamma UCL	**203**
Lead (Total)	mg/kg	RW38/39	(2) All Depths	15	100%	100.0	130.6	3.4	440	-	15	99.97	130.6	Gamma	95% Approximate Gamma UCL	**203**
Lead (Di-STLC)	mg/L	RW15	(1) 0 - 3 ft bgs	3	100%	-	-	0.25	1.9	-	15	0.527	0.733	Gamma	95% Approximate Gamma UCL	**0.996**
Lead (Di-STLC)	mg/L	RW15	(2) All Depths	3	100%	-	-	0.25	1.9	-	17	0.476	0.701	Gamma	95% Approximate Gamma UCL	**0.862**
Lead (Di-STLC)	mg/L	RW205	(1) 0 - 3 ft bgs	3	100%	-	-	0.25	2.4	-	15	0.483	0.708	Gamma	95% Approximate Gamma UCL	**0.921**
Lead (Di-STLC)	mg/L	RW205	(2) All Depths	3	100%	-	-	0.25	2.4	-	15	0.483	0.708	Gamma	95% Approximate Gamma UCL	**0.921**
Lead (Di-STLC)	mg/L	RW209	(1) 0 - 3 ft bgs	7	100%	1.95	2.34	0.28	6.6	-	15	1.053	1.788	Gamma	95% Adjusted Gamma UCL	**2.69**
Lead (Di-STLC)	mg/L	RW209	(2) All Depths	7	100%	1.95	2.34	0.28	6.6	-	16	0.989	1.746	Gamma	95% Adjusted Gamma UCL	**2.45**
Lead (Di-STLC)	mg/L	RW314	(1) 0 - 3 ft bgs	1	100%	-	-	3.9	3.9	-	5	1.375	1.557	Normal	95% Student's-t UCL	**2.86**
Lead (Di-STLC)	mg/L	RW314	(2) All Depths	2	100%	-	-	3.9	5.7	-	8	1.588	2.121	Gamma	95% Approximate Gamma UCL	**5.17**
Lead (Di-STLC)	mg/L	RW315	(1) 0 - 3 ft bgs	8	100%	5.43	6.83	0.079	21	-	15	2.939	5.56	Gamma	95% Adjusted Gamma UCL	**9.28**
Lead (Di-STLC)	mg/L	RW315	(2) All Depths	8	100%	5.43	6.83	0.079	21	-	15	2.939	5.56	Gamma	95% Adjusted Gamma UCL	**9.28**
Lead (Di-STLC)	mg/L	RW316	(1) 0 - 3 ft bgs	3	100%	-	-	0.64	8.5	-	15	1.181	2.225	Gamma	95% Adjusted Gamma UCL	**2.87**
Lead (Di-STLC)	mg/L	RW316	(2) All Depths	3	100%	-	-	0.64	8.5	-	15	1.181	2.225	Gamma	95% Adjusted Gamma UCL	**2.87**
Lead (Di-STLC)	mg/L	RW38/39	(1) 0 - 3 ft bgs	1	100%	-	-	0.17	0.17	-	15	0.582	0.879	Gamma	95% Approximate Gamma UCL	**1.26**
Lead (Di-STLC)	mg/L	RW38/39	(2) All Depths	1	100%	-	-	0.17	0.17	-	15	0.582	0.879	Gamma	95% Approximate Gamma UCL	**1.26**
Lead (STLC)	mg/L	RW15	(1) 0 - 3 ft bgs	7	100%	14.3	16.1	1.5	47	-	15	7.123	12.66	Gamma	95% Approximate Gamma UCL	**15.5**
Lead (STLC)	mg/L	RW15	(2) All Depths	7	100%	14.3	16.1	1.5	47	-	17	6.36	12.04	Lognormal	99% Chebyshev (Mean, Sd) UCL	**35.4**
Lead (STLC)	mg/L	RW205	(1) 0 - 3 ft bgs	6	100%	6.05	5.91	0.88	17	-	15	2.967	4.421	Gamma	95% Approximate Gamma UCL	**5.58**
Lead (STLC)	mg/L	RW205	(2) All Depths	6	100%	6.05	5.91	0.88	17	-	15	2.967	4.421	Gamma	95% Approximate Gamma UCL	**5.58**
Lead (STLC)	mg/L	RW209	(1) 0 - 3 ft bgs	9	100%	16.1	11.5	4.3	31	-	15	9.801	11.76	Gamma	95% Adjusted Gamma UCL	**24.3**
Lead (STLC)	mg/L	RW209	(2) All Depths	9	100%	16.1	11.5	4.3	31	-	16	9.205	11.61	Gamma	95% Adjusted Gamma UCL	**22.3**
Lead (STLC)	mg/L	RW314	(1) 0 - 3 ft bgs	5	100%	7.86	7.48	1.8	17	-	5	7.86	7.476	Normal	95% Student's-t UCL	**15.0**
Lead (STLC)	mg/L	RW314	(2) All Depths	6	100%	11.2	10.6	1.8	28	-	8	8.527	10.25	Gamma	95% Approximate Gamma UCL	**25.5**
Lead (STLC)	mg/L	RW315	(1) 0 - 3 ft bgs	9	100%	36.1	38.8	3	120	-	15	21.76	34.44	Gamma	95% Adjusted Gamma UCL	**62.8**
Lead (STLC)	mg/L	RW315	(2) All Depths	9	100%	36.1	38.8	3	120	-	15	21.76	34.44	Gamma	95% Adjusted Gamma UCL	**62.8**
Lead (STLC)	mg/L	RW316	(1) 0 - 3 ft bgs	8	100%	6.31	6.26	0.4	16	-	15	3.668	5.312	Gamma	95% Approximate Gamma UCL	**7.13**
Lead (STLC)	mg/L	RW316	(2) All Depths	8	100%	6.31	6.26	0.4	16	-	15	3.668	5.312	Gamma	95% Approximate Gamma UCL	**7.13**
Lead (STLC)	mg/L	RW38/39	(1) 0 - 3 ft bgs	2	100%	-	-	3.6	5.4	-	15	3.905	5.512	Gamma	95% Approximate Gamma UCL	**8.16**
Lead (STLC)	mg/L	RW38/39	(2) All Depths	2	100%	-	-	3.6	5.4	-	15	3.905	5.512	Gamma	95% Approximate Gamma UCL	**8.16**

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				Summary Statistics - Raw Data				Detected and Nondetect Values			Summary Statistics - Data Included Predicted Values from Regression			Goodness-of-Fit Test	Upper Confidence Limit (UCL)	
Parameter	Unit	Retaining Wall	Depth Group	No. of Samples	Detection Rate	Mean	Std Dev	Min Detected	Max Detected	Reporting Limit of NDs	No. of Samples	Mean	Std Dev	Distribution	Method of UCL Calculation	Assessed 95% UCL
Lead (TCLP)	mg/L	RW15	(1) 0 - 3 ft bgs	1	100%	-	-	36	36	-	15	2.516	8.949	Lognormal	99% KM (Chebyshev) UCL	**30.7**
Lead (TCLP)	mg/L	RW15	(2) All Depths	1	100%	-	-	36	36	-	17	2.234	8.441	Lognormal	99% KM (Chebyshev) UCL	**27.2**
Lead (TCLP)	mg/L	RW205	(1) 0 - 3 ft bgs	0	-	-	-	-	-	-	15	-	-	-	-	**-**
Lead (TCLP)	mg/L	RW205	(2) All Depths	0	-	-	-	-	-	-	15	-	-	-	-	**-**
Lead (TCLP)	mg/L	RW209	(1) 0 - 3 ft bgs	3	67%	-	-	0.19	0.29	0.1	15	0.144	0.0426	Normal	95% KM (t) UCL	**0.165**
Lead (TCLP)	mg/L	RW209	(2) All Depths	3	67%	-	-	0.19	0.29	0.1	16	0.143	0.0415	Normal	95% KM (t) UCL	**0.163**
Lead (TCLP)	mg/L	RW314	(1) 0 - 3 ft bgs	0	-	-	-	-	-	-	5	0.16	0.00219	Non-parametric	95% KM (t) UCL	**0.163**
Lead (TCLP)	mg/L	RW314	(2) All Depths	1	100%	-	-	0.17	0.17	-	8	0.161	0.00395	Normal	95% KM (t) UCL	**0.164**
Lead (TCLP)	mg/L	RW315	(1) 0 - 3 ft bgs	7	86%	0.594	0.437	0.14	1.4	0.1	15	0.352	0.375	Normal	95% KM (t) UCL	**0.539**
Lead (TCLP)	mg/L	RW315	(2) All Depths	7	86%	0.594	0.437	0.14	1.4	0.1	15	0.352	0.375	Normal	95% KM (t) UCL	**0.539**
Lead (TCLP)	mg/L	RW316	(1) 0 - 3 ft bgs	1	0%	-	-	-	-	0.1	15	0.119	0.0122	Normal	95% KM (t) UCL	**0.126**
Lead (TCLP)	mg/L	RW316	(2) All Depths	1	0%	-	-	-	-	0.1	15	0.119	0.0122	Normal	95% KM (t) UCL	**0.126**
Lead (TCLP)	mg/L	RW38/39	(1) 0 - 3 ft bgs	0	-	-	-	-	-	-	15	0.132	0.0333	Normal	95% KM (t) UCL	**0.151**
Lead (TCLP)	mg/L	RW38/39	(2) All Depths	0	-	-	-	-	-	-	15	0.132	0.0333	Normal	95% KM (t) UCL	**0.151**

Notes:

(1) If duplicates exist, the average of the duplicate results is used as a single data point.

(2) All samples collected at various depths at the same location are considered independent data points.

(3) Goodness-of-Fit Test at 5% significance level is used to test for distributional assumption.

(4) The distributional assumption from (3) is used to select the appropriate UCL calculation method. For normal distribution, the UCL is based on the t-statistics. For lognormal distribution, gamma distribution, and non-parametric assumption, the UCL is based on the recommendations from USEPA (2002) and Singh (2010).

(5) References:

USEPA. 2002. Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. Office of Emergency and Remedial Response, U.S. Environmental Protection Agency, Report No. OSWER 9285.6-10.
Singh, A., R. Maichle, and N. Armbya. 2010a. ProUCL Version 4.1 User Guide. Office of Research and Development, U.S. Environmental Protection Agency, Report No. EPA/600/R-07/038.
Singh, A., N. Armbya, and A.K. Singh. 2010b. ProUCL Version 4.1 Technical Guide. Office of Research and Development, U.S. Environmental Protection Agency, Report No. EPA/600/R-07/041.
USEPA. 2011. ProUCL Version 4.1.01 (Software). Retrieved from http://www.epa.gov/osp/hstl/tsc/software.htm. July.

Table 9
US-101 Broadway Project: Summary Statistics and 95% UCL Results - Clearing and Grubbing
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

				Summary Statistics - Raw Data				Detected and Nondetect Values			Summary Statistics - Data Included Predicted Values from Regression			Goodness-of-Fit Test	Upper Confidence Limit (UCL)	
Parameter	Unit	Stage	Depth Group	No. of Samples	Detection Rate	Mean	Std Dev	Min Detected	Max Detected	Reporting Limit of NDs	No. of Samples	Mean	Std Dev	Distribution	Method of UCL Calculation	Assessed 95% UCL
Lead (Total)	mg/kg	1	(1) 0 - 0.5 ft	23	100%	320.1	306.4	15	1200	-	23	320.1	306.4	Gamma	95% Approximate Gamma UCL	**473.4**
Lead (Total)	mg/kg	2	(1) 0 - 0.5 ft	15	100%	149	133	23.5	550	-	15	149	133	Gamma	95% Approximate Gamma UCL	**216**
Lead (Total)	mg/kg	3	(1) 0 - 0.5 ft	21	100%	391	372	61	1600	-	21	391	372	Gamma	95% Approximate Gamma UCL	**546**
Lead (Total)	mg/kg	4	(1) 0 - 0.5 ft	6	100%	110	62	35	190	-	6	110	62	Normal	95% Student's-t UCL	**161**
Lead (Total)	mg/kg	5	(1) 0 - 0.5 ft	9	100%	222	246	29	820	-	9	222	246	Gamma	95% Approximate Gamma UCL	**436**
Lead (Di-STLC)	mg/L	1	(1) 0 - 0.5 ft	14	100%	8.83	12.02	0.084	42	-	23	5.75	10.09	Gamma	95% Adjusted Gamma UCL	**11.2**
Lead (Di-STLC)	mg/L	2	(1) 0 - 0.5 ft	9	100%	2.25	2.97	0.034	9.6	-	15	1.54	2.42	Gamma	95% Approximate Gamma UCL	**2.92**
Lead (Di-STLC)	mg/L	3	(1) 0 - 0.5 ft	17	100%	7.27	15.82	0.25	65	-	21	6.32	14.31	Lognormal	95% Chebyshev (Mean, Sd) UCL	**19.9**
Lead (Di-STLC)	mg/L	4	(1) 0 - 0.5 ft	2	100%	-	-	0.17	1.9	-	6	0.706	0.702	Normal	95% Student's-t UCL	**1.28**
Lead (Di-STLC)	mg/L	5	(1) 0 - 0.5 ft	7	100%	5.93	8.54	0.44	24	-	9	4.66	7.81	Gamma	95% Approximate Gamma UCL	**13.8**
Lead (STLC)	mg/L	1	(1) 0 - 0.5 ft	19	100%	15.5	15.5	1.6	62.5	-	23	13.0	15.1	Gamma	95% Approximate Gamma UCL	**20.1**
Lead (STLC)	mg/L	2	(1) 0 - 0.5 ft	13	100%	8.32	8.62	2.6	34	-	15	7.42	8.33	Gamma	95% Approximate Gamma UCL	**11.5**
Lead (STLC)	mg/L	3	(1) 0 - 0.5 ft	21	100%	19.1	22.9	0.57	100	-	21	19.1	22.9	Gamma	95% Approximate Gamma UCL	**29.0**
Lead (STLC)	mg/L	4	(1) 0 - 0.5 ft	5	100%	4.26	2.37	2	7.7	-	6	3.77	2.45	Normal	95% Student's-t UCL	**5.78**
Lead (STLC)	mg/L	5	(1) 0 - 0.5 ft	8	100%	28.5	50.0	2.95	150	-	9	25.4	47.6	Gamma	95% Approximate Gamma UCL	**72.2**
Lead (TCLP)	mg/L	1	(1) 0 - 0.5 ft	6	83%	0.8	1.2	0.1	3.4	0.1	23	0.2	0.4	Non-parametric	95% KM (BCA) UCL	**0.4**
Lead (TCLP)	mg/L	2	(1) 0 - 0.5 ft	0	-	-	-	-	-	-	15	0.164	0.038	Normal	95% KM (t) UCL	**0.185**
Lead (TCLP)	mg/L	3	(1) 0 - 0.5 ft	9	89%	0.424	0.395	0.11	1.1	0.1	21	0.233	0.274	Non-parametric	95% KM (t) UCL	**0.341**
Lead (TCLP)	mg/L	4	(1) 0 - 0.5 ft	0	-	-	-	-	-	-	6	-	-	-	-	**-**
Lead (TCLP)	mg/L	5	(1) 0 - 0.5 ft	1	100%	-	-	1.9	1.9	-	9	0.318	0.560	Gamma	95% KM (t) UCL	**0.719**

Notes:
(1) If duplicates exist, the average of the duplicate results is used as a single data point.
(2) All samples collected at various depths at the same location are considered independent data points.
(3) Goodness-of-Fit Test at 5% significance level is used to test for distributional assumption.
(4) The distributional assumption from (3) is used to select the appropriate UCL calculation method. For normal distribution, the UCL is based on the t-statistics. For lognormal distribution, gamma distribution, and non-
(5) References:
(6) Locations designated as CDSM are included in this statistical evaluation.

Table 10
Soil Sampling Results
1299 Bayshore Highway and 1212 Rollins Road
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Sample Identification	Depth	Lab ID	Sample Date	Sample Time	Antimony	Arsenic	Barium	Berylium	Cadmium	Chromium Total	Cobalt	Copper	Lead	Mercury	Molydenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc	TPH-g	TPH-d	TPH-mo	VOCs	4,4'-DDT	PCBs
				EPA Method	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	8260TPH	8015B	8015B	8260B	8081A	8260B
				Units	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	ug/kg	mg/kg	mg/kg	ug/kg	ug/kg	ug/kg
				10 x STLC	150	50	1,000	7.5	10	50	800	250	50	2	3,500	200	10	50	70	240	2,500	NE	NE	NE	varies	10,000	NE
				20 x TCLP	NE	100	2,000	NE	20	100	NE	NE	100	4	NE	NE	20	100	NE	NE	NE	NE	NE	NE	varies	NE	NE
				ESLs	310	15	2,600	98	39	1,200,000[#]	94	310,000	750	58	3,900	260	3,900	3,900	62	770	230,000	4,200,000	4,200	12,000	varies	87,000	6,700
1299 Bayshore Highway																											
SB-05	0.5	1111096-001A	11/15/2011	0930	--	--	--	--	--	--	--	--	17	--	--	--	--	--	--	--	--	ND	ND	920	ND	--	--
	1.0	1111096-002A	11/15/2011	0930	--	--	--	--	--	--	--	--	20	--	--	--	--	--	--	--	--	ND	ND	120	ND	--	--
	1.5	1111096-003A	11/15/2011	0930	--	--	--	--	--	--	--	--	12	--	--	--	--	--	--	--	--	ND	ND	92	ND	--	--
	2.0	1111096-004A	11/15/2011	0930	--	--	--	--	--	--	--	--	20	--	--	--	--	--	--	--	--	ND	ND	100	ND	--	--
	3.0	1111096-005A	11/15/2011	0930	--	--	--	--	--	--	--	--	7.3	--	--	--	--	--	--	--	--	ND	ND	5.7	ND	--	--
1212 Rollins Road																											
SB-10	0.5	1112072-011A	12/11/2011	1045	--	--	--	--	--	--	--	--	15	--	--	--	--	--	--	--	--	ND	ND	1500	ND	--	--
	1.0	1111096-012A	12/11/2011	1045	<5.0	10.0	170	<2.0	<1.0	**53**	12	25	35	<0.50	<5.0	52	<5.0	<1.0	<5.0	40	65	--	--	--	--	20	ND
	1.5	1112072-013A	12/11/2011	1045	--	--	--	--	--	--	--	--	21	--	--	--	--	--	--	--	--	ND	ND	50	ND	--	--
	2.0	1112072-014A	12/11/2011	1045	--	--	--	--	--	--	--	--	25	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3.0	1112072-015A	12/11/2011	1045	--	--	--	--	--	--	--	--	44	--	--	--	--	--	--	--	--	ND	ND	11	ND	--	--
SB-11	0.5	1112072-001A	12/11/2011	0955	--	--	--	--	--	--	--	--	23	--	--	--	--	--	--	--	--	ND	ND	19	ND	--	--
	1.0	1112072-002A	12/11/2011	0955	--	--	--	--	--	--	--	--	16	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	1.5	1112072-003A	12/11/2011	0955	--	--	--	--	--	--	--	--	17	--	--	--	--	--	--	--	--	ND	ND	17	ND	--	--
	2.0	1112072-004A	12/11/2011	0955	<5.0	5.0	150	<2.0	<1.0	30	8.9	21	20	<0.50	<5.0	35	<5.0	<1.0	<5.0	29	44	--	--	--	--	--	--
	3.0	1112072-005A	12/11/2011	0955	--	--	--	--	--	--	--	--	13	--	--	--	--	--	--	--	--	ND	ND	7.9	ND	--	--

Notes:
1: Samples with results exceeding these limits were tested using STLC procedures to determine if the materials were hazardous wastes.
[1] The 750 mg/kg refers to the Commercial/Industrial ESL for Chromium III and the 8 mg/kg refers to the Commercial/Industrial ESL for Chromium VI.
EPA = US Environmental Protection Agency
NA = Not Applicable
NE = Not Established
-- = Not analyzed
ND = Not detected at or above the Practical Quantitation Limit. See analytical reports for individual detection limits.
Bold = Exceed 10 X STLC Limits or Commercial/Industrial ESL
STLC = Soluable Threshold Limit Criteria. Leachate sample exceeding this value represent a California Hazaroud Waste.
ESL = San Francisco Regional Water Qaulity Control Board Environmental Screening Levels Interim Final November 2007, revised in May 2008

Table 11
Groundwater Sampling Results
1299 Bayshore Highway and 1212 Rollins Road
US 101/Broadway Interchange Reconstruction Project
Burlingame, California
San Mateo County

Sample Identification	Depth	Lab ID	Sample Date	Sample Time	Lead	TPH-g	TPH-d	TPH-mo	1,1-Dichloroethane	Other VOCs
				EPA Method	6010B	8260TPH	8015B	8015B	8260B	8260B
				Units	mg/L	ug/L	mg/L	mg/L	ug/L	ug/kg
				STLC Limits	5	NE	NE	NE	NE	Varies
				ESL Limits	0.0025	210	0.21	0.21	47	Varies
				Burlingame Municipal Code Sanitary Sewer Limits	0.365	10 mg/L (aggregate TPH)			NE	NE
1299 Bayshore Highway										
SB-05-GW	--	1111096-007A	11/15/2011	0950	0.019	<50	<0.1	<0.20	<0.50	ND
1212 Rollins Road										
SB-11-GW	--	1112072-010A	12/11/2011	0955	0.14	<5.0	<0.1	0.27	1.1	ND

Notes:
1: Samples with results exceeding these limits were tested using STLC procedures to determine if the materials were hazardous wastes.
EPA = US Environmental Protection Agency
ESL = Regional Water Quality Control Board Environmental Screening Limits for Groundwater that is not a current or
STLC = Soluble Threshold Limits Concentrations
mg/L = milligrams per liter
ug/L = micrograms per liter
NE = Not Established
ND = Not detected at or above the Practical Quantitation Limit. See analytical reports for individual detection limits.
The symbol "<" (less than) indicates that the analyte was not detected at a concentration above the laboratory detection
Bold indicates value exceeds Burlingame Municipal Code Sanitary Sewer Limits
Yellow highlighting indicates value exceeds ESL.

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

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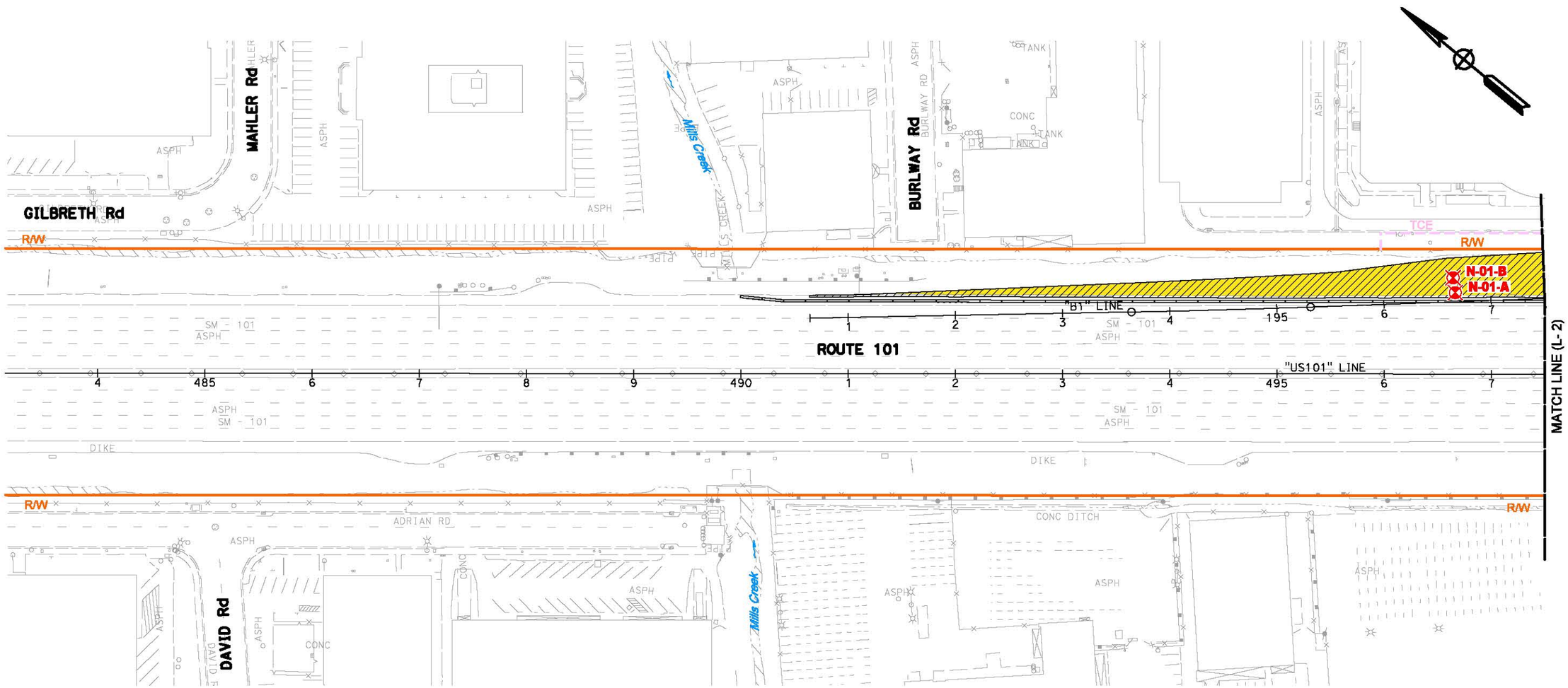
LEGEND:

- Stage 1: 0-1.5': ROADWAY EXCAVATION (Type Y-2) (Aerially Deposited Lead) >1.5': NON-HAZARDOUS WASTE SOIL
- CDSM - SOIL TREATMENT SOIL CEMENT - 33% PATTERN
- CDSM - SOIL TREATMENT SOIL CEMENT - 21% PATTERN
- CDSM - SOIL TREATMENT CELLULAR CONCRETE
- BORING LOCATION
- BORING LOCATION (This STAGE)



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AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT
STAGE 1 - PHASE 1

L-1

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CHECKED BY: ELIE-ABI-JAOUDE
CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

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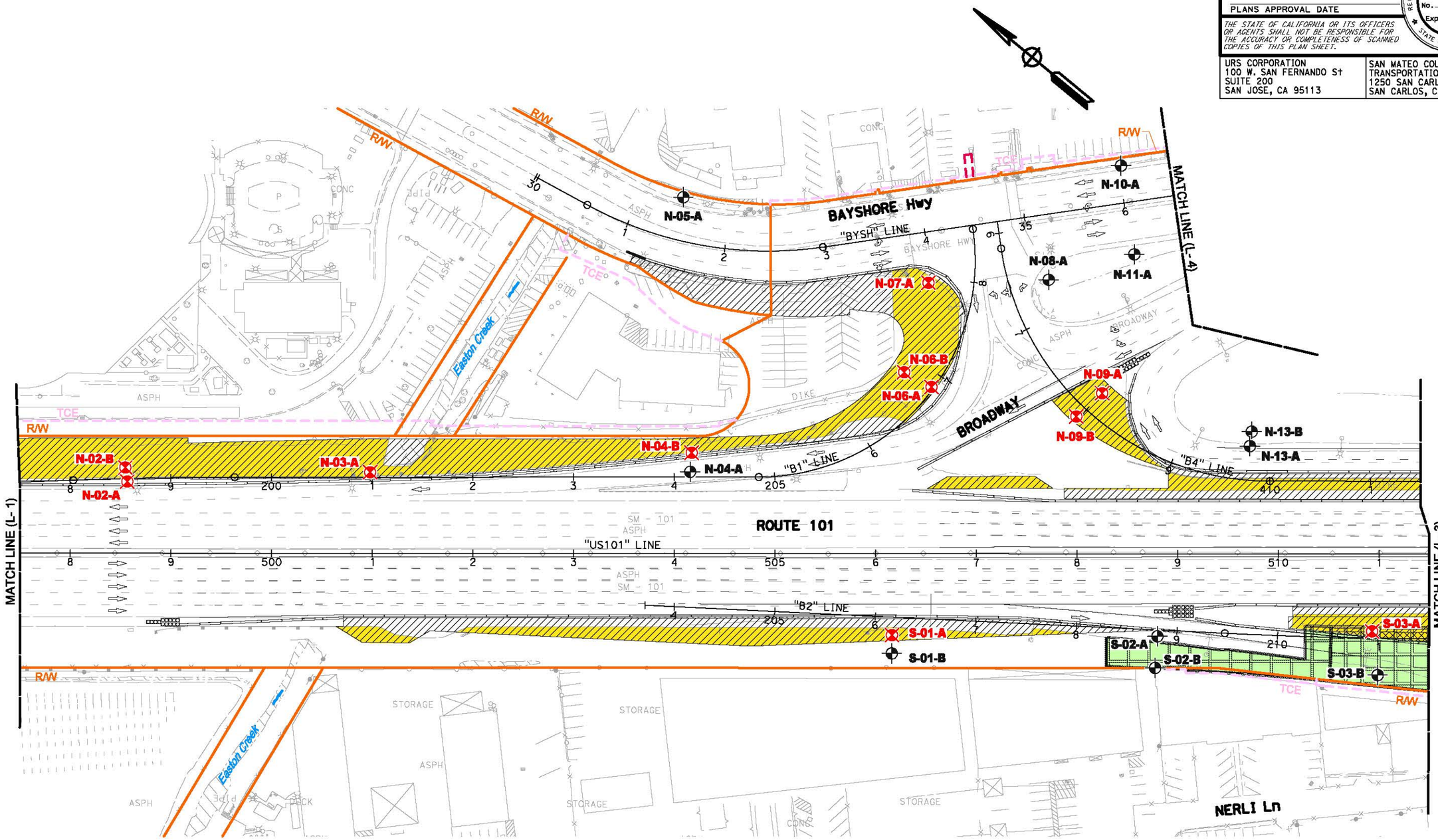

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STAGE 1 - PHASE 1

L-2

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04	SM	101	16.3/17.1	.	.

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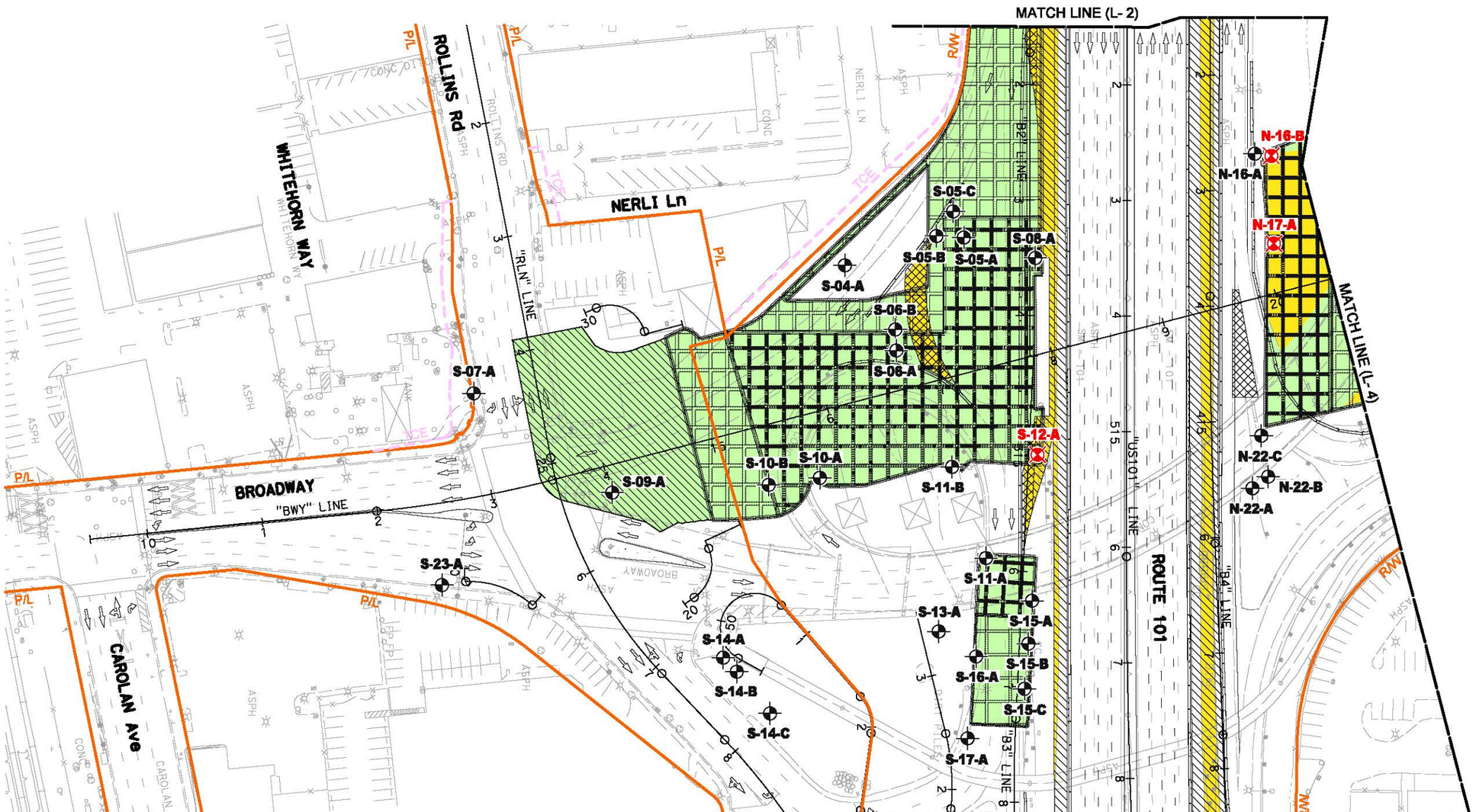

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AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 1 - PHASE 1

L-3

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04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

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AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 1 - PHASE 1

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04	SM	101	16.3/17.1	.	.

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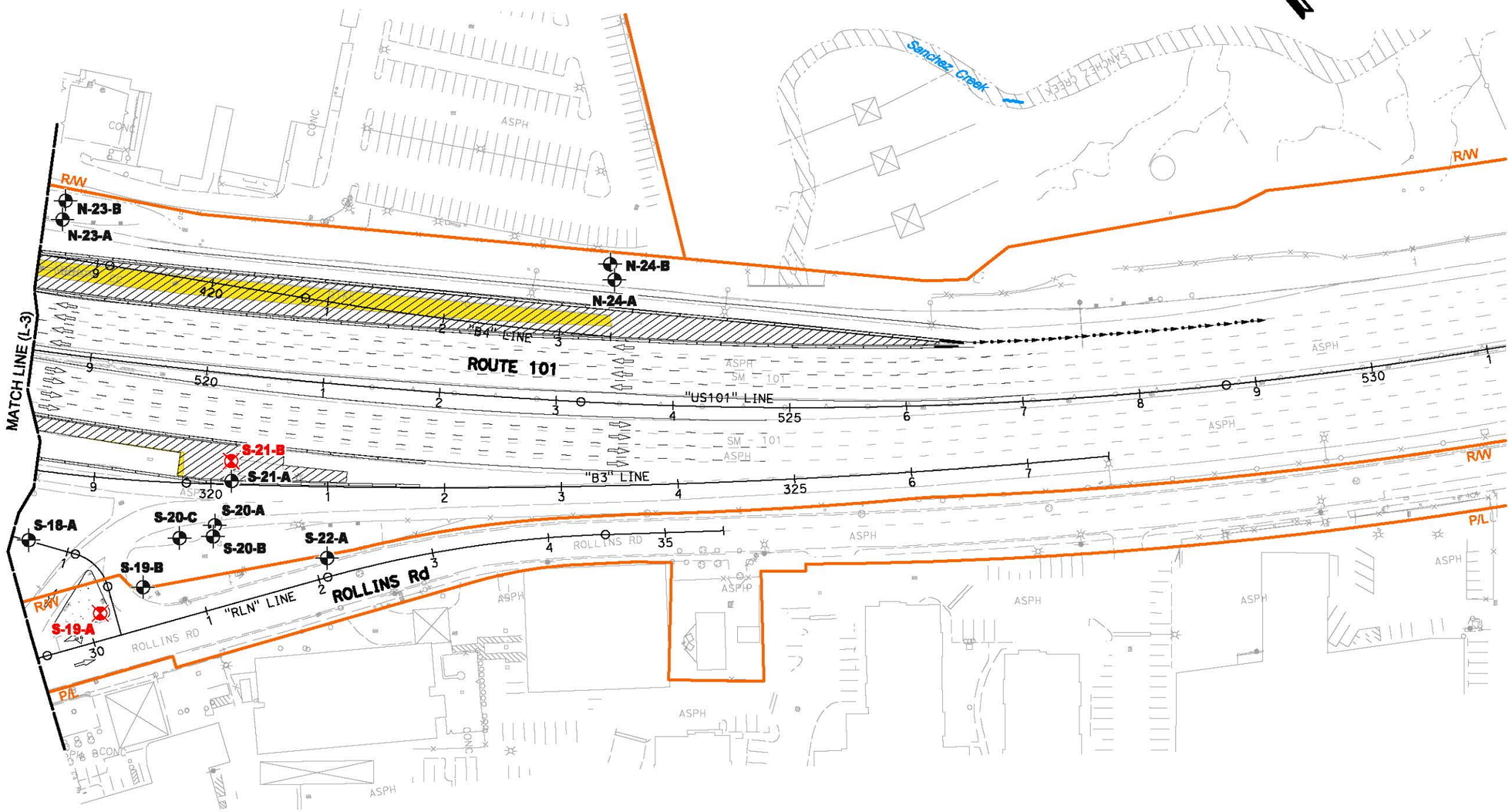

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BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

LEGEND:

Stage 1: 0-1.5': ROADWAY EXCAVATION (Type Y-2) (Aerially Deposited Lead)
>1.5': NON-HAZARDOUS WASTE SOIL

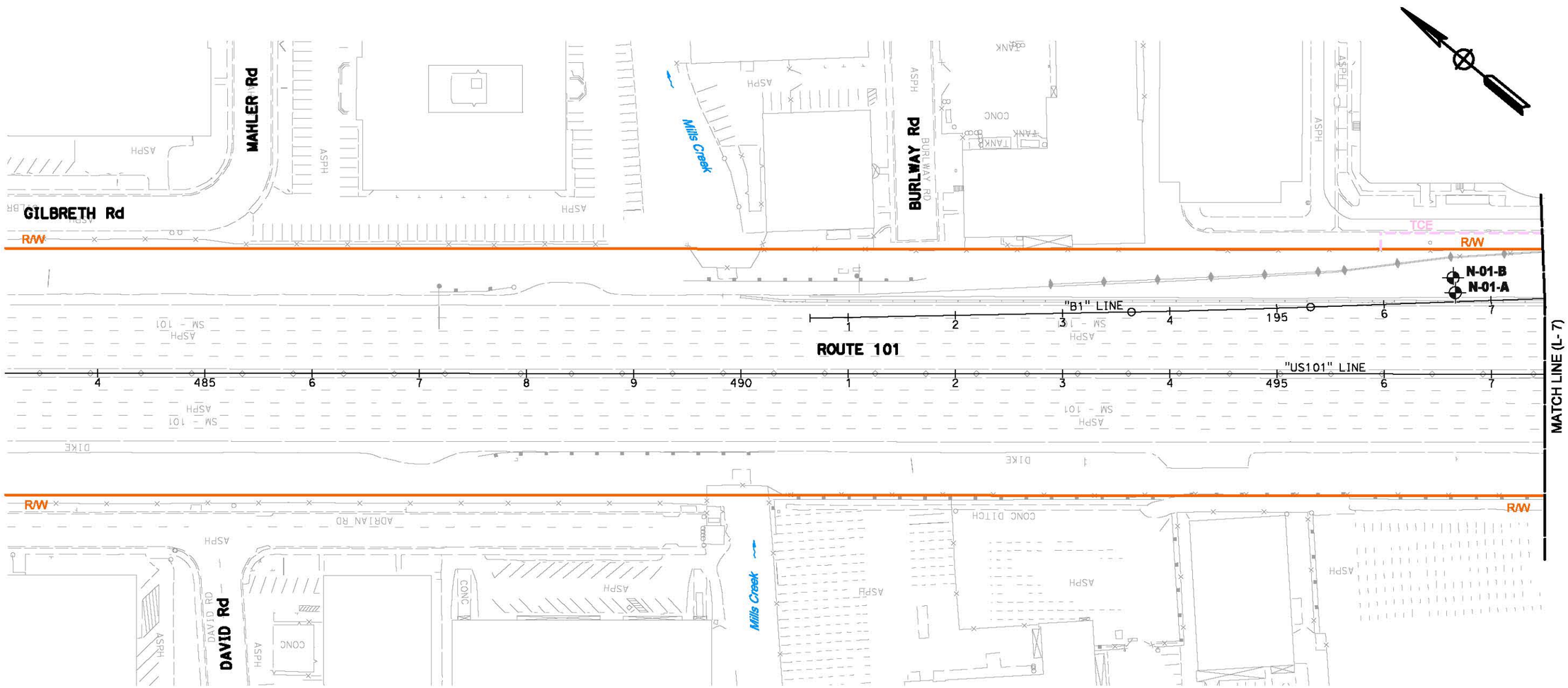
CDSM - SOIL TREATMENT
SOIL CEMENT - 33% PATTERN

CDSM - SOIL TREATMENT
SOIL CEMENT - 21% PATTERN

CDSM - SOIL TREATMENT
CELLULAR CONCRETE

BORING LOCATION

BORING LOCATION (This STAGE)



PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT
STAGE 1 - PHASE 2

L-6

REVISED BY	DATE REVISED
.	.

CALCULATED-DESIGNED BY: ABHIJEET BHOI
CHECKED BY: ELIE-ABI-JAOUDE
CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

LAST REVISION 06-28-12
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TIME PLOTTED => $TIME

$FILE$

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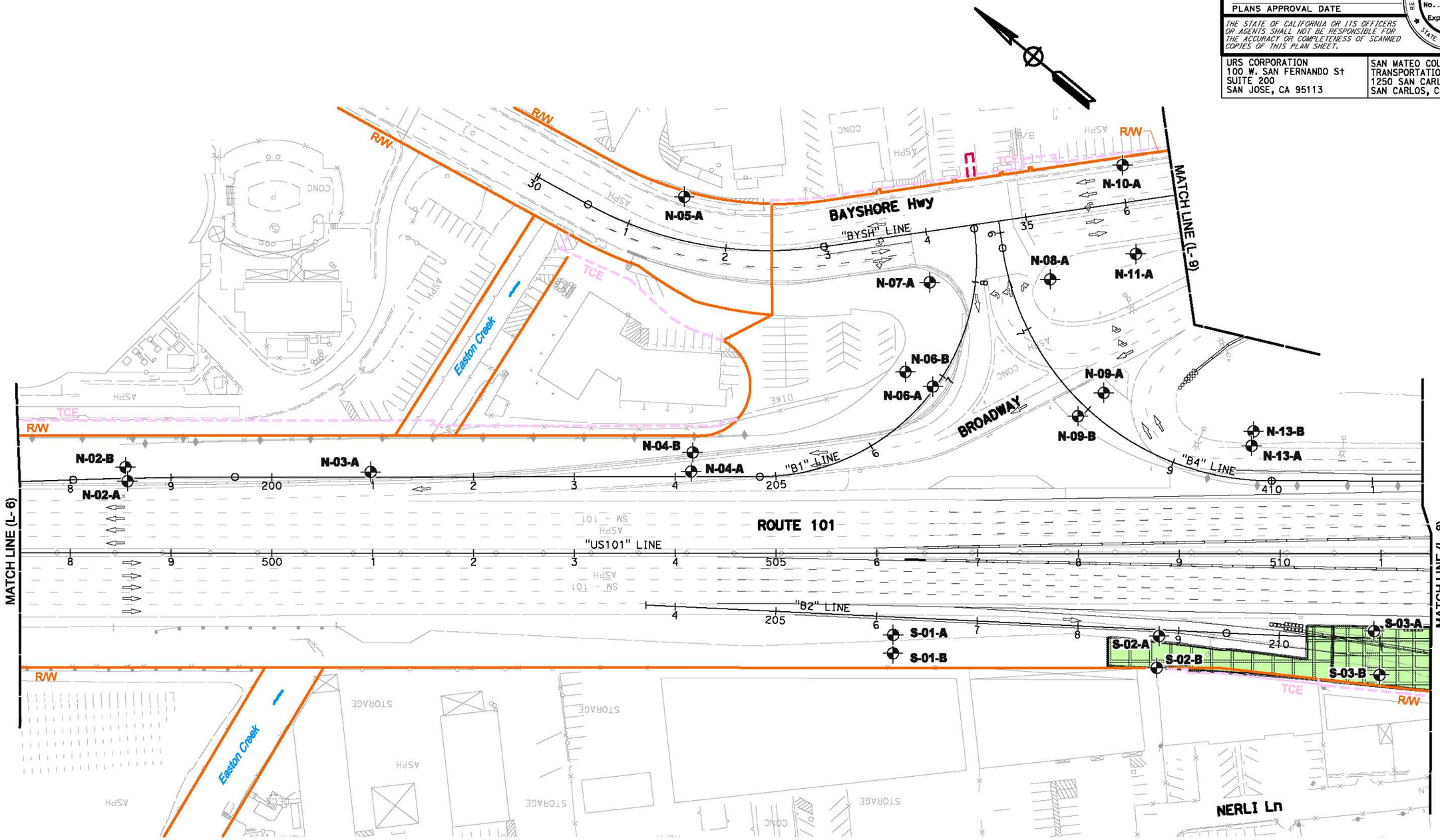
SAN CARLOS, CA 94070-1306



PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 1 - PHASE 2

L-7

REVISED BY	DATE REVISED
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$FILE$

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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PRELIMINARY PLANS SUBJECT TO REVISION

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 1 - PHASE 2

L-8

REVISED BY	DATE REVISED
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$FILE$

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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PLANS APPROVAL DATE

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PRELIMINARY PLANS SUBJECT TO REVISION

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 1 - PHASE 2

L-9

REVISED BY	DATE REVISED
.	.

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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

$FILE$

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PLANS APPROVAL DATE

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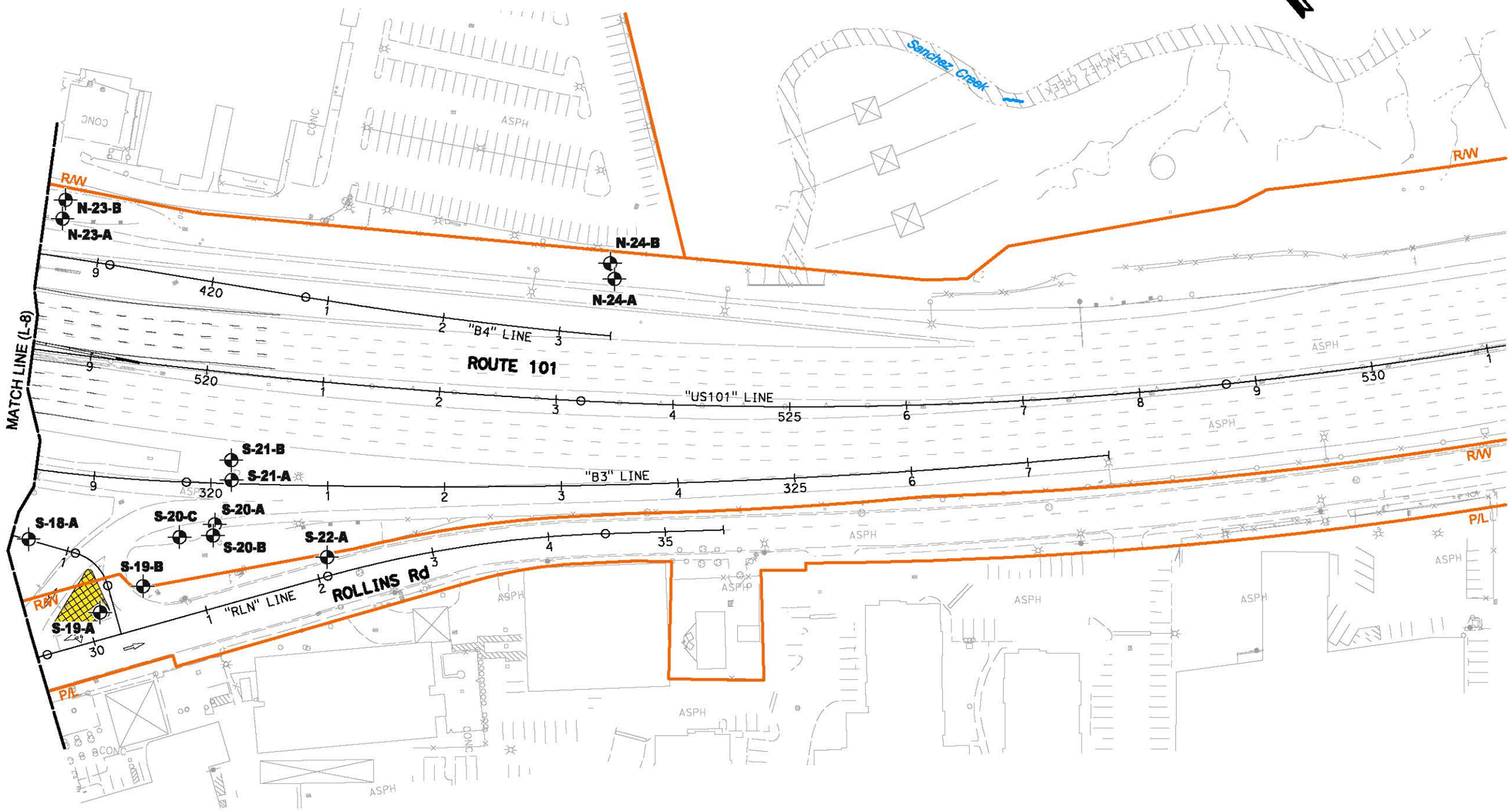

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 1 - PHASE 2

L-10

REVISED BY	.
DATE REVISED	.
CALCULATED-DESIGNED BY	ABHIJEET BHOI
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PLANS APPROVAL DATE

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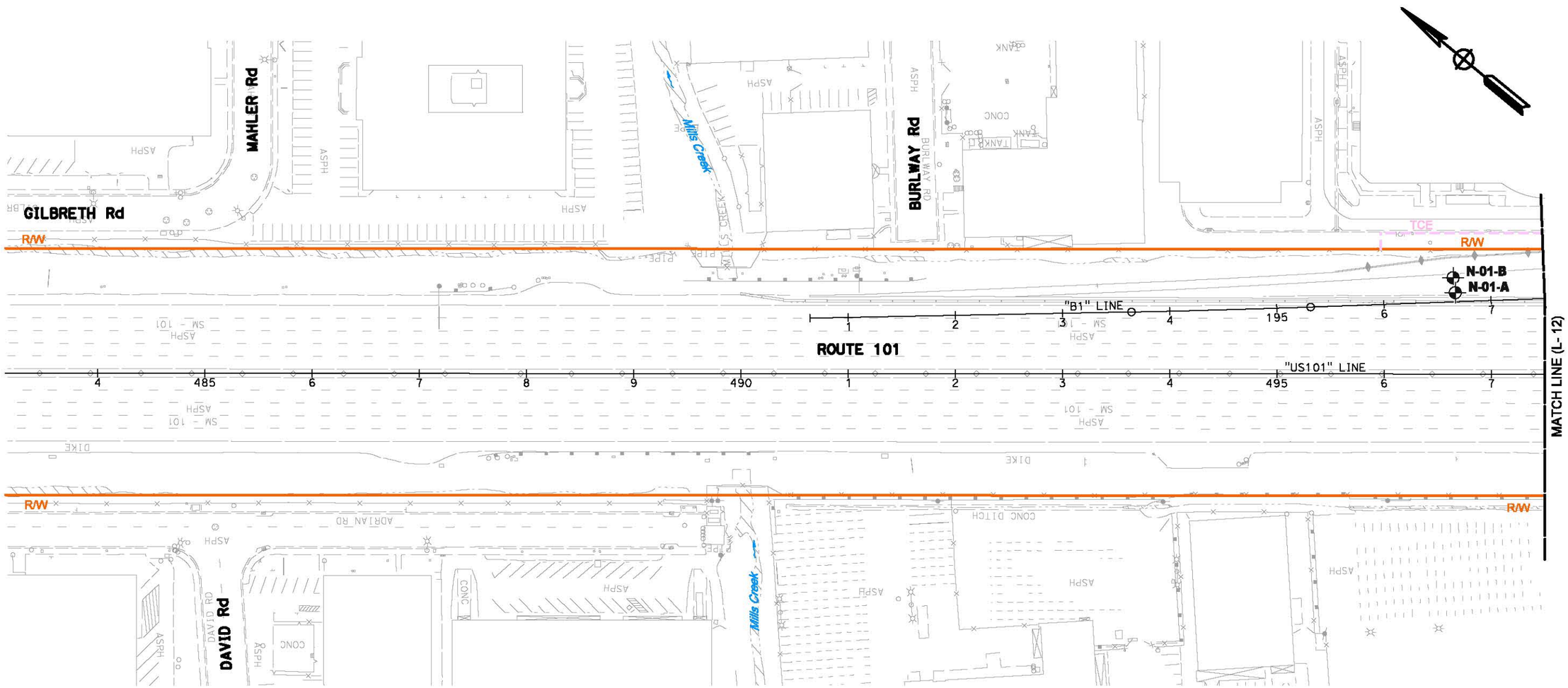
SAN CARLOS, CA 94070-1306

LEGEND:

- Stage 2 : 0-1.5': ROADWAY EXCAVATION (Type Y-2) (Aerially Deposited Lead)
  1.5'-3.0': ROADWAY EXCAVATION (Type Y-1) (Aerially Deposited Lead)
  >3.0': NON-HAZARDOUS WASTE SOIL
- CDSM - SOIL TREATMENT SOIL CEMENT - 33% PATTERN
- CDSM - SOIL TREATMENT SOIL CEMENT - 21% PATTERN
- CDSM - SOIL TREATMENT CELLULAR CONCRETE
- BORING LOCATION
- BORING LOCATION (This STAGE)



PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT
STAGE 2 - PHASE 1

L-11

REVISED BY	DATE REVISED
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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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LAST REVISION 06-28-12 DATE PLOTTED => $DATE TIME PLOTTED => $TIME

$FILE$

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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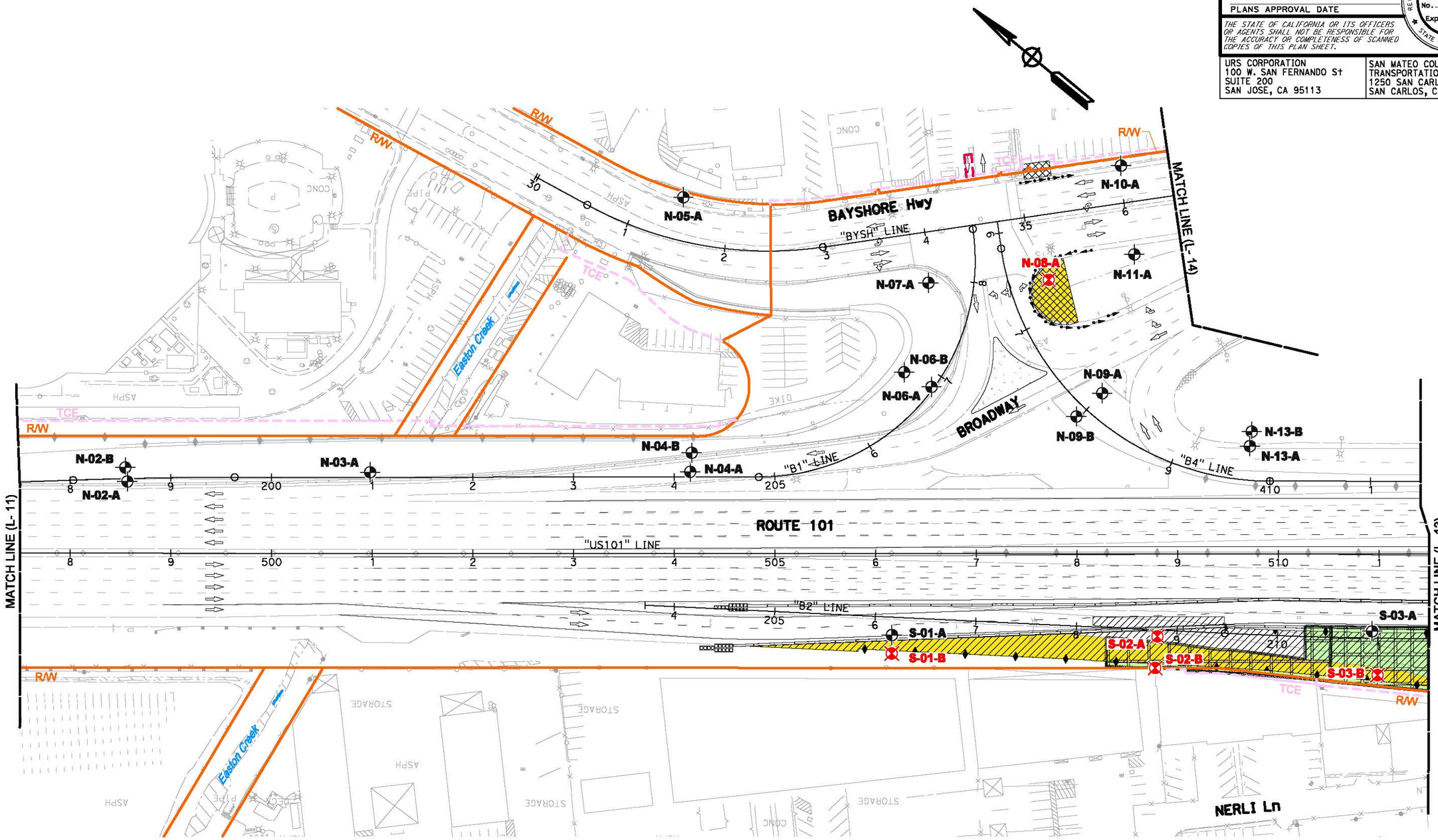

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 2 - PHASE 1

L-12

REVISED BY	DATE REVISED
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PRELIMINARY PLANS SUBJECT TO REVISION

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 2 - PHASE 1

L-13

REVISED BY	DATE REVISED
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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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PLANS APPROVAL DATE

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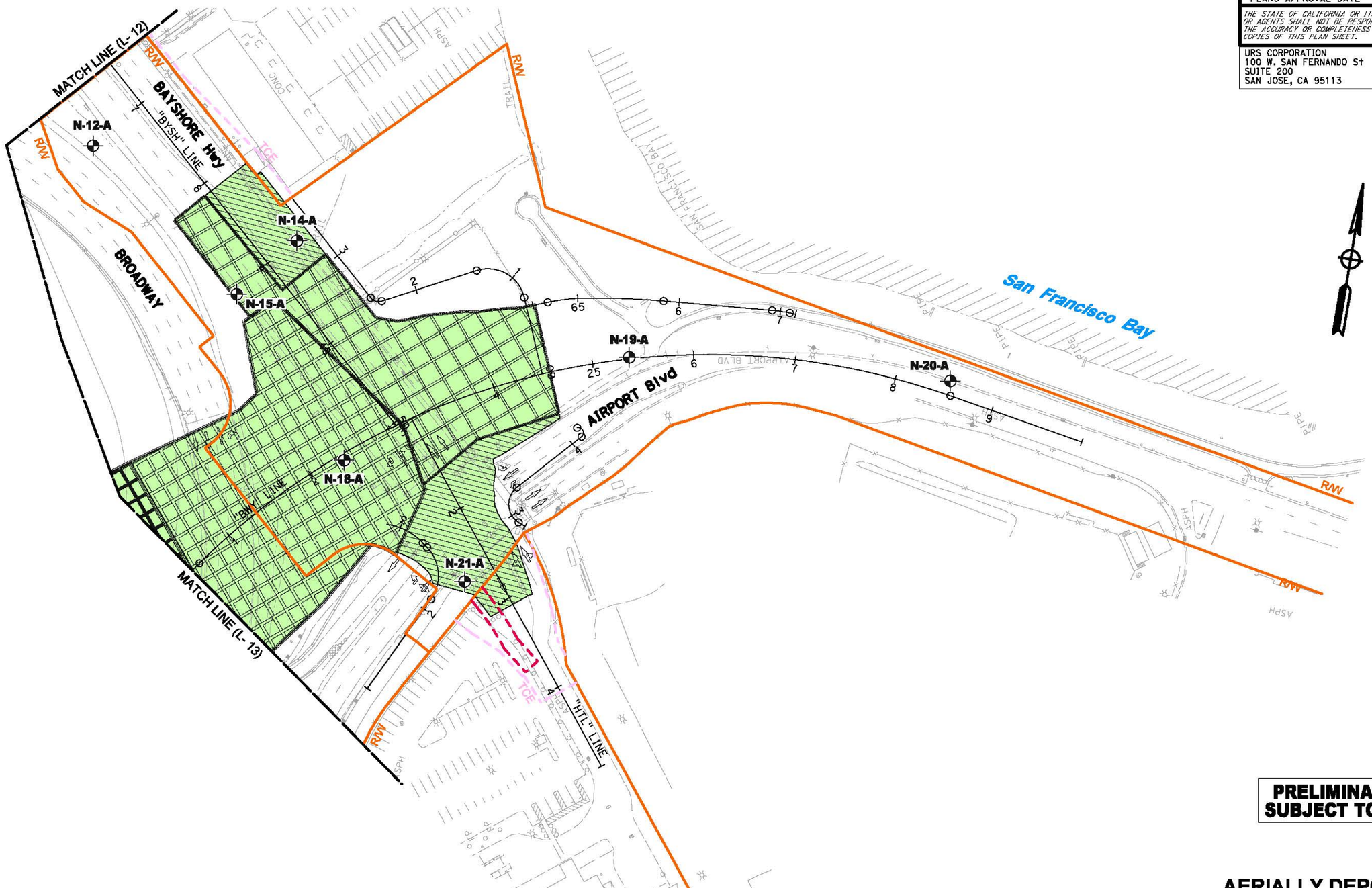

PRELIMINARY PLANS SUBJECT TO REVISION

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 2 - PHASE 1

L-14

REVISED BY	DATE REVISED
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CALCULATED-DESIGNED BY: ABHIJEET BHOI
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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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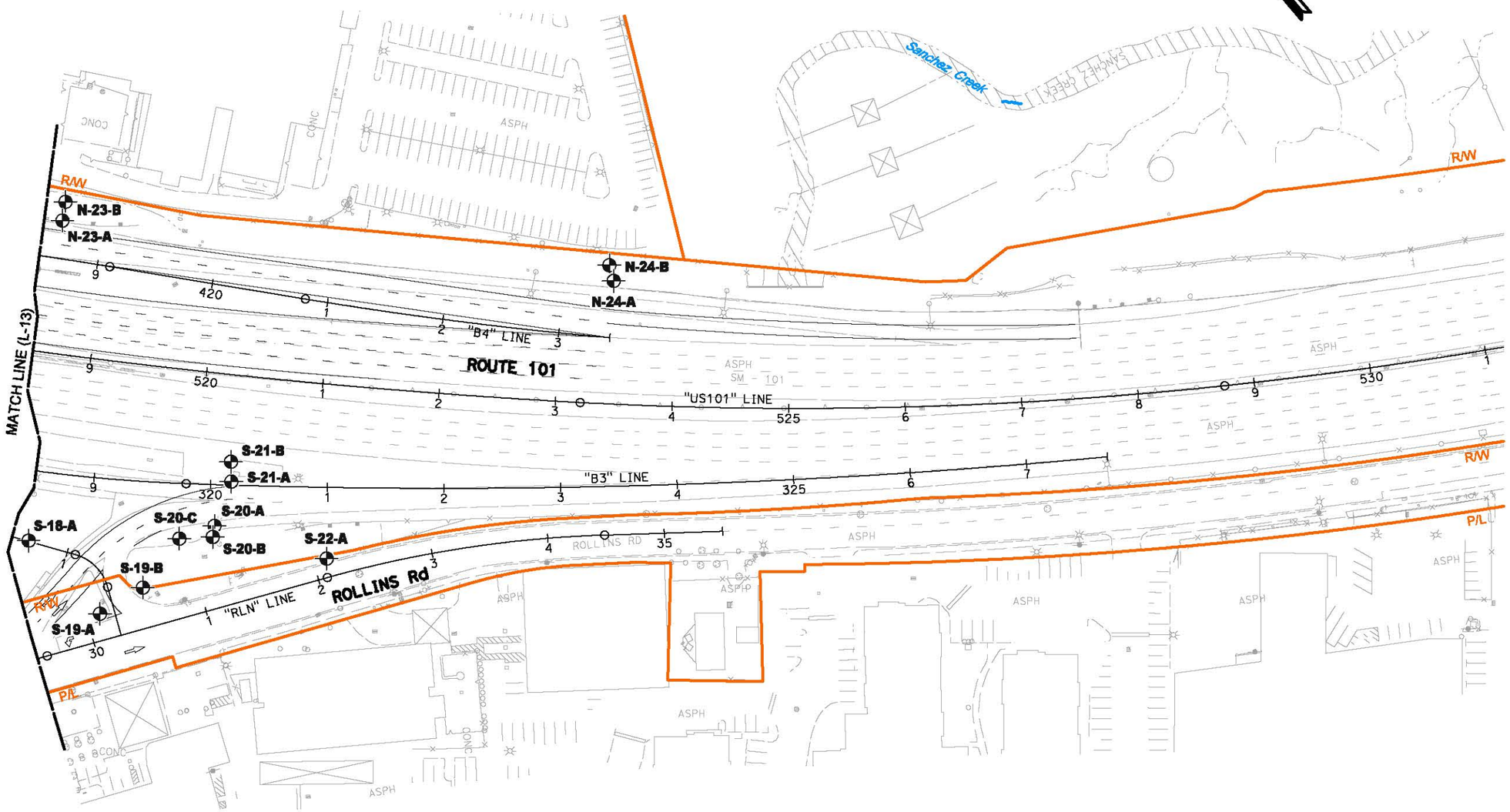

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 2 - PHASE 1

L-15

REVISED BY	.
DATE REVISED	.
CALCULATED-DESIGNED BY	ABHIJEET BHOI
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CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN

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LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

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BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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LEGEND:

- Stage 2 : 0-1.5': ROADWAY EXCAVATION (Type Y-2) (Aerially Deposited Lead)
  1.5'-3.0': ROADWAY EXCAVATION (Type Y-1) (Aerially Deposited Lead)
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- CDSM - SOIL TREATMENT SOIL CEMENT - 21% PATTERN
- CDSM - SOIL TREATMENT CELLULAR CONCRETE
- BORING LOCATION
- BORING LOCATION (This STAGE)

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT
STAGE 2 - PHASE 2

L-16

REVISED BY	DATE REVISED
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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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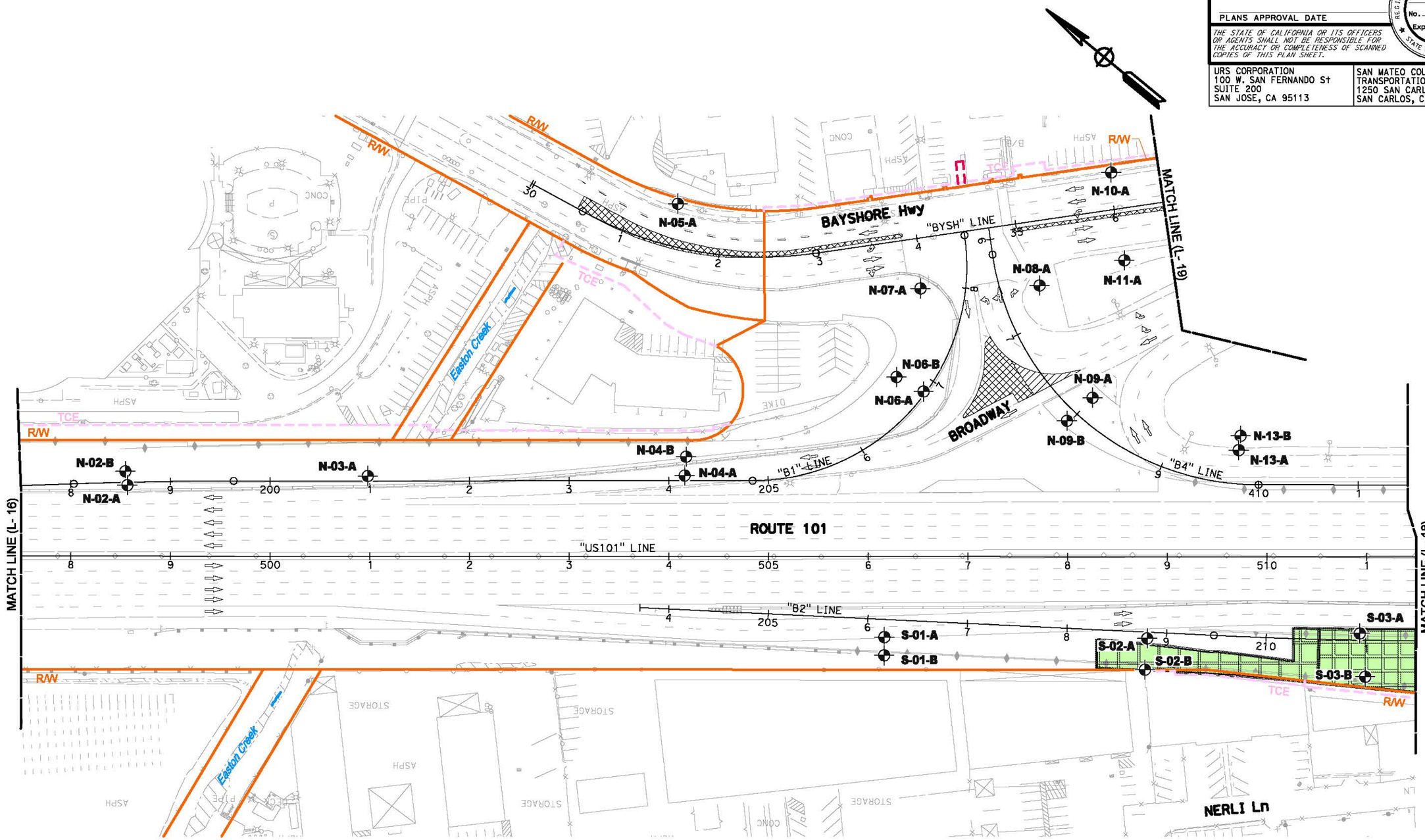

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 2 - PHASE 2

L-17

REVISED BY . DATE REVISED .

CALCULATED-DESIGNED BY ABHIJEET BHOI
CHECKED BY ELIE-ABI-JAOUDE

CONSULTANT FUNCTIONAL SUPERVISOR RAMSEY J. HISSEN

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Caltrans

LAST REVISION 06-28-12 DATE PLOTTED => $DATE TIME PLOTTED => $TIME

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BORDER LAST REVISED 7/2/2010 | USERNAME => $USER DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

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PRELIMINARY PLANS SUBJECT TO REVISION

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 2 - PHASE 2

L-18

REVISED BY	DATE REVISED
.	.

CALCULATED-DESIGNED BY: ABHIJEET BHOI
CHECKED BY: ELIE-ABI-JAOUDE

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

$FILE$

BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

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PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 2 - PHASE 2

L-19

REVISED BY	.
DATE REVISED	.
CALCULATED-DESIGNED BY	ABHIJEET BHOI
CHECKED BY	ELIE-ABI-JAOUDE
CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN

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$FILE$

BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

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PLANS APPROVAL DATE

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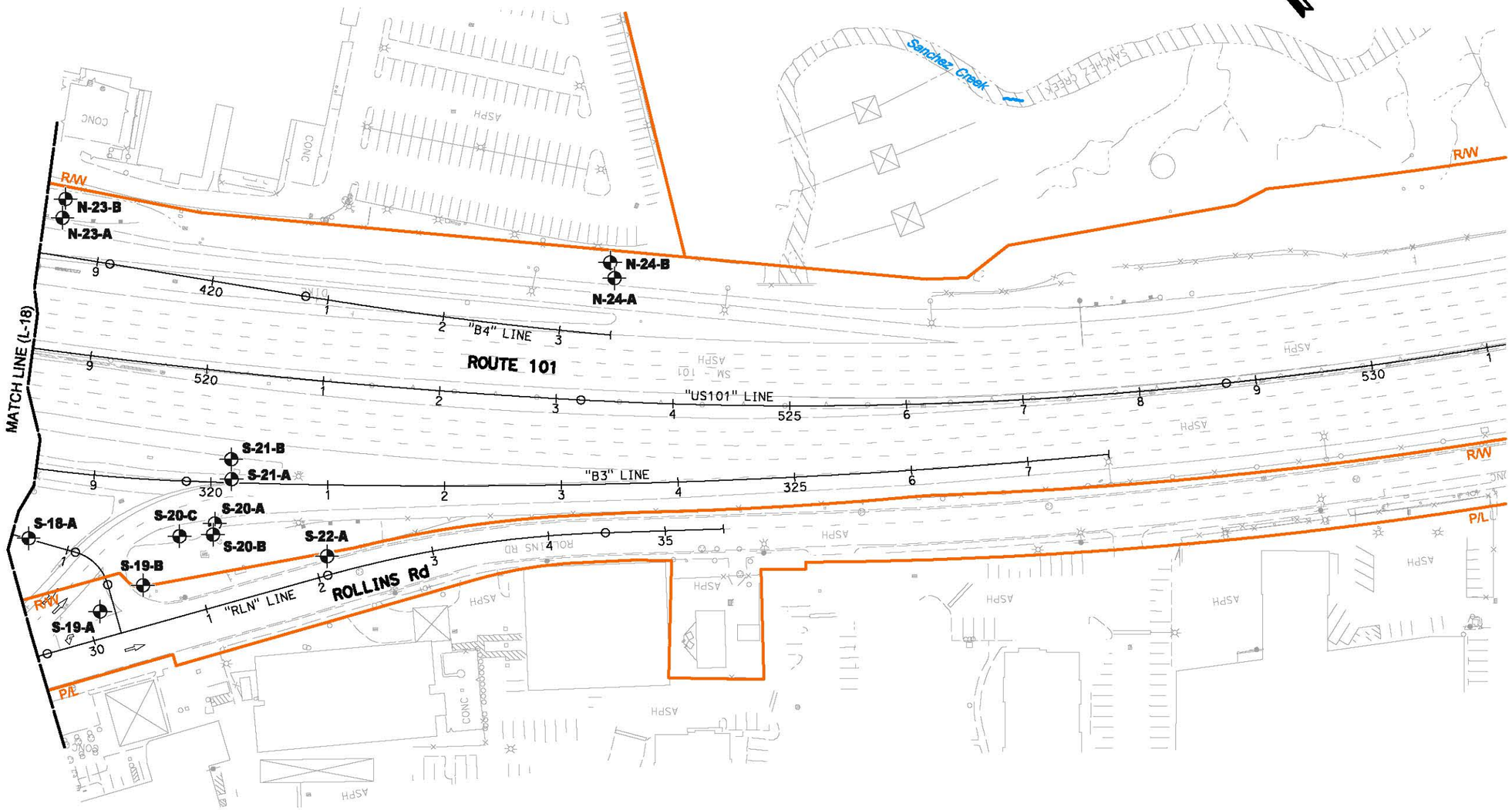

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 2 - PHASE 2

L-20

REVISED BY	.
DATE REVISED	.

CALCULATED-DESIGNED BY	ABHIJEET BHOI
CHECKED BY	ELIE-ABI-JAOUDE

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

$FILE$

BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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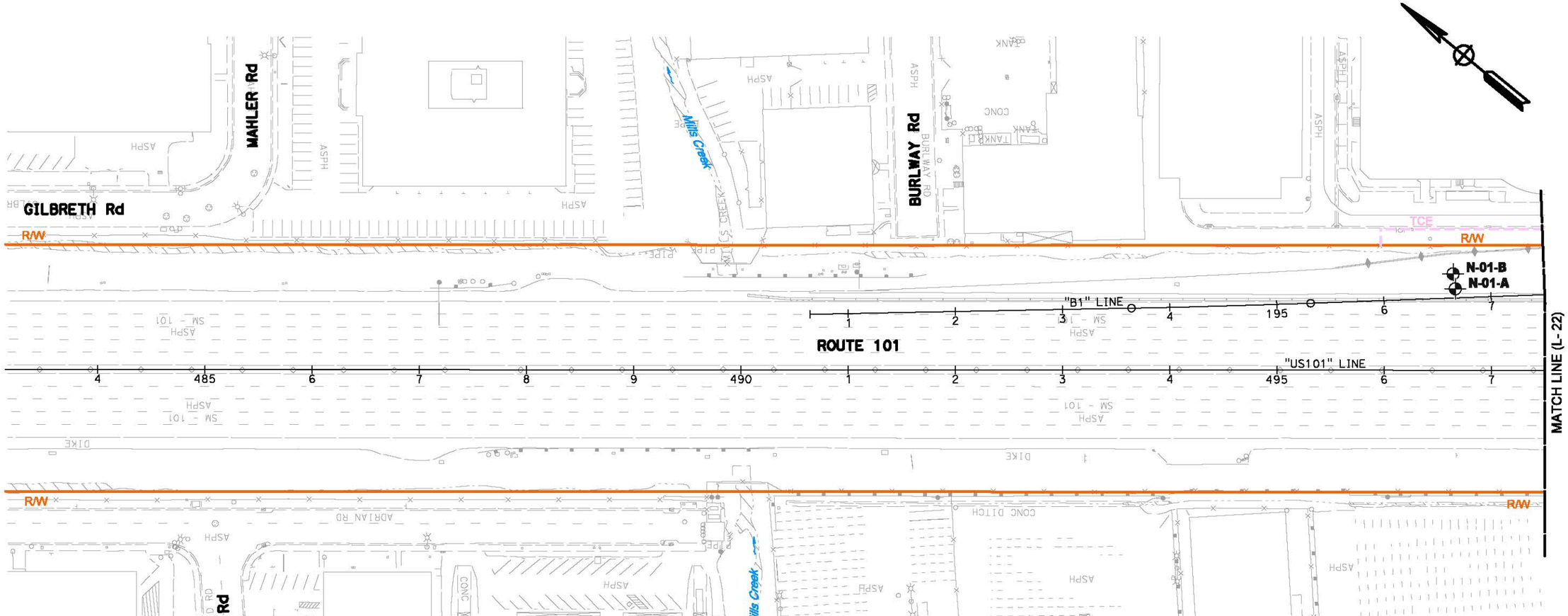
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

LEGEND:

- Stage 3 : 0-1.5': ROADWAY EXCAVATION (Type Y-2) (Aerially Deposited Lead) >1.5': NON-HAZARDOUS WASTE SOIL
- CDSM - SOIL TREATMENT SOIL CEMENT - 33% PATTERN
- CDSM - SOIL TREATMENT SOIL CEMENT - 21% PATTERN
- CDSM - SOIL TREATMENT CELLULAR CONCRETE
- BORING LOCATION
- BORING LOCATION (This STAGE)



PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT
STAGE 3 - PHASE 1A

L-21

REVISED BY . DATE REVISED .

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CONSULTANT FUNCTIONAL SUPERVISOR RAMSEY J. HISSEN

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LAST REVISION 06-28-12 DATE PLOTTED => $DATE TIME PLOTTED => $TIME

$FILE$

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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PLANS APPROVAL DATE

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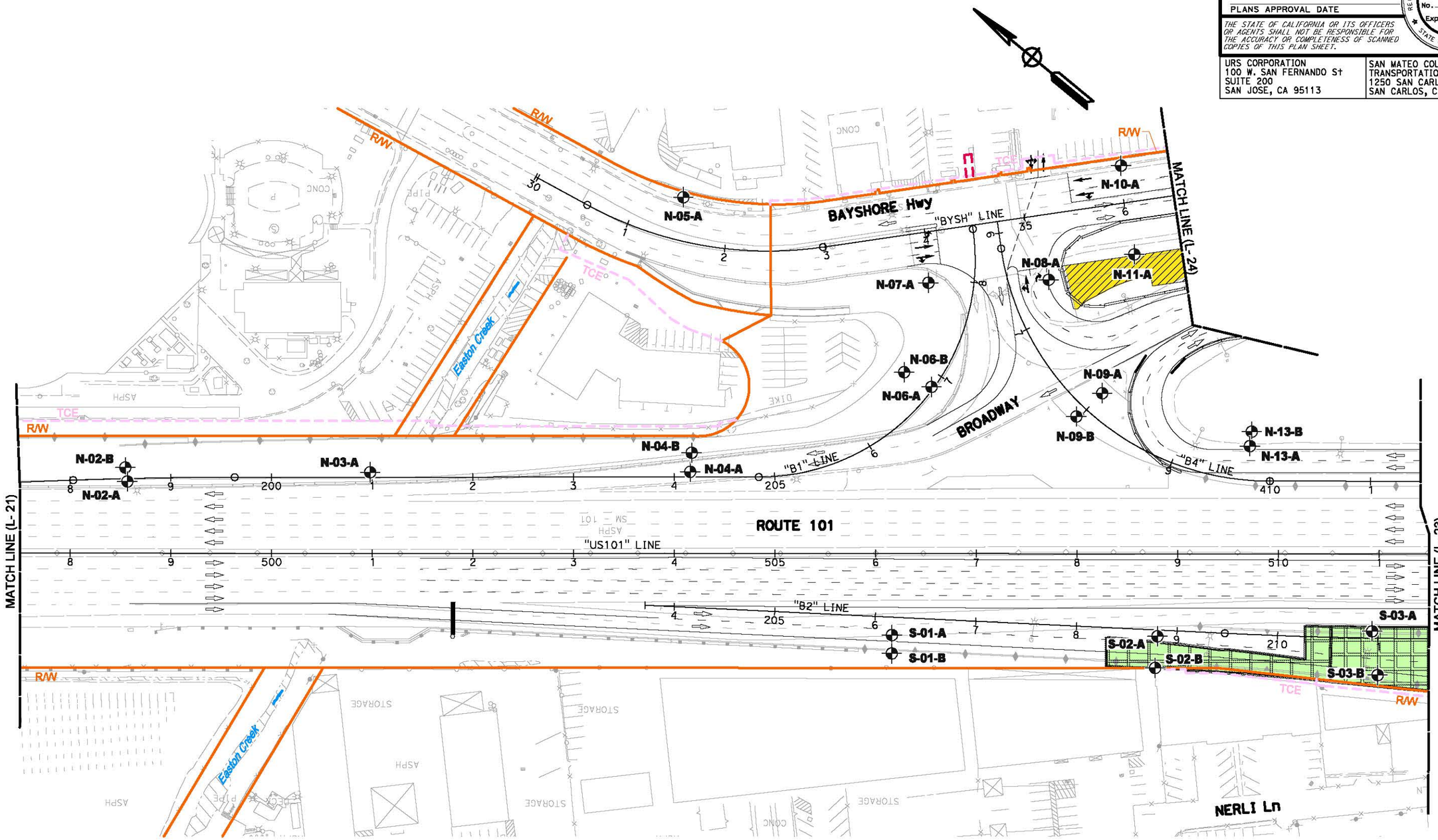

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT
STAGE 3 - PHASE 1A

L-22

REVISED BY	.
DATE REVISED	.
CALCULATED-DESIGNED BY	ABHIJEET BHOI
CHECKED BY	ELIE-ABI-JAOUDE
CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN

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LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

$FILE$

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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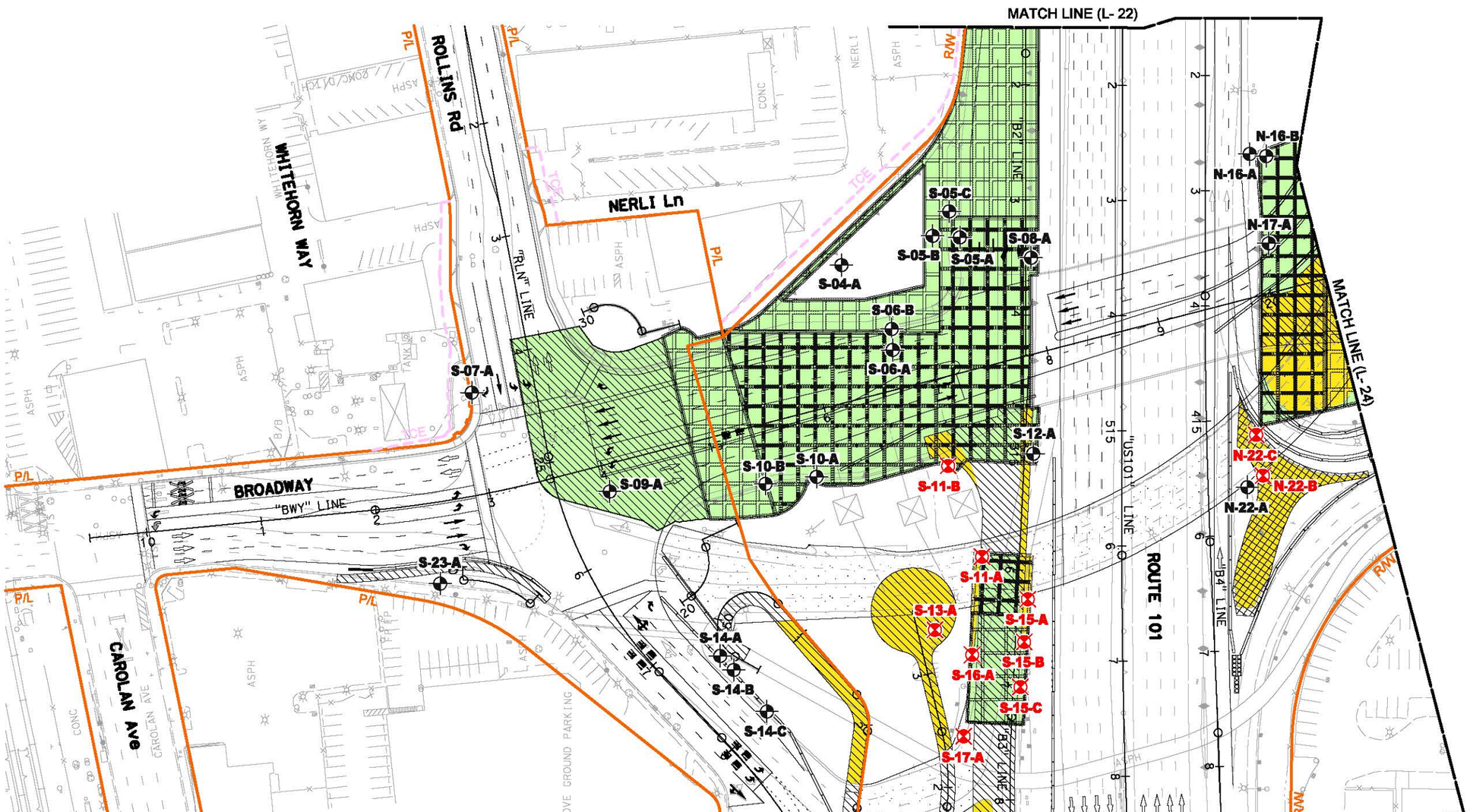
SAN CARLOS, CA 94070-1306



PRELIMINARY PLANS SUBJECT TO REVISION

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 3 - PHASE 1A

L-23

REVISED BY	.
DATE REVISED	.
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CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN

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LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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SAN CARLOS, CA 94070-1306

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 3 - PHASE 1A

L-24

REVISED BY	DATE REVISED
.	.

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CHECKED BY: ELIE-ABI-JAOUDE
CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

$FILE$

BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

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PLANS APPROVAL DATE

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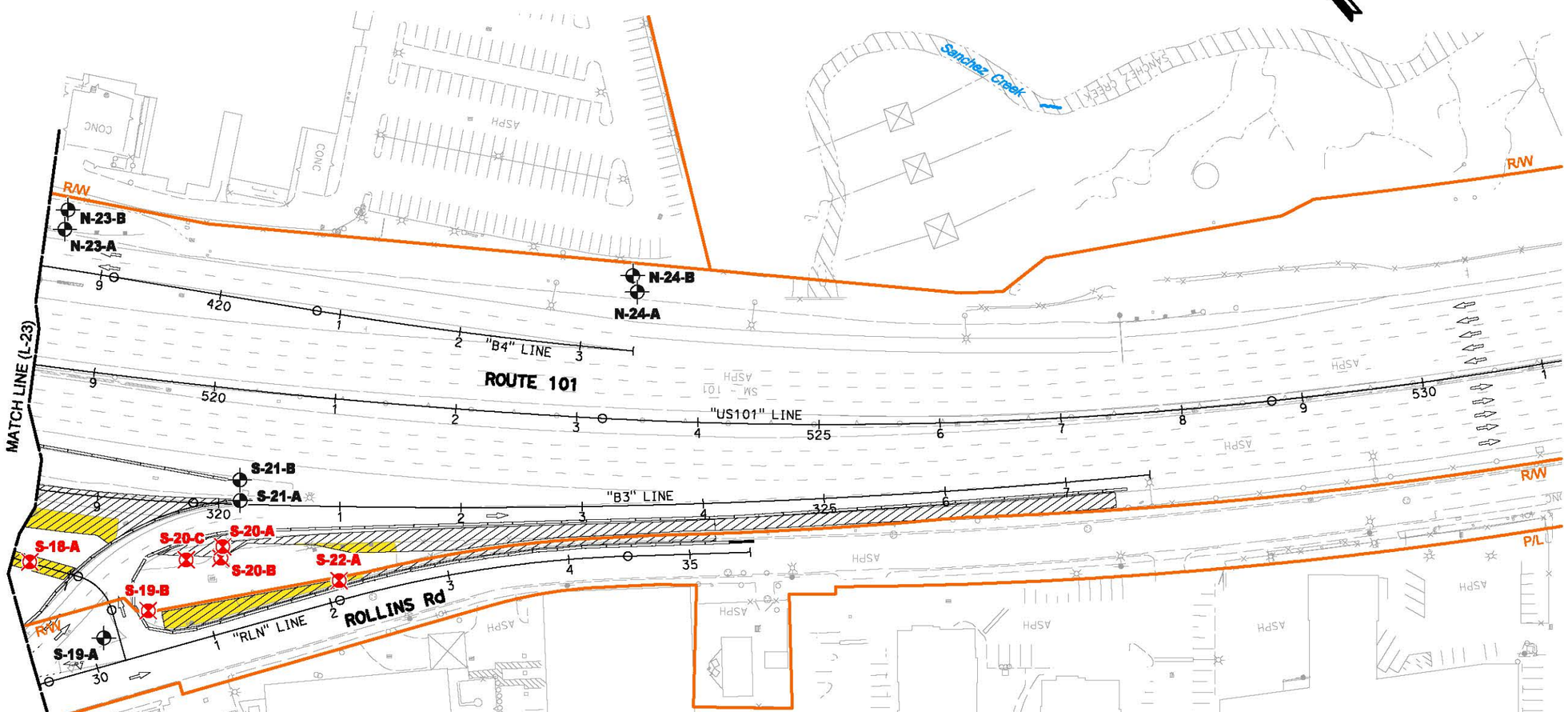
SAN CARLOS, CA 94070-1306



PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 3 - PHASE 1A

L-25

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

CALCULATED-DESIGNED BY: ABHIJEET BHOI

CHECKED BY: ELIE-ABI-JAOUDE

REVISED BY: .

DATE REVISED: .

LAST REVISION DATE PLOTTED => $DATE
06-28-12 TIME PLOTTED => $TIME

$FILE$

BORDER LAST REVISED 7/2/2010

USERNAME => $USER
DGN FILE => $REQUEST

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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TRANSPORTATION AUTHORITY
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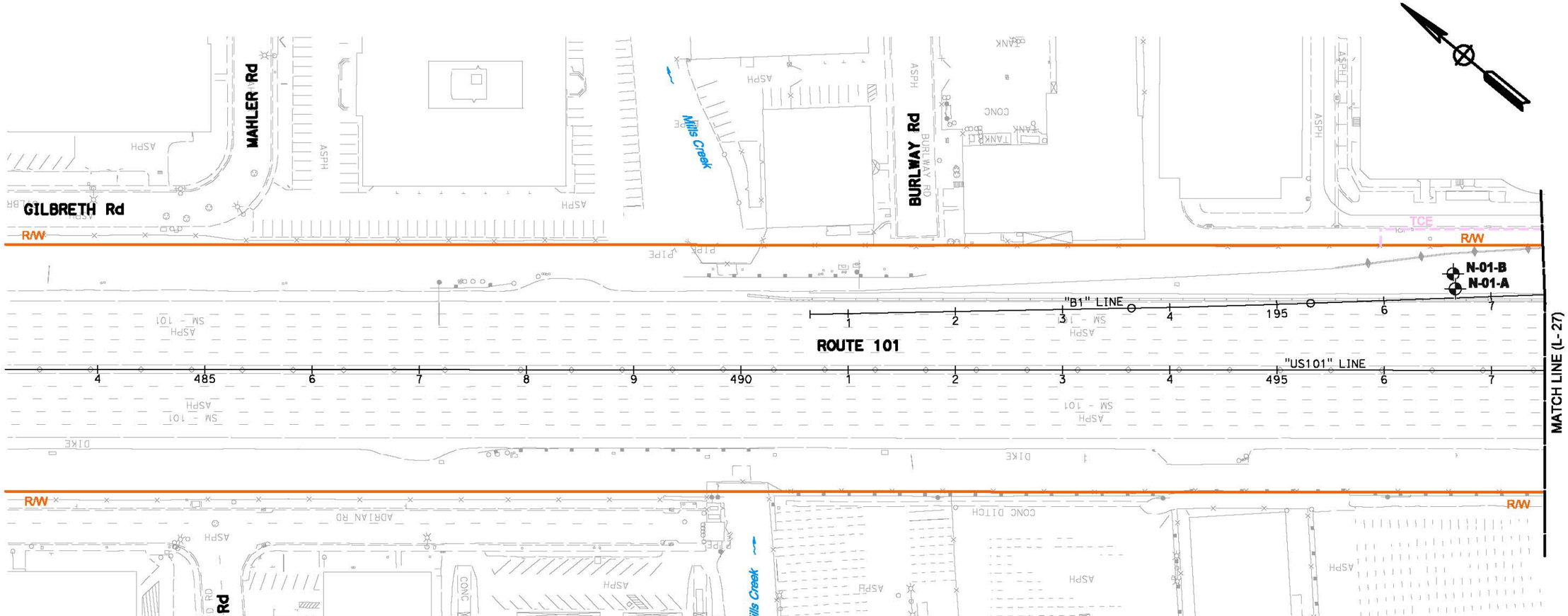
SAN CARLOS, CA 94070-1306

LEGEND:

- Stage 3: 0-1.5': ROADWAY EXCAVATION (Type Y-2) (Aerially Deposited Lead) >1.5': NON-HAZARDOUS WASTE SOIL
- CDSM - SOIL TREATMENT SOIL CEMENT - 33% PATTERN
- CDSM - SOIL TREATMENT SOIL CEMENT - 21% PATTERN
- CDSM - SOIL TREATMENT CELLULAR CONCRETE
- BORING LOCATION
- BORING LOCATION (This STAGE)



PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT
STAGE 3 - PHASE 1B

L-26

REVISED BY	DATE REVISED
.	.

CALCULATED-DESIGNED BY: ABHIJEET BHOI
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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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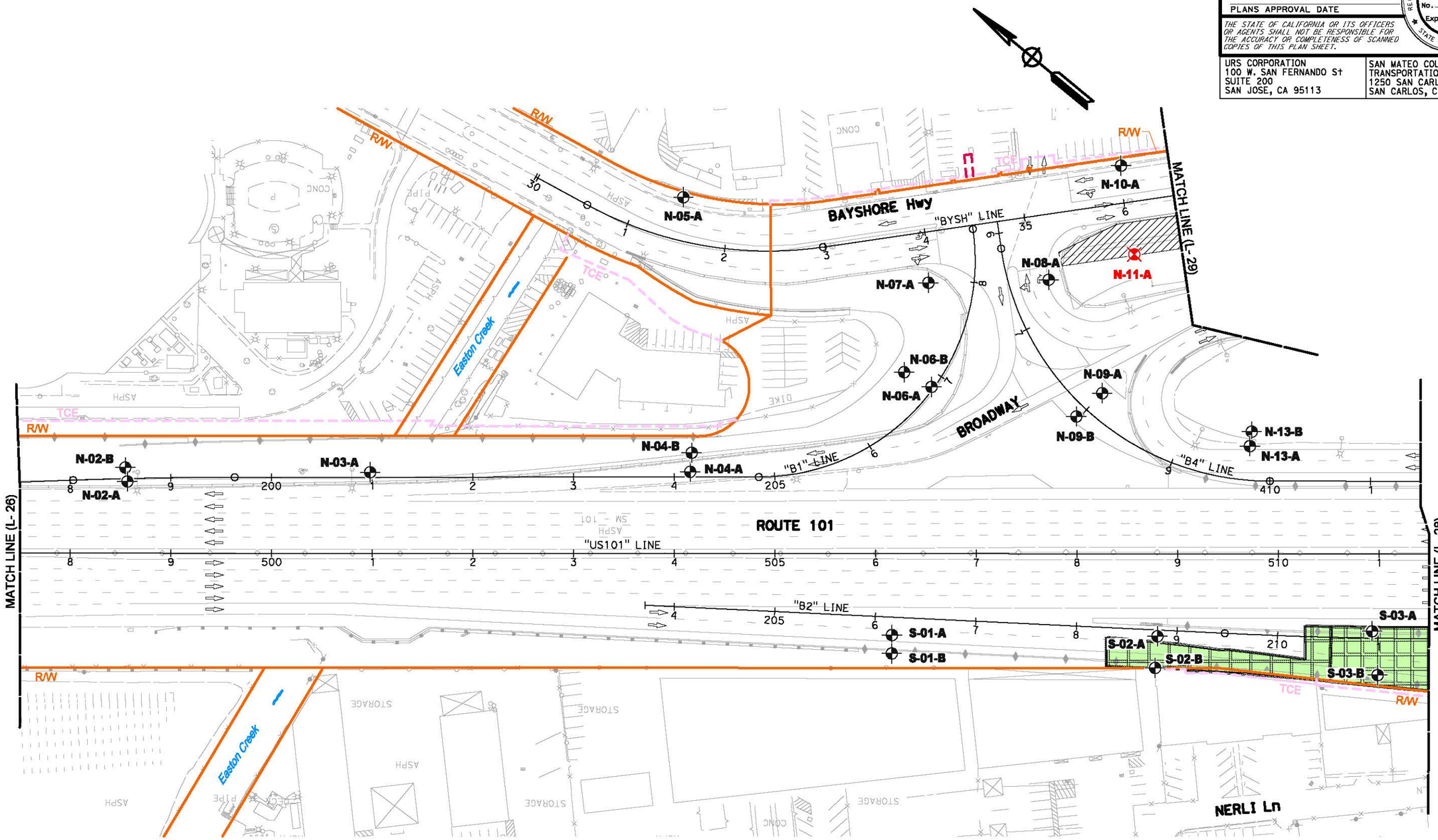

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT
STAGE 3 - PHASE 1B

L-27

REVISED BY	.
DATE REVISED	.
CALCULATED-DESIGNED BY	ABHIJEET BHOI
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CONSULTANT FUNCTIONAL SUPERVISOR	RAMSEY J. HISSEN

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LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

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PLANS APPROVAL DATE

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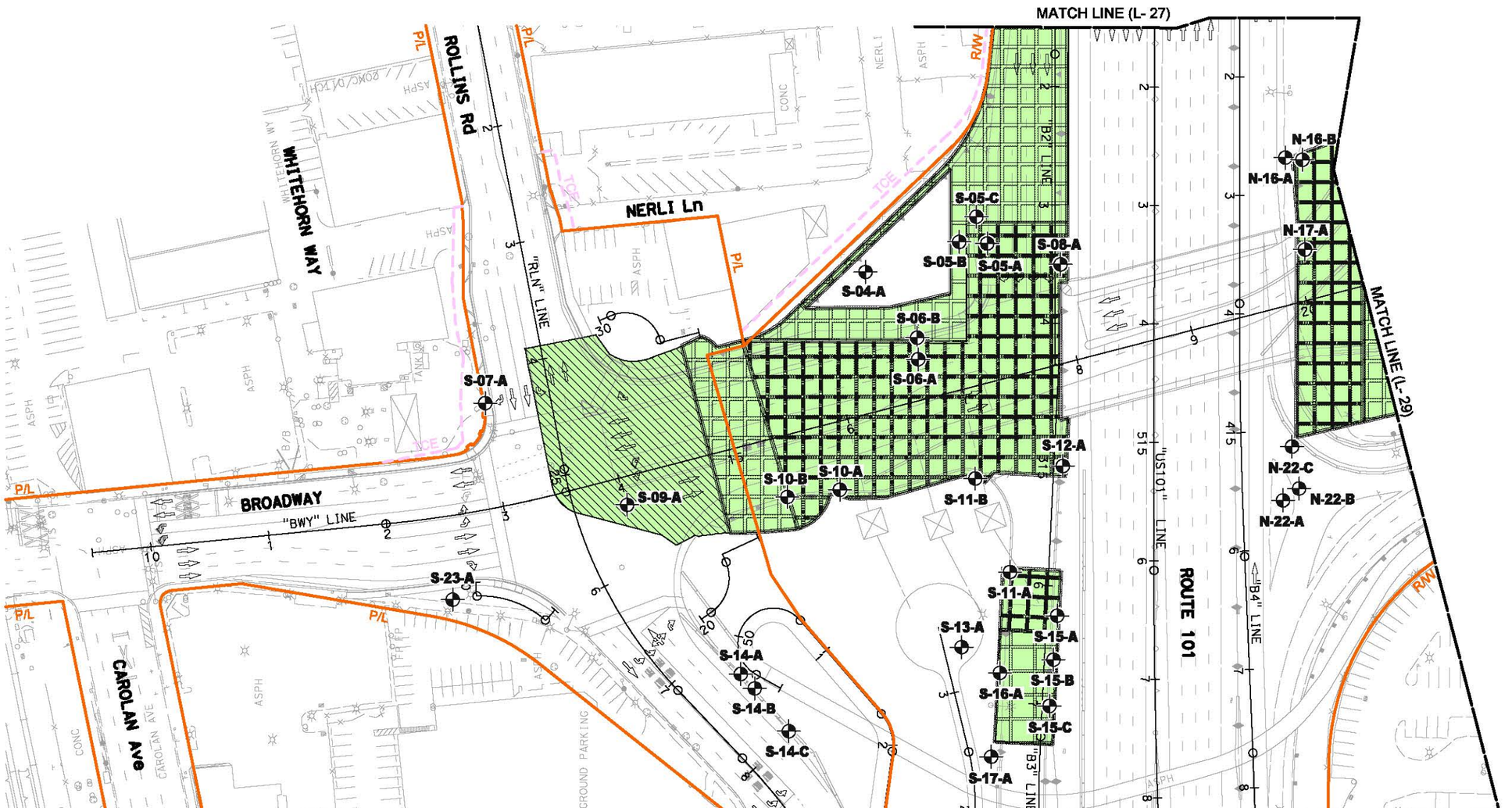

PRELIMINARY PLANS SUBJECT TO REVISION

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 3 - PHASE 1B

L-28

REVISED BY	DATE REVISED
.	.

CALCULATED-DESIGNED BY: ABHIJEET BHOI
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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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TRANSPORTATION AUTHORITY
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PRELIMINARY PLANS SUBJECT TO REVISION

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 3 - PHASE 1B

L-29

REVISED BY	DATE REVISED
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CHECKED BY: ELIE-ABI-JAOUDE
CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE .

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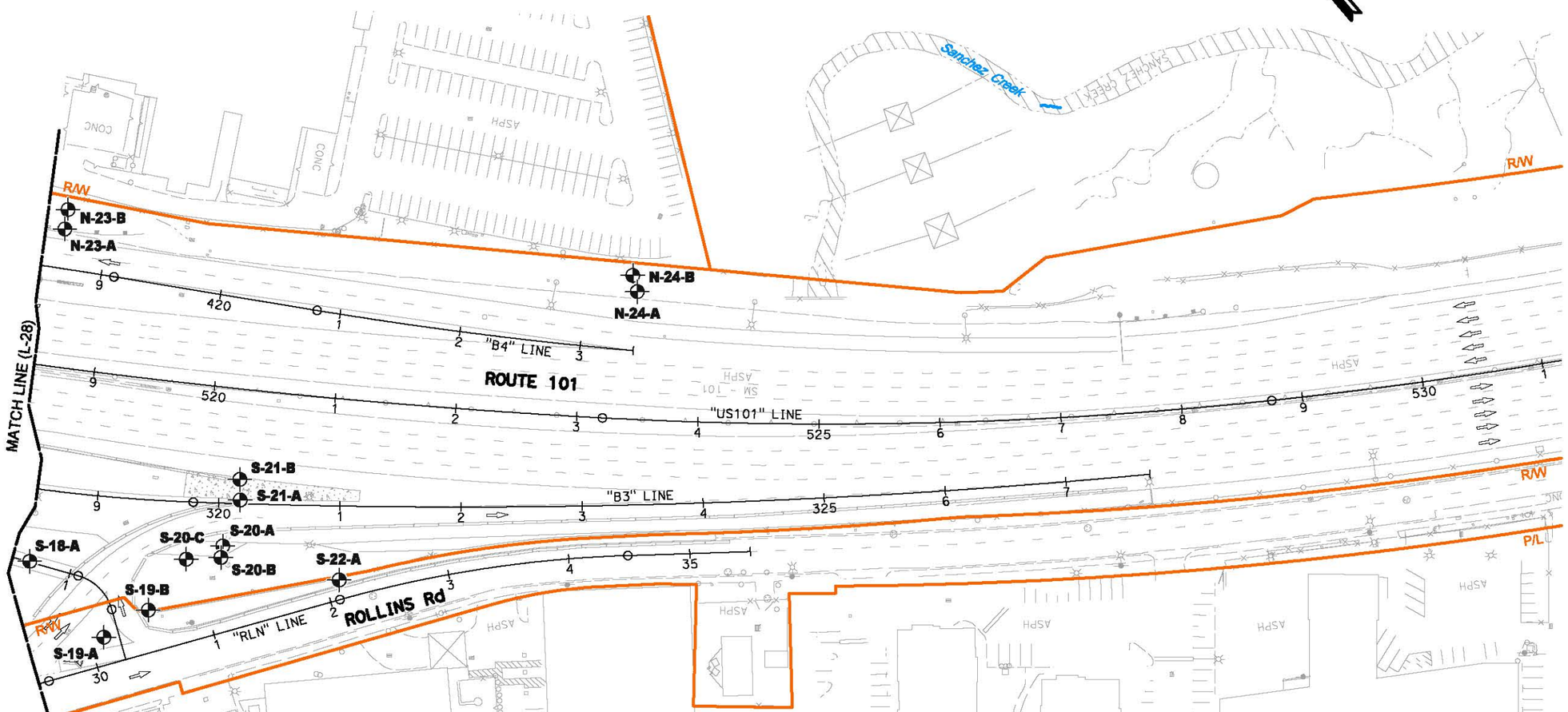

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 3 - PHASE 1B

L-30

REVISED BY	DATE REVISED
.	.

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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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Parsons

LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

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SAN CARLOS, CA 94070-1306

LEGEND:

- STAGE 3: 0-1.5' : ROADWAY EXCAVATION (Type Y-2) (Aerially Deposited Lead) >1.5': NON-HAZARDOUS WASTE SOIL
- CDSM - SOIL TREATMENT SOIL CEMENT - 33% PATTERN
- CDSM - SOIL TREATMENT SOIL CEMENT - 21% PATTERN
- CDSM - SOIL TREATMENT CELLULAR CONCRETE
- BORING LOCATION
- BORING LOCATION (This STAGE)

PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT
STAGE 3 - PHASE 2

L-31

REVISED BY	DATE REVISED
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CALCULATED-DESIGNED BY: ABHIJEET BHOI
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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

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BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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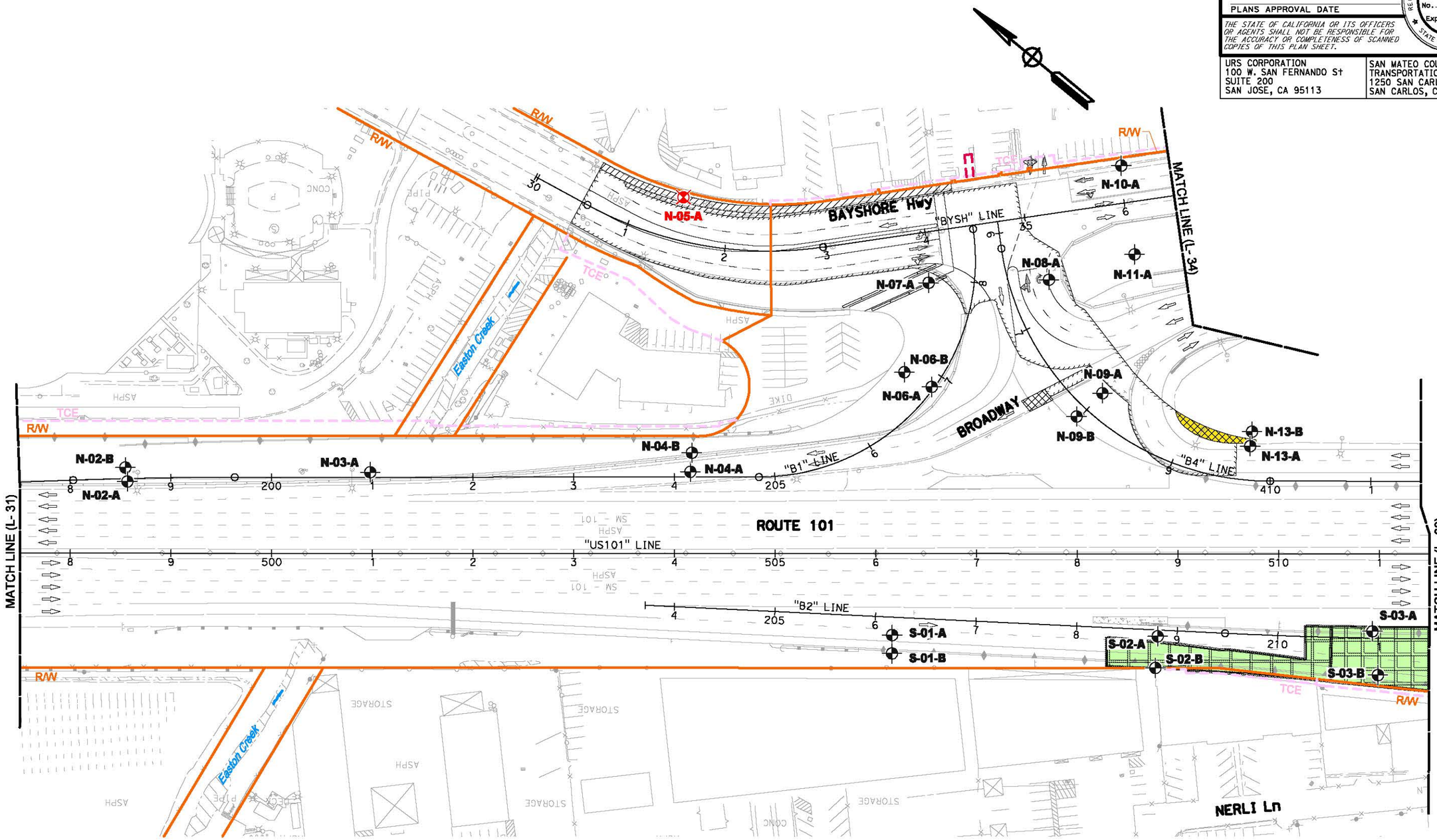
SAN CARLOS, CA 94070-1306



PRELIMINARY PLANS SUBJECT TO REVISION

0 100 200 Ft

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 3 - PHASE 2

L-32

REVISED BY	DATE REVISED
.	.

CALCULATED-DESIGNED BY: ABHIJEET BHOI
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CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

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LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

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BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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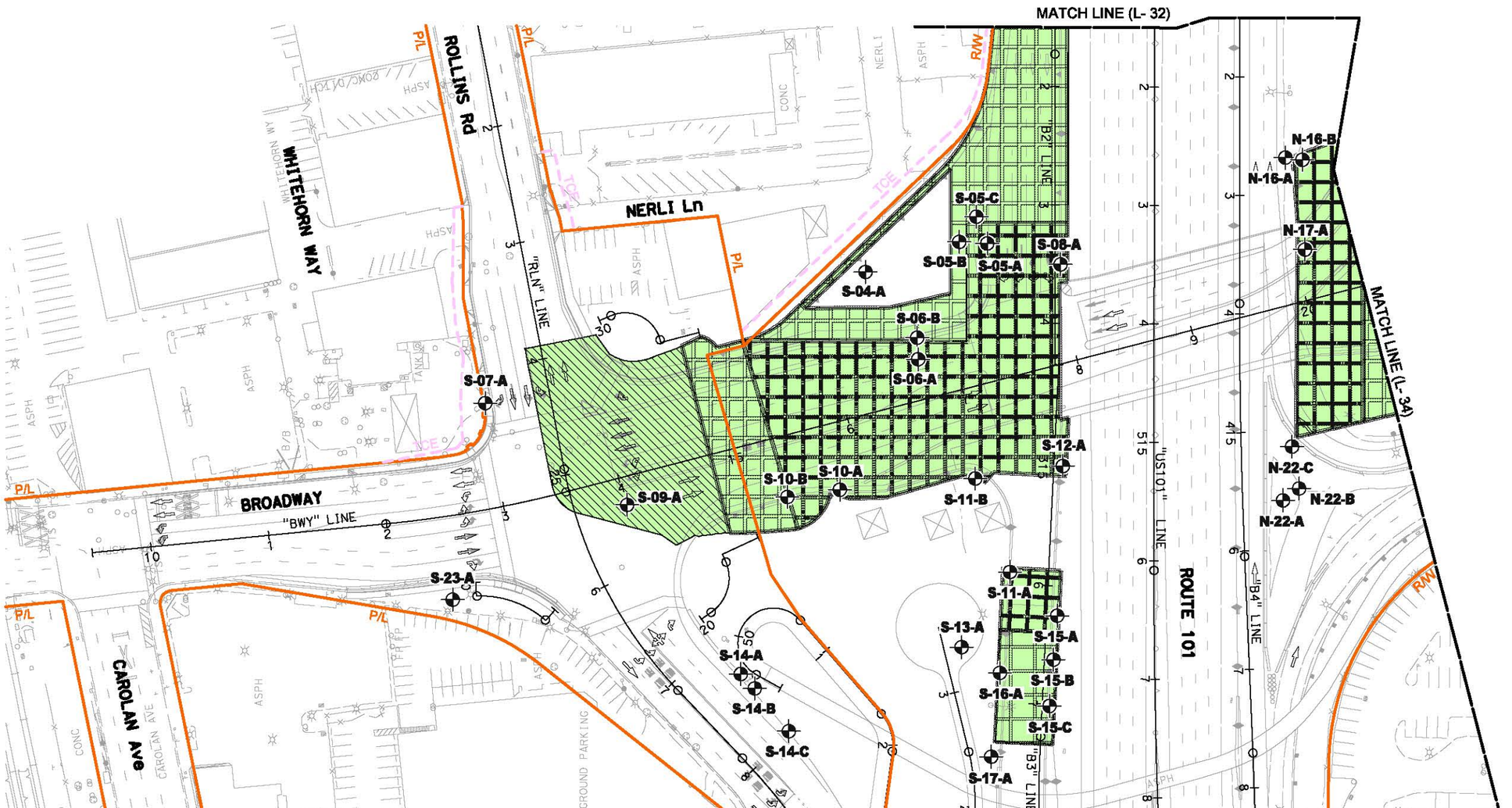
SAN CARLOS, CA 94070-1306



PRELIMINARY PLANS SUBJECT TO REVISION

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 3 - PHASE 2

L-33

REVISED BY	DATE REVISED
.	.

CALCULATED-DESIGNED BY: ABHIJEET BHOI
CHECKED BY: ELIE-ABI-JAOUDE
CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

$FILE$

BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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SAN CARLOS, CA 94070-1306

PRELIMINARY PLANS SUBJECT TO REVISION

AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 3 - PHASE 2

L-34

REVISED BY	DATE REVISED
.	.

CALCULATED-DESIGNED BY: ABHIJEET BHOI
CHECKED BY: ELIE-ABI-JAOUDE

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY J. HISSEN

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

LAST REVISION 06-28-12 | DATE PLOTTED => $DATE | TIME PLOTTED => $TIME

$FILE$

BORDER LAST REVISED 7/2/2010 | USERNAME => $USER | DGN FILE => $REQUEST | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
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PLANS APPROVAL DATE

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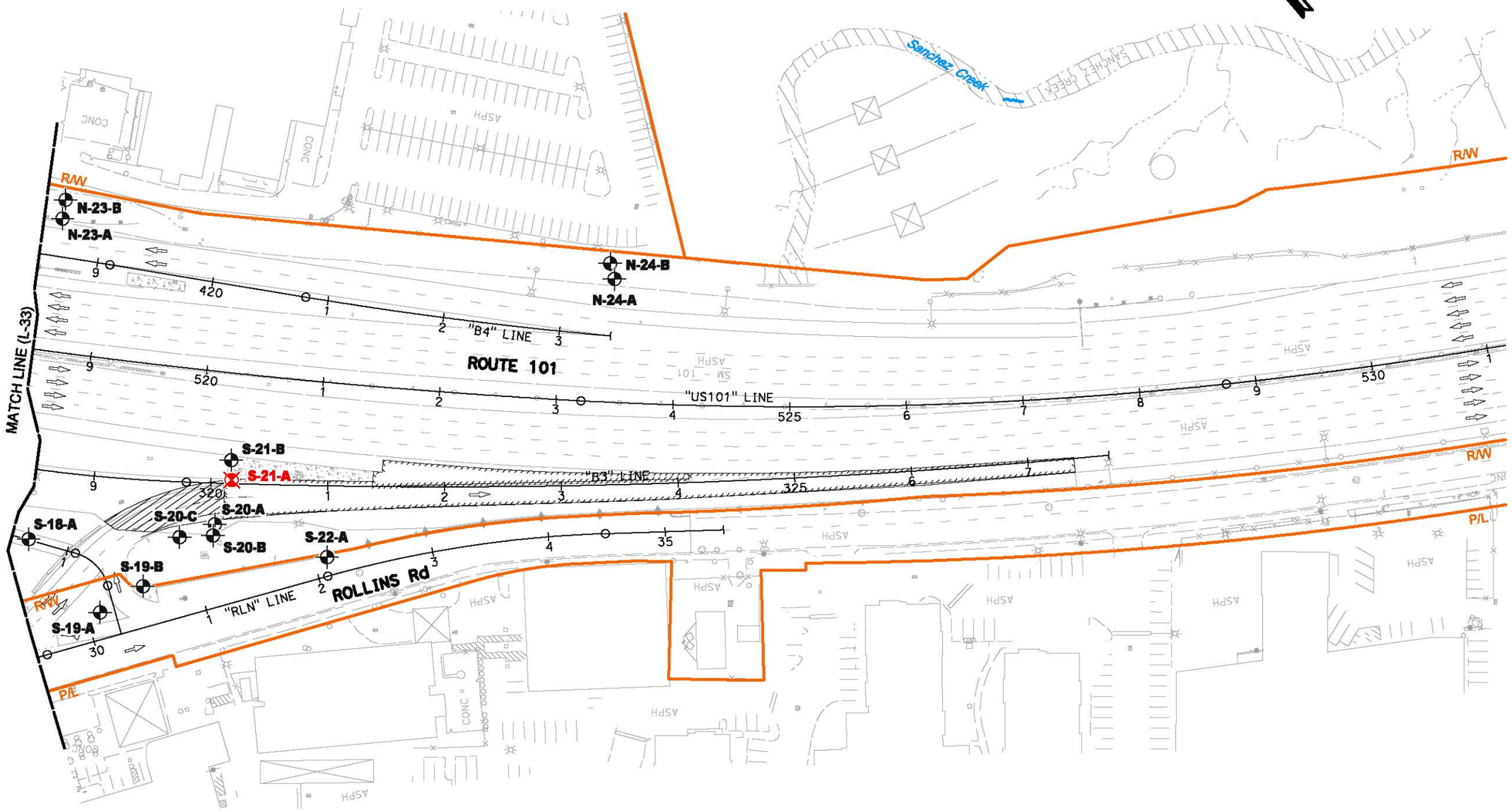

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STAGE 3 - PHASE 2

L-35

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LEGEND:

STAGE 4: 0-1.5': ROADWAY EXCAVATION (Type Y-1) (Aerially Deposited Lead)
1.5'-3.0': ROADWAY EXCAVATION (Type Y-2) (Aerially Deposited Lead)
>3.0': NON-HAZARDOUS WASTE SOIL

CDSM - SOIL TREATMENT
SOIL CEMENT - 33% PATTERN

CDSM - SOIL TREATMENT
SOIL CEMENT - 21% PATTERN

CDSM - SOIL TREATMENT
CELLULAR CONCRETE

BORING LOCATION

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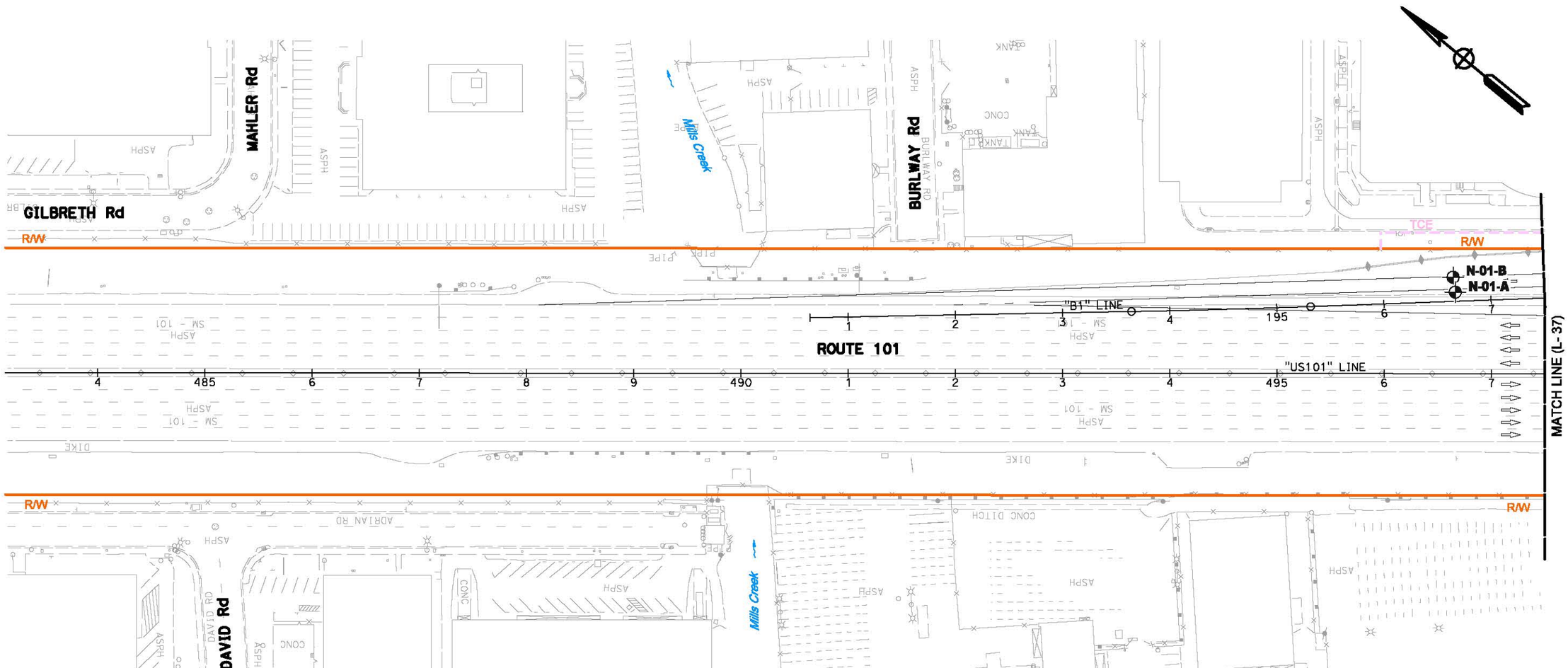

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AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT
STAGE 4 - PHASE 1

L-36

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- CDSM - SOIL TREATMENT CELLULAR CONCRETE
- BORING LOCATION
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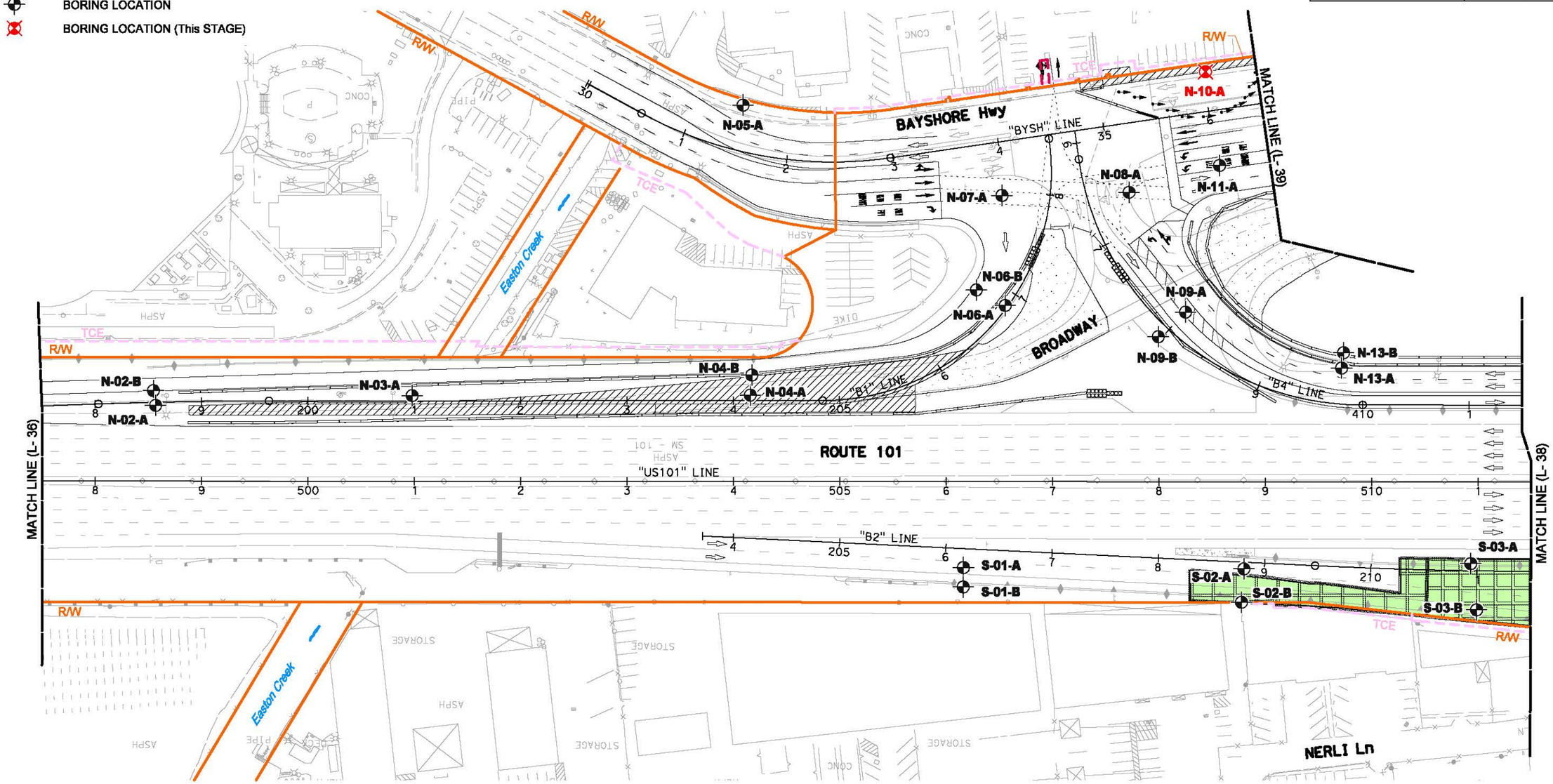

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STAGE 4 - PHASE 1

L-37

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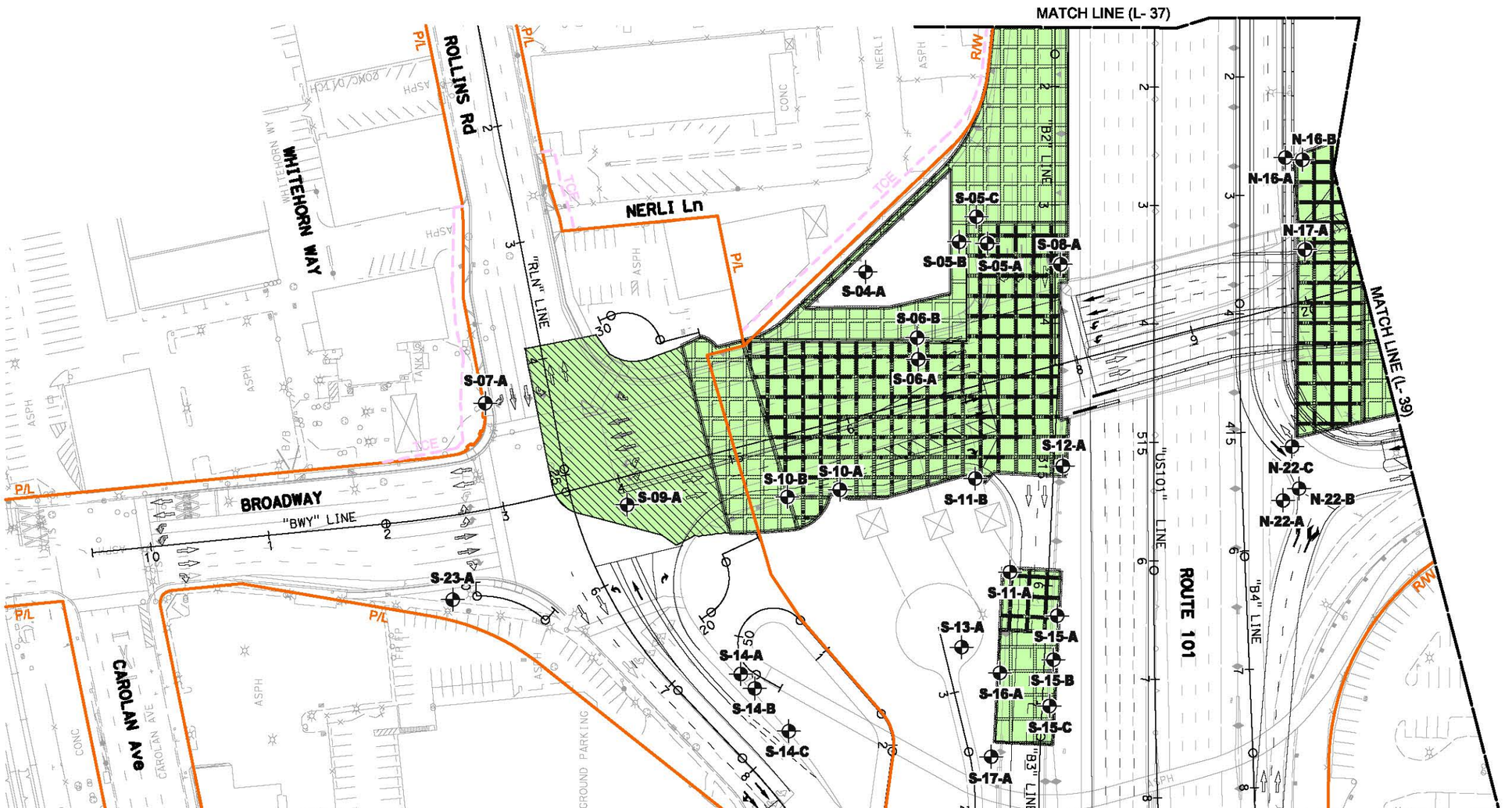

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STAGE 4 - PHASE 1

L-38

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STAGE 4 - PHASE 1

L-39

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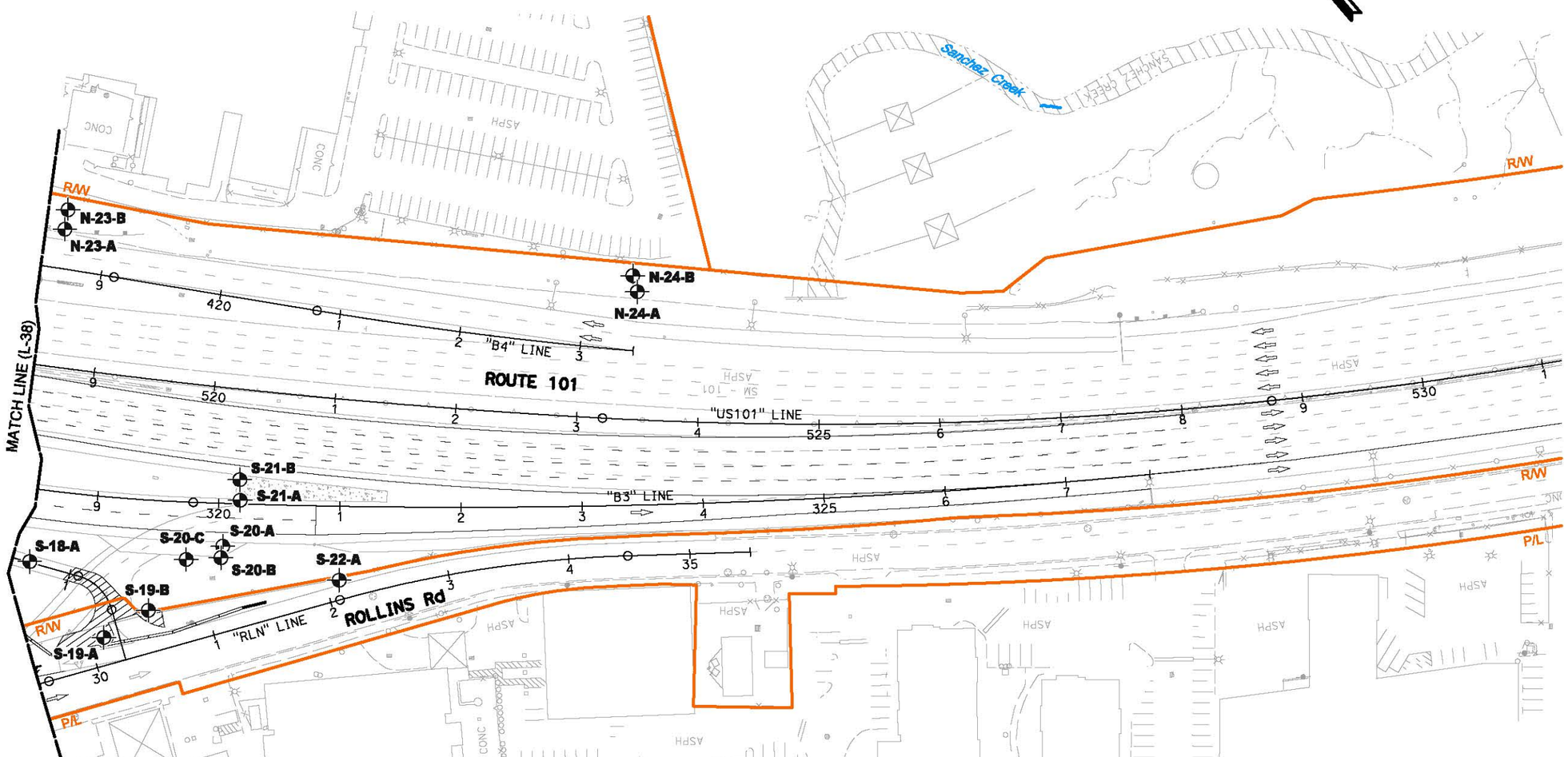

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STAGE 4 - PHASE 1

L-40

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CELLULAR CONCRETE

BORING LOCATION

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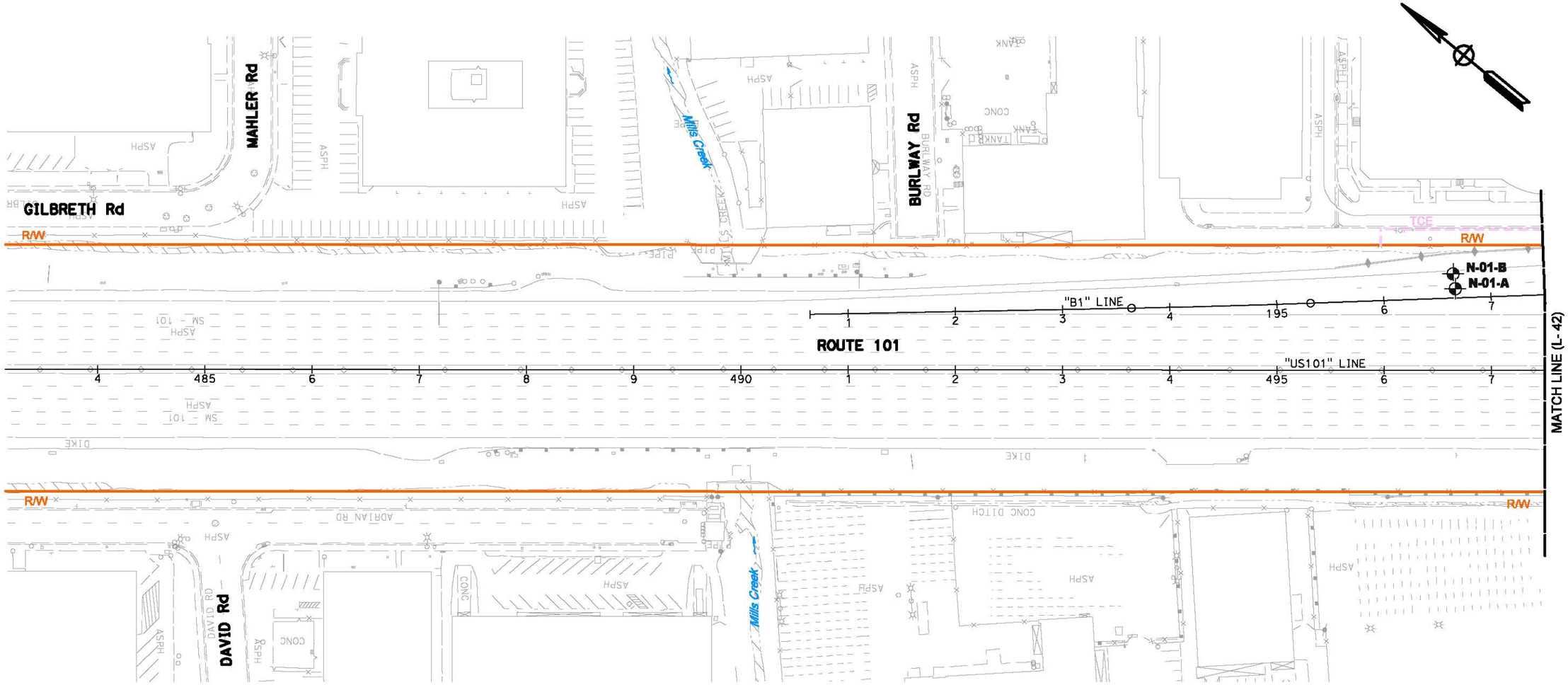

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STAGE 5 - PHASE 1

L-41

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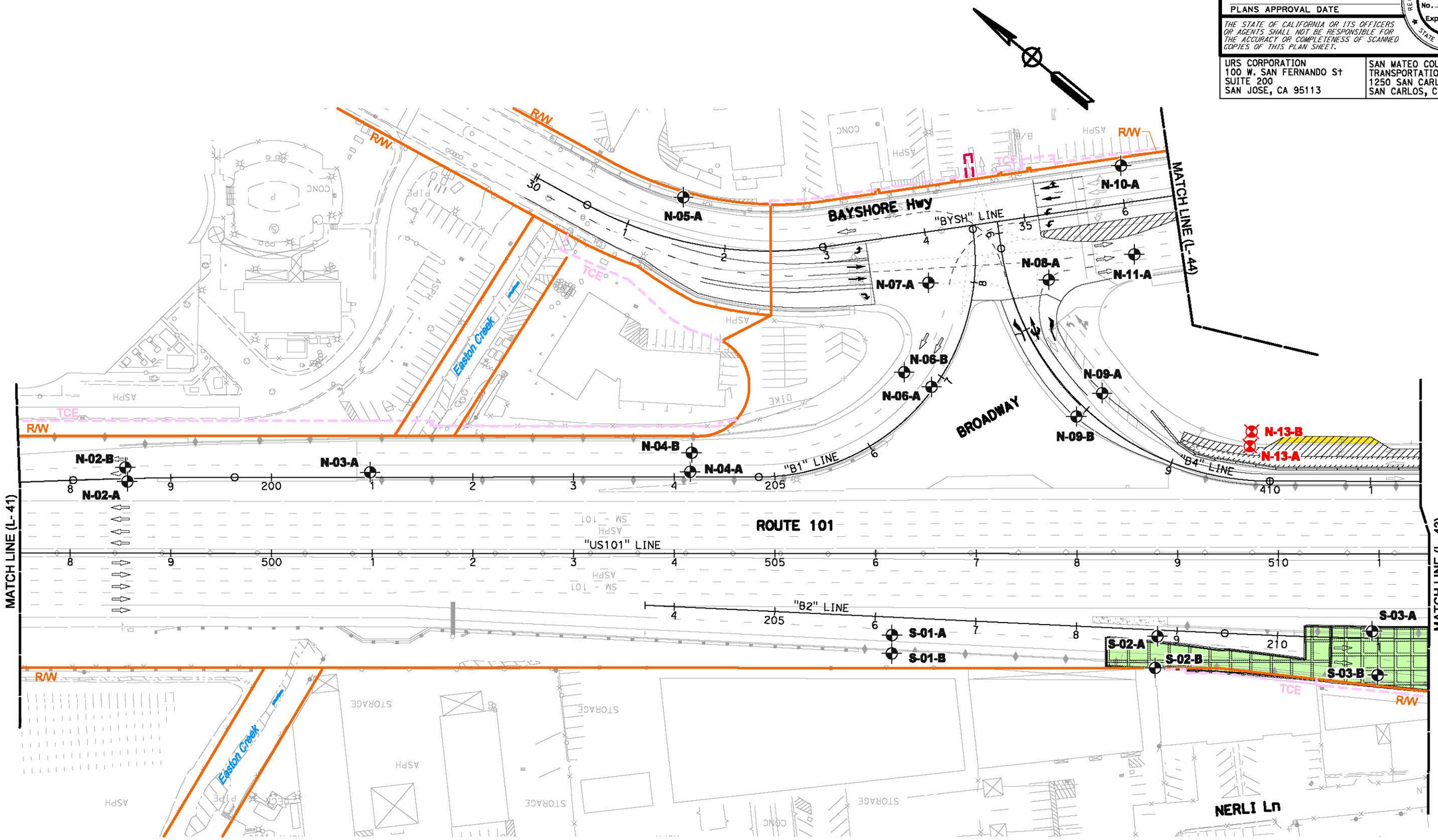

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AERIALLY DEPOSITED LEAD REUSE/DISPOSAL LAYOUT

STAGE 5 - PHASE 1

L-42

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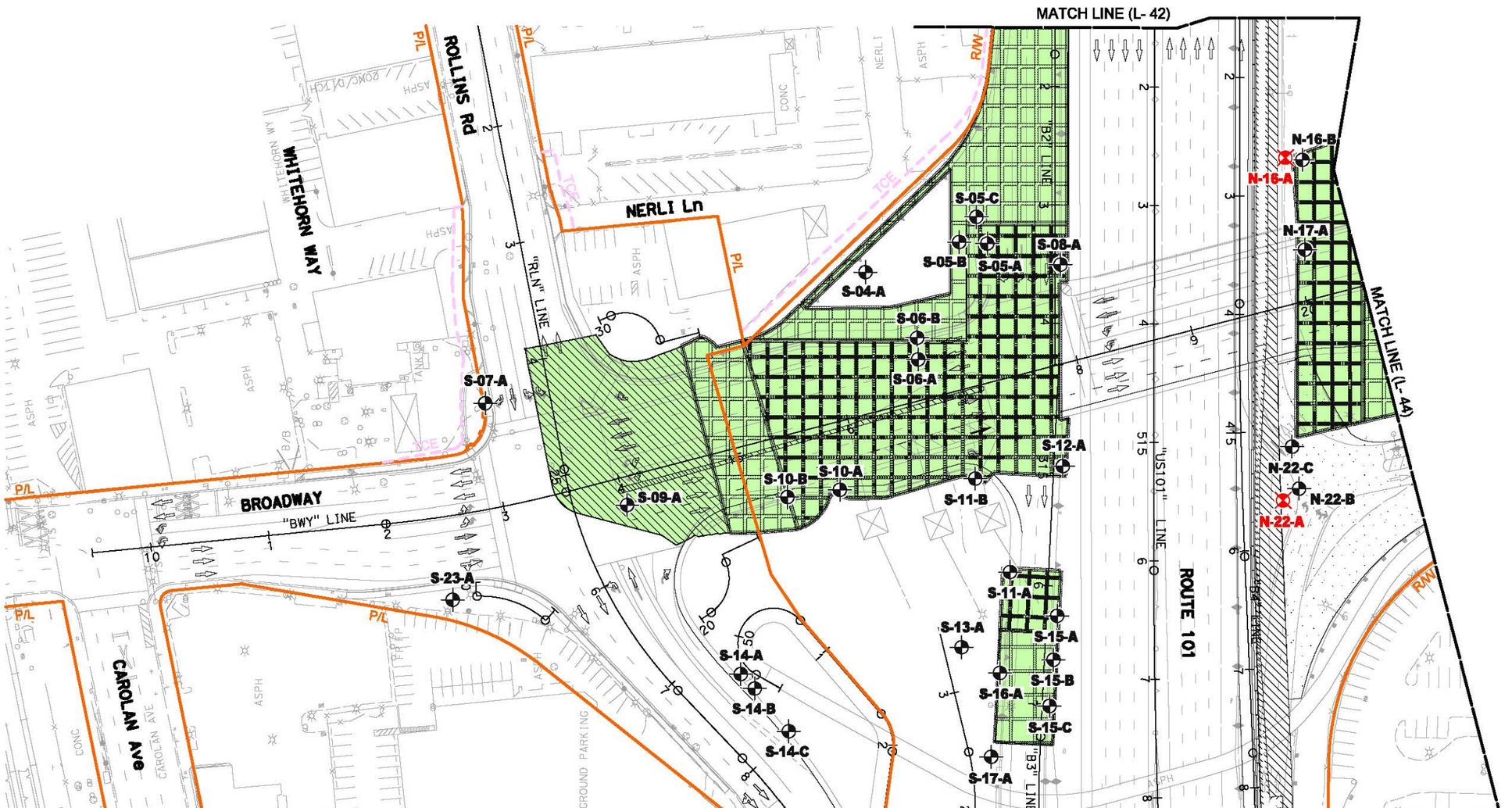

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STAGE 5 - PHASE 1

L-43

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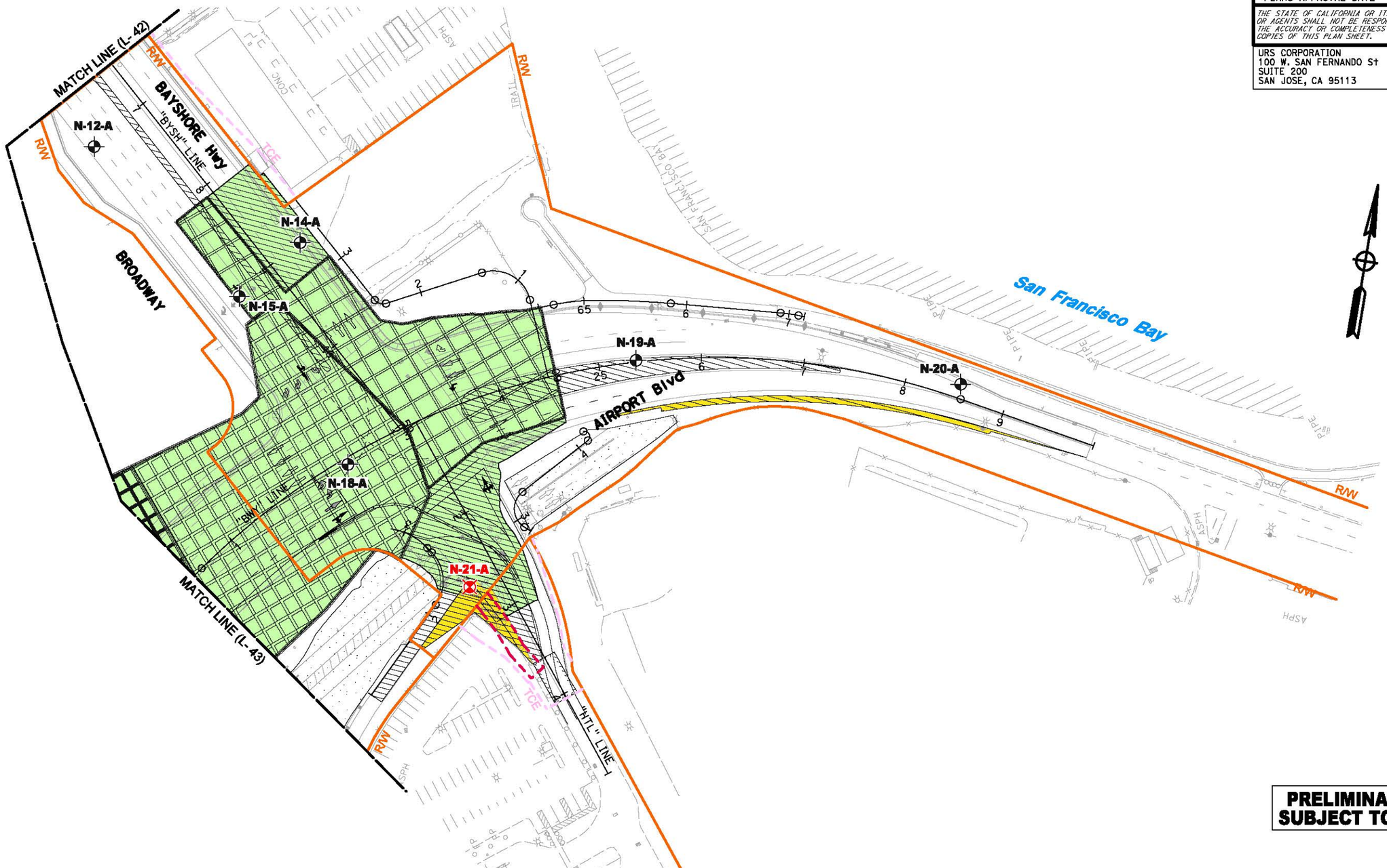

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STAGE 5 - PHASE 1

L-44

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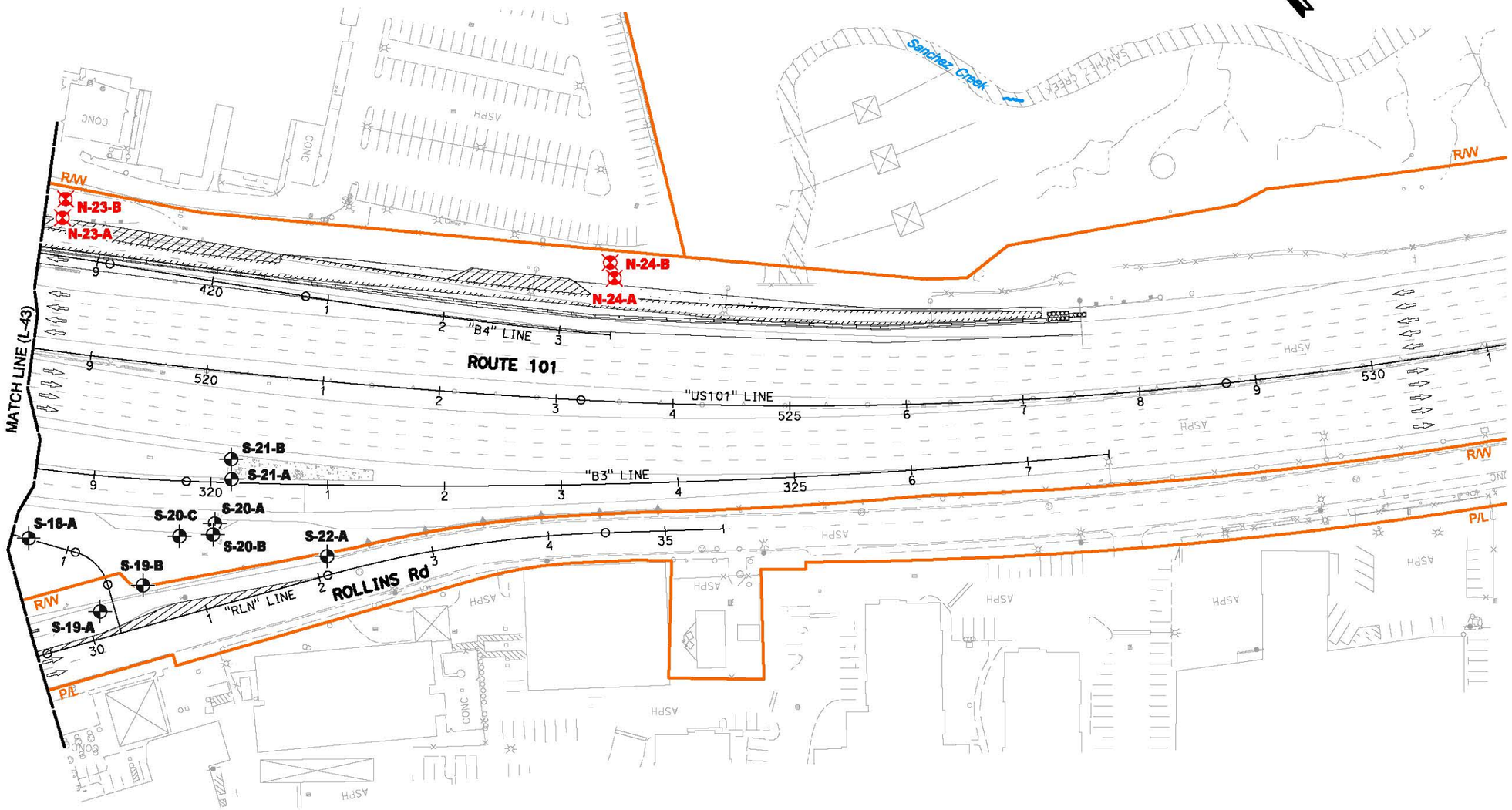

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STAGE 5 - PHASE 1

L-45

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US101/BROADWAY INTERCHANGE RECONSTRUCTION PROJECT

PS&E Phase

Drainage Report

April 17, 2013

THE CITY OF BURLINGAME INCORPORATED 1908

SAN MATEO COUNTY Transportation Authority

Caltrans

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04-SM-101
PM 16.3/17.1
EA-04-235841

US 101/Broadway Interchange Reconstruction Project
City of Burlingame, San Mateo County, California

Drainage Report

Submitted to:
San Mateo County Transportation Authority
California Department of Transportation

This report has been prepared by or under the supervision of the following Registered Engineer. The Registered Civil Engineer attests to the technical information contained herein and has judged the qualifications of any technical specialists providing engineering data upon which recommendations, conclusions, and decisions are based.

_____
Andrew Sekioka, P.E.
Registered Civil Engineer

_____
Date

April 2013

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Executive Summary

This document is the Drainage Report for the proposed United States 101 (US 101)/Broadway Interchange Reconstruction Project (Project) located in the City of Burlingame, San Mateo County, California. The purpose of this report is to summarize the design criteria, discuss known drainage issues, examine design reference documents, and analyze the proposed drainage design for the Project.

The Project improvements will include replacing the Broadway overcrossing with a wider structure, reconfiguring all northbound and southbound ramp connections to US 101, and installing ramp meters on northbound and southbound on-ramps.

The existing drainage systems within the Project limits consist of roadside ditches, cross culverts, asphalt concrete (AC) dikes, inlets, and longitudinal drainage systems. These drainage systems drain either to Mills Creek, Easton Creek, Sanchez Creek, or the "unnamed" channel near the gas station at the corner of Airport Boulevard and Bayshore Highway.

The principal features of the Project improvements that will impact the existing drainage facilities include the replacement of the Broadway overcrossing with a new wider structure, the re-alignment of the Broadway bridge approach embankment, the widening of on- and off-ramps, the addition of concrete raised medians, and the construction of new retaining walls to support the new Broadway overcrossing.

The drainage design improvements will accommodate the increase in flow from additional impervious areas. The drainage design will include additional inlets, longitudinal systems, and modifications to existing drainage systems as a result of the addition of concrete barriers, retaining walls, and roadway widening. The drainage design also includes extension of the Easton Creek box culvert to accommodate the US101 northbound on-ramp widening. The design will maintain existing drainage patterns to the maximum extent practicable. The proposed drainage systems will be designed to intercept and treat stormwater runoff from the Project and areas adjacent to Caltrans' right-of-way (R/W), including areas within the City of Burlingame.

Issues that were considered during the design of the drainage systems in the area include the relatively flat terrain, the high runoff potential due to the local soil conditions, and the flooding potential identified on the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM). The elevation in the Project area ranges from 4 to 12 ft and slopes east toward San Francisco Bay. The soils in the area consist mostly of Bay Mud, which has a high runoff rate. The FIRM for the area shows flooding in parts of the proposed Project area. Mitigation for the flooding is examined in detail in the Location Hydraulic Study (LHS), some of which is also discussed in this report.

Any proposed drainage improvements within the Caltrans' ROW will meet the Caltrans' design criteria, and any proposed drainage improvements that affect local drainage

systems must also meet local agency requirements and regulatory requirements. This Project will not significantly affect the existing drainage patterns. The increased flows are not significant when compared to the overall watersheds of the receiving water bodies of the Project. In addition, the Project will incorporate Best Management Practices (BMP), including water quality treatment measures, to address potential temporary and permanent water quality impacts from the Project.

This Project is not susceptible to hydromodification mitigation requirements because two hydromodification exempt zones ("Low gradient" and "Hardened channel") overlap in the Project area.

Acronyms

AC	Asphalt Concrete
APC	Alternative Pipe Culvert
APE	Area of Potential Effect
BMP	Best Management Practices
BCDC	San Francisco Bay Conservation and Development Commission
Caltrans	California Department of Transportation
CMP	Corrugated Metal Pipe
cfs	cubic foot per second
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
ft	feet
HDM	Highway Design Manual
HDPE	High-Density Polyethylene
HEC	Hydraulic Engineering Circular
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HGL	Hydraulic Grade Line
hr	hour
HSG	Hydrologic Soil Group
IDF	Intensity Duration Frequency
in.	inch
in/hr	inches per hour
LHS	Location Hydraulic Study
LOS	Level of Service
mph	miles per hour
NB	Northbound
NRCS	Natural Resources Conservation Service
PA/ED	Project Approval/Environmental Document
PS&E	Plans, Specifications and Estimates
PSR	Project Study Report
RCB	Reinforced concrete box
R/W	Right of way
SB	Southbound
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SMCTA	San Mateo County Transportation Authority
US 101	United States 101
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
WSS	Web Soil Survey

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1 GENERAL DESCRIPTION

1.1 Project Description

The California Department of Transportation (Caltrans), in cooperation with the San Mateo County Transportation Authority (SMCTA), proposes to reconstruct the United States 101 (US 101)/Broadway Interchange Project (Project) in the City of Burlingame, San Mateo County, California. The Project will replace the existing Broadway overcrossing with a new wider structure, reconfigure all northbound (NB) and southbound (SB) ramp connections to US 101, and install ramp meters on the NB and SB on-ramps. The total length of the Project is 0.76 miles (from Post Miles 16.30 to 17.06). The Project area is between East Millbrae Avenue to the north and Anza Boulevard to the south. The purpose of the Project is to reduce congestion, enhance safety, and improve performance of the interchange. The Project improvements will also include enhanced pedestrian and bicycle access over the freeway. The Project Vicinity Map and Project Location Map are shown in Figure 1 and Figure 2, respectively.

The Project will replace the existing interchange with a combination buttonhook and diamond configuration as recommended in the 2005 Project Study Report (PSR), which has been further refined in the current phase. The Project will include constructing a new seven-lane Broadway overcrossing approximately 170 feet (ft) to the north of the existing four-lane structure. The overcrossing will have a 10-foot sidewalk on the north side, 5-foot shoulders on each side, and a 3-foot raised median. Broadway will be realigned to extend straight across US 101 from the Broadway/Rollins Road intersection in the west to Bayshore Highway in the east, eliminating the existing curvilinear alignment. The northern terminus of Airport Boulevard will be shifted approximately 130 ft to the north to meet the new eastern touchdown of the overcrossing and maintain a four-leg intersection with Broadway, Bayshore Highway, and the entrance to the Crowne Plaza Hotel.

In general, the proposed ramps will have standard 12-ft-wide lanes and standard shoulders as required. Side slopes of 4:1 (H:V) or flatter will be used where feasible, and 2:1 or flatter as required for the embankments. Retaining walls are also proposed within the Project limits to minimize the need for right-of-way (R/W) acquisition. Type 60D concrete barriers with minimum 10-ft shoulders will be constructed in front of any cut retaining walls for protection from vehicular collisions. New traffic signals and street lights will be installed as part of the Project.

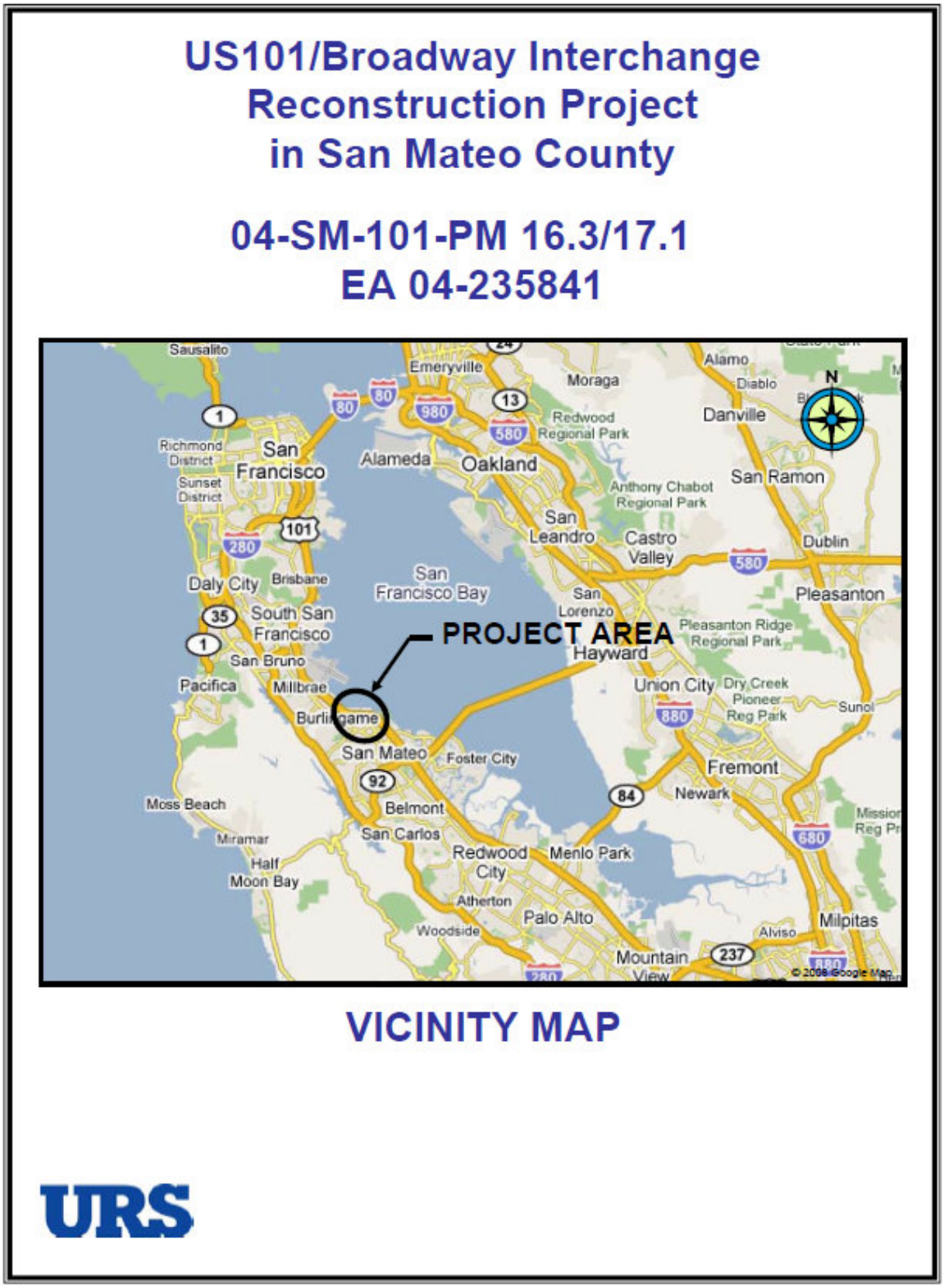

Figure 1. Vicinity Map

Source: URS Corporation

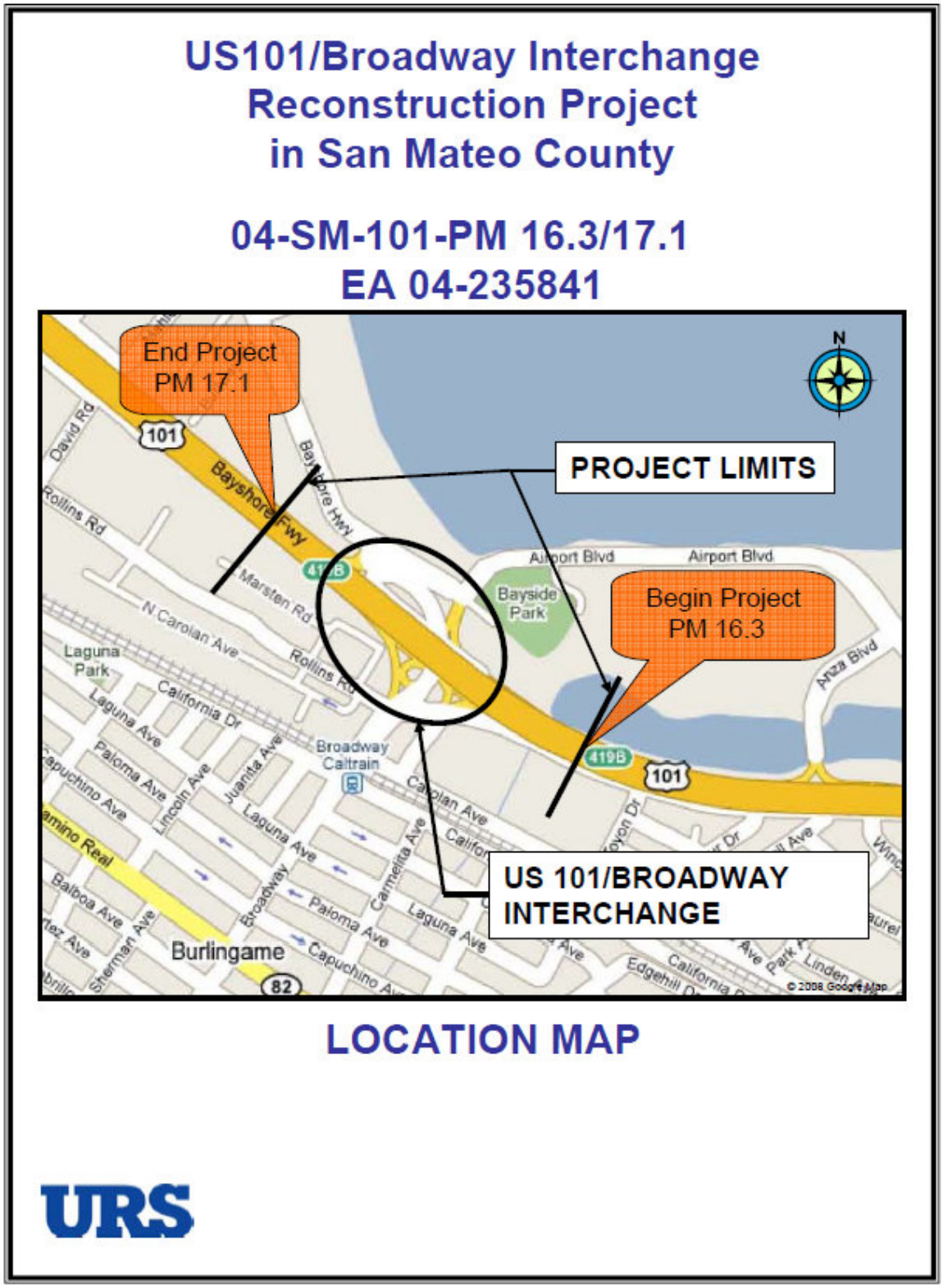

Figure 2. Location Map

Source: URS Corporation

1.2 Need for Project

The purpose of the Project is to reconfigure the US 101/Broadway Interchange to reduce traffic congestion, enhance safety and improve traffic operation performance. Specifically, the Project will provide the following vehicular and pedestrian operation improvements to the interchange and the local road network:

1. Replace or reconstruct all existing on- and off-ramps. The proposed ramps will provide additional lanes and additional storage and reduce queue lengths.

2. Replace the Broadway overcrossing with a wider structure allowing seven lanes to accommodate projected traffic growth.

3. Ensure all intersections operate at acceptable of levels of service (LOS D or better), and where feasible, show an improvement in the 2035 Build Condition compared to the 2035 no-build conditions.

4. Improve system performance with new geometry that eliminates the present circuitous traffic movements and short weaving length between the loop ramps in the SB direction and the single-lane off-ramp that branches to two separate ramps in the SB direction. It is anticipated that accident rates will also reduce with these improvements.

5. Improve bicycle access by adding Class II bike lanes within the Project area.

6. Correct and/or improve existing nonstandard design features.

The following is a description of the existing conditions in the Project area that will be improved or eliminated by this Project: The existing movement from SB Bayshore Highway to westbound Broadway is not typical, requiring the driver to travel NB at one point and also use the NB off-ramp to reach the other side of the freeway. The existing SB off-ramp to Broadway is also not typical and requires that travelers use Rollins Road to access eastbound Broadway. The NB on-ramp is congested in the morning and the SB off-ramp traffic to westbound Broadway is heavily congested in the afternoon. The present SB diagonal off-ramp meets the Rollins Road and Broadway intersection at a skewed angle, creating a five-legged intersection. Finally, the radius of the loop on-ramp in the northwest quadrant is below current design standards.

Improvements to the interchange will require right of way acquisition. The areas impacted by the Project include the area northeast of US 101 occupied by hotels, restaurants, gas stations, and office buildings, Bayside Park and a multi-story hotel situated in the southeast quadrant, the northwest quadrant containing light industrial businesses, and the southwest quadrant which is a mix of residential houses and businesses.

The traffic forecast has projected that vehicle volumes on the US 101 mainline will grow 28% and volumes on the US 101 ramps within the interchange will grow 30% by the year 2035. The Broadway/Rollins Road intersection currently operates at LOS D and will operate at LOS F in 2035 if no improvements are made. The combined growth projections and current inadequate system capacity warrant the proposed Project.

1.3 Project History

US 101 is the principal arterial serving local and interregional traffic along the San Mateo Peninsula and the greater Bay Area. US 101 is a north-south freeway in the Federal Aid Primary System extending most of the length of California from the Oregon border to Los Angeles. US-101 is part of the FHWA-designated Strategic Highway Network (STRAHNET). In the Bay Area, the freeway connects the San Francisco business district and San Francisco International Airport to San Jose and "Silicon Valley" to the south. The interchange being studied is located within an urban corridor at Broadway and US 101 in the City of Burlingame in San Mateo County.

US 101 was adopted into the State Highway System in 1929. The portion of the route on the San Mateo Peninsula was improved to a conventional four-lane highway in 1932. The Broadway overcrossing and ramps were constructed in 1949. Portions of US 101 were improved to a six-lane facility in 1958 and to an eight-lane freeway in 1965. The peak-hour volume spread has increased over recent years and is expected to continue to increase if no improvements are provided.

In 1990, Caltrans prepared a Project Study Report (PSR) (EA 04-217-23584G) for the reconstruction of the US 101/Broadway interchange, which was approved on July 16, 1990. However, the PSR did not proceed to the next phase of the Project development as the City of Burlingame had concerns about the proposed alternative.

In 2000, the SMCTA began the preparation of a new PSR based on current standards and the latest Project requirements. In preparing the new PSR, the design consultant re-evaluated the previous alternatives, developed new alternatives, and selected one alternative as the build alternative, called the Buttonhook/Diamond Interchange. The PSR was approved on November 22, 2005.

The existing US 101/Broadway interchange is a Trumpet (Type L-12) configuration, with modified buttonhook ramps on the NB US 101 side and a modified partial cloverleaf on the SB US 101 side.

US 101 within the Project limits is an 8-lane divided freeway on level terrain and within 1 mile of the San Francisco Bay. The width of the median on US 101 within the Project limits varies between 6 to 22 ft. The posted speed limit along US 101 is 65 miles per hour (mph). The existing lane widths on US 101 are 12 ft with a 10-foot outside shoulder and a 2-foot inside shoulder in both directions,

The Broadway overcrossing over US 101 provides four travel lanes, two in each direction with a raised median. The vertical clearance of the Broadway overcrossing structure above US 101 is 14 ft 6 inches, which does not meet current Department standards. Broadway intersects with Rollins Road and Carolan Avenue to the west prior to the Caltrain railroad grade crossing. The Broadway/Bayshore Highway/NB US 101 on-ramp intersection is located just east of the interchange. All intersections mentioned are signalized. The posted speed limit on Broadway overcrossing in the Project area is 35mph.

Rollins Road is a two-lane collector road that links with Millbrae Avenue to the north, intersects with Broadway, and continues south parallel to US 101 until it becomes N. Amphlett Boulevard. It is a busy route and serves as an alternative to US 101 between Millbrae Avenue and Broadway. The signalized intersection of Rollins Road and Cadillac Way, just south of Broadway, serves as an exit/entry to US 101 in the SB direction. The posted speed limit on Rollins Road in the Project area is 35mph.

Bayshore Highway, Airport Boulevard, the Crowne Plaza Hotel entrance and the US 101 NB off-ramp form an intersection on the eastern end of the Project area. Bayshore Highway provides access from US 101 to the business areas south of the San Francisco International Airport and ends at the Millbrae Avenue intersection.

1.4 Reference Documents

Base drawings for the Project, including topographic surveys; right-of-way; roadway layout; profiles; superelevation diagrams; and cross sections; and drainage plans were provided by URS Corporation.

1.4.1 As-Built Record Documents

WRECO utilized as-built record drawings, the City of Burlingame's *Storm System Facilities* maps, and the Project-specific survey file and cross sections from URS Corporation to determine elevations and inverts of the existing drainage facilities for the design of the drainage systems. The as-built record drawings used were as follows:

Caltrans:

- Document No. 40001177 (Relocation of State Highway) (Caltrans, 1949)
- Contract No. 04-205387201 (Caltrans, 1970)
- Contract No. 04-387204 (Caltrans, 1971)
- Contract No. 04-108424 (Caltrans, 1994)
- Contract No.04-264201 (Caltrans, 2006)

City of Burlingame:

- Storm System Facilities (City of Burlingame, 2008)
- Improvement Plans PLAN & PROFILE Bearint Industrial Park (City of Burlingame, 1964)
- Improvement Plan for Reconstruction of Bayshore Highway (City of Burlingame, 1984)

- Master Storm Drainage Pipeline Outfall Structure and Easton Creek Widening Project (City Project No. 80520, 2010)

1.4.2 Layout Sheets

Project plans were prepared and provided by URS Corporation. Project drainage plans are attached in Appendix B.

1.4.3 Geographical References

- Project location and vicinity maps were prepared by URS Corporation.
- Google Inc., retrieved from http://maps.google.com
- Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) panels for the City of Burlingame

1.5 Soil Characteristics

Project site soils generally consist of up to 10 ft of artificial fill underlain by 5 to 10 ft of soft organic clay (Bay Mud). Historic borings, which were drilled to a maximum depth of 85 ft, at the interchange encountered no bedrock. It should also be noted that both groundwater and soils at the site are corrosive (Parikh, 2001). The lack of slopes and the fact that the Project area is predominantly paved reduces the potential for erosion.

According to the Natural Resources Conservation Service Web Soil Survey (NRCS WSS), the predominant materials appearing in the surface at the site within the Project are Urban land-Orthents: reclaimed complex (0-2% slopes) and Novato clay (0-1% slopes). Both of these soils are in Hydrologic Soil Group (HSG) D, which indicates high runoff potential and low infiltration rates.

1.6 Land Use

The Project site is located within Burlingame, a suburban city with an approximate population of 28,000 and an approximate land area of 5.5 mi^2 (City of Burlingame, 2009). Commercial and light industrial development dominate the land use at and adjacent to the Project area, with residential uses in the southern portion of the Project limits (FEMA, 1981).

1.7 Creeks, Streams, and River Crossings

US 101 crosses two named creeks, Easton Creek and Sanchez Creek, within the Project limits. Both these creeks are tidally influenced by San Francisco Bay. A portion of the NB US 101 north of Easton Creek drains to Mill Creek, located just outside the northern Project limit.

Sanchez Creek crosses beneath US 101 near the southern limit of the Project through a triple reinforced concrete box culvert (RCB) that drains into Burlingame Lagoon.

Easton Creek crosses beneath US 101 near the northern limit of the Project through a double RCB. A concrete-lined rectangular channel conveys Easton Creek to another

double RCB beneath Bayshore Highway. In this reach of channel, the southern bank is lower than the northern bank, but a channel wall extends above the adjacent grade on the southern side, making the confining bank heights on both sides of the channel approximately level. Downstream of Bayshore Highway, the creek drains into a straight trapezoidal earthen channel that discharges directly into San Francisco Bay.

The City of Burlingame is currently upgrading Easton Creek and Marsten Pump Station to alleviate the chronic flooding in the Hillside residential areas and the industrial area north of Broadway. These improvements include the following:

- A new Marsten Outfall pipe to discharge stormwater from the Marsten Pump Station to Easton Creek, bypassing Highway 101 and Bayshore Boulevard, which can be hydraulically restricted during large storm events.

- Widening of Easton Creek downstream of Bayshore Boulevard which will accommodate the additional flows.

- Installation of additional pumps to increase the pumping capacity and to improve the overall capacity of Easton Creek downstream of Rollins Road.

- Diverting stormwater flow to the pump station from Easton Creek to stabilize the water surface elevation to eliminate flooding.

In addition, the area surrounding and beneath the eastern landing of the Broadway overcrossing between US 101 and Airport Boulevard drains to a culvert beneath Bayshore Highway. The outfall of this culvert conveys the runoff to a blocked unlined channel on the north side of the gas station at the corner of Airport Boulevard and Bayshore Highway. The Project team observed that the outfall of this system was entirely buried beneath the bottom of the channel during field visits in April 2009.

The “unnamed” channel previously drained directly to San Francisco Bay. A berm acting as an informal walkway at its eastern end now restricts water exchange with the bay (see Photo 1). The presence of pickleweed (*Salicorna virginica*) along the edge of the channel indicates that the water in the channel is brackish and that water from the bay occasionally washes over the berm into the channel during extreme high tide events.

Photo 1. Panorama of Unnamed Channel

1.8 Existing Drainage and Drainage Design Issues

The existing drainage systems within the Project limits consist of roadside ditches, cross culverts, longitudinal culverts, slotted drains (in freeway median), asphalt concrete (AC) dikes and concrete curbs with inlets to collect stormwater at shoulders.

Figure 3. Project Site

Source: Google Earth

Currently, the runoff from the Project area drains to one of five waterways: Mills Creek, Easton Creek, the unlined channel near the intersection of Airport Boulevard and Bayshore Highway, Sanchez Creek, or San Francisco Bay, Lower. Most of the runoff from SB US 101 within the Project limits north of the Broadway overcrossing drains to Easton Creek through a series of open channels and roadside culverts along US 101. The area to the east of Rollins Road north of the Broadway overcrossing drains to Easton Creek, and the area to the east of Rollins Road south of the Broadway overcrossing drains in an easterly direction under US 101 to an open ditch adjacent to the NB US 101 off-ramp, which drains into Sanchez Creek and ultimately into Burlingame Lagoon. The area surrounding and beneath the eastern landing of the Broadway overcrossing between US 101 and Airport Boulevard drains to a culvert beneath Bayshore Highway, which drains into an unlined channel whose outlet to the bay has been blocked by a berm. Bayshore Highway drains to the east into Easton Creek. A portion of the NB US 101 north of Easton Creek drains to an open ditch along NB US 101 that eventually drains to

Mills Creek located just north of the Project's northern limit. A small portion of Airport Boulevard drains to San Fracnsico Bay, Lower.

The principal features of the Project improvements that will impact the existing drainage facilities include the replacement of the Broadway overcrossing with a new wider structure, the re-alignment of the Broadway bridge approach embankment, the widening of on- and off-ramps, the addition of concrete raised medians, and the construction of new retaining walls to support the new Broadway overcrossing.

Drainage design improvements will accommodate the increase in flow from increased impervious areas. The drainage design will include additional inlets, longitudinal systems, and modifications to existing drainage systems as a result of the addition of concrete barriers, retaining walls, and roadway widening. The design will maintain existing drainage patterns to the maximum extent practicable. The proposed drainage systems are designed to intercept and treat storm water runoff from the Project and areas (within the City of Burlingame) adjacent to Caltrans' R/W.

The Project will not significantly affect the existing drainage patterns, except in the vicinity of the northeastern landing of the Broadway overcrossing because this area will be raised to meet current Caltrans design standards. This area was identified in the Project Location Hydraulic Study (LHS) as an area of problematic flooding. The sources of flooding for this area are extreme high tides in San Francisco Bay and the blocked outfall of the "unnamed" channel discussed in Section 1.7. The proposed drainage system will divert most of the runoff currently draining to this blocked channel to Easton Creek to improve the current flooding condition.

Drainage issues in the area include the relatively flat terrain and the low infiltration rate of the soils in the area which results in problematic flooding. The Project area has relatively flat terrain with elevations ranging from 4 ft to 12 ft. The site is not influenced by hills or valleys, with the general drainage pattern being sheet flow east toward San Francisco Bay. As described in Section 1.5, the soils in the area predominantly consist of Bay Mud, with low infiltration rates and high runoff potential. The flooding in the area is addressed in detail in the Project LHS.

Photo 2. Berm across Eastern End of Unnamed Channel

The City of Burlingame has completed the first phase of a multi-stage project that will decrease peak flows in Easton Creek utilizing the Easton Creek Pump Station. The project includes increasing the capacity of the pump station, constructing a 66-inch diameter storm drain force main beneath Easton Creek from the pump station to an outfall into Easton Creek immediately downstream of Bayshore Highway, and widening the unlined portion of Easton Creek from Bayshore Highway to the bay.

The City has already completed installation of the 66-inch pipe for the new force main and completed channel widening but has left the pump station as an item to be completed as part of subsequent projects. The residents of the City of Burlingame passed a bond measure in May 2009 that will pay for these improvements. The completion of the force main, pump station and channel widening will eliminate flooding between US 101 and Bayshore Highway originating from Easton Creek by confining peak flows to the channel.

The City of Burlingame has indicated that when all the Easton Creek improvements are complete it will lower and stabilize the water surface elevation in Easton Creek during peak storm events by diverting half of the flow around US 101 and Bayshore Highway bypassing the constricting box culverts that are located below these roadways.

1.9 Drainage Design Criteria

The drainage design for the Project within the Caltrans R/W adheres to the methodologies in the *Highway Design Manual* (HDM) (Caltrans, 2006) and *Hydraulic Engineering Circular Number 22, Urban Drainage Design Manual* (HEC-22) (FHWA, 2009), a publication for highway pavement drainage design published by the U.S. Department of Transportation, Federal Highway Administration (FHWA). For cross culverts, drainage improvements will be evaluated and designed based on the ability to pass an entire 10% probability of annual exceedance event (i.e. 10-year storm) within the

cross culvert, and a 1% probability of annual exceedance event (i.e. 100-year storm) without objectionable backwater. The final on-site hydrology calculations for this segment utilized the Rational Method to predict stormwater runoff. Roadway drainage design discharges for the longitudinal systems along Rollins Road, Broadway and Bayshore Highway will be based on the 10% probability of annual exceedance event. The drainage system on the on- and off-ramps and any culverts under US 101 were designed using the 4% probability of annual exceedance (i.e. 25-year storm). In addition, the HDM recommends a minimum time of concentration of 5 minutes for paved areas. This time of concentration will be used throughout the Project limits because the land use is mostly commercial and light industrial.

The drainage improvements proposed for local roads conform to local agencies' requirements. City of Burlingame municipal code states that storm drain systems should be designed to adequately remove storm water at a maximum rate of one (1) in/hr. All proposed drainage systems within Caltrans right-of-way were designed per the HDM.

1.10 Special Circumstances

The technical report, *Identification of Waters of the US*, prepared by H.T. Harvey and Associates (H.T. Harvey, 2001) identified jurisdictional waters in the US 101 Auxiliary Lane Project area, some of which are within the US 101/Broadway Interchange Reconstruction Project area. This document identified portions of the Burlingame Recreational Lagoon and the coastal area near the"unnamed" channel as meeting the criteria as wetland resources under the National Wetland Inventory System. The majority of the bed and banks of these wetlands, including the Burlingame Lagoon, have been significantly modified over the last hundred years. Artificial drainages excavated in dry uplands are dismissed as potential jurisdictional waters by H.T. Harvey and Associates. One such drainage within the Project area is the "unnamed" channel discussed in Section 1.7.

Additionally, according to the Project Wetland Report (URS 2009), riparian habitat exists along the Easton Creek corridor east of Bayshore Highway and around the "unnamed" channel near the intersection of Bayshore Highway and Airport Boulevard. Refer to the Project Wetland Report for more details on wetlands in the Project area.

The berm in the unnamed channel discussed in Section 1.7, which acts as an informal walkway that now restricts water exchange with the bay, was identified by Caltrans District 4 Maintenance, Hydraulics Division staff and City of Burlingame staff as one of the two sources responsible for the flooding indicated in the FIRM in the vicinity of the Broadway overcrossing east of US 101. The berm traps water and sediment that would otherwise drain into the bay. As a result, the high water surface elevation in the channel and the buried outfall both prevent efficient drainage, resulting in problematic flooding in this area. The proposed drainage system will divert most of the runoff currently draining to this blocked channel to Easton Creek to improve the current flooding condition.

1.11 Agencies Impacting Design

The Project is located in the City of Burlingame, San Mateo County, California. Any drainage improvements proposed for local roads and/or any other off-site drainage systems impacted by the Project will conform to the local agencies' requirements.

The Project is under the jurisdiction of the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB) (Region 2), United States Army Corps of Engineers (USACE), Federal Emergency Management Agency (FEMA), San Francisco Bay Conservation and Development Commission (BCDC).

Permits from the following agencies are anticipated:

- USACE (404)
- California Department of Fish and Game (1602)
- SFBRWQCB (401)

2 OFF-SITE HYDROLOGY AND HYDRAULICS

The climate in the Project area is typical of the San Francisco peninsula with warm, dry summers and mild, humid winters. The mean annual precipitation is approximately 22 in. with most of the rainfall occurring between October and April, according to the City of Burlingame FIS (FEMA, 1981a).

Except for a small portion of the Project area at the Project's northern limits that drains toward Mills Creek to the north, most of the Project is split between the Easton Creek and Sanchez Creek watersheds, with Broadway Avenue dividing the watersheds. Most of the creeks in the area originate from the eastern side of the Santa Cruz Mountains and form a series of small parallel basins that drain northeasterly to San Francisco Bay. According to the City of Burlingame Flood Insurance Study (FIS) (FEMA, 1981), Mills Creek is 2.3 miles long and draining an area of 1.1 square miles; Easton Creek is 2.4 miles long and drains an area of 1.2 square miles; Sanchez Creek is 1.9 miles long and drains an area of 2.1 square miles.

According to the FIS, during the 50-year storm event, Mills Creek and Easton Creek each is carrying 840 cfs, and Sanchez Creek is carry 1,600 cfs at the US 101 crossings. The Project will result in a net added impervious area of less than 2 acre and will not modify Mills Creek and Sanchez Creek. Therefore, the hydrologic and hydraulic characteristics for Mills Creek and Sanchez Creek will not significantly change as a result of the Project, and no detailed analysis is necessary. The Project will extend the box culvert at Easton Creek / US 101 crossing to accommodate the roadway widening. However, the Project team had determined during the PA/ED phase that a Location Hydraulic Study (LHS) was not necessary. Caltrans has also concurred at the 65% PS&E design phase that an LHS is not necessary for the box extension at Easton Creek (See Appendix I). The following reasons were cited for this conclusion (URS, 2012):

1. Upstream Controlling Feature: The controlling feature of this drainage facility is the upstream entrance to the box culvert. This will not change with the proposed improvements.

2. Scour is not an issue: Existing and proposed future at this location include full concrete lined channel, so there would not be a need to do a scour analysis.

3. Pump Station Project: The City has been working on a pump station bypass project that will pump storm drainage from upstream bypass storm drain waters from the location of this box culvert extension, making it even less critical. Phase 3 of this project has recently been completed and that phase 4 (last phase) has been started and should be completed within a year. This system should be fully operational well before construction begins on the 101 Broadway Project.

3 ON-SITE ROADWAY DRAINAGE

URS Corporation provided detailed drainage design plans (drainage plans, profiles, details). These design plans are used to determine the location of drainage structures, to establish the top of grate elevations of proposed inlets and rim elevations of manholes, and to calculate the required drainage pipe sizes needed to convey the design flow.

3.1 Recurrence Interval

This Project will re-align and replace the Broadway overcrossing with a new wider structure and includes improvements to on- and off- ramps as well as local streets. The permitted speeds on the traveled ways along the Broadway overcrossing, Rollins Road and Bayshore Highway are 45 mph or less; therefore, the 10% probability of annual exceedance (i.e. 10-year) recurrence interval is the design criteria for these local streets. The speeds expected on or approaching the on- and off-ramps are 45 or greater, therefore the design criteria for the on- and off-ramps is the 4% probability of annual exceedance (i.e. 25-year) recurrence interval. The information regarding the selection of a recurrence interval was obtained from Section 821.3 of the HDM.

3.2 Time of Concentration

The HDM recommends a minimum time of concentration of 5 minutes for paved areas and 10 minutes for rural and undeveloped areas. A time of concentration of 5 minutes will be used for all on-site paved watersheds in the runoff estimate because all the paved watersheds within the Project area are small such that the calculated time of concentration for each is shorter than 5 minutes. For watersheds including a combination of paved and unpaved areas, the times of concentration were estimated following the method in Section 816 of the HDM.

3.3 Grate Interception and Gutter Capacity

Grate interception, inlet bypass, gutter spread, and inlet capacity calculations used the methodologies and procedures presented in the Hydraulic Engineering Circular No.22 (HEC-22) (FHWA, 2001).

In compliance with Table 831.3 of the HDM, the design water spread for the areas with 10% probability of annual exeedance will require to be contained within the outer half of the outside lane. The design water spread for the on- and off-ramps, which were designed with the 4% probability of annual exceedance, will require to be contained within the shoulder. Within the Project, the average width of shoulder for the on- and off-ramps is typically 8 ft.

In compliance with Section 831.4 of the HDM, no more than 0.1 cubic ft per second (cfs) of concentrated flow is allowed to flow across the roadway. At the Broadway overcrossing, inlets were proposed at locations immediately adjacent to the structural support such that no runoff from the overcrossing structural section will flow across the

road. Deck drains for the overcrossing will be incorporated in the bridge structural design.

Detailed on-site system watershed maps and grate interception and gutter capacity calculations are shown Appendix C and Appendix D, respectively.

3.4 Ditches and Swales

The Project included re-alignment of existing ditches and addition of new ditches and biofiltration swales along the highway. The ditches and biofiltration swales are part of the on-site roadway drainage systems and were designed to convey the 25% probability of annual exceedance (i.e. 25-year) storm runoff. The ditch and biofiltration swale capacity are evaluated using the Manning's equation. Detailed calculations are provided in Appendix E.

3.5 Hydraulic Grade Line Calculations

The storm drain systems were analyzed for capacity using Hydraflow Storm Sewers Extension (Autodesk, 2009), a culvert capacity analysis program. Existing and proposed pipe sizes, materials, and flow line information for the proposed drainage systems were taken from drainage plans and profiles, as-built drawings, or surveyed information provided by URS.

The Manning's roughness coefficient for existing reinforced concrete pipe (RCP) and existing corrugated metal pipe (CMP) will be assumed to be 0.013 and 0.024, respectively. Unless otherwise specified on the plans, all proposed pipes will be "Alternative Pipe Culverts" (APC) and are assumed to have a Manning's roughness coefficient of 0.012. This is due to load limitations, only smooth interior HDPEs are proposed for APC.

The hydraulic grade line (HGL) for the 25-year peak flow is required to maintain at least 0.75 ft below the top of grate of drainage inlets, per the HDM. Detailed storm drain system capacity calculations are provided in Appendix F.

The City of Burlingame provided the Project Team the Hydrologic Engineering Centers River Analysis System (HEC-RAS) model output showing the 30-Year water surface elevation for Easton Creek. This profile was used to set the tail water conditions in the culvert analysis for the systems discharging into Easton Creek. The City of Burlingame also provided the predicted annual maximum mean high tide level in 2003 of 5.82 ft and recommended to assume the discharge water elevation for systems draining to Sanchez Creek to be at the level of the coincident tide. This elevation was used as the tail water condition in the culvert analysis for the system discharging to Sanchez Creek. The aforementioned information provided by the City of Burlingame is included in Appendix J.

3.6 Culvert Material

A list of allowable culvert materials is specified in the design, per recommendations from the Materials Report. Extensions to the existing culverts will generally match the same material as the respective existing culverts.

3.7 Inlet and Outlet Treatment and Energy Dissipation

Typical inlet and outlet treatments for culverts are either flared end sections or headwalls. Rock slope protection is typically recommended by Caltrans and FHWA at culvert entrances and outfalls to prevent scour and erosion.

3.8 Storm Water Best Management Practices

The Project will utilize appropriate BMP measures to decrease impacts to all water resources; these BMP measures are discussed in detail in the Project Storm Water Data Report (WRECO 2013). In addition, the Project design team considered storm water quality treatment measures to address potential temporary and permanent water quality impacts on the Project, as defined in the *Project Planning and Design Guide* (Caltrans, 2007).

3.9 Hydromodification

The Project is not required to incorporate hydromodification because the Project overlaps two zones that are exempt from hydromodification. One is a “Low Gradient” zone and the other is a “Hardened Channel” zone according to the *Hydromodification Management Plan* (STOPPP, 2005).

4 TEMPORARY DRAINAGE SYSTEMS

The Project includes work in Easton Creek. Dewatering operations and temporary creek diversion may be needed during construction to protect water quality. Work will be scheduled only during the allowed construction window. To avoid stormwater impacts, the Project will be phased to minimize soil-disturbing work during the rainy season.

The drainage design includes temporary drainage systems to be constructed as part of particular construction stages to prevent flooding during the construction window. The proposed temporary drainage systems include temporary ditch, culverts, and DIs (Refer to temporary drainage plans). Existing drainage systems will be utilized whenever feasible in the temporary drainage design.

The Storm Water Data Report (WRECO 2013) provides more detail concerning the temporary Construction Site BMPs anticipated for this Project.

5 FLOODPLAIN INFORMATION

Floodplain information on the Project area is discussed in detail in the Project Location Hydraulic Study Report (WRECO 2009). The LHS found flooding at three locations within the Project area. The most problematic flooding is in the vicinity of the northeastern landing of the Broadway overcrossing, and the source of this flooding is the relatively high tailwater elevation in the channel. See Appendix G for an excerpt of the City of Burlingame FIRM.

The outfall from the storm drain system draining the flooded area is buried under the channel bottom. The combination of the high tailwater elevation in the channel relative to the storm drain system and the buried outfall prevents adequate conveyance, which results in water frequently ponding in the vicinity of the intersection of Bayshore Highway and Airport Boulevard.

Another area believed to experience flooding due to high tides is between the Crowne Plaza Hotel parking lot and the US 101 NB off-ramp to Airport Boulevard.

A third area subject to flooding is where overbank flow from Easton Creek has historically flooded an area between Bayshore Highway and the on-ramp from Bayshore Highway to NB US 101.

The Project has no impacts on the existing floodplains.

6 COST ESTIMATE

The estimated Project cost is based on the URS Preliminary Project Cost Estimate dated April 2013. The Preliminary cost for the entire Project is estimated to be $51.50 million in 2013 dollars. The construction cost for drainage improvements at this stage of the Project is anticipated to be $1.13 million, which is about 2.19% of the Project total cost. This cost includes proposed longitudinal drainage systems, ditches, cross culvert adjustments, and improvements to the existing drainage systems.

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Appendix A Hydrologic Data

NOAA Atlas 14, Volume 6, Version 2
Location name: Burlingame, California, US*
Coordinates: 37.5900, -122.3611
Elevation: 12 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	1.50 (1.31-1.74)	1.82 (1.58-2.11)	2.28 (1.98-2.65)	2.66 (2.29-3.13)	3.24 (2.66-3.97)	3.71 (2.98-4.68)	4.21 (3.28-5.48)	4.76 (3.58-6.43)	5.57 (3.96-7.91)	6.23 (4.25-9.24)
10-min	1.07 (0.936-1.24)	1.30 (1.13-1.51)	1.63 (1.42-1.90)	1.91 (1.64-2.25)	2.32 (1.91-2.85)	2.66 (2.13-3.35)	3.02 (2.35-3.93)	3.42 (2.56-4.61)	3.99 (2.84-5.67)	4.46 (3.04-6.62)
15-min	0.864 (0.756-1.00)	1.05 (0.916-1.22)	1.32 (1.14-1.53)	1.54 (1.32-1.81)	1.87 (1.54-2.30)	2.14 (1.72-2.70)	2.44 (1.89-3.17)	2.76 (2.06-3.72)	3.22 (2.29-4.57)	3.60 (2.45-5.34)
30-min	0.596 (0.520-0.690)	0.724 (0.630-0.838)	0.904 (0.784-1.05)	1.06 (0.910-1.25)	1.29 (1.06-1.58)	1.47 (1.18-1.86)	1.68 (1.30-2.18)	1.89 (1.42-2.55)	2.21 (1.57-3.14)	2.48 (1.69-3.67)
60-min	0.423 (0.369-0.490)	0.514 (0.448-0.596)	0.642 (0.557-0.747)	0.753 (0.646-0.885)	0.914 (0.752-1.12)	1.05 (0.838-1.32)	1.19 (0.924-1.55)	1.35 (1.01-1.81)	1.57 (1.12-2.23)	1.76 (1.20-2.61)
2-hr	0.310 (0.270-0.358)	0.374 (0.326-0.434)	0.464 (0.402-0.540)	0.540 (0.464-0.634)	0.648 (0.533-0.796)	0.736 (0.589-0.928)	0.828 (0.643-1.08)	0.928 (0.695-1.25)	1.07 (0.760-1.52)	1.18 (0.806-1.75)
3-hr	0.257 (0.224-0.298)	0.311 (0.271-0.361)	0.385 (0.335-0.449)	0.448 (0.385-0.527)	0.537 (0.442-0.659)	0.608 (0.487-0.766)	0.682 (0.529-0.887)	0.762 (0.570-1.03)	0.873 (0.621-1.24)	0.963 (0.656-1.43)
6-hr	0.180 (0.157-0.209)	0.221 (0.192-0.256)	0.275 (0.239-0.320)	0.321 (0.275-0.377)	0.384 (0.316-0.472)	0.435 (0.348-0.548)	0.487 (0.378-0.633)	0.542 (0.406-0.730)	0.618 (0.440-0.878)	0.680 (0.463-1.01)
12-hr	0.115 (0.100-0.133)	0.145 (0.127-0.168)	0.186 (0.162-0.216)	0.220 (0.189-0.259)	0.267 (0.219-0.328)	0.303 (0.243-0.383)	0.341 (0.265-0.444)	0.381 (0.286-0.514)	0.436 (0.310-0.619)	0.479 (0.327-0.710)
24-hr	0.074 (0.067-0.083)	0.096 (0.087-0.107)	0.125 (0.114-0.141)	0.150 (0.135-0.169)	0.183 (0.160-0.214)	0.209 (0.179-0.250)	0.236 (0.197-0.289)	0.264 (0.214-0.333)	0.303 (0.235-0.398)	0.333 (0.250-0.453)
2-day	0.047 (0.043-0.053)	0.060 (0.055-0.067)	0.077 (0.070-0.087)	0.091 (0.082-0.103)	0.111 (0.097-0.129)	0.126 (0.107-0.150)	0.141 (0.118-0.173)	0.158 (0.128-0.198)	0.180 (0.140-0.236)	0.197 (0.148-0.268)
3-day	0.037 (0.034-0.042)	0.047 (0.043-0.052)	0.059 (0.054-0.067)	0.070 (0.063-0.079)	0.084 (0.074-0.099)	0.095 (0.082-0.114)	0.107 (0.089-0.131)	0.119 (0.096-0.150)	0.135 (0.105-0.177)	0.148 (0.111-0.201)
4-day	0.031 (0.028-0.035)	0.039 (0.035-0.043)	0.049 (0.045-0.055)	0.058 (0.052-0.065)	0.069 (0.060-0.081)	0.078 (0.067-0.093)	0.087 (0.073-0.107)	0.097 (0.079-0.122)	0.110 (0.085-0.144)	0.120 (0.090-0.163)
7-day	0.022 (0.020-0.024)	0.027 (0.025-0.031)	0.035 (0.031-0.039)	0.041 (0.037-0.046)	0.049 (0.042-0.057)	0.055 (0.047-0.066)	0.061 (0.051-0.075)	0.068 (0.055-0.086)	0.077 (0.060-0.101)	0.084 (0.063-0.115)
10-day	0.017 (0.016-0.019)	0.022 (0.020-0.024)	0.028 (0.025-0.031)	0.032 (0.029-0.037)	0.039 (0.034-0.045)	0.044 (0.037-0.052)	0.049 (0.041-0.060)	0.054 (0.044-0.068)	0.061 (0.048-0.081)	0.067 (0.050-0.091)
20-day	0.011 (0.010-0.013)	0.014 (0.013-0.016)	0.018 (0.016-0.020)	0.021 (0.019-0.024)	0.025 (0.022-0.030)	0.029 (0.024-0.034)	0.032 (0.026-0.039)	0.035 (0.028-0.044)	0.039 (0.031-0.052)	0.043 (0.032-0.058)
30-day	0.009 (0.008-0.010)	0.012 (0.011-0.013)	0.015 (0.014-0.017)	0.017 (0.016-0.020)	0.021 (0.018-0.024)	0.023 (0.020-0.028)	0.026 (0.021-0.031)	0.028 (0.023-0.036)	0.031 (0.024-0.041)	0.034 (0.026-0.046)
45-day	0.007 (0.007-0.008)	0.009 (0.009-0.011)	0.012 (0.011-0.013)	0.014 (0.013-0.016)	0.017 (0.014-0.019)	0.018 (0.016-0.022)	0.020 (0.017-0.025)	0.022 (0.018-0.028)	0.025 (0.019-0.032)	0.026 (0.020-0.036)
60-day	0.007 (0.006-0.008)	0.009 (0.008-0.010)	0.011 (0.010-0.012)	0.013 (0.011-0.014)	0.015 (0.013-0.017)	0.016 (0.014-0.020)	0.018 (0.015-0.022)	0.019 (0.016-0.025)	0.021 (0.017-0.028)	0.023 (0.017-0.031)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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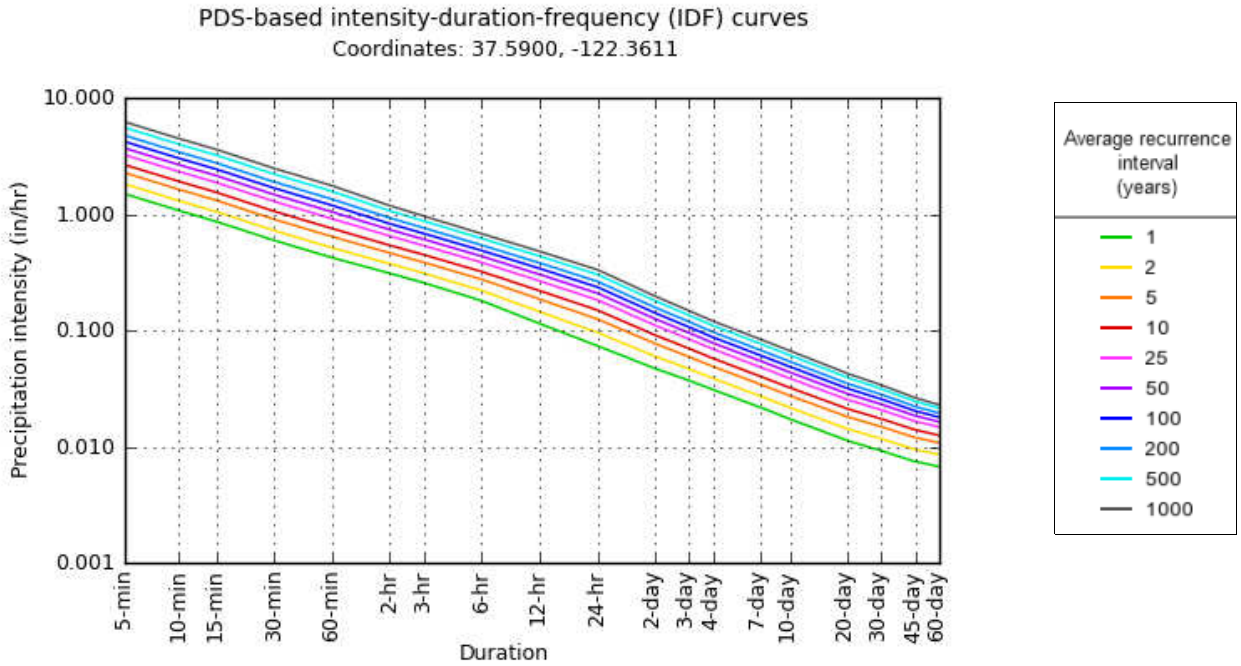
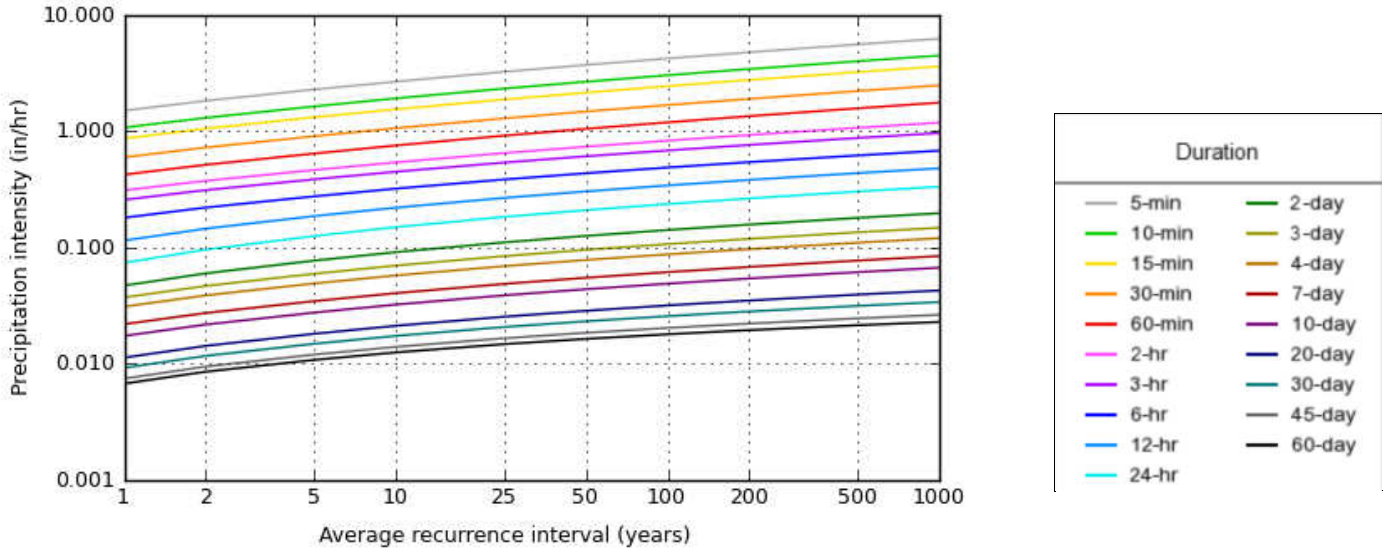
PF graphical





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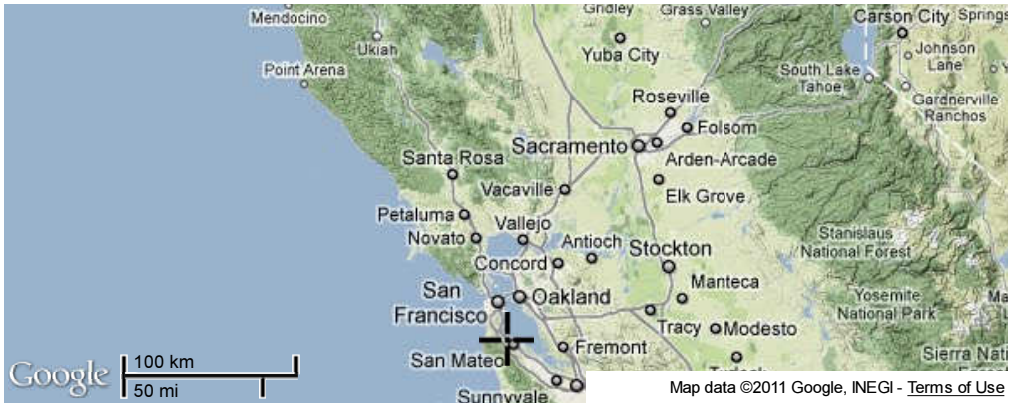
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map

Large scale aerial

Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix B Drainage Plans

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER 4/22/13 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Huey S Nham No. 65138 Exp. 9/30/13 CIVIL STATE OF CALIFORNIA

THE STATE OF CALIFORNIA OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF SCANNED COPIES OF THIS PLAN SHEET.

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SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTES:

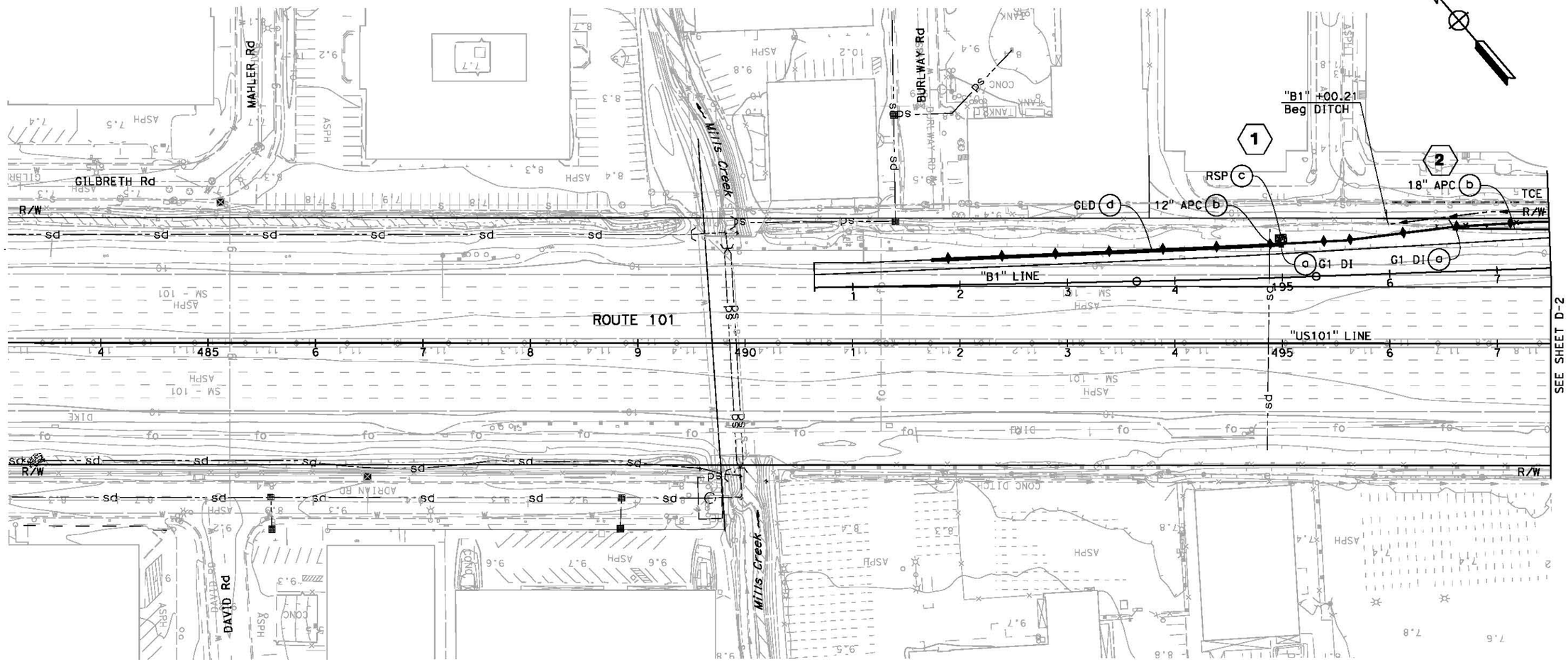
1. FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.
2. FOR GLD DETAILS, SEE STANDARD PLANS D98C.
3. STATION AND OFFSET REFERENCE LOCATIONS FOR DRAINAGE STRUCTURES ARE SHOWN ON DRAINAGE DETAIL SHEET DD-1.
4. LOCATIONS OF EXISTING DRAINAGE FACILITIES SHOWN ON THE PLANS ARE APPROXIMATE. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL FIELD VERIFY THE LOCATIONS AND FLOW LINES OF EXISTING DRAINAGE FACILITIES. ANY DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER.
5. FOR ALL DRAINAGE DITCH LOCATIONS AND ELEVATIONS, SEE DRAINAGE DETAIL PLAN.

LEGEND:

- # — DRAINAGE SYSTEM No.
- a — DRAINAGE SYSTEM UNIT
- RSP
- FLOW DIRECTION
- ——--sd—— EXISTING STORM DRAIN LINE
- ✕-✕-✕sd✕-✕-✕ EXISTING CULVERT TO BE REMOVED
- #-#-#sd#-#-# EXISTING CULVERT TO BE ABANDONED

ABBREVIATION:

GLD GRATED LINE DRAIN



DRAINAGE PLAN

SCALE: 1" = 50'

D-1

APPROVED FOR DRAINAGE WORK ONLY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY HISSEN

CALCULATED-DESIGNED BY: HUEY S. NHAM

CHECKED BY: ELIE-ABI-JAOUDE

REVISED BY: .

DATE REVISED: .

LAST REVISION 06-27-12

DATE PLOTTED => 4/16/2013
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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

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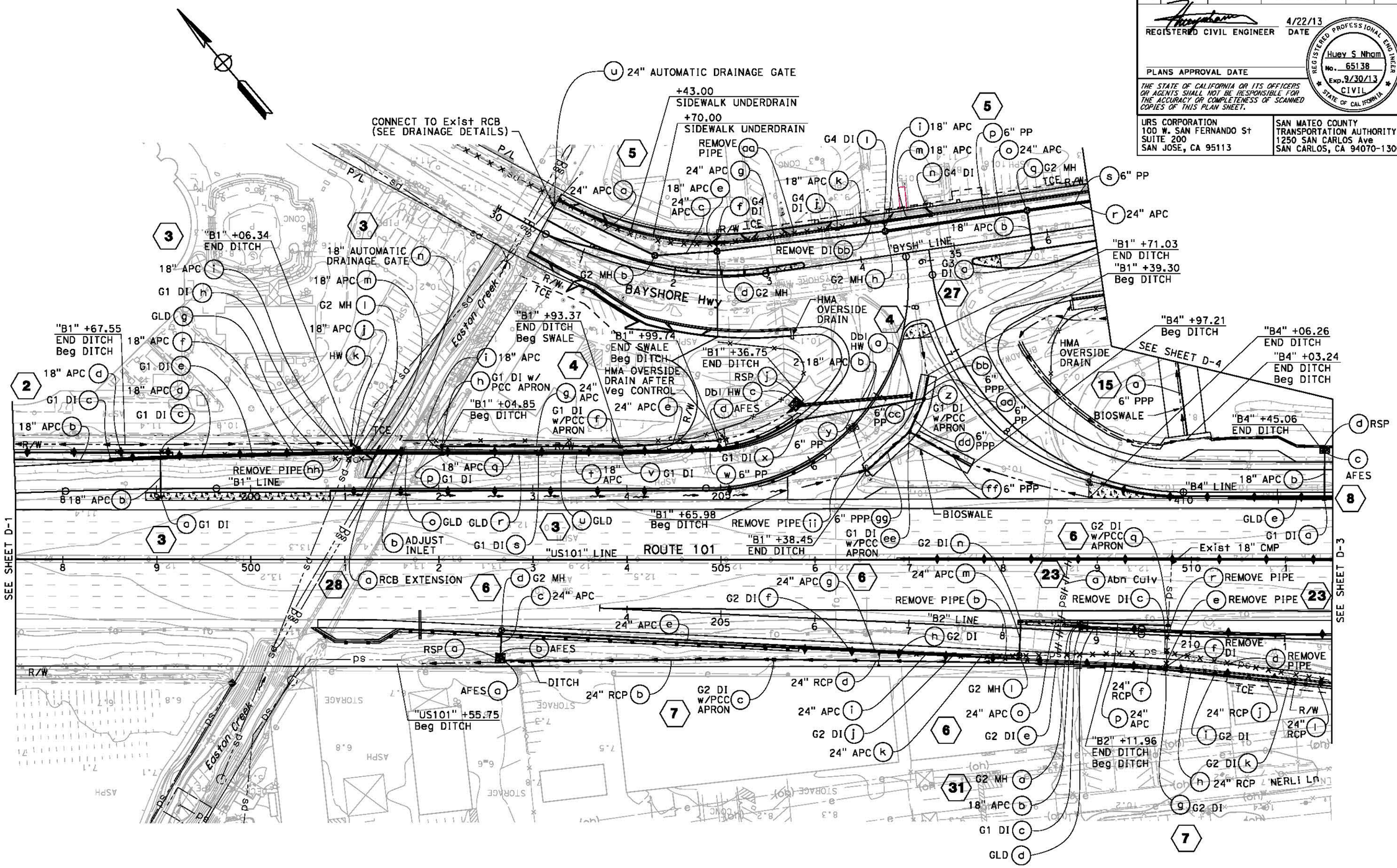

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET D-1

DRAINAGE PLAN

SCALE: 1" = 50'

D-2

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DATE REVISED: .

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DATE PLOTTED => 4/16/2013
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BORDER LAST REVISED 7/2/2010

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DGN FILE => 04000006841ia002.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

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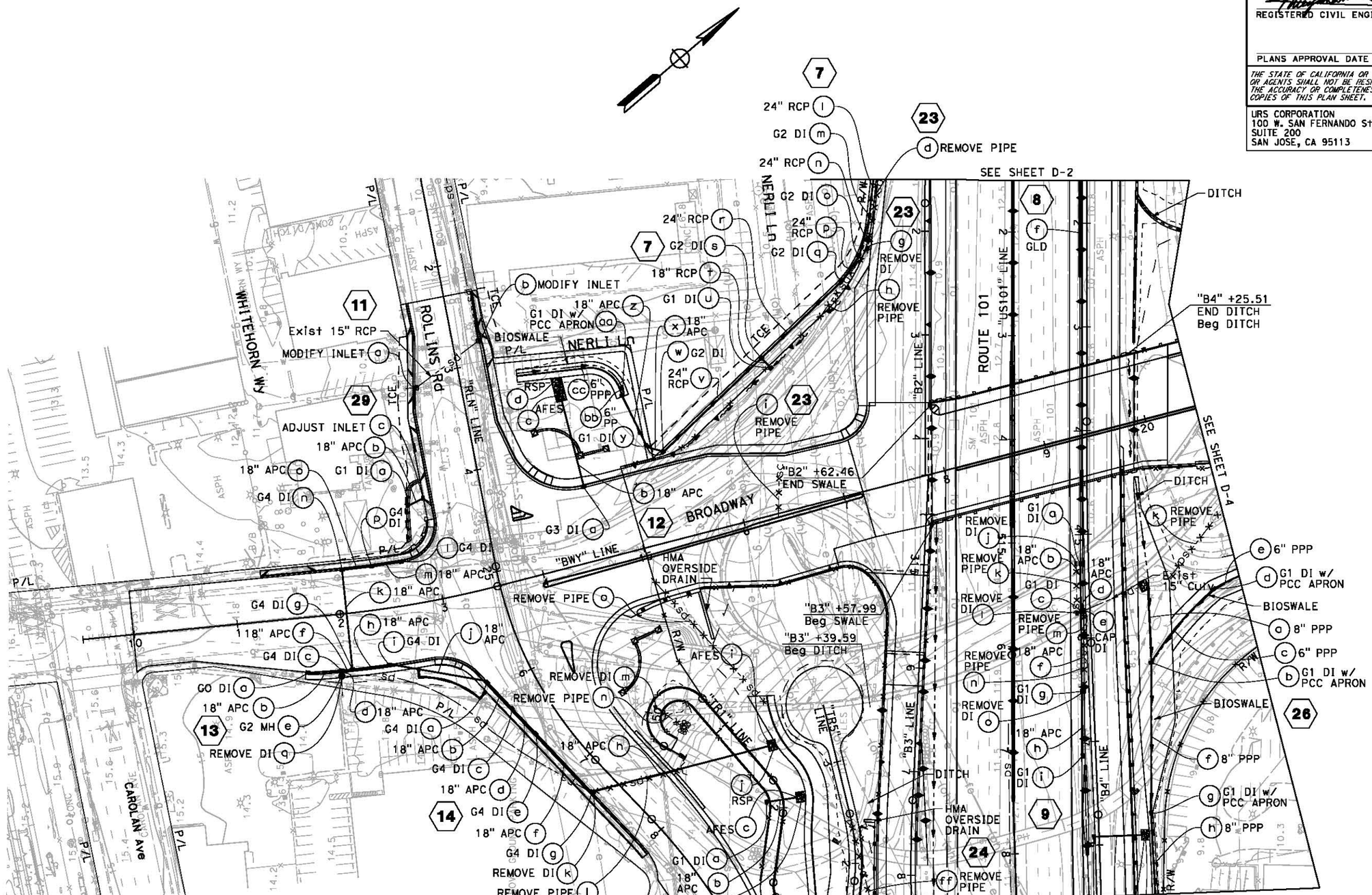

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET D-1

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DRAINAGE PLAN

SCALE: 1" = 50'

D-3

CALCULATED-DESIGNED BY	.	HUEY S. NHAM	.	REVISED BY	.
CHECKED BY	.	ELIE-ABI-JAOUDE	.	DATE REVISED	.

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY HISSEN

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER 4/22/13 DATE

PLANS APPROVAL DATE

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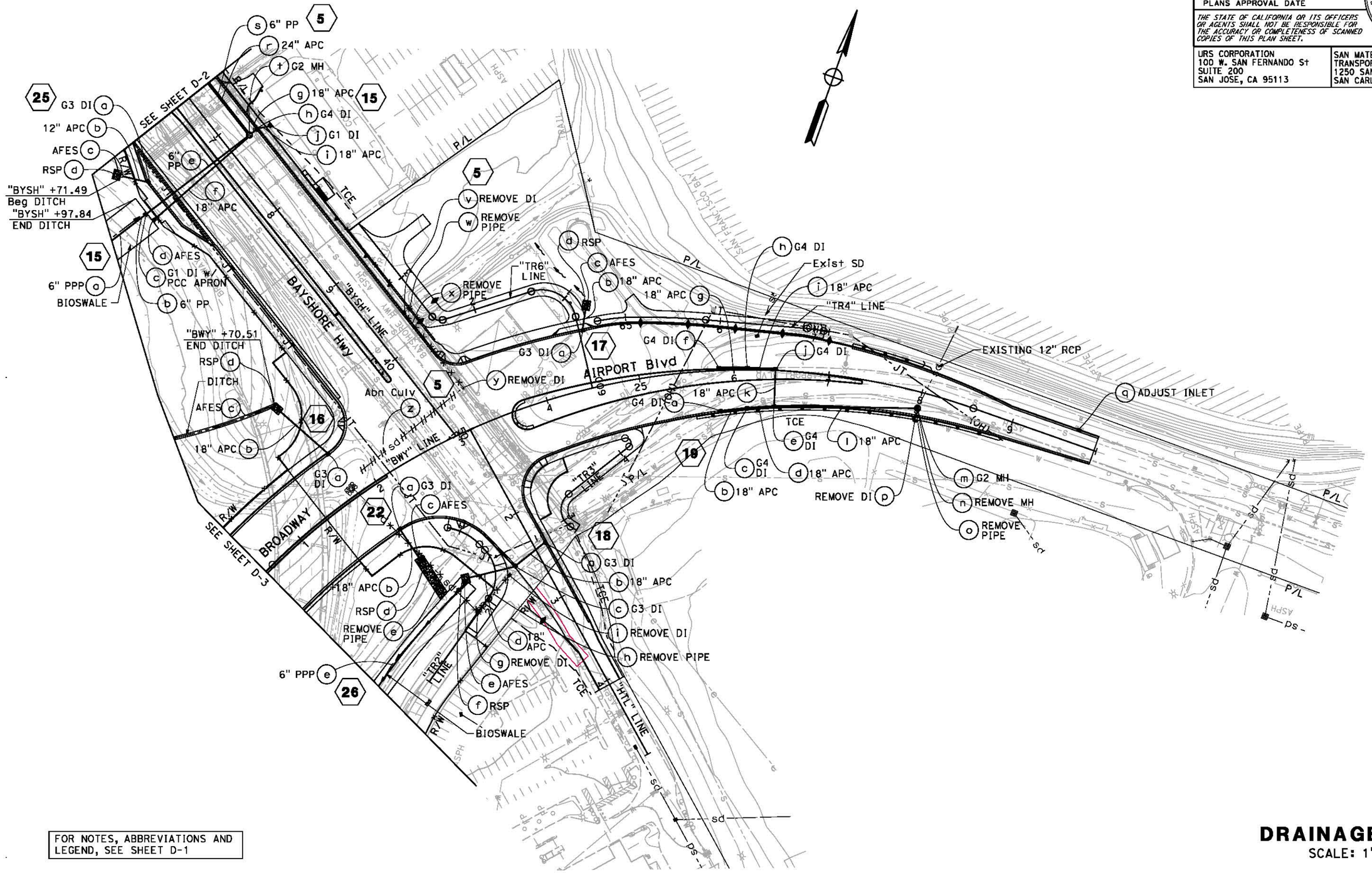

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET D-1

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DRAINAGE PLAN

SCALE: 1" = 50'

D-4

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

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CALCULATED-DESIGNED BY: HUEY S. NHAM

CHECKED BY: ELIE-ABI-JAOUDE

REVISED BY: .

DATE REVISED: .

LAST REVISION 06-27-12

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TIME PLOTTED => 2:03:17 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER 4/22/13 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Huey S Nham No. 65138 Exp. 9/30/13 CIVIL STATE OF CALIFORNIA

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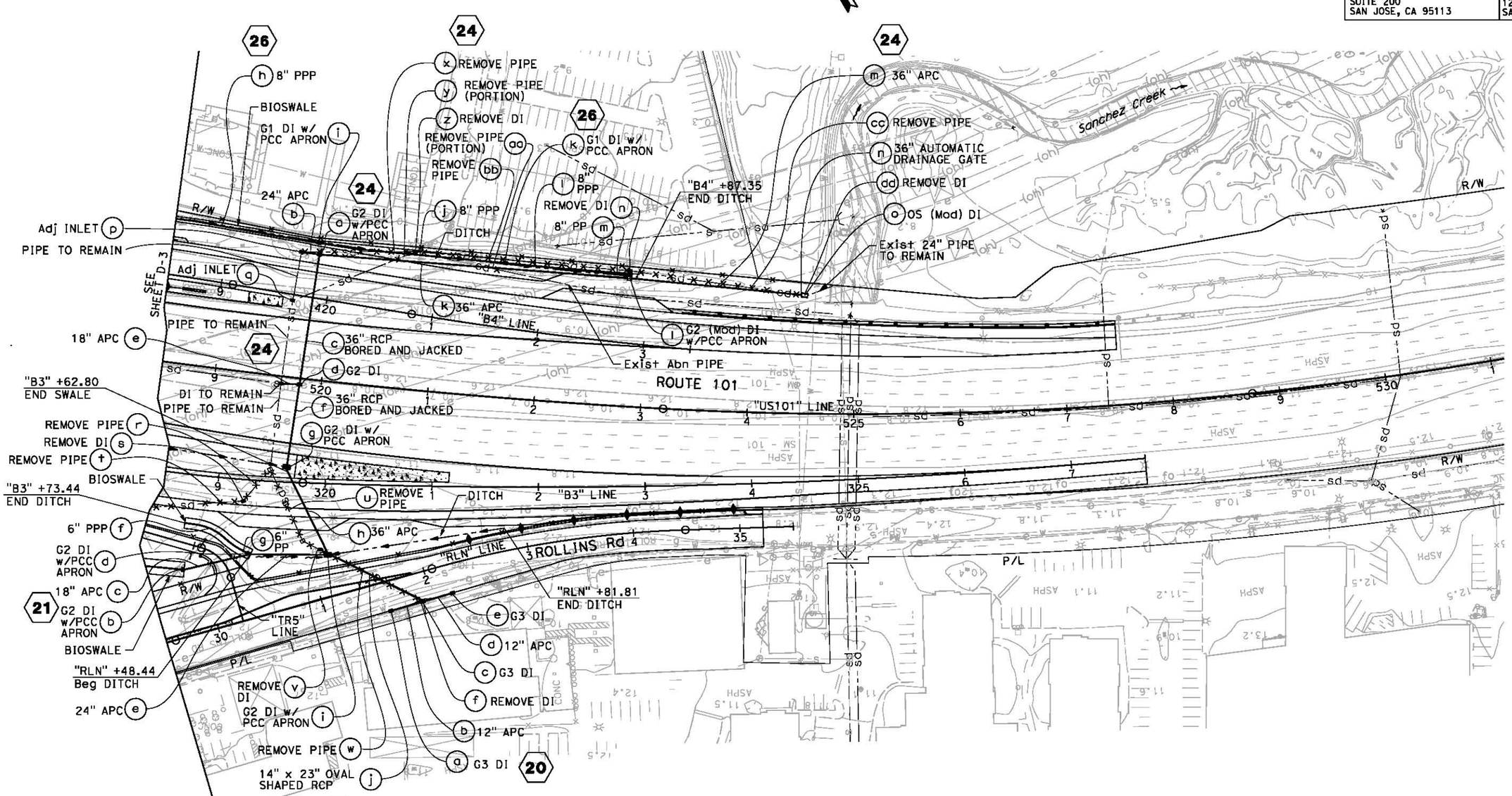

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET D-1

DRAINAGE PLAN

SCALE: 1" = 50'

D-5

APPROVED FOR DRAINAGE WORK ONLY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Gibbons

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY HISSEN

CALCULATED-DESIGNED BY: HUEY S. NHAM

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REVISED BY: .

DATE REVISED: .

LAST REVISION 06-27-12

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Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER 4/22/13 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Huey S Nham No. 65138 Exp. 9/30/13 CIVIL STATE OF CALIFORNIA

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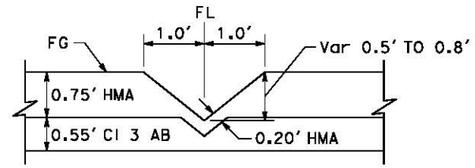
SAN JOSE, CA 95113

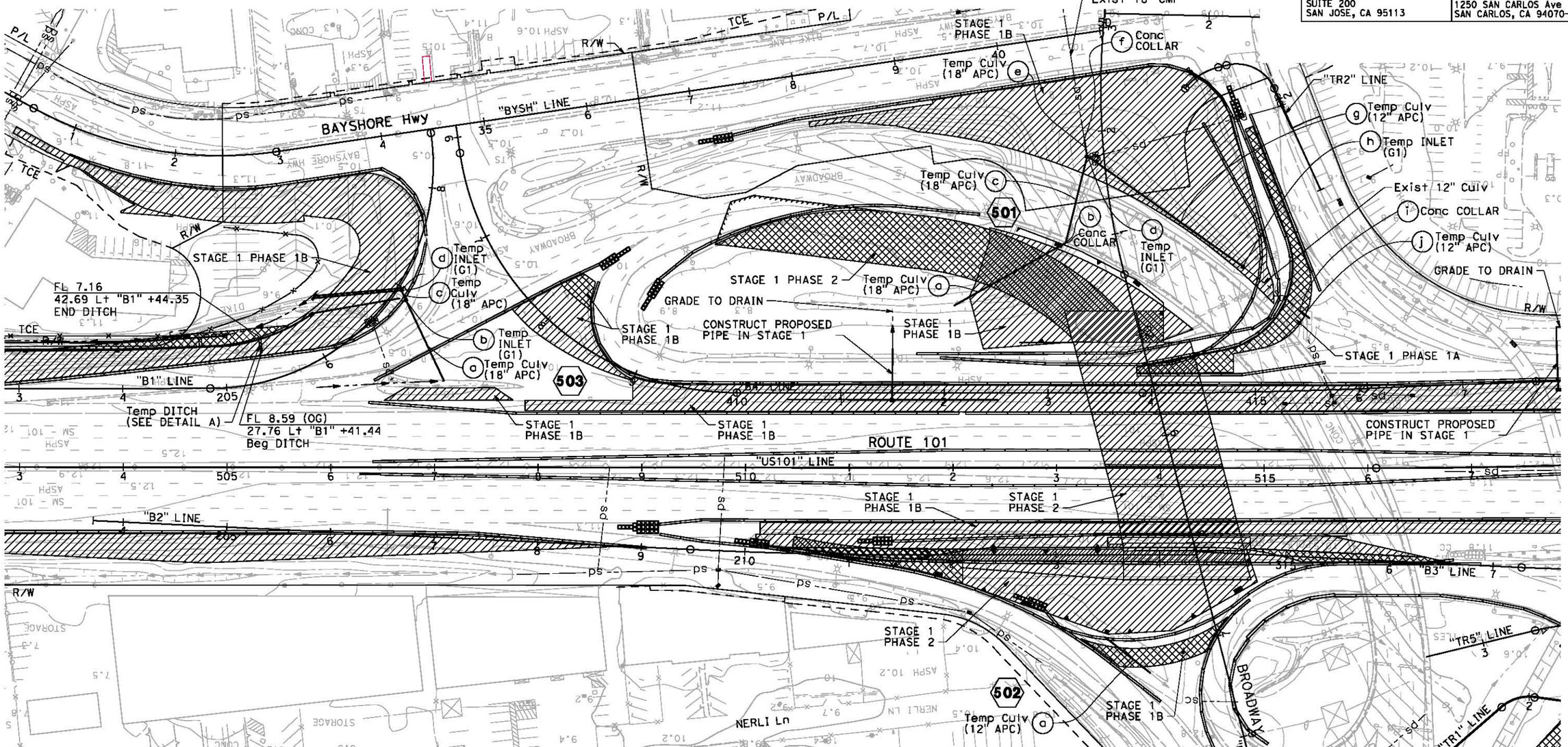
SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTES:

1. TEMPORARY DRAINAGE SYSTEM "501" PLACED DURING STAGE 1 PHASE 2 CONSTRUCTION WILL BE USED FOR STAGE 3 CONSTRUCTION AS WELL.
2. REGARDING TEMPORARY DRAINAGE SYSTEM "501", DRAINAGE UNITS "e" AND "f" SHALL BE LEFT OUT, AND SHALL BE INSTALLED JUST PRIOR TO STAGE 3 CONSTRUCTION.



DETAIL A
TEMPORARY DITCH
NO SCALE



FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET D-1

TEMPORARY DRAINAGE PLAN
STAGE 1 CONSTRUCTION
SCALE: 1" = 50'

D-6

APPROVED FOR TEMPORARY DRAINAGE WORK ONLY

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DATE REVISED	.
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CALCULATED-DESIGNED BY	.
CHECKED BY	.
CONSULTANT FUNCTIONAL SUPERVISOR	.
RAMSEY HISSEN	.

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

LAST REVISION 06-27-12 | DATE PLOTTED => 4/16/2013 TIME PLOTTED => 3:10:10 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER 4/22/13 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Huey S Nham No. 65138 Exp. 9/30/13 CIVIL STATE OF CALIFORNIA

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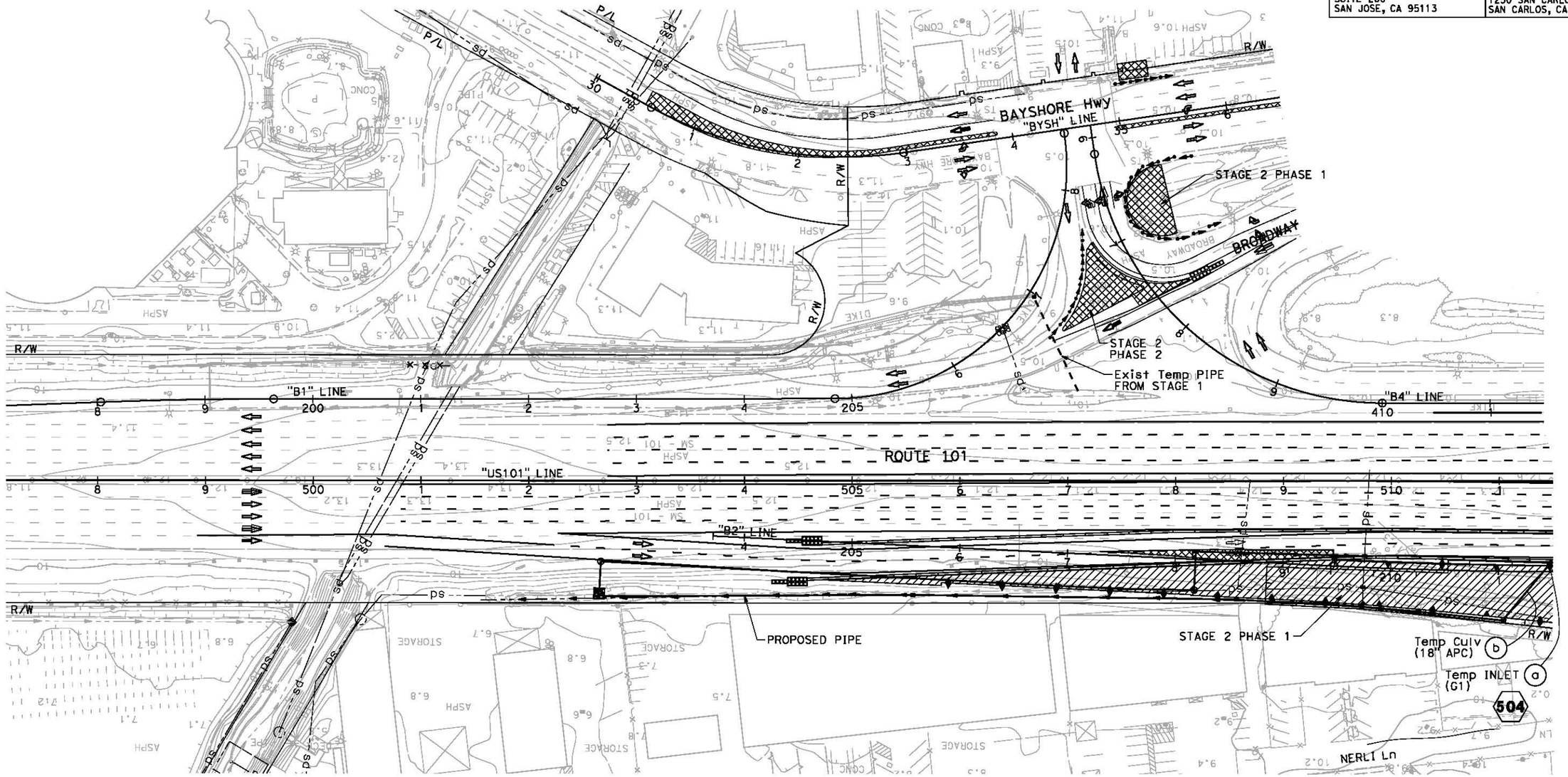
SUITE 200
SAN JOSE, CA 95113

SAN MATEO COUNTY
TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306



TEMPORARY DRAINAGE PLAN
STAGE 2 CONSTRUCTION
SCALE: 1" = 50'

D-7

APPROVED FOR TEMPORARY DRAINAGE WORK ONLY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY HISSEN

CALCULATED-DESIGNED BY: HUEY S. NHAM

CHECKED BY: ELLIE-ABI-JAOUDE

REVISED BY: .

DATE REVISED: .

LAST REVISION 06-27-12

DATE PLOTTED => 4/16/2013
TIME PLOTTED => 3:11:41 PM

BORDER LAST REVISED 7/2/2010

USERNAME => Carol_Doehne
DGN FILE => 04000006841ia007.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER 4/22/13 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Huey S Nham No. 65138 Exp. 9/30/13 CIVIL STATE OF CALIFORNIA

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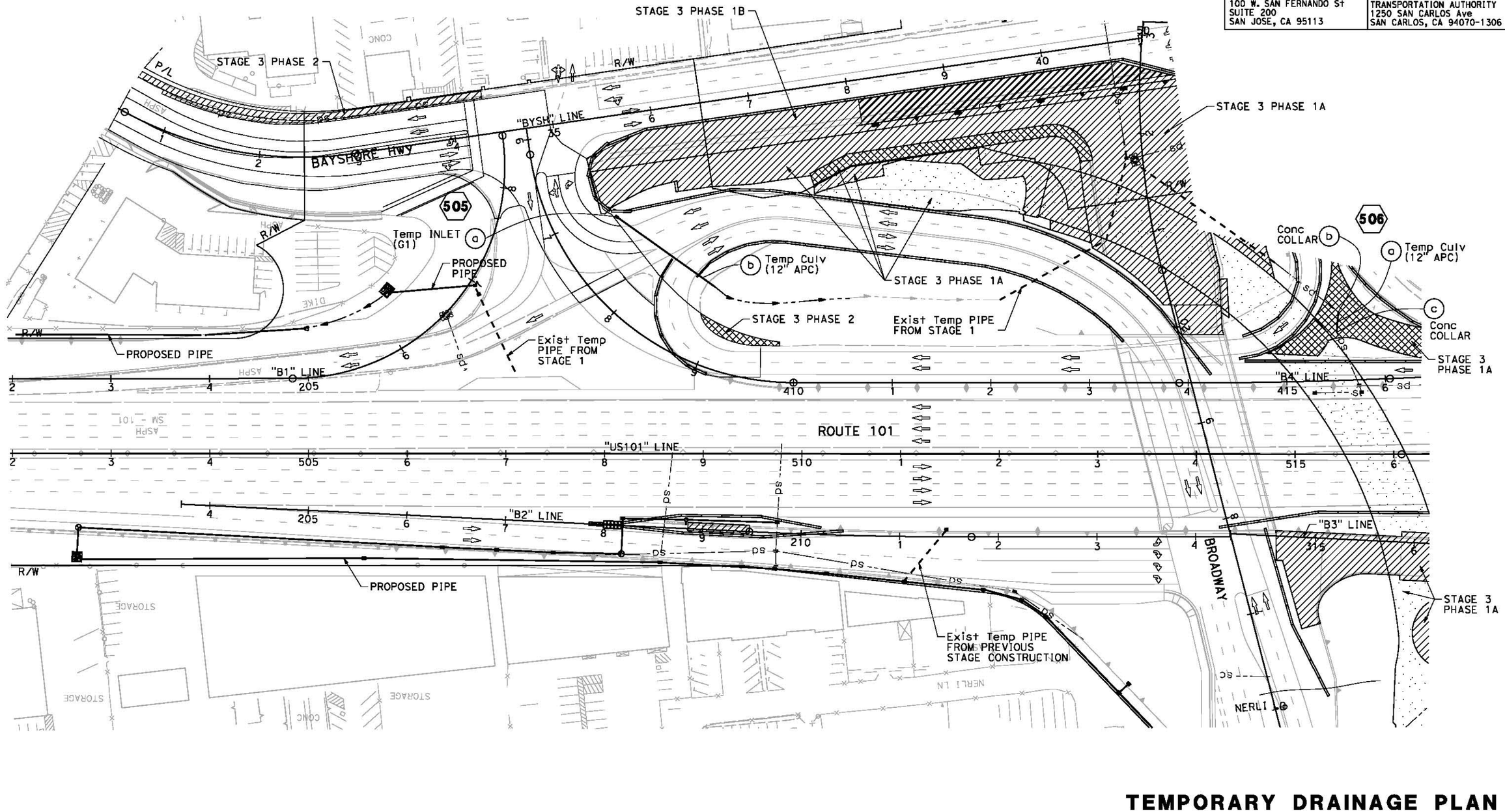

TEMPORARY DRAINAGE PLAN
STAGE 3 CONSTRUCTION
SCALE: 1" = 50'

D-8

APPROVED FOR TEMPORARY DRAINAGE WORK ONLY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY HISSEN

CALCULATED-DESIGNED BY: HUEY S. NHAM

CHECKED BY: ELIE-ABI-JAOUDE

REVISED BY: .

DATE REVISED: .

LAST REVISION 06-27-12

DATE PLOTTED => 4/16/2013
TIME PLOTTED => 2:03:24 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER 4/22/13 DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Huey S Nham No. 65138 Exp. 9/30/13 CIVIL STATE OF CALIFORNIA

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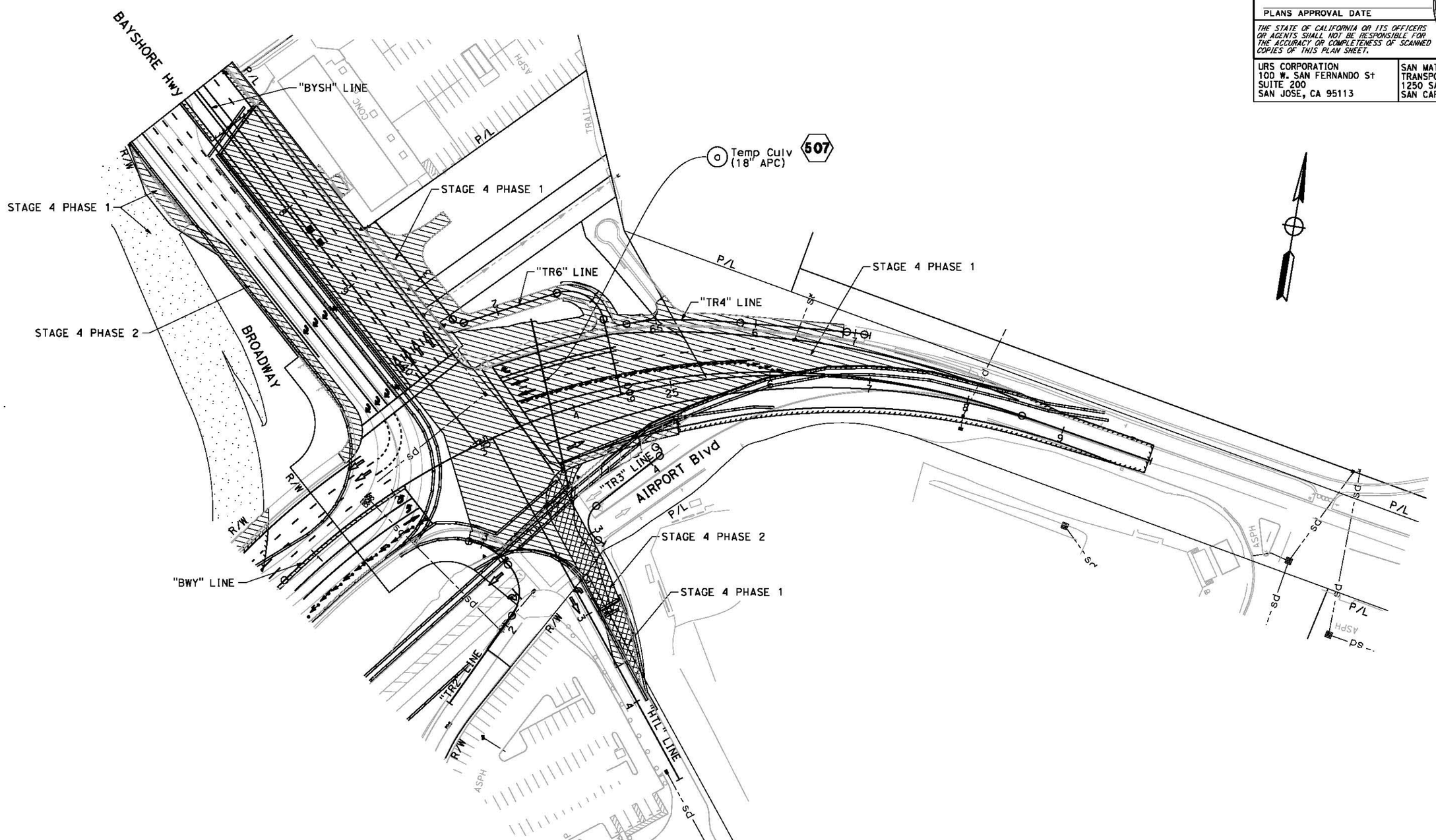
SAN CARLOS, CA 94070-1306



APPROVED FOR TEMPORARY DRAINAGE WORK ONLY

TEMPORARY DRAINAGE PLAN
STAGE 4 CONSTRUCTION
SCALE: 1" = 50'

D-9

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: RAMSEY HISSEN

CALCULATED-DESIGNED BY: HUEY S. NHAM

CHECKED BY: ELIE-ABI-JAOUDE

REVISED BY: .

DATE REVISED: .

LAST REVISION 06-27-12

DATE PLOTTED => 4/16/2013
TIME PLOTTED => 3:16:47 PM

Appendix C Proposed Watershed Maps

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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TRANSPORTATION AUTHORITY
1250 SAN CARLOS Ave
SAN CARLOS, CA 94070-1306

NOTE:

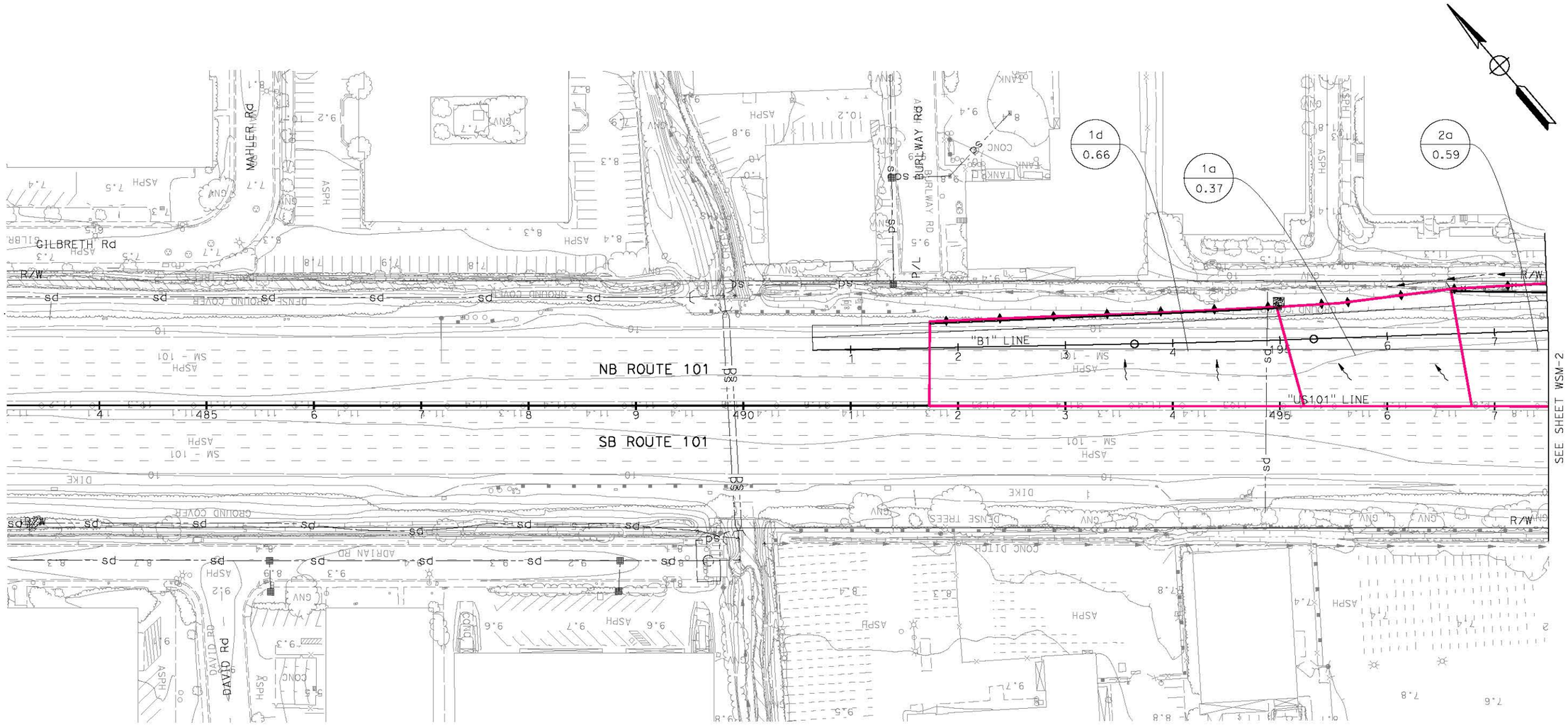
FOR ACCURATE RIGHT OF WAY DATA, CONTACT RIGHT OF WAY ENGINEERING AT THE DISTRICT OFFICE.

LEGEND:

DRAINAGE SYSTEM UNIT
AREA (ac)

UNPAVED WATERSHED BOUNDARY

PAVED WATERSHED BOUNDARY



WATERSHED MAP

SCALE: 1"=50'

WSM-1

THIS PLAN ACCURATE FOR WATERSHED MAP WORK ONLY

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: HAN-BIN LIANG

CALCULATED-DESIGNED BY: TERENCE XIAO

CHECKED BY: ANDREW SEKIOKA

REVISED BY: .

DATE REVISED: .

LAST REVISION: 00-00-00

DATE PLOTTED => 4/17/2013

TIME PLOTTED => 12:44:22 PM

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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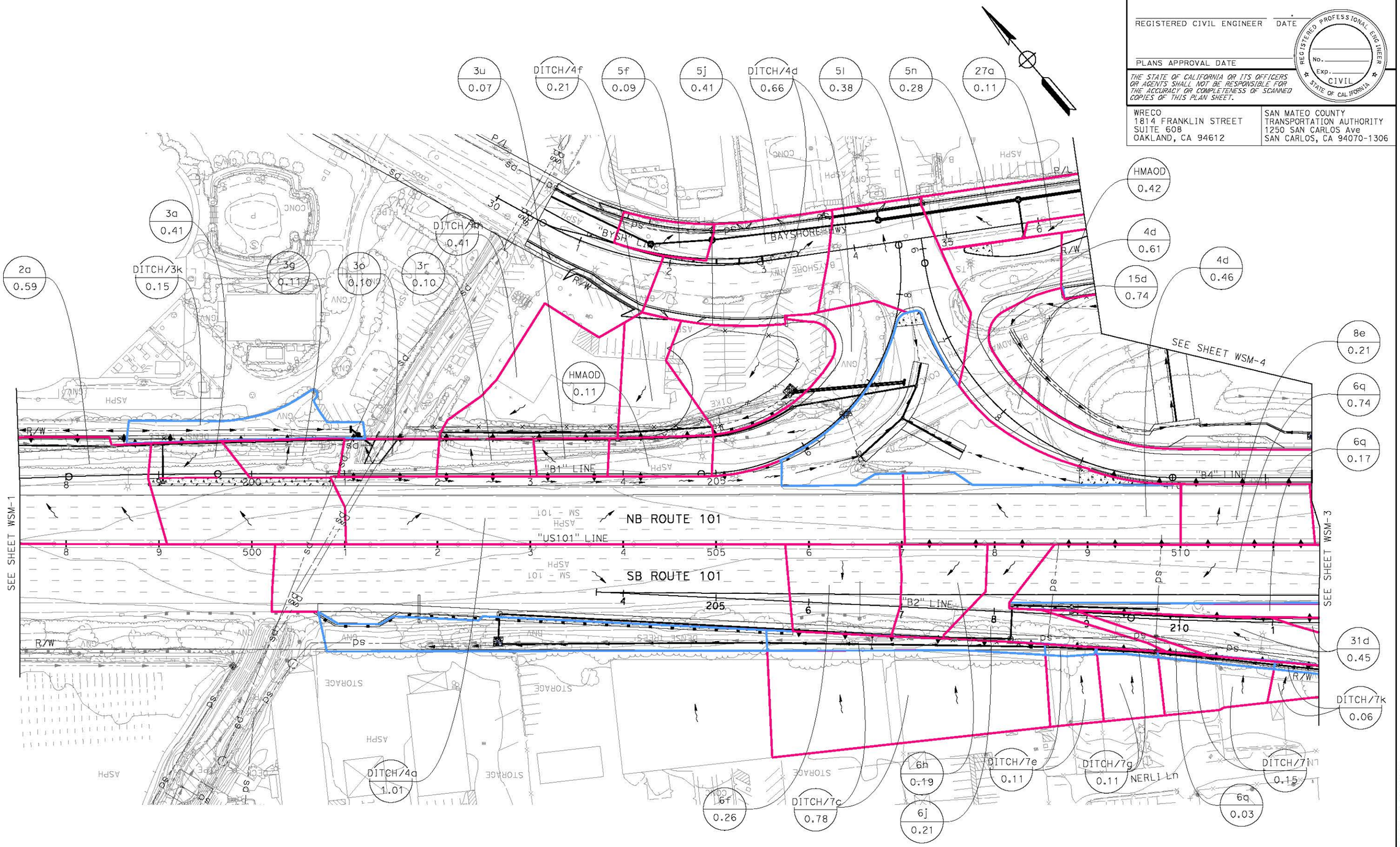

WATERSHED MAP

SCALE: 1"=50'

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WSM-1

THIS PLAN ACCURATE FOR WATERSHED MAP WORK ONLY

WSM-2

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: HAN-BIN LIANG

CALCULATED-DESIGNED BY: TERENCE XIAO

CHECKED BY: ANDREW SEKIOKA

REVISED BY: .

DATE REVISED: .

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DATE PLOTTED => 4/17/2013

TIME PLOTTED => 12:44:26 PM

BORDER LAST REVISED 7/2/2010

USERNAME => terence_xiao
DGN FILE => ...\Dwg\WM\0400023584ia002.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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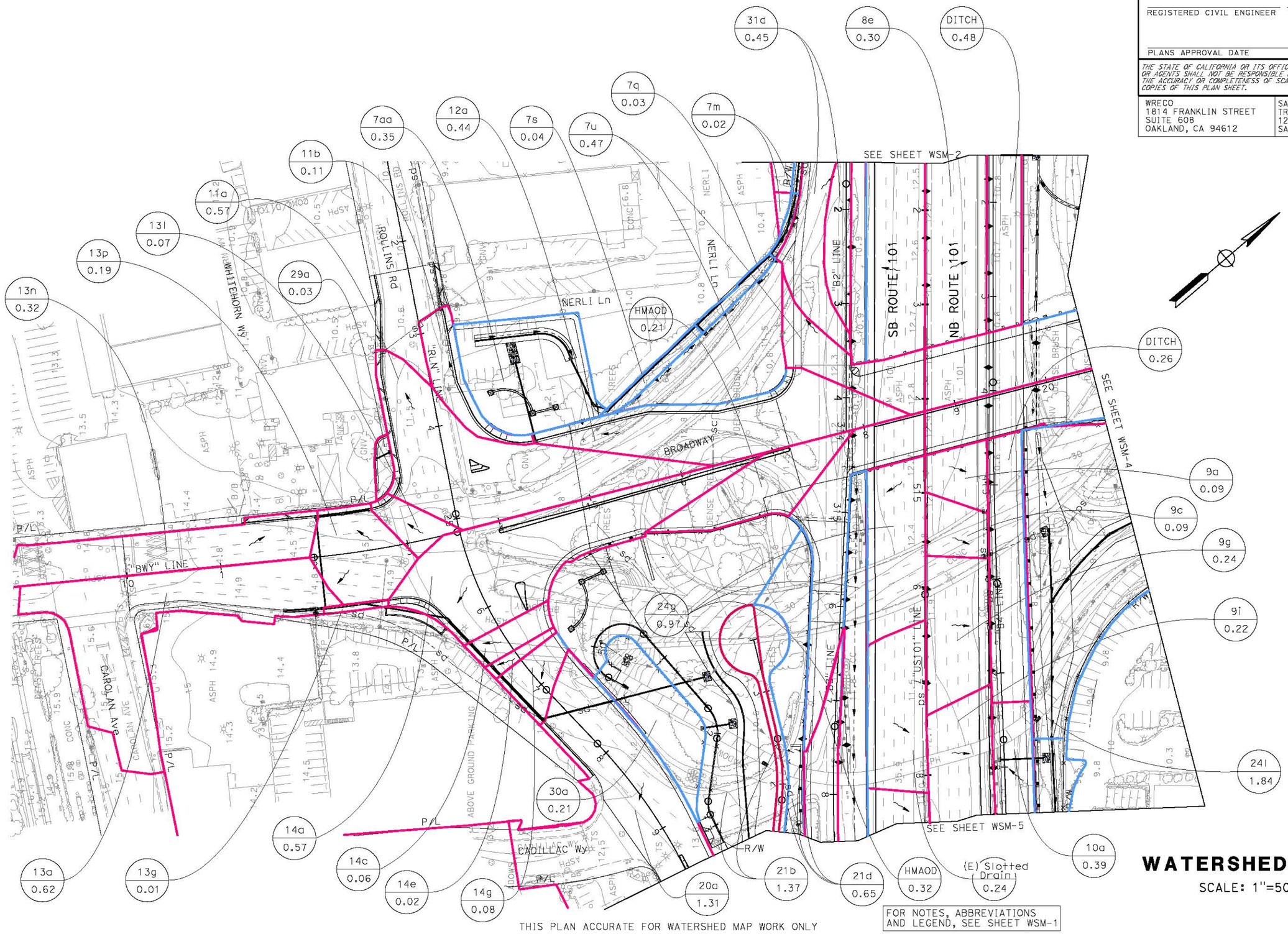

WATERSHED MAP

SCALE: 1"=50'

THIS PLAN ACCURATE FOR WATERSHED MAP WORK ONLY

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WSM-1

WSM-3

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

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CALCULATED-DESIGNED BY: TERENCE XIAO

CHECKED BY: ANDREW SEKIOKA

REVISED BY: .

DATE REVISED: .

LAST REVISION 00-00-00

DATE PLOTTED => 4/17/2013

TIME PLOTTED => 12:44:27 PM

BORDER LAST REVISED 7/2/2010

USERNAME => terence_xiao
DGN FILE => ...\Dwg\WM\0400023584ia003.dgn

RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3

UNIT 0703

PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

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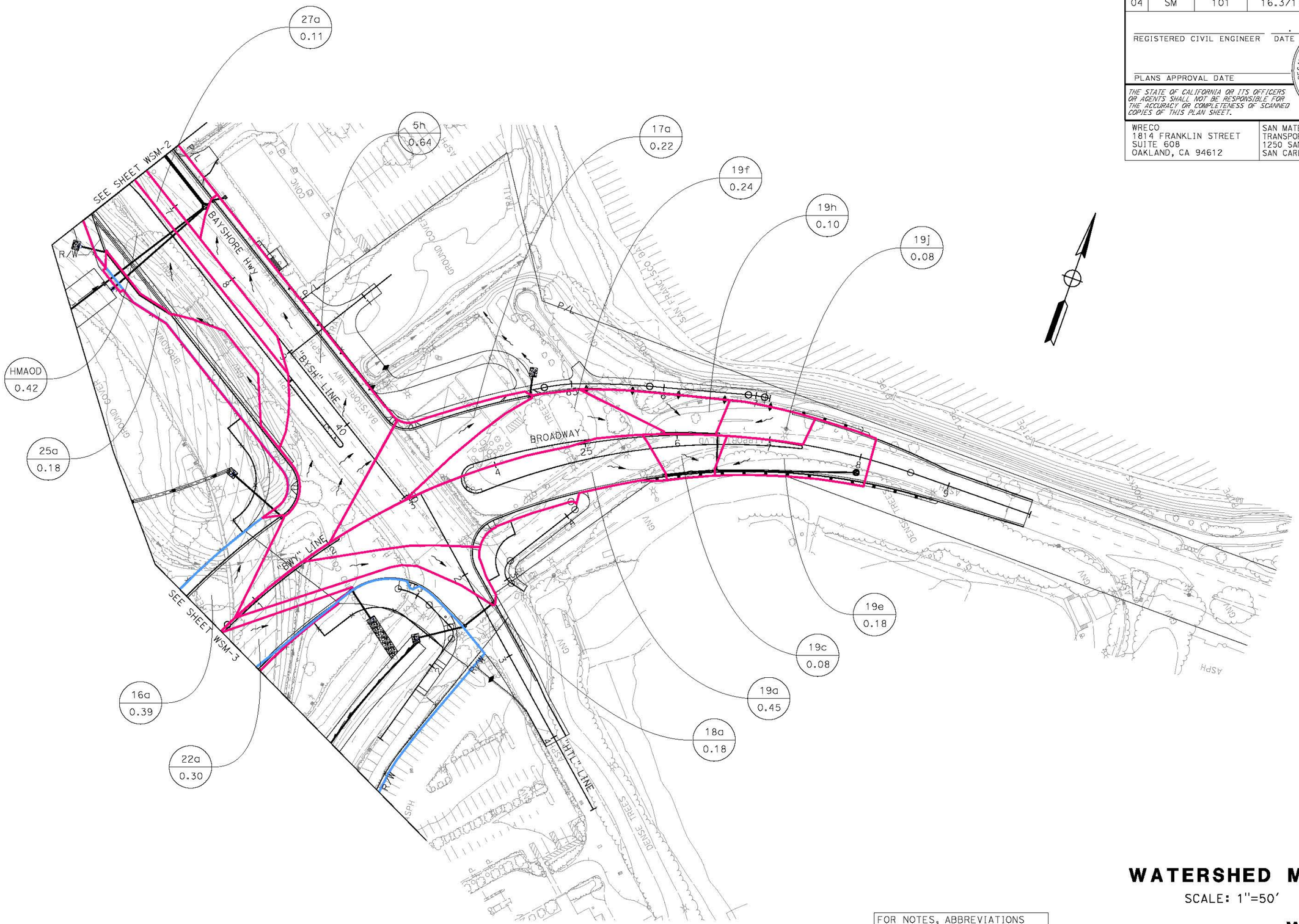

THIS PLAN ACCURATE FOR WATERSHED MAP WORK ONLY

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WSM-1

WATERSHED MAP

SCALE: 1"=50'

WSM-4

REVISED BY	DATE REVISED
.	.

TERENCE XIAO — ANDREW SEKIOKA

CALCULATED-DESIGNED BY — CHECKED BY

CONSULTANT FUNCTIONAL SUPERVISOR: HAN-BIN LIANG

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Caltrans

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BORDER LAST REVISED 7/2/2010 | USERNAME => terence_xiao | DGN FILE => ...\Dwg\WM\0400023584ia004.dgn | RELATIVE BORDER SCALE IS IN INCHES 0 1 2 3 | UNIT 0703 | PROJECT NUMBER & PHASE 04000006841

Dist	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No.	TOTAL SHEETS
04	SM	101	16.3/17.1	.	.

REGISTERED CIVIL ENGINEER DATE

PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER No. Exp. CIVIL STATE OF CALIFORNIA

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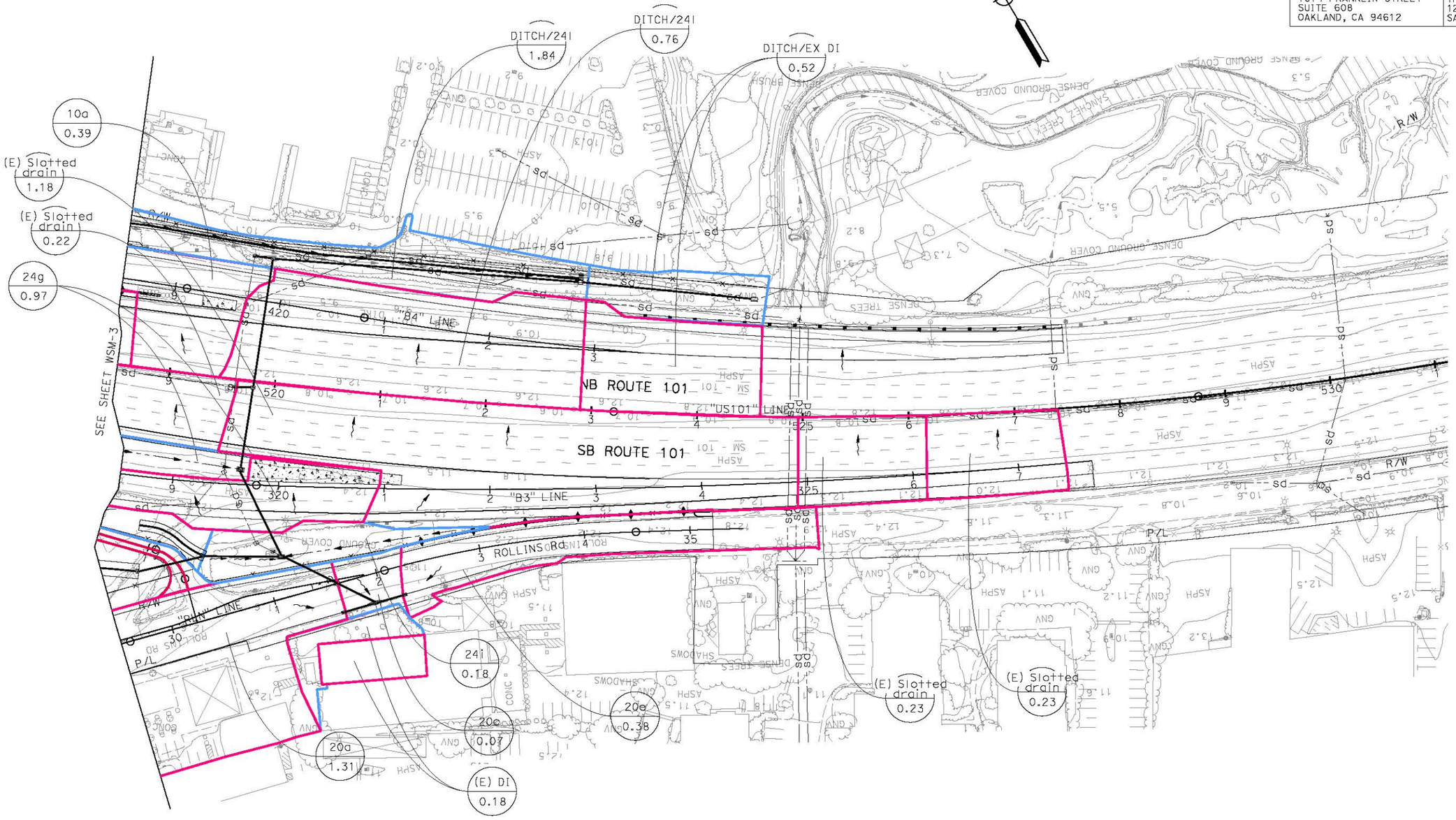


WATERSHED MAP

SCALE: 1"=50'

FOR NOTES, ABBREVIATIONS AND LEGEND, SEE SHEET WSM-1

THIS PLAN ACCURATE FOR WATERSHED MAP WORK ONLY

WSM-5

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION

Caltrans

CONSULTANT FUNCTIONAL SUPERVISOR: HAN-BIN LIANG

CALCULATED-DESIGNED BY: . CHECKED BY: .

REVISED BY: . DATE REVISED: .

TERENCE XIAO ANDREW SEKIOKA

LAST REVISION: 00-00-00 DATE PLOTTED => 4/17/2013 TIME PLOTTED => 12:44:29 PM

Appendix D Spread Flow Calculations

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"B1"	"B1"	"B1"		"B1"	"B1"	
In#	**Inlet number:**			1d	1a		2a		
		(Input Data Required)							
HYDROLOGY COMPUTATION:			<<<	<<<	<<<		<<<		
	Begin Station			192+88	195+00		196+63		
	End Station			195+00	196+63		197+80		
St	Structure location station:	>>	192+88	195+00	195+00	195+55	196+63	197+80	198+90
N	Notes		Sheet Flow	GLD	G1 DI	HP	G1 DI at LP	Flip (flow toward mainline then back to B1 Lt Shld (2a)	upstream flows to Gore Ditch
	Off-site contributing watershed area (acres):	>>							
	On-site contributing watershed area (acres):	>>		0.66	0.37		0.59		
Ar	**Contributing watershed area (acres):**			**0.66**	**0.37**		**0.59**		
C	Composite Runoff Coefficient "C":	>>		1	1		1		
Ic	Precipitation intensity (in/hr):	>>		3.24	3.24		3.24		
Qa	Subarea discharge Q (ft^3/s):			2.14	1.20		1.91		
qq	Previous by-pass flow (ft^3/s):	>		0.19			0.00		
Qadd	Discharge added by operator (ft^3/s):	>							
Qt	**Total discharge Q (ft^3/s):**			**2.32**	**1.20**		**1.91**		
SHOULDER AND GUTTER CONFIGURATION:									
n	Manning's n:	>>		0.015	0.015		0.015		
S	Longitudinal slope S (ft/ft):	>>		0.001	0.003				
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>		3	1		1		
LP	Longitudinal profile (1=on-grade, 2=sag):	>>		1	1		2		
ID	Inlet description:	>		GLD	G1		G1		
	Grate Type:	>>			24-9		24-9		
	Standard Gutter Depression (1=SGD, 2=no SGD)	>			2		2		
Gw	Grate width (in):	>			24.0		24.0		
Gl	Grate length (in):	>			36.0		36.0		
	3 or 4 sided weir?	>			3		3		
Lco	Curb opening length provided (ft):	>							
Ls	Slotted drain length provided: (ft)	>		209.00					
Sx	Shoulder cross-slope Sx (ft/ft):	>>		0.0500	0.0500		0.0453		
W	Width of gutter from flowline (in):	>		0.0	0.0		0.0		
a(t)	Gutter depression from horizontal (in):	>		0.0	0.0		0.0		
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)			0.050	0.050		0.045		
	Available Flooded Width (ft)	>		8.00	8.00		15.00		
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**			**-----**	**5.32**		**-----**		
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**			**-----**	**5.32**		**-----**		
Du/s	Depth at flowline before inlet (ft):			-----	0.27		-----		
Au/s	Water cross-area before inlet (ft^2):			-----	0.71		-----		
Vu/s	Velocity for total discharge before inlet (ft/s):			-----	1.69		-----		
Eod	Ratio of gutter depression flow to total Q (Eod):			-----	-----		-----		
Se	Equivalent cross-slope (ft/ft):			0.050	0.050		0.045		
GRATE INLETS ON-GRADE:									
Eog	Ratio of grate frontal flow to total flow:			-----	72%		-----		
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression			-----	0.86		-----		
Vo	Vo for effective length (P-50, Chart 5) (ft/s):			-----	7.76		-----		
Rf	Fraction of frontal flow intercepted (Rf):			-----	1.00		-----		
Qs	Side flow in ft^3/s (Qs):			-----	0.34		-----		
Gle	Effective grate length w/ 25% clogging (in):			-----	27		-----		
Rs	Fraction of side flow interception (Rs):			-----	46%		-----		
E	Grate Efficiency (E):			-----	84%		-----		
Qi	**Total flow intercepted (ft^3/s):**			**-----**	**1.01**		**-----**		
Qb	**Grate flow-by (ft^3/s):**			**-----**	**0.19**		**-----**		
SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)									
Lt	Length required for total interception (ft):			9.02	-----		-----		
Ci	Interception for provided length L (ft^3/s):			2.3	-----		-----		
El	Efficiency for provided length L:			100%	-----		-----		
Qs	**Slotted drain or side opening flow-by (ft^3/s):**			**0.0**	**-----**		**-----**		
INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:									
	Grate Inlets								
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	-----		0.26		
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	-----		0.32		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----		5.83		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----		7.09		
	Slotted drains								
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	-----		-----		
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	-----		-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----		-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----		-----		
	Curb opening inlets								
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):			-----	-----		-----		
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):			-----	-----		-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----		-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----		-----		
Lc	Length of the vertical curve (ft):	>							
g1	approach grade #1 (%):	>							
g2	approach grade #2 (%):	>							
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):			-----	-----		-----		
Df	Flanking inlets distance (ft):			-----	-----		-----		

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"B1"	"B1"	"B1"	"B1"	"B1"	"B1"	"B1"	"B1"	"B1"	"B1"	"B1"	"B1"	"B1"
In#	**Inlet number:**			3g		3h	3o	3p	3r	3s	3u		3v		
		(Input Data Required)													
HYDROLOGY COMPUTATION:						>>>	>>>	>>>		<<<	<<<		>>>	>>>	>>>
	Begin Station			199+68			200+80		202+04					203+80	
	End Station			200+80			202+04		203+06					204+75	
St	Structure location station:	>>	199+68	200+02	200+80	201+02	201+02	202+04	202+04	203+06	203+06	203+80	203+94	204+75	
N	Notes		upstream flows to Gore Ditch	GLD (Local LP at 200+40)	Local HP	G1 DI (Junction Only)	GLD	G1 DI (Junctio n Only)	GLD (LP at 202+20)	G1 DI (Junctio n Only)	GLD	HP	G1 DI (Junction Only)	HMA OD	flow to Ditch
	Off-site contributing watershed area (acres):	>>													
	On-site contributing watershed area (acres):	>>		0.10			0.11		0.10		0.07			0.11	
Ar	**Contributing watershed area (acres):**			**0.10**			**0.11**		**0.10**		**0.07**			**0.11**	
C	Composite Runoff Coefficient "C":	>>		1			1		1		1			1	
Ic	Precipitation intensity (in/hr):	>>		3.24			3.24		3.24		3.24			3.24	
Qa	Subarea discharge Q (ft^3/s):			0.32			0.36		0.32		0.23			0.36	
qq	Previous by-pass flow (ft^3/s):	>							0.00						
Qadd	Discharge added by operator (ft^3/s):	>													
Qt	**Total discharge Q (ft^3/s):**			**0.32**			**0.36**		**0.32**		**0.23**			**0.36**	
SHOULDER AND GUTTER CONFIGURATION:															
n	Manning's n:	>>		0.015			0.015		0.015		0.015			0.015	
S	Longitudinal slope S (ft/ft):	>>									0.002			0.021	
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>		3			3		3		3			2	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>		2			1		2		1			1	
ID	Inlet description:	>		GLD			GLD		GLD		GLD			HMA OD	
	Grate Type:	>>					.								
	Standard Gutter Depression (1=SGD, 2=no SGD)	>													
Gw	Grate width (in):	>													
Gl	Grate length (in):	>													
	3 or 4 sided weir?	>													
Lco	Curb opening length provided (ft):	>												13.00	
Ls	Slotted drain length provided: (ft)	>		97.00			98.00		100.00		86.00				
Sx	Shoulder cross-slope Sx (ft/ft):	>>		0.0200			0.0450		0.0500		0.0500			0.0750	
W	Width of gutter from flowline (in):	>													
a(t)	Gutter depression from horizontal (in):	>		0.0			0.0		0.0		0.0			0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)			0.020			0.045		0.050		0.050			0.075	
	Available Flooded Width (ft)	>		2.00			2.00		2.00		2.00			2.00	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**			**-----**			**-----**		**-----**		**-----**			**1.82**	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**			**-----**			**-----**		**-----**		**-----**			**1.82**	
Du/s	Depth at flowline before inlet (ft):			-----			-----		-----		-----			0.14	
Au/s	Water cross-area before inlet (ft^2):			-----			-----		-----		-----			0.12	
Vu/s	Velocity for total discharge before inlet (ft/s):			-----			-----		-----		-----			2.86	
Eod	Ratio of gutter depression flow to total Q (Eod):			-----			-----		-----		-----			-----	
Se	Equivalent cross-slope (ft/ft):			0.020			0.045		0.050		0.050			0.075	
GRATE INLETS ON-GRADE:															
Eog	Ratio of grate frontal flow to total flow:			-----			-----		-----		-----			-----	
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression			-----			-----		-----		-----			-----	
Vo	Vo for effective length (P-50, Chart 5) (ft/s):			-----			-----		-----		-----			-----	
Rf	Fraction of frontal flow intercepted (Rf):			-----			-----		-----		-----			-----	
Qs	Side flow in ft^3/s (Qs):			-----			-----		-----		-----			-----	
Gle	Effective grate length w/ 25% clogging (in):			-----			-----		-----		-----			-----	
Rs	Fraction of side flow interception (Rs):			-----			-----		-----		-----			-----	
E	Grate Efficiency (E):			-----			-----		-----		-----			-----	
Qi	**Total flow intercepted (ft^3/s):**			**-----**			**-----**		**-----**		**-----**			**-----**	
Qb	**Grate flow-by (ft^3/s):**			**-----**			**-----**		**-----**		**-----**			**-----**	
SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)															
Lt	Length required for total interception (ft):			-----			0.00		-----		3.74			7.18	
Ci	Interception for provided length L (ft^3/s):			-----			0.4		-----		0.2			0.4	
El	Efficiency for providged length L:			-----			100%		-----		100%			100%	
Qs	**Slotted drain or side opening flow-by (ft^3/s):**			**-----**			**0.0**		**-----**		**0.0**			**0.0**	
INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:															
	Grate Inlets														
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----			-----		-----		-----			-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----			-----		-----		-----			-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----			-----		-----		-----			-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----			-----		-----		-----			-----	
	Slotted drains														
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			0.02			-----		0.02		-----			-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			0.02			-----		0.02		-----			-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			0.80			-----		0.31		-----			-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			0.97			-----		0.38		-----			-----	
	Curb opening inlets														
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):			-----			-----		-----		-----			-----	
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):			-----			-----		-----		-----			-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----			-----		-----		-----			-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----			-----		-----		-----			-----	
Lc	Length of the vertical curve (ft):	>													
g1	approach grade #1 (%):	>													
g2	approach grade #2 (%):	>													
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):			-----			-----		-----		-----			-----	
Df	Flanking inlets distance (ft):			-----			-----		-----		-----			-----	

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX **Date:** 4/15/2013
Checked by: AS **Date:** 4/15/2013

	Layout Line:		"B2"	"B2"	"B2"	"B2"	"B2"	"B2"	"B2"	"B2"
In#	**Inlet number:**			6f	6h	6j		31d		
	(Input Data Required)									
HYDROLOGY COMPUTATION:			>>>		<<<	<<<	<<<	<<<	<<<	
	Begin Station			205+00	206+93	207+50		208+83	211+00	
	End Station			206+93	207+50	208+83		211+00	212+50	
St	Structure location station:	>>	205+00	206+37.52	206+93	207+50	208+83	208+83	211+00	212+50
N	Notes		**Sheet Flow**	**G2 DI @ LP**	**G2 DI**	**G2 DI**	**Flip, upstream drains to GLD**	**GLD**	**Spread Calc Only**	**Sheet Flow to ditch / Flip**
	Off-site contributing watershed area (acres):	>>								
	On-site contributing watershed area (acres):	>>		0.26	0.18	0.19		0.45	0.10	
Ar	**Contributing watershed area (acres):**			**0.26**	**0.18**	**0.19**		**0.45**	**0.10**	
C	Composite Runoff Coefficient "C":	>>		1	1	1		1	1	
Ic	Precipitation intensity (in/hr):	>>		3.24	3.24	3.24		3.24	3.24	
Qa	Subarea discharge Q (ft^3/s):			0.84	0.60	0.62		1.46	0.32	
qq	Previous by-pass flow (ft^3/s):	>		0.23	0.21				0.00	
Qadd	Discharge added by operator (ft^3/s):	>								
Qt	**Total discharge Q (ft^3/s):**			**1.07**	**0.80**	**0.62**		**1.46**	**0.32**	
SHOULDER AND GUTTER CONFIGURATION:										
n	Manning's n:	>>		0.015	0.015	0.015		0.015	0.015	
S	Longitudinal slope S (ft/ft):	>>			0.009	0.015		0.028	0.055	
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>		1	1	1		3	1	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>		2	1	1		1	1	
ID	Inlet description:	>		G2	G2	G2		G2		
	Grate Type:	>>		24-9	24-9	24-9		24-9		
	Standard Gutter Depression (1=SGD, 2=no SGD)	>		2	2	2		2		
Gw	Grate width (in):	>		24.0	24.0	24.0		24.0		
Gl	Grate length (in):	>		36.0	36.0	36.0		36.0		
	3 or 4 sided weir?	>		3	3	3		3		
Lco	Curb opening length provided (ft):	>								
Ls	Slotted drain length provided: (ft)	>						217.00		
Sx	Shoulder cross-slope Sx (ft/ft):	>>		0.0275	0.0213	0.0138		0.0055	0.0200	
W	Width of gutter from flowline (in):	>		0.0	0.0	0.0		0.0	0.0	
a(t)	Gutter depression from horizontal (in):	>		0.0	0.0	0.0		0.0	0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)			0.028	0.021	0.014		0.006	0.020	
	Available Flooded Width (ft)	>		8.00	8.00	8.00		4.00	4.00	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**			**-----**	**6.37**	**6.90**		**-----**	**3.35**	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**			**-----**	**6.37**	**6.90**		**-----**	**3.35**	
Du/s	Depth at flowline before inlet (ft):			-----	0.14	0.09		-----		
Au/s	Water cross-area before inlet (ft^2):			-----	0.43	0.33		-----		
Vu/s	Velocity for total discharge before inlet (ft/s):			-----	1.87	1.88		-----		
Eod	Ratio of gutter depression flow to total Q (Eod):			-----	-----	-----		-----		
Se	Equivalent cross-slope (ft/ft):			0.028	0.021	0.014		0.006		
GRATE INLETS ON-GRADE:										
Eog	Ratio of grate frontal flow to total flow:			-----	63%	60%		-----		
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression			-----	0.51	0.37		-----		
Vo	Vo for effective length (P-50, Chart 5) (ft/s):			-----	7.76	7.76		-----		
Rf	Fraction of frontal flow intercepted (Rf):			-----	1.00	1.00		-----		
Qs	Side flow in ft^3/s (Qs):			-----	0.29	0.25		-----		
Gle	Effective grate length w/ 25% clogging (in):			-----	27	27		-----		
Rs	Fraction of side flow interception (Rs):			-----	23%	16%		-----		
E	Grate Efficiency (E):			-----	72%	66%		-----		
Qi	**Total flow intercepted (ft^3/s):**			**-----**	**0.58**	**0.41**		**-----**		
Qb	**Grate flow-by (ft^3/s):**			**-----**	**0.23**	**0.21**		**-----**		
SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)										
Lt	Length required for total interception (ft):			-----	-----	-----		67.80		
Ci	Interception for provided length L (ft^3/s):			-----	-----	-----		1.5		
El	Efficiency for providged length L:			-----	-----	-----		100%		
Qs	**Slotted drain or side opening flow-by (ft^3/s):**			**-----**	**-----**	**-----**		**0.0**		
INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:										
	Grate Inlets									
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			0.18	-----	-----		-----		
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			0.22	-----	-----		-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			6.52	-----	-----		-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			7.93	-----	-----		-----		
	Slotted drains									
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	-----	-----		-----		
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	-----	-----		-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----	-----		-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----	-----		-----		
	Curb opening inlets									
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):			-----	-----	-----		-----		
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):			-----	-----	-----		-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----	-----		-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----	-----		-----		
Lc	Length of the vertical curve (ft):	>								
g1	approach grade #1 (%):	>								
g2	approach grade #2 (%):	>								
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):			-----	-----	-----		-----		
Df	Flanking inlets distance (ft):			-----	-----	-----		-----		

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"BWY"	"B3"	"B3"
In#	**Inlet number:**				
		[Input Data Required]			
HYDROLOGY COMPUTATION:					
	Begin Station			18+70 "BWY"	
	End Station			317+57	
St	Structure location station:	>>	18+70	317+57.	
N	Notes		From HP on BWY	HMAOD	downstream sheet flow to roadside ditch
	Off-site contributing watershed area (acres):	>>			
	On-site contributing watershed area (acres):	>>		0.32	
Ar	**Contributing watershed area (acres):**			**0.32**	
C	Composite Runoff Coefficient "C":	>>		1	
Ic	Precipitation intensity (in/hr):	>>		3.24	
Qa	Subarea discharge Q (ft^3/s):			1.04	
qq	Previous by-pass flow (ft^3/s):	>		0.00	
Qadd	Discharge added by operator (ft^3/s):	>			
Qt	**Total discharge Q (ft^3/s):**			**1.04**	
SHOULDER AND GUTTER CONFIGURATION:					
n	Manning's n:	>>		0.015	
S	Longitudinal slope S (ft/ft):	>>		0.051	
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>		2	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>		1	
ID	Inlet description:	>			
	Grate Type:	>>			
	Standard Gutter Depression (1=SGD, 2=no SGD)	>			
Gw	Grate width (in):	>			
Gl	Grate length (in):	>			
	3 or 4 sided weir?	>			
Lco	Curb opening length provided (ft):	>		13.00	
Ls	Slotted drain length provided: (ft)	>			
Sx	Shoulder cross-slope Sx (ft/ft):	>>		0.0200	
W	Width of gutter from flowline (in):	>		0.0	
a(t)	Gutter depression from horizontal (in):	>		0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)			0.020	
	Available Flooded Width (ft)	>		8.00	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**			**5.25**	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**			**5.25**	
Du/s	Depth at flowline before inlet (ft):			0.11	
Au/s	Water cross-area before inlet (ft^2):			0.28	
Vu/s	Velocity for total discharge before inlet (ft/s):			3.76	
Eod	Ratio of gutter depression flow to total Q (Eod):			-----	
Se	Equivalent cross-slope (ft/ft):			0.020	
GRATE INLETS ON-GRADE:					
Eog	Ratio of grate frontal flow to total flow:			-----	
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression			-----	
Vo	Vo for effective length (P-50, Chart 5) (ft/s):			-----	
Rf	Fraction of frontal flow intercepted (Rf):			-----	
Qs	Side flow in ft^3/s (Qs):			-----	
Gle	Effective grate length w/ 25% clogging (in):			-----	
Rs	Fraction of side flow interception (Rs):			-----	
E	Grate Efficiency (E):			-----	
Qi	**Total flow intercepted (ft^3/s):**			**-----**	
Qb	**Grate flow-by (ft^3/s):**			**-----**	
SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)					
Lt	Length required for total interception (ft):			32.47	
Ci	Interception for provided length L (ft^3/s):			0.6	
El	Efficiency for providged length L:			60%	
Qs	**Slotted drain or side opening flow-by (ft^3/s):**			**0.4**	
INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:					
	Grate Inlets				
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	
	Slotted drains				
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	
	Curb opening inlets				
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):			-----	
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):			-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	
Lc	Length of the vertical curve (ft):	>			
g1	approach grade #1 (%):	>			
g2	approach grade #2 (%):	>			
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):			-----	
Df	Flanking inlets distance (ft):			-----	

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"B4"	"B4"	"B4"
In#	**Inlet number:**			10a	
		[Input Data Required]			
HYDROLOGY COMPUTATION:					
	Begin Station			417+30	
	End Station			419+90	
St	Structure location station:	>>		417+91.83	
N	Notes		upstream sheet flow to roadside ditch	DI at LP	upstream sheet flow to roadside ditch
	Off-site contributing watershed area (acres):	>>			
	On-site contributing watershed area (acres):	>>		0.39	
Ar	**Contributing watershed area (acres):**			**0.39**	
C	Composite Runoff Coefficient "C":	>>		1	
Ic	Precipitation intensity (in/hr):	>>		3.24	
Qa	Subarea discharge Q (ft^3/s):			1.26	
qq	Previous by-pass flow (ft^3/s):	>		0.00	
Qadd	Discharge added by operator (ft^3/s):	>			
Qt	**Total discharge Q (ft^3/s):**			**1.26**	
SHOULDER AND GUTTER CONFIGURATION:					
n	Manning's n:	>>		0.015	
S	Longitudinal slope S (ft/ft):	>>			
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>		1	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>		2	
ID	Inlet description:	>		G1	
	Grate Type:	>>		24-9	
	Standard Gutter Depression (1=SGD, 2=no SGD)	>		2	
Gw	Grate width (in):	>		24.0	
Gl	Grate length (in):	>		36.0	
	3 or 4 sided weir?	>		3	
Lco	Curb opening length provided (ft):	>			
Ls	Slotted drain length provided: (ft)	>			
Sx	Shoulder cross-slope Sx (ft/ft):	>>		0.0200	
W	Width of gutter from flowline (in):	>		0.0	
a(t)	Gutter depression from horizontal (in):	>		0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)			0.020	
	Available Flooded Width (ft)	>		7.30	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**			-----	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**			-----	
Du/s	Depth at flowline before inlet (ft):			-----	
Au/s	Water cross-area before inlet (ft^2):			-----	
Vu/s	Velocity for total discharge before inlet (ft/s):			-----	
Eod	Ratio of gutter depression flow to total Q (Eod):			-----	
Se	Equivalent cross-slope (ft/ft):			-----	
GRATE INLETS ON-GRADE:					
Eog	Ratio of grate frontal flow to total flow:			-----	
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression			-----	
Vo	Vo for effective length (P-50, Chart 5) (ft/s):			-----	
Rf	Fraction of frontal flow intercepted (Rf):			-----	
Qs	Side flow in ft^3/s (Qs):			-----	
Gle	Effective grate length w/ 25% clogging (in):			-----	
Rs	Fraction of side flow interception (Rs):			-----	
E	Grate Efficiency (E):			-----	
Qi	**Total flow intercepted (ft^3/s):**			-----	
Qb	**Grate flow-by (ft^3/s):**			-----	
SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)					
Lt	Length required for total interception (ft):			-----	
Ci	Interception for provided length L (ft^3/s):			-----	
El	Efficiency for providged length L:			-----	
Qs	**Slotted drain or side opening flow-by (ft^3/s):**			-----	
INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:					
	Grate Inlets				
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			0.20	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			0.24	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			10.03	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			12.19	
	Slotted drains				
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	
	Curb opening inlets				
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):			-----	
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):			-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	
Lc	Length of the vertical curve (ft):	>			
g1	approach grade #1 (%):	>			
g2	approach grade #2 (%):	>			
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):			-----	
Df	Flanking inlets distance (ft):			-----	

Note: For System 10a, the actual ponding depth is 0.10 & 0.14 (Hwy/City) above TG because inlet depressin, so actual ponded widths are 5' & 7' (Higyway/City)

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"
In#	**Inlet number:**				8e	8a	8e		9a	9c	9g	9i	
		(Input Data Required)											
HYDROLOGY COMPUTATION:			<<<		>>>		<<<		>>>	>>>		<<<	
	Begin Station				510+00		511+41		514+43	515+20	515+68	517+06	
	End Station				511+41		513+47		515+20	515+68	517+06	518+59	
St	Structure location station:	>>		510+00	511+41	511+41	511+41	Bridge	515+20	515+68	516+43	517+06	
N	Notes		Sheet Flow to Triangle	HP	GLD	G1 DI Junction Only at LP	GLD	HP	G1 DI	G1 DI	G1 DI @ LP	G1 DI	Upstream flows to B4
	Off-site contributing watershed area (acres):	>>											
	On-site contributing watershed area (acres):	>>			0.21		0.30		0.09	0.09	0.24	0.22	
Ar	**Contributing watershed area (acres):**				**0.21**		**0.30**		**0.09**	**0.09**	**0.24**	**0.22**	
C	Composite Runoff Coefficient "C":	>>			1		1		1	1	1	1	
Ic	Precipitation intensity (in/hr):	>>			3.24		3.24		3.24	3.24	3.24	3.24	
Qa	Subarea discharge Q (ft^3/s):				0.68		0.97		0.29	0.29	0.78	0.71	
qq	Previous by-pass flow (ft^3/s):	>								0.06	0.12		
Qadd	Discharge added by operator (ft^3/s):	>											
Qt	**Total discharge Q (ft^3/s):**				**0.68**		**0.97**		**0.29**	**0.35**	**0.90**	**0.71**	
SHOULDER AND GUTTER CONFIGURATION:													
n	Manning's n:	>>			0.015		0.015		0.015	0.015	0.015	0.015	
S	Longitudinal slope S (ft/ft):	>>			0.003		0.003		0.007	0.007		0.006	
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>			3		3		1	1	1	1	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>			1		1		1	1	2	1	
ID	Inlet description:	>			GLD		GLD		G1	G1	G1	G1	
	Grate Type:	>>							24-9	24-9	24-9	24-9	
	Standard Gutter Depression (1=SGD, 2=no SGD)	>							2	2	2	2	
Gw	Grate width (in):	>							24.0	24.0	24.0	24.0	
Gl	Grate length (in):	>							36.0	36.0	36.0	36.0	
	3 or 4 sided weir?	>							3	3	3	3	
Lco	Curb opening length provided (ft):	>											
Ls	Slotted drain length provided: (ft)	>			100.00		100.00						
Sx	Shoulder cross-slope Sx (ft/ft):	>>			0.038		0.0498		0.0154	0.0154	0.0620	0.0620	
W	Width of gutter from flowline (in):	>			0.0		0.0		0.0	0.0	0.0	0.0	
a(t)	Gutter depression from horizontal (in):	>			0.0		0.0		0.0	0.0	0.0	0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)				0.038		0.050		0.060	0.060	0.060	0.060	
	Available Flooded Width (ft)	>			10.00		10.00		10.00	10.00	10.00	10.00	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**				**-----**		**-----**		**5.56**	**5.97**	**-----**	**3.36**	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**				**-----**		**-----**		**5.55**	**5.95**	**-----**	**3.36**	
Du/s	Depth at flowline before inlet (ft):				-----		-----		0.09	0.09	-----	0.21	
Au/s	Water cross-area before inlet (ft^2):				-----		-----		0.24	0.27	-----	0.35	
Vu/s	Velocity for total discharge before inlet (ft/s):				-----		-----		1.23	1.29	-----	2.04	
Eod	Ratio of gutter depression flow to total Q (Eod):				-----		-----		-----	-----	-----	-----	
Se	Equivalent cross-slope (ft/ft):				0.038		0.050		0.015	0.015	0.062	0.062	
GRATE INLETS ON-GRADE:													
Eog	Ratio of grate frontal flow to total flow:				-----		-----		70%	67%	-----	91%	
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression				-----		-----		0.20	0.23	-----	0.65	
Vo	Vo for effective length (P-50, Chart 5) (ft/s):				-----		-----		7.76	7.76	-----	7.76	
Rf	Fraction of frontal flow intercepted (Rf):				-----		-----		1.00	1.00	-----	1.00	
Qs	Side flow in ft^3/s (Qs):				-----		-----		0.09	0.12	-----	0.06	
Gle	Effective grate length w/ 25% clogging (in):				-----		-----		27	27	-----	27	
Rs	Fraction of side flow interception (Rs):				-----		-----		31%	30%	-----	43%	
E	Grate Efficiency (E):				-----		-----		79%	76%	-----	95%	
Qi	**Total flow intercepted (ft^3/s):**				**-----**		**-----**		**0.23**	**0.27**	**-----**	**0.68**	
Qb	**Grate flow-by (ft^3/s):**				**-----**		**-----**		**0.06**	**0.08**	**-----**	**0.04**	
SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)													
Lt	Length required for total interception (ft):				7.93		7.80		-----	-----	-----	-----	
Ci	Interception for provided length L (ft^3/s):				0.7		1.0		-----	-----	-----	-----	
El	Efficiency for provided length L:				100%		100%		-----	-----	-----	-----	
Qs	**Slotted drain or side opening flow-by (ft^3/s):**				**0.0**		**0.0**		**-----**	**-----**	**-----**	**-----**	
INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:													
	Grate Inlets												
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):				-----		-----		-----	-----	0.16	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):				-----		-----		-----	-----	0.19	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):				-----		-----		-----	-----	2.57	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):				-----		-----		-----	-----	3.13	-----	
	Slotted drains												
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):				-----		-----		-----	-----	-----	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):				-----		-----		-----	-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):				-----		-----		-----	-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):				-----		-----		-----	-----	-----	-----	
	Curb opening inlets												
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):				-----		-----		-----	-----	-----	-----	
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):				-----		-----		-----	-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):				-----		-----		-----	-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):				-----		-----		-----	-----	-----	-----	
Lc	Length of the vertical curve (ft):	>											
g1	approach grade #1 (%):	>											
g2	approach grade #2 (%):	>											
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):				-----		-----		-----	-----	-----	-----	
Df	Flanking inlets distance (ft):				-----		-----		-----	-----	-----	-----	

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
ecked by: AS ☐ Date: 4/15/2013

	Layout Line:		"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"	"US101"
In#	**Inlet number:**								24d								
	(Input Data Required)																
HYDROLOGY COMPUTATION:			>>>	>>>	>>>	>>>		<<<	>>>	<<<		>>>	>>>	>>>	>>>	>>>	
	Begin Station			516+40		518+17			519+80	521+87		525+00		526+14			
	End Station			518+17		519+63			525+00	525+00		526+14		527+39			
St	Structure location station:	>>	516+40	518+17	518+17	519+63	519+63	519+80	519+80	521+87	525+00	526+14	526+14	527+39	527+29	525+70	
N	Notes		**Sheet Flow to Ditch**	**Flip**	**Exist Slotted Drain**	**Exist DI (Junction Onlly)**	**Exist Slotted Drain**	**Exist DI (Junction Onlly) LP**	**G2 DI (Junction Onlly)**	**Exist Slotted Drain**	**Exist DI (Junction Only) Spread Calc Only**	**HP**	**Existing Slotted Drain**	**Exist DI (Junction Onlly)**	**Existing Slotted Drain**	**Exist DI (Junction Onlly)**	**End Project**
	Off-site contributing watershed area (acres):	>>															
	On-site contributing watershed area (acres):	>>			0.24		0.22			1.18	0.73		0.23		0.23		
Ar	**Contributing watershed area (acres):**				**0.24**		**0.22**			**1.18**	**0.73**		**0.23**		**0.23**		
C	Composite Runoff Coefficient "C":	>>			1		1			1	1		1		1		
Ic	Precipitation intensity (in/hr):	>>			3.24		3.24			3.24	3.24		3.24		3.24		
Qa	Subarea discharge Q (ft^3/s):				0.78		0.71			3.82	2.37		0.75		0.75		
qq	Previous by-pass flow (ft^3/s):	>			0.00		0.00			0.00							
Qadd	Discharge added by operator (ft^3/s):	>															
Qt	**Total discharge Q (ft^3/s):**				**0.78**		**0.71**			**3.82**	**2.37**		**0.75**		**0.75**		
SHOULDER AND GUTTER CONFIGURATION:																	
n	Manning's n:	>>			0.015		0.015			0.015	0.015		0.015		0.015		
S	Longitudinal slope S (ft/ft):	>>			0.004						0.001		0.006		0.001		
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>			3		3			3			3		3		
LP	Longitudinal profile (1=on-grade, 2=sag):	>>			1		2			2			1		1		
ID	Inlet description:	>			(E)Slotted Drain		(E)Slotted Drain			(E)Slotted Drain			(E)Slotted Drain		(E)Slotted Drain		
	Grate Type:	>>															
	Standard Gutter Depression (1=SGD, 2=no SGD)	>															
Gw	Grate width (in):	>															
Gl	Grate length (in):	>															
	3 or 4 sided weir?	>															
Lco	Curb opening length provided (ft):	>															
Ls	Slotted drain length provided: (ft)	>			22.00		145.00			206.00			94.00		121.00		
Sx	Shoulder cross-slope Sx (ft/ft):	>>			0.0229		0.0272			0.0272	0.0272		0.0334		0.0232		
W	Width of gutter from flowline (in):	>			0.0		0.0			0.0	0.0		0.0		0.0		
a(t)	Gutter depression from horizontal (in):	>			0.0		0.0			0.0	0.0		0.0		0.0		
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)				0.023		0.020			0.020	0.020		0.020		0.020		
	Available Flooded Width (ft)	>			14.00		19.00			19.00	15.00		7.50		5.00		
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**				**-----**		**-----**			**-----**	**12.35**		**-----**		**-----**		
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**				**-----**		**-----**			**-----**	**12.35**		**-----**		**-----**		
Du/s	Depth at flowline before inlet (ft):				-----		-----			-----			-----		-----		
Au/s	Water cross-area before inlet (ft^2):				-----		-----			-----			-----		-----		
Vu/s	Velocity for total discharge before inlet (ft/s):				-----		-----			-----			-----		-----		
Eod	Ratio of gutter depression flow to total Q (Eod):				-----		-----			-----			-----		-----		
Se	Equivalent cross-slope (ft/ft):				0.023		0.027			0.027			0.033		0.023		
GRATE INLETS ON-GRADE:																	
Eog	Ratio of grate frontal flow to total flow:				-----		-----			-----			-----		-----		
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression				-----		-----			-----			-----		-----		
Vo	Vo for effective length (P-50, Chart 5) (ft/s):				-----		-----			-----			-----		-----		
Rf	Fraction of frontal flow intercepted (Rf):				-----		-----			-----			-----		-----		
Qs	Side flow in ft^3/s (Qs):				-----		-----			-----			-----		-----		
Gle	Effective grate length w/ 25% clogging (in):				-----		-----			-----			-----		-----		
Rs	Fraction of side flow interception (Rs):				-----		-----			-----			-----		-----		
E	Grate Efficiency (E):				-----		-----			-----			-----		-----		
Qi	**Total flow intercepted (ft^3/s):**				**-----**		**-----**			**-----**			**-----**		**-----**		
Qb	**Grate flow-by (ft^3/s):**				**-----**		**-----**			**-----**			**-----**		**-----**		
SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)																	
Lt	Length required for total interception (ft):				12.16		-----			-----			11.04		8.89		
Ci	Interceotion for provided lenath L (ft^3/s):				0.8		-----			-----			0.7		0.7		
El	Efficiency for provided length L:				100%		-----			-----			100%		100%		
Qs	**Slotted drain or side opening flow-by (ft^3/s):**				**0.0**		**-----**			**-----**			**0.0**		**0.0**		
INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:																	
	Grate Inlets																
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):				-----		-----			-----			-----		-----		
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):				-----		-----			-----			-----		-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):				-----		-----			-----			-----		-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):				-----		-----			-----			-----		-----		
	Slotted drains																
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):				-----		0.02			0.05			-----		-----		
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):				-----		0.03			0.06			-----		-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):				-----		0.76			1.84			-----		-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):				-----		0.92			2.23			-----		-----		
	Curb opening inlets																
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):				-----		-----			-----			-----		-----		
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):				-----		-----			-----			-----		-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):				-----		-----			-----			-----		-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):				-----		-----			-----			-----		-----		
Lc	Length of the vertical curve (ft):	>															
g1	approach grade #1 (%):	>															
g2	approach grade #2 (%):	>															
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):				-----		-----			-----			-----		-----		
Df	Flanking inlets distance (ft):				-----		-----			-----			-----		-----		

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ **Date:** 4/15/2013
Checked by: AS ☐ **Date:** 4/15/2013

	Layout Line:		"BYSH"	"BYSH"	"BYSH"	"BYSH"	"BYSH"	"BYSH"	"BWY"
In#	**Inlet number:**			5f	5j	5l	5n	15h	
		[Input Data Required]							
	HYDROLOGY COMPUTATION:			>>>	>>>		<<<	<<<	<<<
	Begin Station			31+33	32+46	33+80	34+30	20+71 (BWY)	
	End Station			32+46	33+80	34+80	34+80	37+20	
St	Structure location station:	>>	31+33	32+46	33+80	34+30	34+80	37+20	20+71
N	Notes		HP	G4 DI	G4 DI	G4 DI @ LP	G4 DI	G4 DI	From Bridge
	Off-site contributing watershed area (acres):	>>							
	On-site contributing watershed area (acres):	>>		0.09	0.41	0.38	0.28	0.64	
Ar	**Contributing watershed area (acres):**			**0.09**	**0.41**	**0.38**	**0.28**	**0.64**	
C	Composite Runoff Coefficient "C":	>>		0.95	0.95	0.95	0.95	0.95	
Ic	Precipitation intensity (in/hr):	>>		2.66	2.66	2.66	2.66	2.66	
Qa	Subarea discharge Q (ft^3/s):			0.23	1.04	0.96	0.71	1.62	
qq	Previous by-pass flow (ft^3/s):	>			0.00	0.33	0.36	0.00	
Qadd	Discharge added by operator (ft^3/s):	>							
Qt	**Total discharge Q (ft^3/s):**			**0.23**	**1.04**	**1.29**	**1.07**	**1.62**	
	SHOULDER AND GUTTER CONFIGURATION:								
n	Manning's n:	>>		0.015	0.015	0.015	0.015	0.015	
S	Longitudinal slope S (ft/ft):	>>		0.008	0.004		0.012	0.013	
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>		1	1	1	1	1	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>		1	1	2	1	1	
ID	Inlet description:	>		G4	G4	G4	G4	G4	
	Grate Type:	>>		24-12	24-12	24-12	24-12	24-12	
	Standard Gutter Depression (1=SGD, 2=no SGD)	>		1	1	1	1	1	
Gw	Grate width (in):	>		24.0	24.0	24.0	24.0	24.0	
Gl	Grate length (in):	>		36.0	36.0	36.0	36.0	36.0	
	3 or 4 sided weir?	>		3	3	3	3	3	
Lco	Curb opening length provided (ft):	>							
Ls	Slotted drain length provided: (ft)	>							
Sx	Shoulder cross-slope Sx (ft/ft):	>>		0.0295	0.0201	0.0201	0.0201	0.0201	
W	Width of gutter from flowline (in):	>		17.4	18.0	18.0	18.0	18.0	
a(t)	Gutter depression from horizontal (in):	>		0.0	0.0	0.0	0.0	0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)			0.083	0.083	0.083	0.083	0.083	
	Available Flooded Width (ft)	>		11.00	11.00	11.00	11.00	11.00	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**			**3.31**	**8.43**	**-----**	**6.94**	**7.99**	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**			**2.21**	**7.66**	**-----**	**5.98**	**7.17**	
Du/s	Depth at flowline before inlet (ft):			0.14	0.25	-----	0.22	0.24	
Au/s	Water cross-area before inlet (ft^2):			0.13	0.66	-----	0.43	0.59	
Vu/s	Velocity for total discharge before inlet (ft/s):			1.77	1.57	-----	2.48	2.75	
Eod	Ratio of gutter depression flow to total Q (Eod):			98%	57%	-----	69%	60%	
Se	Equivalent cross-slope (ft/ft):			0.082	0.056	-----	0.064	0.058	
	GRATE INLETS ON-GRADE:								
Eog	Ratio of grate frontal flow to total flow:			100%	65%	-----	77%	69%	
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression			0.23	0.68	-----	0.83	1.11	
Vo	Vo for effective length (P-50, Chart 5) (ft/s):			6.88	6.88	-----	6.88	6.88	
Rf	Fraction of frontal flow intercepted (Rf):			1.00	1.00	-----	1.00	1.00	
Qs	Side flow in ft^3/s (Qs):			0.00	0.36	-----	0.24	0.51	
Gle	Effective grate length w/ 25% clogging (in):			27	27	-----	27	27	
Rs	Fraction of side flow interception (Rs):			56%	52%	-----	35%	29%	
E	Grate Efficiency (E):			100%	83%	-----	85%	78%	
Qi	**Total flow intercepted (ft^3/s):**			**0.23**	**0.86**	**-----**	**0.91**	**1.26**	
Qb	**Grate flow-by (ft^3/s):**			**0.00**	**0.17**	**-----**	**0.16**	**0.36**	
	SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)								
Lt	Length required for total interception (ft):			-----	-----	-----	-----	-----	
Ci	Interception for provided length L (ft^3/s):			-----	-----	-----	-----	-----	
El	Efficiency for providged length L:			-----	-----	-----	-----	-----	
Qs	**Slotted drain or side opening flow-by (ft^3/s):**			**-----**	**-----**	**-----**	**-----**	**-----**	
	INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:								
	Grate Inlets								
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	-----	0.20	-----	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	-----	0.25	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----	11.59	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----	13.77	-----	-----	
	Slotted drains								
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	-----	-----	-----	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	-----	-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----	-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----	-----	-----	-----	
	Curb opening inlets								
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):			-----	-----	-----	-----	-----	
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):			-----	-----	-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----	-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----	-----	-----	-----	
Lc	Length of the vertical curve (ft):	>							
g1	approach grade #1 (%):	>							
g2	approach grade #2 (%):	>							
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):			-----	-----	-----	-----	-----	
Df	Flanking inlets distance (ft):			-----	-----	-----	-----	-----	

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"BYSH"	"BYSH"	"BYSH"	"BWY"
In#	**Inlet number:**			25a		
		(Input Data Required)				
HYDROLOGY COMPUTATION:				<<<	<<<	<<<
	Begin Station		36+15	36+92		
	End Station		36+92	39+25		
St	Structure location station:	>>	36+15	36+92	38+67	39+25
N	Notes		upstream sheet flow to loop	OD @ LP	G3 DI	Flip	Scupper at Island
	Off-site contributing watershed area (acres):	>>				
	On-site contributing watershed area (acres):	>>	0.42	0.18		
Ar	**Contributing watershed area (acres):**		**0.42**	**0.18**		
C	Composite Runoff Coefficient "C":	>>	0.95	0.95		
Ic	Precipitation intensity (in/hr):	>>	2.66	2.66		
Qa	Subarea discharge Q (ft^3/s):		1.06	0.45		
qq	Previous by-pass flow (ft^3/s):	>	0.00	0.00		
Qadd	Discharge added by operator (ft^3/s):	>				
Qt	**Total discharge Q (ft^3/s):**		**1.06**	**0.45**		
SHOULDER AND GUTTER CONFIGURATION:						
n	Manning's n:	>>	0.015	0.015		
S	Longitudinal slope S (ft/ft):	>>		0.023		
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>	2	1		
LP	Longitudinal profile (1=on-grade, 2=sag):	>>	2	1		
ID	Inlet description:	>	HMAOD	G3		
	Grate Type:	>>		24-12		
	Standard Gutter Depression (1=SGD, 2=no SGD)	>		1		
Gw	Grate width (in):	>		24.0		
Gl	Grate length (in):	>		36.0		
	3 or 4 sided weir?	>		3		
Lco	Curb opening length provided (ft):	>	13.00			
Ls	Slotted drain length provided: (ft)	>				
Sx	Shoulder cross-slope Sx (ft/ft):	>>	0.0200	0.0200		
W	Width of gutter from flowline (in):	>	18.0	18.0		
a(t)	Gutter depression from horizontal (in):	>	0.0	0.0		
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)		0.083	0.083		
	Available Flooded Width (ft)	>	11.00	25.00		
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**		**-----**	**4.48**		
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**		**-----**	**2.82**		
Du/s	Depth at flowline before inlet (ft):		-----	0.15		
Au/s	Water cross-area before inlet (ft^2):		-----	0.15		
Vu/s	Velocity for total discharge before inlet (ft/s):		-----	3.02		
Eod	Ratio of gutter depression flow to total Q (Eod):		-----	96%		
Se	Equivalent cross-slope (ft/ft):		-----	0.081		
GRATE INLETS ON-GRADE:						
Eog	Ratio of grate frontal flow to total flow:		-----	99%		
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression		-----	0.45		
Vo	Vo for effective length (P-50, Chart 5) (ft/s):		-----	6.88		
Rf	Fraction of frontal flow intercepted (Rf):		-----	1.00		
Qs	Side flow in ft^3/s (Qs):		-----	0.00		
Gle	Effective grate length w/ 25% clogging (in):		-----	27		
Rs	Fraction of side flow interception (Rs):		-----	32%		
E	Grate Efficiency (E):		-----	99%		
Qi	**Total flow intercepted (ft^3/s):**		**-----**	**0.45**		
Qb	**Grate flow-by (ft^3/s):**		**-----**	**0.00**		
SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)						
Lt	Length required for total interception (ft):		-----	-----		
Ci	Interception for provided length L (ft^3/s):		-----	-----		
El	Efficiency for provided length L:		-----	-----		
Qs	**Slotted drain or side opening flow-by (ft^3/s):**		**-----**	**-----**		
INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:						
	Grate Inlets					
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):		-----	-----		
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):		-----	-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):		-----	-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):		-----	-----		
	Slotted drains					
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):		-----	-----		
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):		-----	-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):		-----	-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):		-----	-----		
	Curb opening inlets					
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):		0.14	-----		
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):		0.17	-----		
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):		8.57	-----		
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):		10.09	-----		
Lc	Length of the vertical curve (ft):	>				
g1	approach grade #1 (%):	>				
g2	approach grade #2 (%):	>				
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):		-----	-----		
Df	Flanking inlets distance (ft):		-----	-----		

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"BWY"	"BWY"	"BWY"	"BWY"	"BWY"	"BWY"	"BWY"	"BWY"	"BWY"	"BWY"
In#	**Inlet number:**			13c	13a				13n	13p	13l	
		[Input Data Required]										
	HYDROLOGY COMPUTATION:			>>>			<<<	>>>	>>>		<<<	<<<
	Begin Station								12+06	12+06	12+66	
	End Station				12+25				12+36	12+66	13+60	
St	Structure location station:	>>	12+25	11+96	10+00		10+00	10+00	12+06	12+36	12+66	13+60
N	Notes		US flows to EB "BWY"	G4 DI Junction only	G4 DI @ LP		End Project	End Project	G4 DI	G4 DI @ LP	G4 DI	Upstream flows to SB Rollins
	Off-site contributing watershed area (acres):	>>										
	On-site contributing watershed area (acres):	>>			0.47	0.15			0.32	0.19	0.07	
Ar	**Contributing watershed area (acres):**				**0.47**	**0.15**			**0.32**	**0.19**	**0.07**	
C	Composite Runoff Coefficient "C":	>>			0.95	0.95			0.95	0.95	0.95	
Ic	Precipitation intensity (in/hr):	>>			2.66	2.66			2.66	2.66	2.66	
Qa	Subarea discharge Q (ft^3/s):				1.18	0.39			0.81	0.48	0.18	
qq	Previous by-pass flow (ft^3/s):	>								0.07		
Qadd	Discharge added by operator (ft^3/s):	>										
Qt	**Total discharge Q (ft^3/s):**				**1.18**	**0.39**			**0.81**	**0.55**	**0.18**	
	SHOULDER AND GUTTER CONFIGURATION:											
n	Manning's n:	>>			0.015	0.015			0.015	0.015	0.015	
S	Longitudinal slope S (ft/ft):	>>							0.006		0.012	
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>			1	2			1	1	1	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>			2	2			1	2	1	
ID	Inlet description:	>			G4	G4			G4	G4	G4	
	Grate Type:	>>			24-12	24-12			24-12	24-12	24-12	
	Standard Gutter Depression (1=SGD, 2=no SGD)	>			1	1			1	1	1	
Gw	Grate width (in):	>			24.0	24.0			24.0	24.0	24.0	
Gl	Grate length (in):	>			36.0	36.0			36.0	36.0	36.0	
	3 or 4 sided weir?	>			3	3			3	3	3	
Lco	Curb opening length provided (ft):	>				3.00						
Ls	Slotted drain length provided: (ft)	>										
Sx	Shoulder cross-slope Sx (ft/ft):	>>			0.0200	0.0200			0.0306	0.0300	0.0300	
W	Width of gutter from flowline (in):	>			18.0	18.0			18.0	18.0	18.0	
a(t)	Gutter depression from horizontal (in):	>			0.0	0.0			0.0	0.0	0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)				0.083	0.083			0.083	0.083	0.083	
	Available Flooded Width (ft)	>			14.00	14.00			7.00	7.00	7.00	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**				-----	-----			**5.44**	-----	**2.76**	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**				-----	-----			**4.81**	-----	**1.46**	
Du/s	Depth at flowline before inlet (ft):				-----	-----			0.23	-----	0.12	
Au/s	Water cross-area before inlet (ft^2):				-----	-----			0.41	-----	0.09	
Vu/s	Velocity for total discharge before inlet (ft/s):				-----	-----			1.96	-----	2.00	
Eod	Ratio of gutter depression flow to total Q (Eod):				-----	-----			73%	-----	100%	
Se	Equivalent cross-slope (ft/ft):				-----	-----			0.069	-----	0.083	
	GRATE INLETS ON-GRADE:											
Eog	Ratio of grate frontal flow to total flow:				-----	-----			83%	-----	100%	
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression				-----	-----			0.67	-----	0.18	
Vo	Vo for effective length (P-50, Chart 5) (ft/s):				-----	-----			6.88	-----	6.88	
Rf	Fraction of frontal flow intercepted (Rf):				-----	-----			1.00	-----	1.00	
Qs	Side flow in ft^3/s (Qs):				-----	-----			0.14	-----	0.00	
Gle	Effective grate length w/ 25% clogging (in):				-----	-----			27	-----	27	
Rs	Fraction of side flow interception (Rs):				-----	-----			47%	-----	0%	
E	Grate Efficiency (E):				-----	-----			91%	-----	100%	
Qi	**Total flow intercepted (ft^3/s):**				-----	-----			**0.74**	-----	**0.18**	
Qb	**Grate flow-by (ft^3/s):**				-----	-----			**0.07**	-----	**0.00**	
	SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)											
Lt	Length required for total interception (ft):				-----	-----			-----	-----	-----	
Ci	Interception for provided length L (ft^3/s):				-----	-----			-----	-----	-----	
El	Efficiency for providged length L:				-----	-----			-----	-----	-----	
Qs	**Slotted drain or side opening flow-by (ft^3/s):**				-----	-----			-----	-----	-----	
	INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:											
	Grate Inlets											
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):				0.19	-----			-----	0.12	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):				0.23	-----			-----	0.14	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):				11.05	-----			-----	5.36	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):				13.11	-----			-----	6.19	-----	
	Slotted drains											
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):				-----	-----			-----	-----	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):				-----	-----			-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):				-----	-----			-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):				-----	-----			-----	-----	-----	
	Curb opening inlets											
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):				-----	0.19			-----	-----	-----	
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):				-----	0.23			-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):				-----	11.10			-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):				-----	13.17			-----	-----	-----	
Lc	Length of the vertical curve (ft):	>										
g1	approach grade #1 (%):	>										
g2	approach grade #2 (%):	>										
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):				-----	-----		-----	-----	-----	-----	
Df	Flanking inlets distance (ft):				-----	-----		-----	-----	-----	-----	

Note: system 13a calculation incldues both curb opening and grate inteception

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"BWY"	"BWY"	"RLN"	"RLN"
In#	**Inlet number:**			12a	11b	
		[Input Data Required]				
	HYDROLOGY COMPUTATION:			>>>	>>>	>>>
	Begin Station			18+67	14+59	
	End Station			14+59	22+78	
St	Structure location station:	>>	18+67	14+59	22+78	22+30
N	Notes		**Upstream flows to B2**	**G3 DI**	**Mod DI**	**End Project**
	Off-site contributing watershed area (acres):	>>				
	On-site contributing watershed area (acres):	>>		0.44	0.11	
Ar	**Contributing watershed area (acres):**			**0.44**	**0.11**	
C	Composite Runoff Coefficient "C":	>>		0.95	0.95	
Ic	Precipitation intensity (in/hr):	>>		2.66	2.66	
Qa	Subarea discharge Q (ft^3/s):			1.11	0.28	
qq	Previous by-pass flow (ft^3/s):	>			0.01	
Qadd	Discharge added by operator (ft^3/s):	>				
Qt	**Total discharge Q (ft^3/s):**			**1.11**	**0.29**	
	SHOULDER AND GUTTER CONFIGURATION:					
n	Manning's n:	>>		0.015	0.015	s
S	Longitudinal slope S (ft/ft):	>>		0.049	0.016	
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>		1	1	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>		1	1	
ID	Inlet description:	>		G3	Mod DI	
	Grate Type:	>>		24-12	24-12	
	Standard Gutter Depression (1=SGD, 2=no SGD)	>		2	2	
Gw	Grate width (in):	>		24.0	24.0	
Gl	Grate length (in):	>		36.0	36.0	
	3 or 4 sided weir?	>		3	3	
Lco	Curb opening length provided (ft):	>				
Ls	Slotted drain length provided: (ft)	>				
Sx	Shoulder cross-slope Sx (ft/ft):	>>		0.0200	0.0484	
W	Width of gutter from flowline (in):	>		24.0	24.0	
a(t)	Gutter depression from horizontal (in):	>		0.0	0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)			0.083	0.060	
	Available Flooded Width (ft)	>		11.00	8.00	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**			**5.44**	**2.32**	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**			**2.94**	**2.04**	
Du/s	Depth at flowline before inlet (ft):			0.18	0.12	
Au/s	Water cross-area before inlet (ft^2):			0.21	0.12	
Vu/s	Velocity for total discharge before inlet (ft/s):			5.23	2.31	
Eod	Ratio of gutter depression flow to total Q (Eod):			99%	100%	
Se	Equivalent cross-slope (ft/ft):			0.082	0.060	
	GRATE INLETS ON-GRADE:					
Eog	Ratio of grate frontal flow to total flow:			99%	100%	
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression			1.10	0.29	
Vo	Vo for effective length (P-50, Chart 5) (ft/s):			6.88	6.88	
Rf	Fraction of frontal flow intercepted (Rf):			1.00	1.00	
Qs	Side flow in ft^3/s (Qs):			0.01	0.00	
Gle	Effective grate length w/ 25% clogging (in):			27	27	
Rs	Fraction of side flow interception (Rs):			15%	36%	
E	Grate Efficiency (E):			99%	100%	
Qi	**Total flow intercepted (ft^3/s):**			**1.10**	**0.29**	
Qb	**Grate flow-by (ft^3/s):**			**0.01**	**0.00**	
	SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)					
Lt	Length required for total interception (ft):			-----	-----	
Ci	Interception for provided length L (ft^3/s):			-----	-----	
El	Efficiency for providged length L:			-----	-----	
Qs	**Slotted drain or side opening flow-by (ft^3/s):**			**-----**	**-----**	
	INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:					
	Grate Inlets					
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----	
	Slotted drains					
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----	
	Curb opening inlets					
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):			-----	-----	
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):			-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----	
Lc	Length of the vertical curve (ft):	>				
g1	approach grade #1 (%):	>				
g2	approach grade #2 (%):	>				
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):			-----	-----	
Df	Flanking inlets distance (ft):			-----	-----	

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"BWY"	"BWY"	"BWY"	"BWY"	"BWY"	"BWY"	"BWY"
In#	**Inlet number:**			17a		19f	19h	19j	
		(Input Data Required)							
	HYDROLOGY COMPUTATION:			>>>	>>>	>>>		<<<	
	Begin Station			21+65		24+57	25+84	26+44	
	End Station			24+57		25+84	26+44	26+46	
St	Structure location station:	>>	21+65	24+57	24+90	25+84	26+14	26+44	26+46
N	Notes		US flows to BYSH	G3 DI @ US of Flip	Flip	G4 DI	G4 DI @ LP	G4 DI	US flows to WB
	Off-site contributing watershed area (acres):	>>							
	On-site contributing watershed area (acres):	>>		0.22		0.24	0.10	0.08	
Ar	**Contributing watershed area (acres):**			**0.22**		**0.24**	**0.10**	**0.08**	
C	Composite Runoff Coefficient "C":	>>		0.95		0.95	0.95	0.95	
Ic	Precipitation intensity (in/hr):	>>		2.66		2.66	2.66	2.66	
Qa	Subarea discharge Q (ft^3/s):			0.56		0.60	0.25	0.20	
qq	Previous by-pass flow (ft^3/s):	>		0.00		0.03	0.28		
Qadd	Discharge added by operator (ft^3/s):	>							
Qt	**Total discharge Q (ft^3/s):**			**0.56**		**0.63**	**0.53**	**0.20**	
	SHOULDER AND GUTTER CONFIGURATION:								
n	Manning's n:	>>		0.015		0.015	0.015	0.015	
S	Longitudinal slope S (ft/ft):	>>		0.032		0.008		0.006	
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>		1		1	1	1	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>		1		1	2	1	
ID	Inlet description:	>		G3		G4	G4	G4	
	Grate Type:	>>		24-9		24-9	24-9	24-9	
	Standard Gutter Depression (1=SGD, 2=no SGD)	>		1		2	2	2	
Gw	Grate width (in):	>		24.0		24.0	24.0	24.0	
Gl	Grate length (in):	>		36.0		36.0	36.0	36.0	
	3 or 4 sided weir?	>		3		3	3	3	
Lco	Curb opening length provided (ft):	>							
Ls	Slotted drain length provided: (ft)	>							
Sx	Shoulder cross-slope Sx (ft/ft):	>>		0.0057		0.0110	0.0151	0.0191	
W	Width of gutter from flowline (in):	>		18.0		0.0	0.0	0.0	
a(t)	Gutter depression from horizontal (in):	>		0.0		0.0	0.0	0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)			0.083		0.011	0.015	0.019	
	Available Flooded Width (ft)	>		8.00		20.00	18.00	17.00	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**			**10.00**		**9.01**	**-----**	**4.40**	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**			**5.80**		**9.01**	**-----**	**4.40**	
Du/s	Depth at flowline before inlet (ft):			0.15		0.10	-----	0.08	
Au/s	Water cross-area before inlet (ft^2):			0.18		0.45	-----	0.18	
Vu/s	Velocity for total discharge before inlet (ft/s):			3.05		1.40	-----	1.09	
Eod	Ratio of gutter depression flow to total Q (Eod):			89%		-----	-----	-----	
Se	Equivalent cross-slope (ft/ft):			0.075		0.011	0.015	0.019	
	GRATE INLETS ON-GRADE:								
Eog	Ratio of grate frontal flow to total flow:			92%		49%	-----	80%	
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression			0.51		0.30	-----	0.16	
Vo	Vo for effective length (P-50, Chart 5) (ft/s):			7.76		7.76	-----	7.76	
Rf	Fraction of frontal flow intercepted (Rf):			1.00		1.00	-----	1.00	
Qs	Side flow in ft^3/s (Qs):			0.04		0.32	-----	0.04	
Gle	Effective grate length w/ 25% clogging (in):			27		27	-----	27	
Rs	Fraction of side flow interception (Rs):			30%		21%	-----	41%	
E	Grate Efficiency (E):			95%		59%	-----	88%	
Qi	**Total flow intercepted (ft^3/s):**			**0.53**		**0.37**	**-----**	**0.18**	
Qb	**Grate flow-by (ft^3/s):**			**0.03**		**0.26**	**-----**	**0.02**	
	SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)								
Lt	Length required for total interception (ft):			-----		-----	-----	-----	
Ci	Interception for provided length L (ft^3/s):			-----		-----	-----	-----	
El	Efficiency for provided length L:			-----		-----	-----	-----	
Qs	**Slotted drain or side opening flow-by (ft^3/s):**			**-----**		**-----**	**-----**	**-----**	
	INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:								
	Grate Inlets								
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----		-----	0.11	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----		-----	0.14	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----		-----	7.45	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----		-----	9.05	-----	
	Slotted drains								
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----		-----	-----	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----		-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----		-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----		-----	-----	-----	
	Curb opening inlets								
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):			-----		-----	-----	-----	
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):			-----		-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----		-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----		-----	-----	-----	
Lc	Length of the vertical curve (ft):	>							
g1	approach grade #1 (%):	>							
g2	approach grade #2 (%):	>							
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):			-----		-----	-----	-----	-----
Df	Flanking inlets distance (ft):			-----		-----	-----	-----	-----

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"BWY"	"BWY"		"HTL"		"BWY"	"BWY"	"BWY"	"BWY"	"BWY"
In#	**Inlet number:**			22a		18a			19a	19c	19e	
		(Input Data Required)										
HYDROLOGY COMPUTATION:				>>>		>>>			>>>		<<<	
	Begin Station			28+67		20+71 (BWY)			21+65	25+78	26+41	
	End Station			21+93		52+50			25+78	26+41	28+10	
St	Structure location station:	>>	28+67	21+93		52+50		21+65	25+78	26+13	26+41	28+10
N	Notes		**Bridge HP**	**G3 DI**	**Flows to HTL**	**G3 DI**	**Flows to HTL**	**US flows to HTL**	**G4 DI**	**G4 DI @ LP**	**G4 DI**	**HP**
	Off-site contributing watershed area (acres):	>>										
	On-site contributing watershed area (acres):	>>		0.30		0.18			0.45	0.08	0.18	
Ar	**Contributing watershed area (acres):**			**0.30**		**0.18**			**0.45**	**0.08**	**0.18**	
C	Composite Runoff Coefficient "C":	>>		0.95		0.95			0.95	0.95	0.95	
Ic	Precipitation intensity (in/hr):	>>		2.66		2.66			2.66	2.66	2.66	
Qa	Subarea discharge Q (ft^3/s):			0.76		0.45			1.14	0.20	0.45	
qq	Previous by-pass flow (ft^3/s):	>				0.05				0.22		
Qadd	Discharge added by operator (ft^3/s):	>										
Qt	**Total discharge Q (ft^3/s):**			**0.76**		**0.50**			**1.14**	**0.43**	**0.45**	
SHOULDER AND GUTTER CONFIGURATION:												
n	Manning's n:	>>		0.015		0.015			0.015	0.015	0.015	
S	Longitudinal slope S (ft/ft):	>>		0.006		0.006			0.006		0.008	
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>		1		1			1	1	1	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>		1		1			1	2	1	
ID	Inlet description:	>		G3		G3			G4	G4	G4	
	Grate Type:	>>		24-9		24-9			24-9	24-9	24-9	
	Standard Gutter Depression (1=SGD, 2=no SGD)	>		1		1			1	1	1	
Gw	Grate width (in):	>		24.0		24.0			24.0	24.0	24.0	
Gl	Grate length (in):	>		36.0		36.0			36.0	36.0	36.0	
	3 or 4 sided weir?	>		3		3			3	3	3	
Lco	Curb opening length provided (ft):	>										
Ls	Slotted drain length provided: (ft)	>										
Sx	Shoulder cross-slope Sx (ft/ft):	>>		0.0200		0.0200			0.0200	0.0200	0.0200	
W	Width of gutter from flowline (in):	>		24.0		18.0			18.0	18.0	18.0	
a(t)	Gutter depression from horizontal (in):	>		0.0		0.0			0.0	0.0	0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)			0.083		0.083			0.083	0.083	0.083	
	Available Flooded Width (ft)	>		8.00		7.50			17.00	17.00	17.00	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**			**6.98**		**5.98**			**8.12**	**-----**	**5.46**	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**			**5.17**		**4.82**			**7.31**	**-----**	**4.17**	
Du/s	Depth at flowline before inlet (ft):			0.23		0.19			0.24	-----	0.18	
Au/s	Water cross-area before inlet (ft^2):			0.39		0.30			0.61	-----	0.24	
Vu/s	Velocity for total discharge before inlet (ft/s):			1.93		1.65			1.88	-----	1.86	
Eod	Ratio of gutter depression flow to total Q (Eod):			88%		79%			59%	-----	85%	
Se	Equivalent cross-slope (ft/ft):			0.075		0.070			0.057	-----	0.074	
GRATE INLETS ON-GRADE:												
Eog	Ratio of grate frontal flow to total flow:			88%		87%			68%	-----	91%	
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression			0.67		0.43			0.77	-----	0.42	
Vo	Vo for effective length (P-50, Chart 5) (ft/s):			7.76		7.76			7.76	-----	7.76	
Rf	Fraction of frontal flow intercepted (Rf):			1.00		1.00			1.00	-----	1.00	
Qs	Side flow in ft^3/s (Qs):			0.09		0.07			0.37	-----	0.04	
Gle	Effective grate length w/ 25% clogging (in):			27		27			27	-----	27	
Rs	Fraction of side flow interception (Rs):			50%		55%			44%	-----	51%	
E	Grate Efficiency (E):			94%		94%			82%	-----	96%	
Qi	**Total flow intercepted (ft^3/s):**			**0.71**		**0.47**			**0.93**	**-----**	**0.44**	
Qb	**Grate flow-by (ft^3/s):**			**0.05**		**0.03**			**0.20**	**-----**	**0.02**	
SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE:		**(No clogging factor)**										
Lt	Length required for total interception (ft):			-----		-----			-----	-----	-----	
Ci	Interceotion for provided lenath L (ft^3/s):			-----		-----			-----	-----	-----	
El	Efficiency for providged length L:			-----		-----			-----	-----	-----	
Qs	**Slotted drain or side opening flow-by (ft^3/s):**			**-----**		**-----**			**-----**	**-----**	**-----**	
INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:												
	Grate Inlets											
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----		-----			-----	0.10	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----		-----			-----	0.12	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----		-----			-----	6.35	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----		-----			-----	7.39	-----	
	Slotted drains											
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----		-----			-----	-----	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----		-----			-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----		-----			-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----		-----			-----	-----	-----	
	Curb opening inlets											
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):			-----		-----			-----	-----	-----	
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):			-----		-----			-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----		-----			-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----		-----			-----	-----	-----	
Lc	Length of the vertical curve (ft):	>										
g1	approach grade #1 (%):	>										
g2	approach grade #2 (%):	>										
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):			-----		-----			-----	-----	-----	
Df	Flanking inlets distance (ft):			-----		-----			-----	-----	-----	

US 101 / Broadway Interchange Reconstruction Project

Caltrans Highway Drainage Inlet Calculations

Job:

Designed by: TX ☐ Date: 4/15/2013
Checked by: AS ☐ Date: 4/15/2013

	Layout Line:		"BWY"	"BWY"	"RLN"	"RLN"	"RLN"	"RLN"	"RLN"	"RLN"	"RLN"	"RLN"	"RLN"
In#	**Inlet number:**				14a	14c	14e		14g	20a	20c	20e	
		(Input Data Required)											
	HYDROLOGY COMPUTATION:			>>>		<<<	<<<		>>>	>>>		<<<	<<<
	Begin Station			18+67	15+42	26+25	26+50		26+80	27+28	31+60	32+20	
	End Station			15+42	26+25	26+50	26+80		27+28	31+60	32+20	35+21	
St	Structure location station:	>>	18+67	15+42	25+92	26+25	26+50	26+80	27+28	31+60	31+91	32+20	35+21
N	Notes		**HP Broadway OC**	**HMAOD**	**G4 DI @ LP**	**G4 DI**	**G4 DI**	**HP**	**G4 DI**	**G3 DI**	**G3 DI @ LP**	**G3 DI**	**End Project**
	Off-site contributing watershed area (acres):	>>											
	On-site contributing watershed area (acres):	>>		0.21	0.57	0.06	0.02		0.08	1.31	0.07	0.38	
Ar	**Contributing watershed area (acres):**			**0.21**	**0.57**	**0.06**	**0.02**		**0.08**	**1.31**	**0.07**	**0.38**	
C	Composite Runoff Coefficient "C":	>>		0.95	0.95	0.95	0.95		0.95	0.95	0.95	0.95	
Ic	Precipitation intensity (in/hr):	>>		2.66	2.66	2.66	2.66		2.66	2.66	2.66	2.66	
Qa	Subarea discharge Q (ft^3/s):			0.53	1.44	0.15	0.05		0.20	3.31	0.18	0.96	
qq	Previous by-pass flow (ft^3/s):	>			0.46	0.00				0.00	1.63		
Qadd	Discharge added by operator (ft^3/s):	>											
Qt	**Total discharge Q (ft^3/s):**			**0.53**	**1.90**	**0.15**	**0.05**		**0.20**	**3.31**	**1.81**	**0.96**	
	SHOULDER AND GUTTER CONFIGURATION:												
n	Manning's n:	>>		0.015	0.015	0.015	0.015		0.015	0.015	0.015	0.015	
S	Longitudinal slope S (ft/ft):	>>		5.000		0.005	0.005		0.014	0.005		0.005	
IT	Inlet type (1=grate, 2=curb opening, 3=slotted):	>>		2	1	1	1		1	1	1	1	
LP	Longitudinal profile (1=on-grade, 2=sag):	>>		1	2	1	1		1	1	2	1	
ID	Inlet description:	>		HMAOD	G4	G4	G4		G4	G3	G3	G3	
	Grate Type:	>>			24-12	24-12	24-12		24-12	24-12	24-12	24-12	
	Standard Gutter Depression (1=SGD, 2=no SGD)	>			1	1	1		1	1	1	1	
Gw	Grate width (in):	>			24.0	24.0	24.0		24.0	24.0	24.0	24.0	
Gl	Grate length (in):	>			36.0	36.0	36.0		36.0	36.0	36.0	36.0	
	3 or 4 sided weir?	>			3	3	3		3	3	3	3	
Lco	Curb opening length provided (ft):	>		13.00									
Ls	Slotted drain length provided: (ft)	>											
Sx	Shoulder cross-slope Sx (ft/ft):	>>		0.0074	0.0200	0.0216	0.0268		0.0300	0.0298	0.0301	0.0297	
W	Width of gutter from flowline (in):	>		0.0	18.0	18.0	18.0		18.0	18.0	18.0	18.0	
a(t)	Gutter depression from horizontal (in):	>		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	
Sw	Gutter cross-slope Sw (ft/ft): (S'w=Sw-Sx) (Sw=Sx if no gutter)			0.083	0.083	0.083	0.083		0.083	0.030	0.030	0.030	
	Available Flooded Width (ft)	>		10.00	15.00	7.50	7.50		8.00	21.00	23.00	23.00	
Tu/s	**Flooded Width from flowline (ft): at inlet w/o gutter depression**			**3.22**	**-----**	**3.77**	**2.20**		**2.82**	**9.78**	**-----**	**6.16**	
Tu/s	**Flooded Width from flowline (ft): at inlet w/ gutter depression**			**3.22**	**-----**	**1.95**	**1.07**		**1.49**	**9.78**	**-----**	**6.16**	
Du/s	Depth at flowline before inlet (ft):			0.02	-----	0.13	0.09		0.12	0.29	-----	0.18	
Au/s	Water cross-area before inlet (ft^2):			0.04	-----	0.11	0.05		0.09	1.43	-----	0.56	
Vu/s	Velocity for total discharge before inlet (ft/s):			13.84	-----	1.38	1.05		2.19	2.32	-----	1.70	
Eod	Ratio of gutter depression flow to total Q (Eod):			-----	-----	100%	100%		100%	36%	-----	52%	
Se	Equivalent cross-slope (ft/ft):			0.007	-----	0.083	0.083		0.083	0.030	-----	0.030	
	GRATE INLETS ON-GRADE:												
Eog	Ratio of grate frontal flow to total flow:			-----	-----	100%	100%		100%	46%	-----	65%	
Qw	Inlet frontal flow in ft^3/s (Qw): at inlet w/ gutter depression			-----	-----	0.15	0.05		0.20	1.51	-----	0.62	
Vo	Vo for effective length (P-50, Chart 5) (ft/s):			-----	-----	6.88	6.88		6.88	6.88	-----	6.88	
Rf	Fraction of frontal flow intercepted (Rf):			-----	-----	1.00	1.00		1.00	1.00	-----	1.00	
Qs	Side flow in ft^3/s (Qs):			-----	-----	0.00	0.00		0.00	1.80	-----	0.34	
Gle	Effective grate length w/ 25% clogging (in):			-----	-----	27	27		27	27	-----	27	
Rs	Fraction of side flow interception (Rs):			-----	-----	0%	0%		0%	22%	-----	33%	
E	Grate Efficiency (E):			-----	-----	100%	100%		100%	58%	-----	76%	
Qi	**Total flow intercepted (ft^3/s):**			**-----**	**-----**	**0.15**	**0.05**		**0.20**	**1.91**	**-----**	**0.73**	
Qb	**Grate flow-by (ft^3/s):**			**-----**	**-----**	**0.00**	**0.00**		**0.00**	**1.40**	**-----**	**0.23**	
	SLOTTED DRAINS AND CURB OPENING INLETS ON-GRADE: (No clogging factor)												
Lt	Length required for total interception (ft):			175.82	-----	-----	-----		-----	-----	-----	-----	
Ci	Interception for provided length L (ft^3/s):			0.1	-----	-----	-----		-----	-----	-----	-----	
El	Efficiency for providged length L:			13%	-----	-----	-----		-----	-----	-----	-----	
Qs	**Slotted drain or side opening flow-by (ft^3/s):**			**0.5**	**-----**	**-----**	**-----**		**-----**	**-----**	**-----**	**-----**	
	INTERCEPTION CAPACITY OF INLETS IN SAG LOCATION:												
	Grate Inlets												
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	0.26	-----	-----		-----	-----	0.25	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	0.32	-----	-----		-----	-----	0.31	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	14.67	-----	-----		-----	-----	9.96	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	17.51	-----	-----		-----	-----	11.78	-----	
	Slotted drains												
d_{33}	Depth of ponding at inlet (33% Clogging - Freeway)(ft):			-----	-----	-----	-----		-----	-----	-----	-----	
d_{50}	Depth of ponding at inlet (50% Clogging City St)(ft):			-----	-----	-----	-----		-----	-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----	-----	-----		-----	-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----	-----	-----		-----	-----	-----	-----	
	Curb opening inlets												
d_{33}	Depth of ponding at inlet (Weir, 33% Clogging - Freeway)(ft):			-----	-----	-----	-----		-----	-----	-----	-----	
d_{50}	Depth of ponding at inlet (Weir, 50% Clogging City St)(ft):			-----	-----	-----	-----		-----	-----	-----	-----	
w_{33}	Ponded width at inlet (33% Clogging - Freeway)(ft):			-----	-----	-----	-----		-----	-----	-----	-----	
w_{50}	Ponded width at inlet (50% Clogging City St)(ft):			-----	-----	-----	-----		-----	-----	-----	-----	
Lc	Length of the vertical curve (ft):	>											
g1	approach grade #1 (%):	>											
g2	approach grade #2 (%):	>											
K	K = Min(Lc/(Diff(g1,g2),167) (Table 4-7, HEC-22):			-----	-----	-----	-----		-----	-----	-----	-----	
Df	Flanking inlets distance (ft):			-----	-----	-----	-----		-----	-----	-----	-----	

Note: the spread at DI 14a should not spread out as much as indicated; flow will go to the next DI (14c) before it spreads out to more than half of the outter traveled lane.

Appendix E Ditch Capacity Calulations

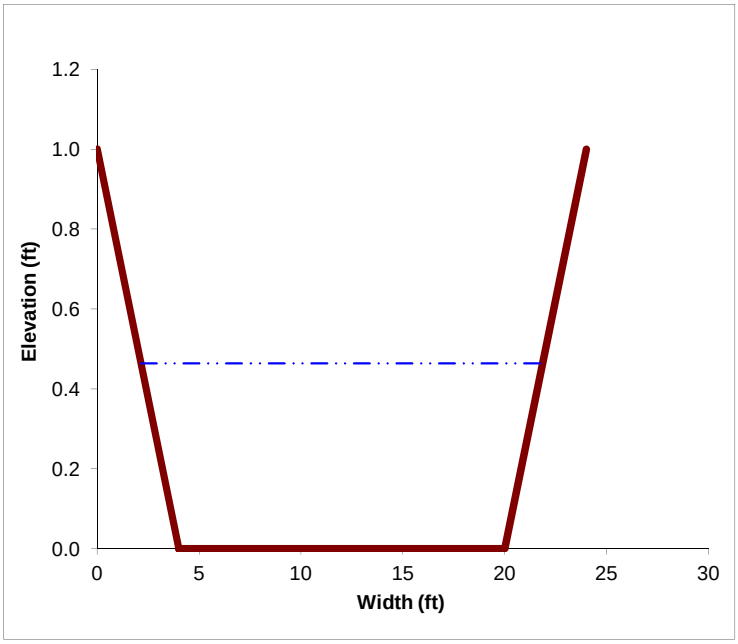
US 101 / Broadway Interchange Reconstruction Project
Normal Depth Calculations for Channels using Manning's Equation
Biofiltration Swale No.1 "B1" Lt 206+38.48 to "B1" Lt 207+39.85

Input Values

Height	1	ft
Width	16	ft
LT Side Slope	4	:1 (h:v)
Rt Side Slope	4	:1 (h:v)
Mannings	0.05	
Slope	0.0020	ft/ft
Design Flow	6.11	cfs

Normal Depth for Channel

Depth	0.463	ft
Area	8.27	ft^2
Perimeter	19.82	ft
Rh	0.42	ft
V	0.74	ft/s
Q	6.11	cfs
Goal Seek	0.00	



Rational

Paved Area (ac)	1.44
Unpaved Area (ac)	0.61
Total Area (ac)	2.05
Rational C	0.92
Rainfall Intensity (in/hr)	3.24
Discharge (cfs)	6.11

Q25=	6.11	cfs
Froude	0.19	Subcritical
Required Freeboard	0.09	ft
Provided Freeboard	0.54	ft
Adequate Freeboard?	YES	

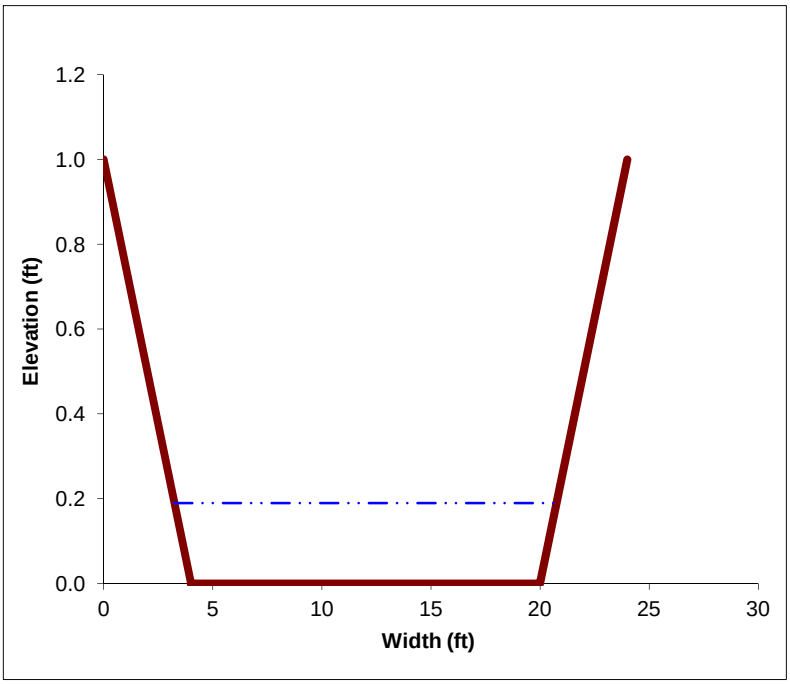
US 101 / Broadway Interchange Reconstruction Project
Normal Depth Calculations for Channels using Manning's Equation
Biofiltration Swale No.2 "B4" Lt 407+42.55 to "B4" Lt 407+97.75

Input Values

Height	1	ft
Width	16	ft
LT Side Slope	4	:1 (h:v)
Rt Side Slope	4	:1 (h:v)
Mannings	0.05	
Slope	0.0071	ft/ft
Design Flow	2.55	cfs

Normal Depth for Channel

Depth	0.190	ft
Area	3.18	ft^2
Perimeter	17.57	ft
Rh	0.18	ft
V	0.80	ft/s
Q	2.55	cfs
Goal Seek	0.00	



Rational

Paved Area (ac)	0.44
Unpaved Area (ac)	0.61
Total Area (ac)	1.05
Rational C	0.75
Rainfall Intensity (in/hr)	3.24
Discharge (cfs)	2.55

Q25=	2.55	cfs
Froude	0.32	Subcritical
Required Freeboard	0.04	ft
Provided Freeboard	0.81	ft
Adequate Freeboard?	YES	

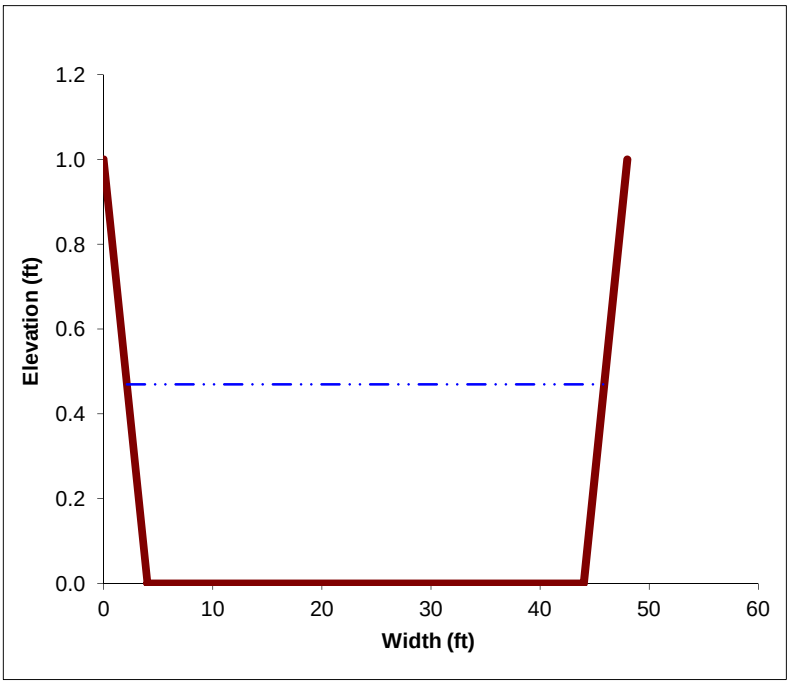
US 101 / Broadway Interchange Reconstruction Project
Normal Depth Calculations for Channels using Manning's Equation
Biofiltration Swale No.3 "BYSH" Rt 37+20.00 to "B4" Lt 410+03.92

Input Values

Height	1	ft
Width	40	ft
LT Side Slope	4	:1 (h:v)
Rt Side Slope	4	:1 (h:v)
Mannings	0.05	
Slope	0.0011	ft/ft
Design Flow	11.17	cfs

Normal Depth for Channel

Depth	0.470	ft
Area	19.67	ft^2
Perimeter	43.87	ft
Rh	0.45	ft
V	0.57	ft/s
Q	11.17	cfs
Goal Seek	0.00	



Rational

Paved Area (ac)	2.24
Unpaved Area (ac)	1.99
Total Area (ac)	4.23
Rational C	0.82
Rainfall Intensity (in/hr)	3.24
Discharge (cfs)	11.17

Q25=	11.17	cfs
Froude	0.15	Subcritical
Required Freeboard	0.09	ft
Provided Freeboard	0.53	ft
Adequate Freeboard?	YES	

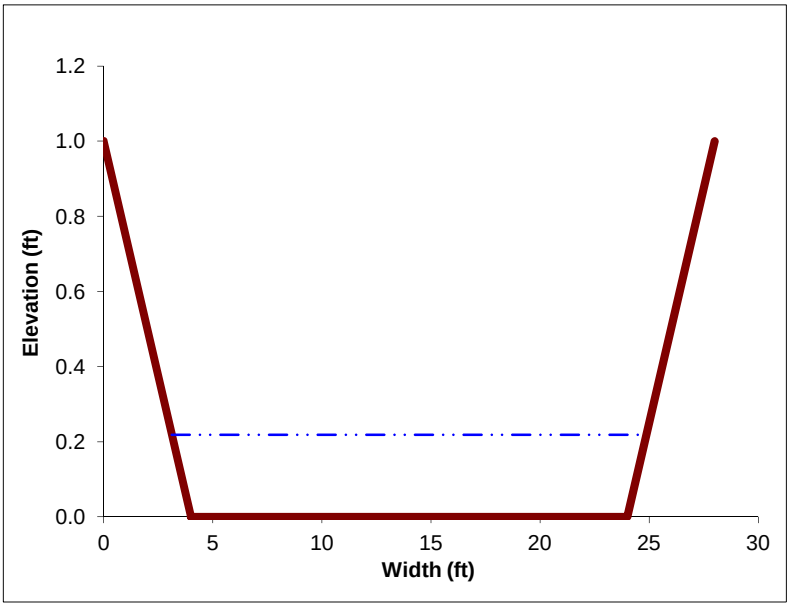
US 101 / Broadway Interchange Reconstruction Project
Normal Depth Calculations for Channels using Manning's Equation
Biofiltration Swale No.4 "HTL" Rt 52+39.27 to "B4" Lt 416+26.11

Input Values

Height	1	ft
Width	20	ft
LT Side Slope	4	:1 (h:v)
Rt Side Slope	4	:1 (h:v)
Mannings	0.05	
Slope	0.0050	ft/ft
Design Flow	3.38	cfs

Normal Depth for Channel

Depth	0.219	ft
Area	4.56	ft^2
Perimeter	21.80	ft
Rh	0.21	ft
V	0.74	ft/s
Q	3.38	cfs
Goal Seek	0.00	



Rational

Paved Area (ac)	0.48
Unpaved Area (ac)	1.04
Total Area (ac)	1.52
Rational C	0.69
Rainfall Intensity (in/hr)	3.24
Discharge (cfs)	3.38

Q25=	3.38	cfs
Froude	0.28	Subcritical
Required Freeboard	0.05	ft
Provided Freeboard	0.78	ft
Adequate Freeboard?	YES	

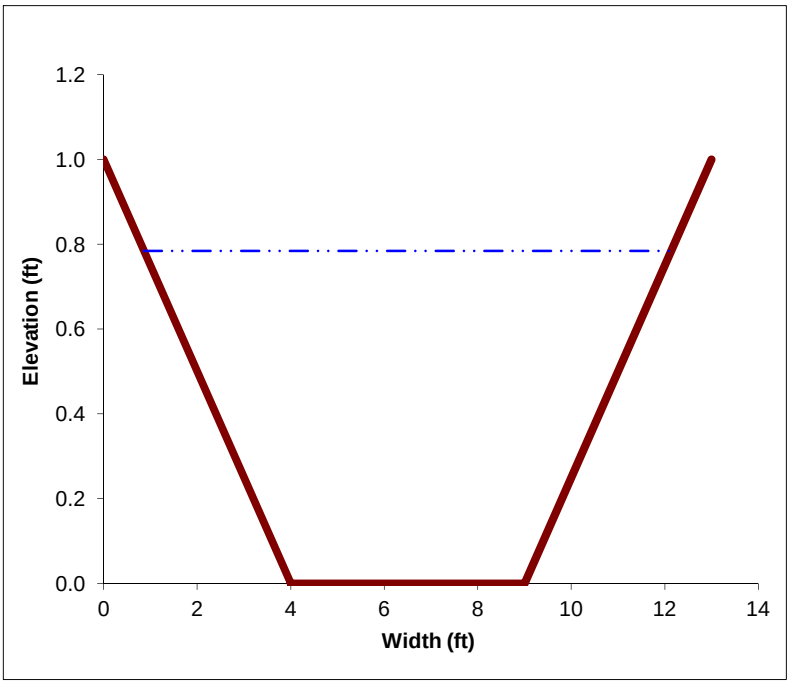
US 101 / Broadway Interchange Reconstruction Project
Normal Depth Calculations for Channels using Manning's Equation
Biofiltration Swale No.5 "B4" Lt 415+47.82 to "B4" Lt 422+80.42

Input Values

Height	1	ft
Width	5	ft
LT Side Slope	4	:1 (h:v)
Rt Side Slope	4	:1 (h:v)
Mannings	0.05	
Slope	0.0031	ft/ft
Design Flow	7.12	cfs

Normal Depth for Channel

Depth	0.784	ft
Area	6.38	ft^2
Perimeter	11.47	ft
Rh	0.56	ft
V	1.12	ft/s
Q	7.12	cfs
Goal Seek	0.00	



Rational

Paved Area (ac)	1.38
Unpaved Area (ac)	1.37
Total Area (ac)	2.75
Rational C	0.80
Rainfall Intensity (in/hr)	3.24
Discharge (cfs)	7.12

Q25=	7.12	cfs
Froude	0.22	Subcritical
Required Freeboard	0.16	ft
Provided Freeboard	0.22	ft
Adequate Freeboard?	YES	

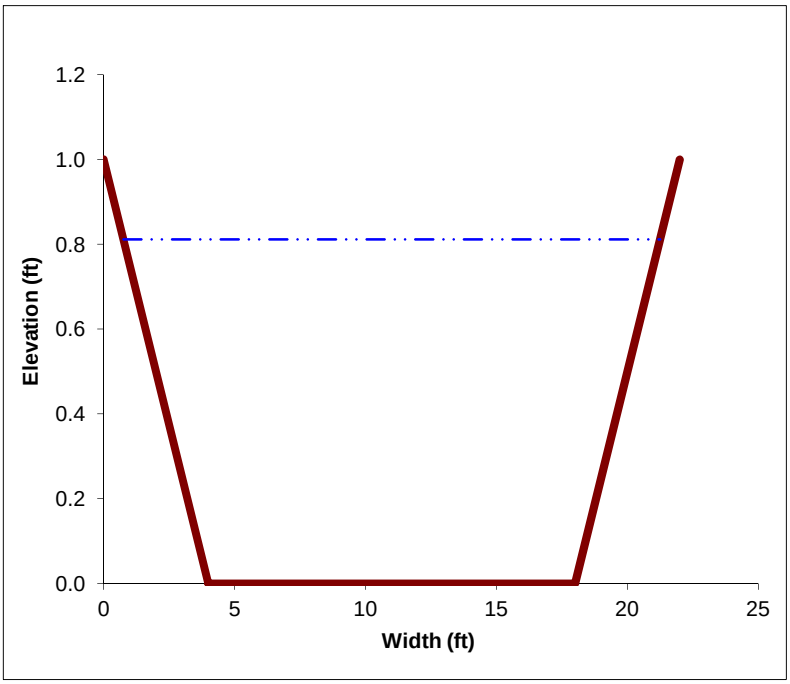
US 101 / Broadway Interchange Reconstruction Project
Normal Depth Calculations for Channels using Manning's Equation
Biofiltration Swale No.6 "B3" Rt 316+33.71 to "B3" Rt 318+78.61

Input Values

Height	1	ft
Width	14	ft
LT Side Slope	4	:1 (h:v)
Rt Side Slope	4	:1 (h:v)
Mannings	0.05	
Slope	0.0031	ft/ft
Design Flow	17.93	cfs

Normal Depth for Channel

Depth	0.811	ft
Area	13.99	ft^2
Perimeter	20.69	ft
Rh	0.68	ft
V	1.28	ft/s
Q	17.93	cfs
Goal Seek	0.00	



Rational

Paved Area (ac)	4.46
Unpaved Area (ac)	1.27
Total Area (ac)	5.73
Rational C	0.97
Rainfall Intensity (in/hr)	3.24
Discharge (cfs)	17.93

Q25=	17.93	cfs
Froude	0.25	Subcritical
Required Freeboard	0.17	ft
Provided Freeboard	0.19	ft
Adequate Freeboard?	YES	

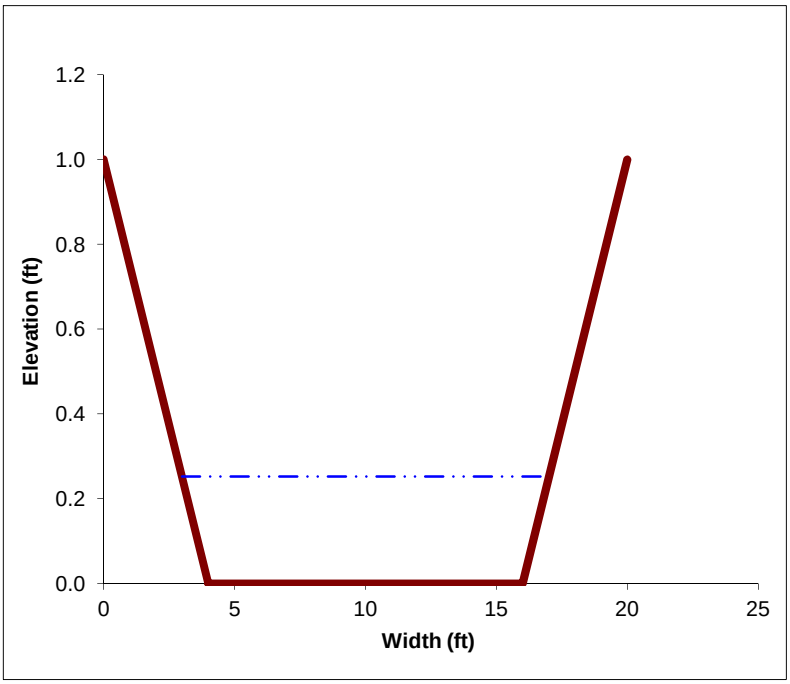
US 101 / Broadway Interchange Reconstruction Project
Normal Depth Calculations for Channels using Manning's Equation
Biofiltration Swale No.7 "RLN" Lt 23+18.54 to "BWY" Lt 15+16.78

Input Values

Height	1	ft
Width	12	ft
LT Side Slope	4	:1 (h:v)
Rt Side Slope	4	:1 (h:v)
Mannings	0.05	
Slope	0.0033	ft/ft
Design Flow	2.13	cfs

Normal Depth for Channel

Depth	0.252	ft
Area	3.28	ft^2
Perimeter	14.08	ft
Rh	0.23	ft
V	0.65	ft/s
Q	2.13	cfs
Goal Seek	0.00	



Rational

Paved Area (ac)	0.44
Unpaved Area (ac)	0.35
Total Area (ac)	0.79
Rational C	0.83
Rainfall Intensity (in/hr)	3.24
Discharge (cfs)	2.13

Q25=	2.13	cfs
Froude	0.23	Subcritical
Required Freeboard	0.05	ft
Provided Freeboard	0.75	ft
Adequate Freeboard?	YES	

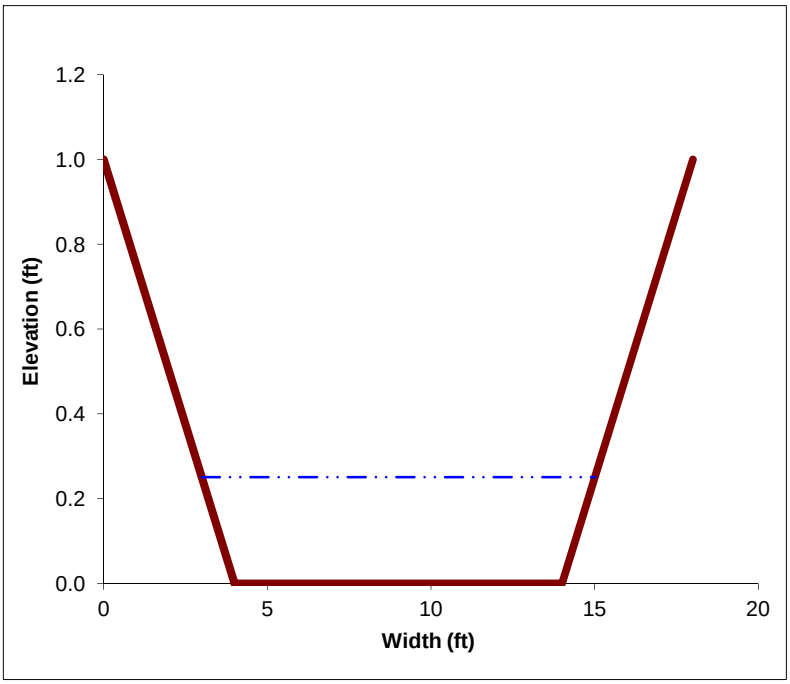
US 101 / Broadway Interchange Reconstruction Project
Normal Depth Calculations for Channels using Manning's Equation
Biofiltration Swale No.8 "B3" Rt 318+73.44 to "B3" Rt 319+33.04

Input Values

Height	1	ft
Width	10	ft
LT Side Slope	4	:1 (h:v)
Rt Side Slope	4	:1 (h:v)
Mannings	0.05	
Slope	0.0035	ft/ft
Design Flow	1.81	cfs

Normal Depth for Channel

Depth	0.251	ft
Area	2.76	ft^2
Perimeter	12.07	ft
Rh	0.23	ft
V	0.66	ft/s
Q	1.81	cfs
Goal Seek	0.00	



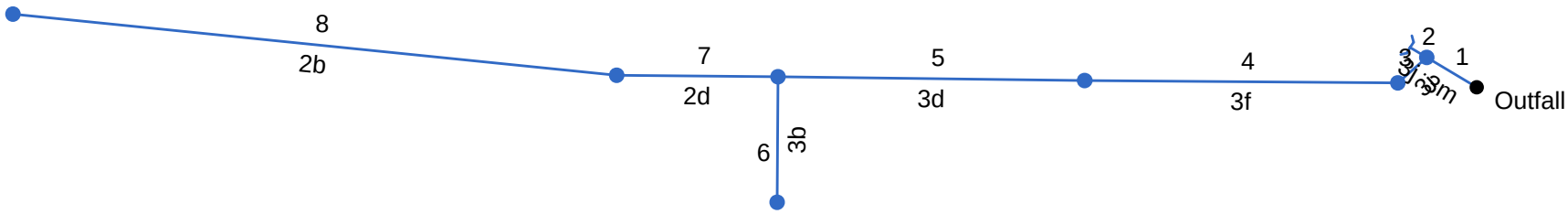
Rational

Paved Area (ac)	0.39
Unpaved Area (ac)	0.26
Total Area (ac)	0.65
Rational C	0.86
Rainfall Intensity (in/hr)	3.24
Discharge (cfs)	1.81

Q25=	1.81	cfs
Froude	0.23	Subcritical
Required Freeboard	0.05	ft
Provided Freeboard	0.75	ft
Adequate Freeboard?	YES	

Appendix F Hydraflow Model Reports

Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: System 3.stm	Number of lines: 8	Date: 04-17-2013

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	18.0	0.00	1.26	0.00	0.00	1.20	0.0	8.8	2.3	2.80	39.68	2.06	18	12.17	3.97	6.16	7.10	7.06	5.47	11.19	3m
2	1	6.0	0.15	0.15	0.60	0.09	0.09	5.0	5.0	3.1	0.28	49.15	1.34	18	18.67	6.85	7.97	7.25	8.17	11.19	9.47	3j
3	1	12.0	0.00	1.11	1.00	0.00	1.11	5.0	8.7	2.3	2.60	8.04	2.13	18	0.50	6.16	6.22	7.17	7.17	11.19	10.82	3i
4	3	97.0	0.11	1.11	1.00	0.11	1.11	5.0	8.1	2.4	2.71	6.22	2.43	18	0.30	6.26	6.55	7.29	7.36	10.82	11.24	3f
5	4	95.0	0.00	1.00	1.00	0.00	1.00	5.0	7.4	2.5	2.54	6.29	2.50	18	0.31	6.55	6.84	7.51	7.59	11.24	11.78	3d
6	5	39.0	0.41	0.41	1.00	0.41	0.41	5.0	5.0	3.1	1.26	18.03	1.98	18	2.51	6.84	7.82	7.90	8.25	11.78	11.32	3b
7	5	50.0	0.00	0.59	1.00	0.00	0.59	5.0	6.8	2.6	1.56	6.23	1.32	18	0.30	6.84	6.99	7.87	7.88	11.78	11.59	2d
8	7	188.0	0.59	0.59	1.00	0.59	0.59	5.0	5.0	3.1	1.81	6.03	1.75	14 x 23 e	0.30	6.99	7.55	7.92	8.08	11.59	9.48	2b

Project File: System 3.stm

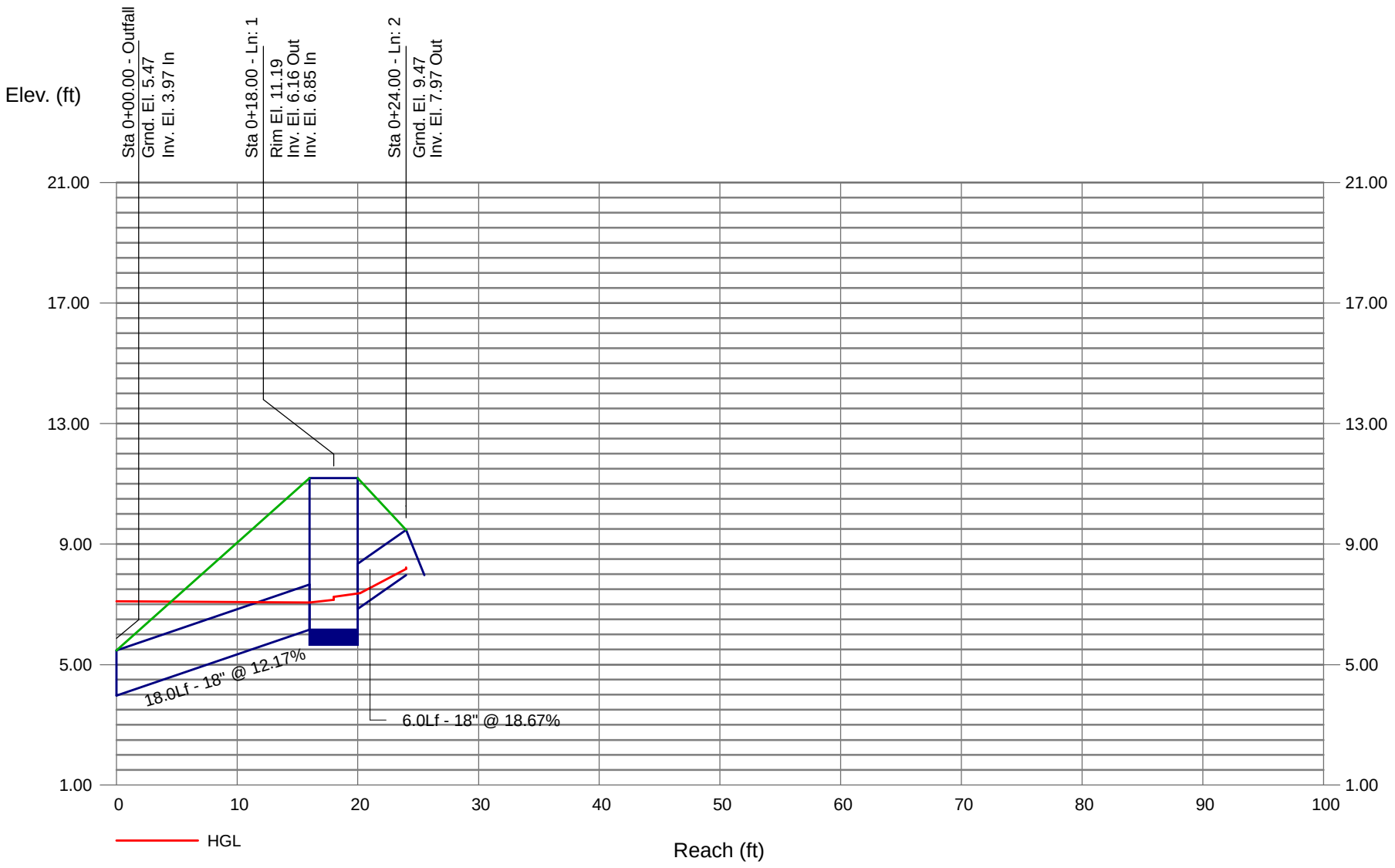
Number of lines: 8

Run Date: 04-17-2013

NOTES: Intensity = 6.87 / (Inlet time + 0.10) ^ 0.49; Return period = 25 Yrs. ; c = cir e = ellip b = box

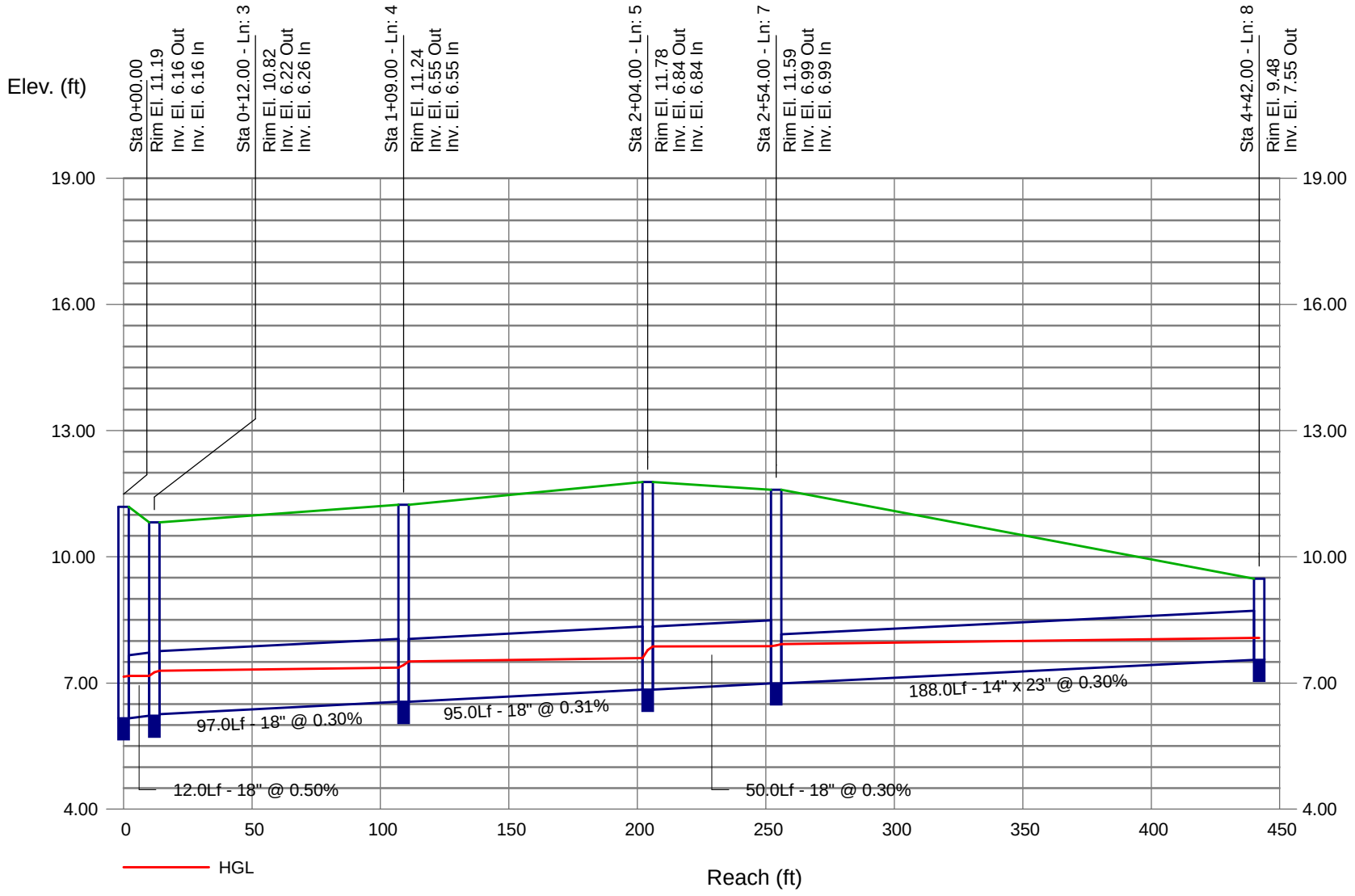
Storm Sewer Profile

Proj. file: System 3.stm



Storm Sewer Profile

Proj. file: System 3.stm



Storm Sewer Profile

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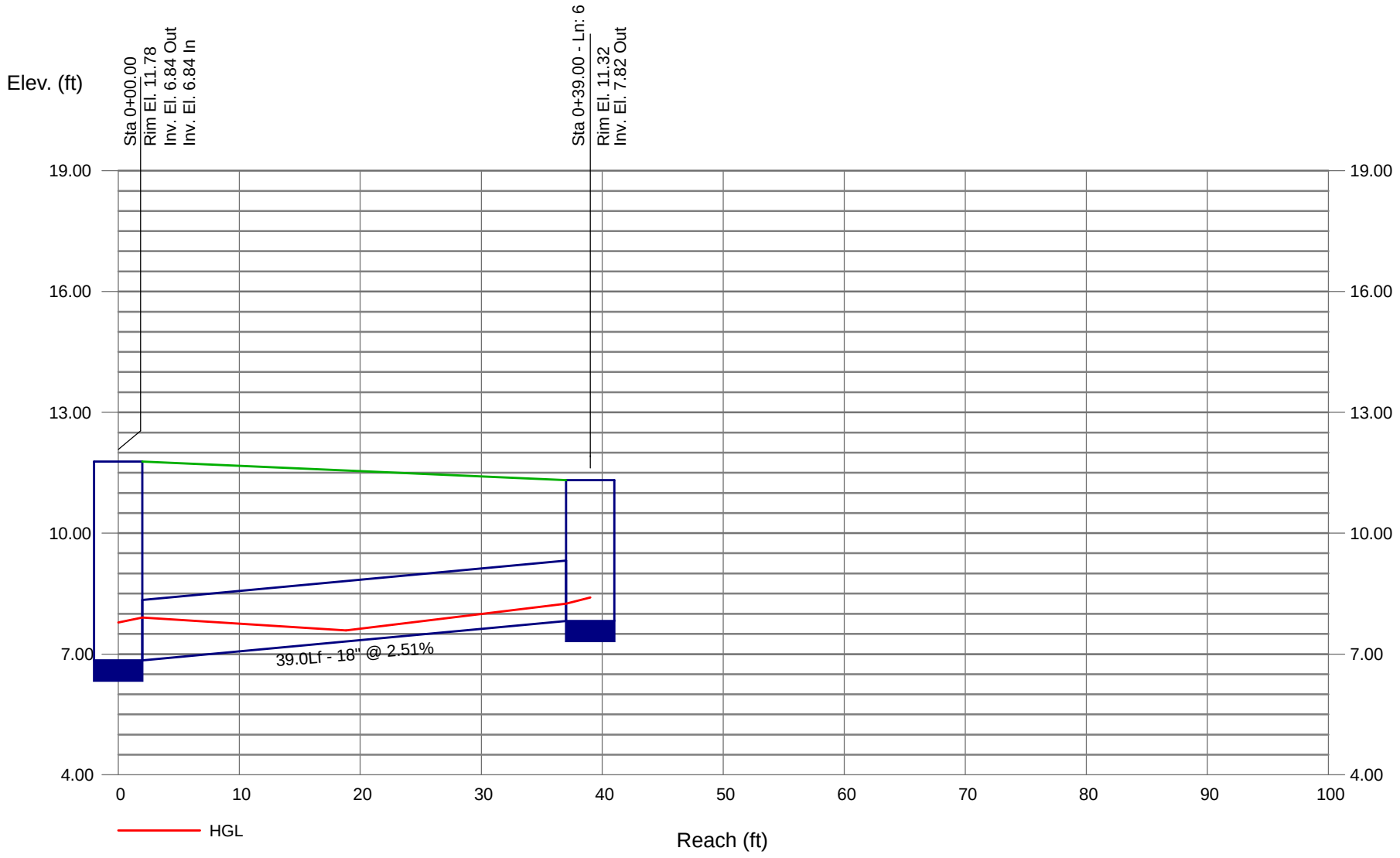
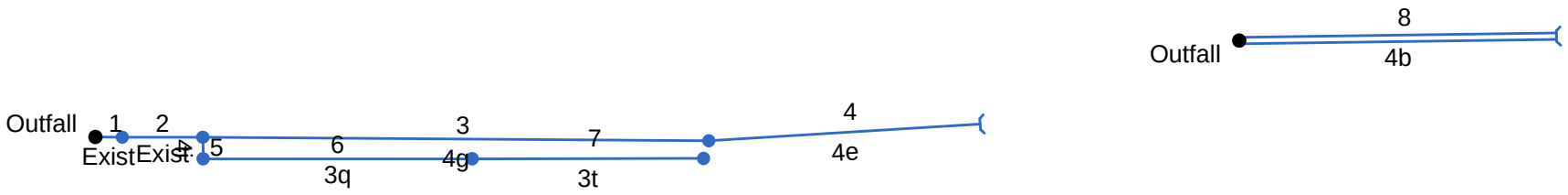


Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: System 3,4.stm	Number of lines: 8	Date: 04-17-2013

Storm Sewer Tabulation

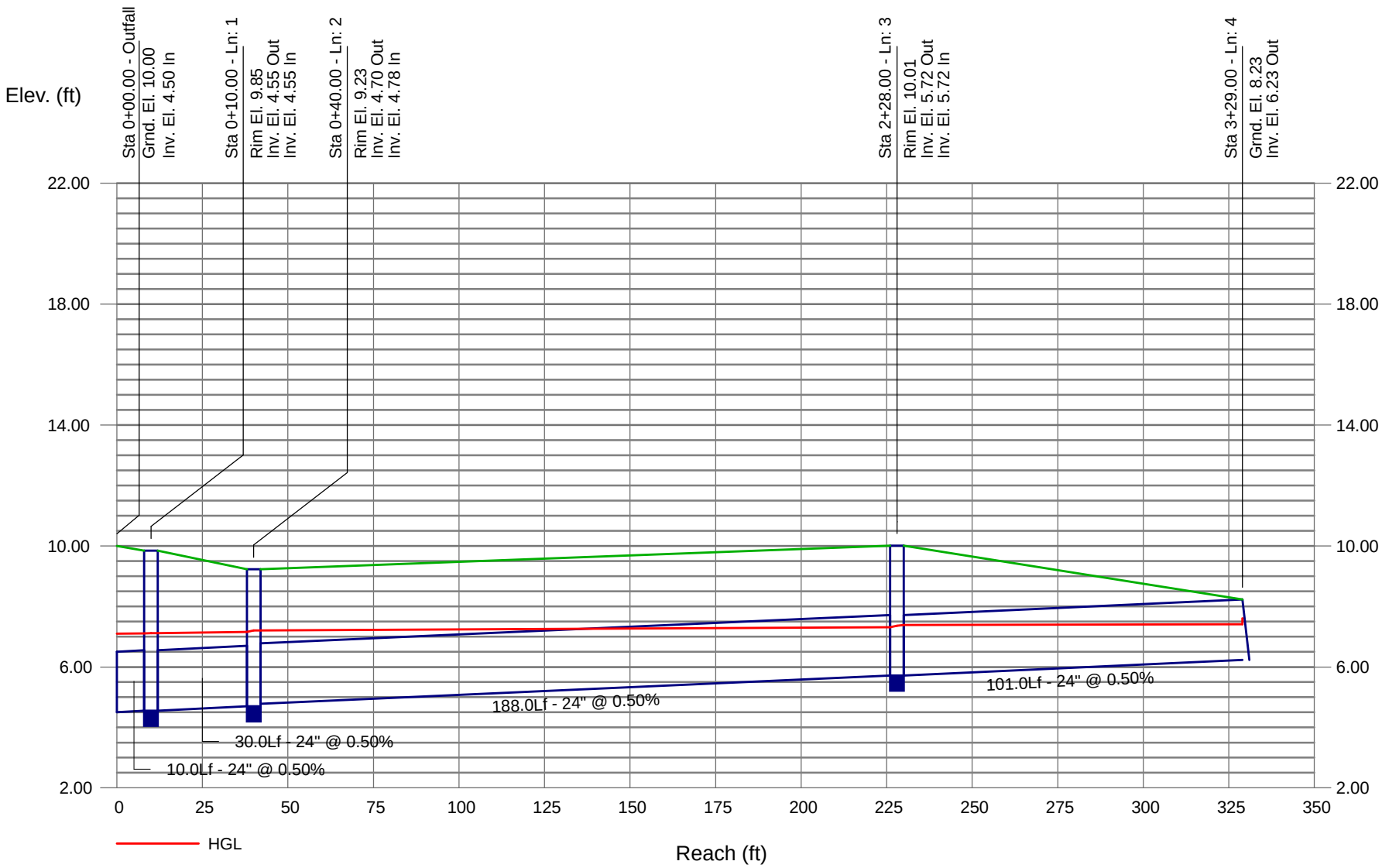
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	10.0	0.00	3.63	0.00	0.00	3.31	0.0	27.9	1.3	4.39	8.66	1.40	24	0.50	4.50	4.55	7.10	7.11	10.00	9.85	Exist
2	1	30.0	0.41	3.63	1.00	0.41	3.31	5.0	27.5	1.3	4.41	8.66	1.40	24	0.50	4.55	4.70	7.12	7.16	9.85	9.23	Exist
3	2	188.0	0.00	2.95	0.00	0.00	2.63	0.0	7.6	2.5	6.60	17.33	2.28	24	0.50	4.78	5.72	7.20	7.32	9.23	10.01	4g
4	3	101.0	2.95	2.95	0.89	2.63	2.63	7.0	7.0	2.6	6.85	17.41	3.00	24	0.50	5.72	6.23	7.38	7.41	10.01	8.23	4e
5	2	8.0	0.10	0.27	1.00	0.10	0.27	5.0	26.9	1.3	0.36	15.05	0.21	18	1.75	4.66	4.80	7.23	7.23	9.23	10.61	4i
6	5	100.0	0.10	0.17	1.00	0.10	0.17	5.0	16.8	1.7	0.29	6.23	0.16	18	0.30	4.80	5.10	7.23	7.23	10.61	10.78	3q
7	6	86.0	0.07	0.07	1.00	0.07	0.07	5.0	5.0	3.1	0.22	6.13	0.12	18	0.29	5.10	5.35	7.23	7.24	10.78	10.76	3t
8	End	118.0	2.08	2.08	0.84	1.75	1.75	5.0	5.0	3.1	5.37	18.50	3.65	18(2b)	0.66	7.51	8.29	8.19	8.92	9.01	9.79	4b

Project File: System 3,4.stm | Number of lines: 8 | Run Date: 04-17-2013

NOTES: Intensity = 6.87 / (Inlet time + 0.10) ^ 0.49; Return period = 25 Yrs. ; c = cir e = ellip b = box

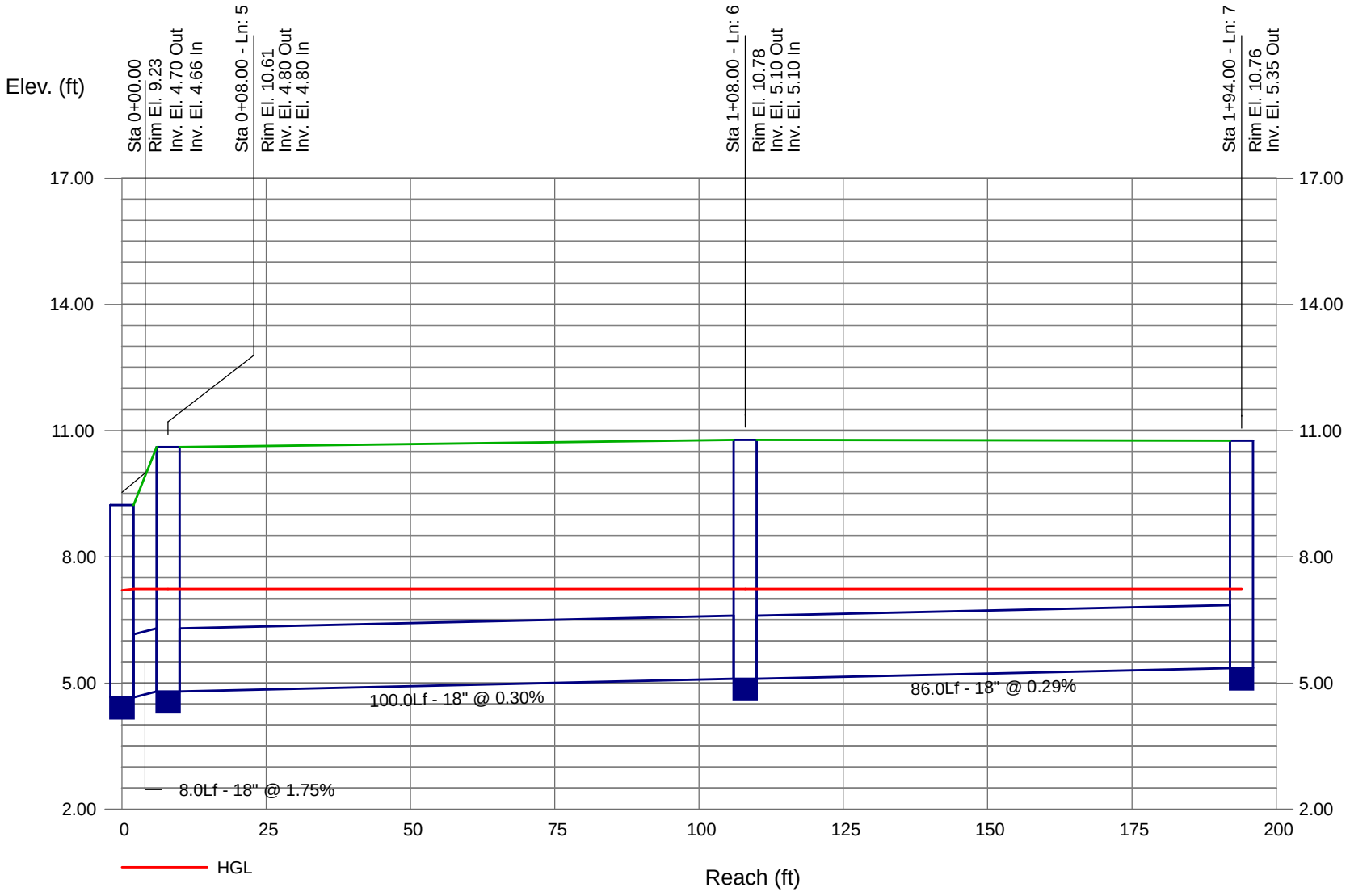
Storm Sewer Profile

Proj. file: System 3,4.stm



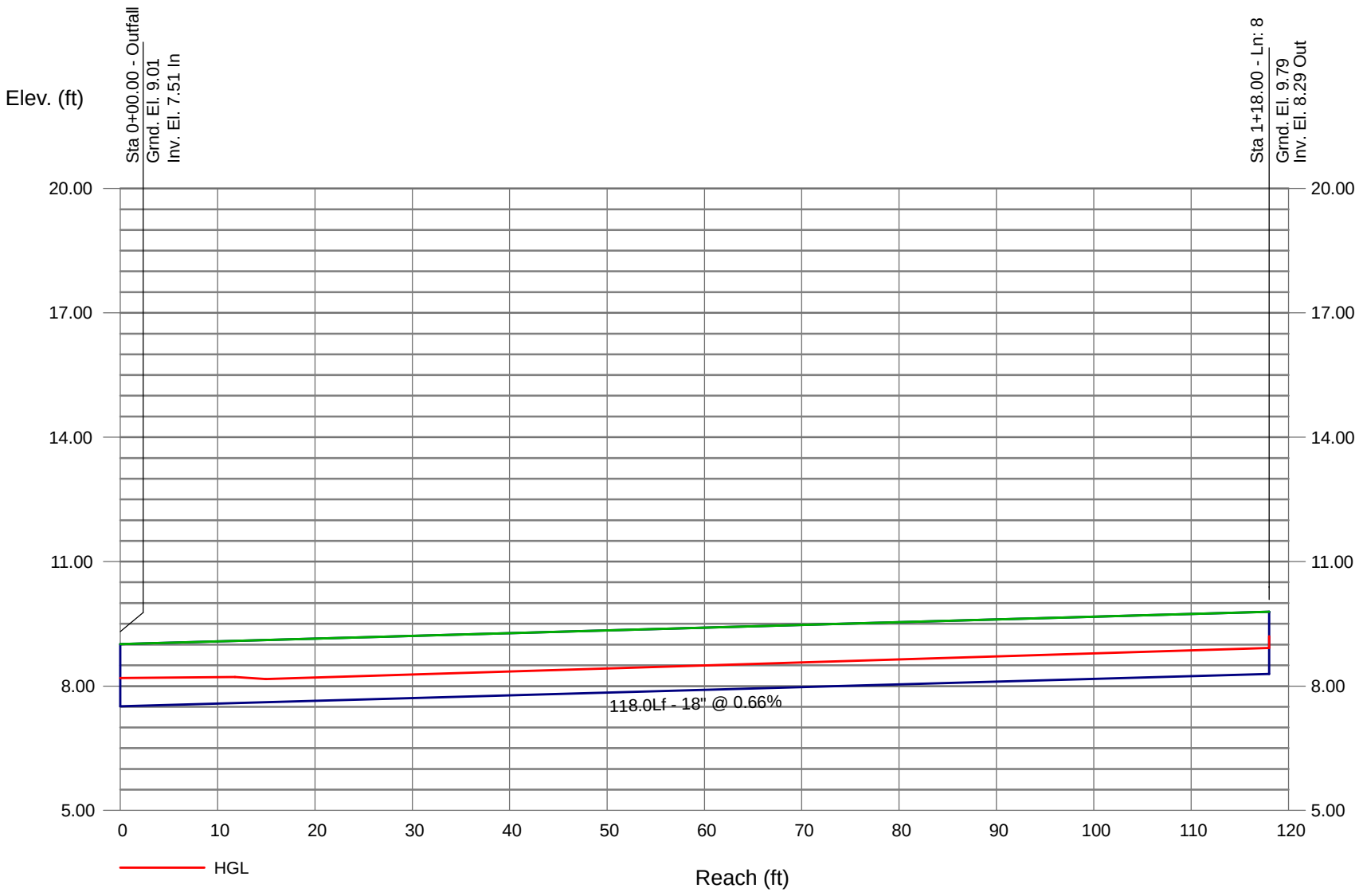
Storm Sewer Profile

Proj. file: System 3,4.stm

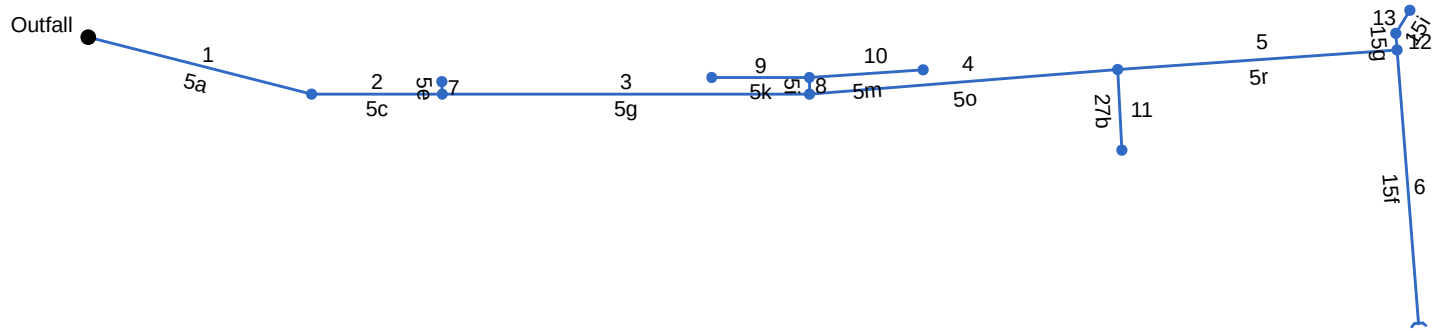


Storm Sewer Profile

Proj. file: System 3,4.stm



Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: System 5.stm	Number of lines: 13	Date: 04-17-2013

Storm Sewer Tabulation

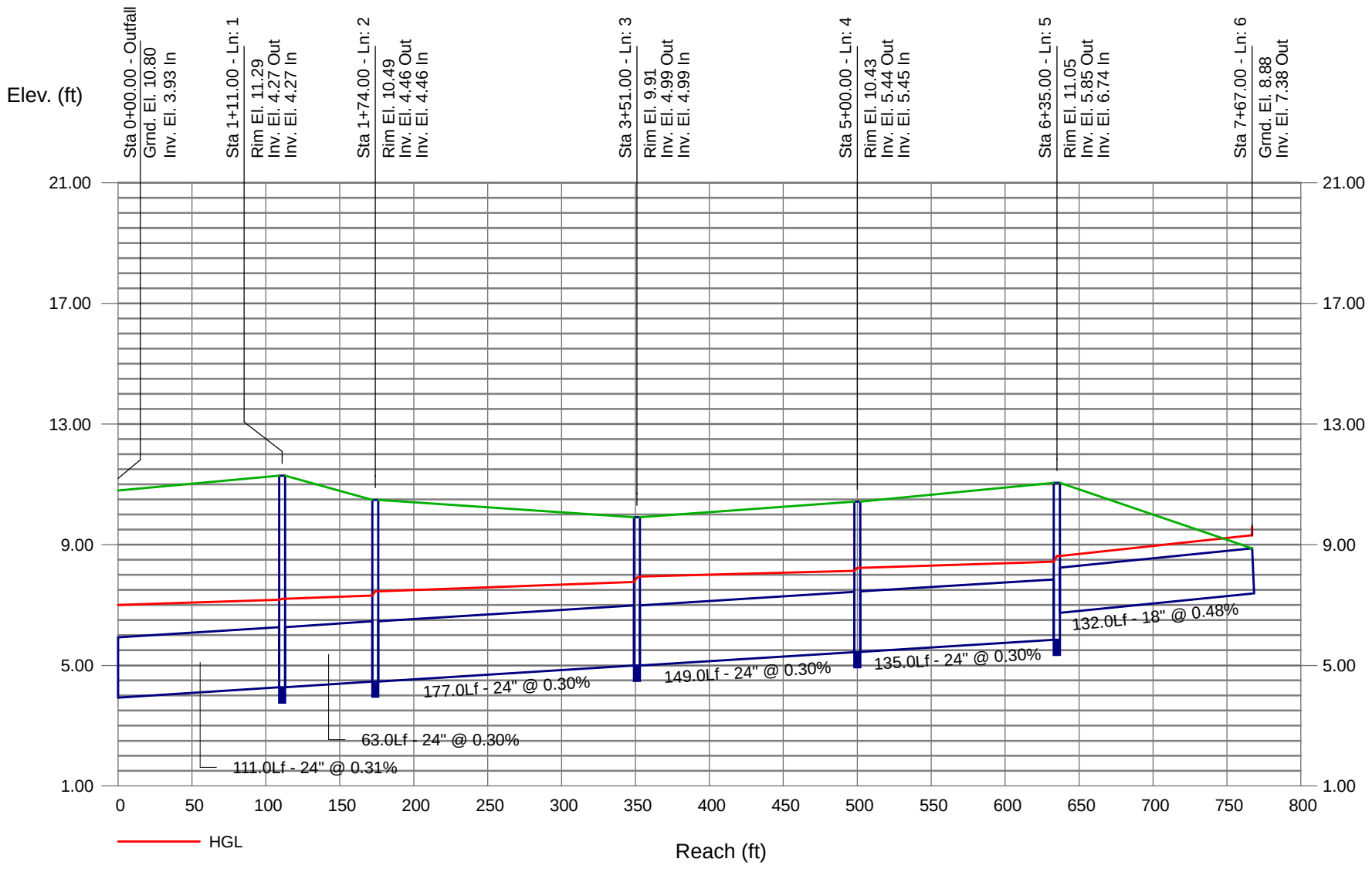
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	111.0	0.00	6.15	0.00	0.00	4.82	0.0	9.6	1.8	9.00	12.52	2.86	24	0.31	3.93	4.27	7.00	7.18	10.80	11.29	5a
2	1	63.0	0.00	6.15	0.00	0.00	4.82	0.0	9.2	1.9	9.17	12.42	2.92	24	0.30	4.27	4.46	7.21	7.32	11.29	10.49	5c
3	2	177.0	0.00	6.06	0.00	0.00	4.74	0.0	8.2	2.0	9.53	12.38	3.03	24	0.30	4.46	4.99	7.45	7.76	10.49	9.91	5g
4	3	149.0	0.00	4.99	0.00	0.00	3.72	0.0	7.2	2.1	8.00	12.43	2.55	24	0.30	4.99	5.44	7.95	8.13	9.91	10.43	5o
5	4	135.0	0.00	4.88	0.00	0.00	3.62	0.0	5.5	2.4	8.82	12.31	2.81	24	0.30	5.45	5.85	8.24	8.44	10.43	11.05	5r
6	5	132.0	4.24	4.24	0.71	3.01	3.01	5.0	5.0	2.5	7.60	7.31	4.30	18	0.48	6.74	7.38	8.62	9.32	11.05	8.88	15f
7	2	6.0	0.09	0.09	0.95	0.09	0.09	5.0	5.0	2.5	0.22	6.06	0.12	18	0.33	4.46	4.48	7.58	7.58	10.49	10.11	5e
8	3	8.0	0.38	1.07	0.95	0.36	1.02	5.0	7.4	2.1	2.12	5.25	1.20	18	0.25	4.99	5.01	8.03	8.03	9.91	9.60	5i
9	8	47.0	0.41	0.41	0.95	0.39	0.39	5.0	5.0	2.5	0.98	5.73	0.56	18	0.30	5.01	5.15	8.10	8.10	9.60	9.66	5k
10	8	55.0	0.28	0.28	0.95	0.27	0.27	5.0	5.0	2.5	0.67	5.66	0.38	18	0.29	5.01	5.17	8.10	8.10	9.60	9.71	5m
11	4	39.0	0.11	0.11	0.95	0.10	0.10	5.0	5.0	2.5	0.26	19.54	0.25	18	3.46	6.32	7.67	8.34	8.34	10.43	10.70	27b
12	5	8.0	0.64	0.64	0.95	0.61	0.61	5.0	5.0	2.5	1.63	5.25	0.93	18	0.25	5.85	5.87	8.73	8.74	11.05	10.63	15g
13	12	13.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.10	10.50	0.06	18	1.00	5.87	6.00	8.76	8.76	10.63	11.07	15i

Project File: System 5.stm | Number of lines: 13 | Run Date: 04-17-2013

NOTES: Intensity = 5.60 / (Inlet time + 0.10) ^ 0.49; Return period = 10 Yrs. ; c = cir e = ellip b = box

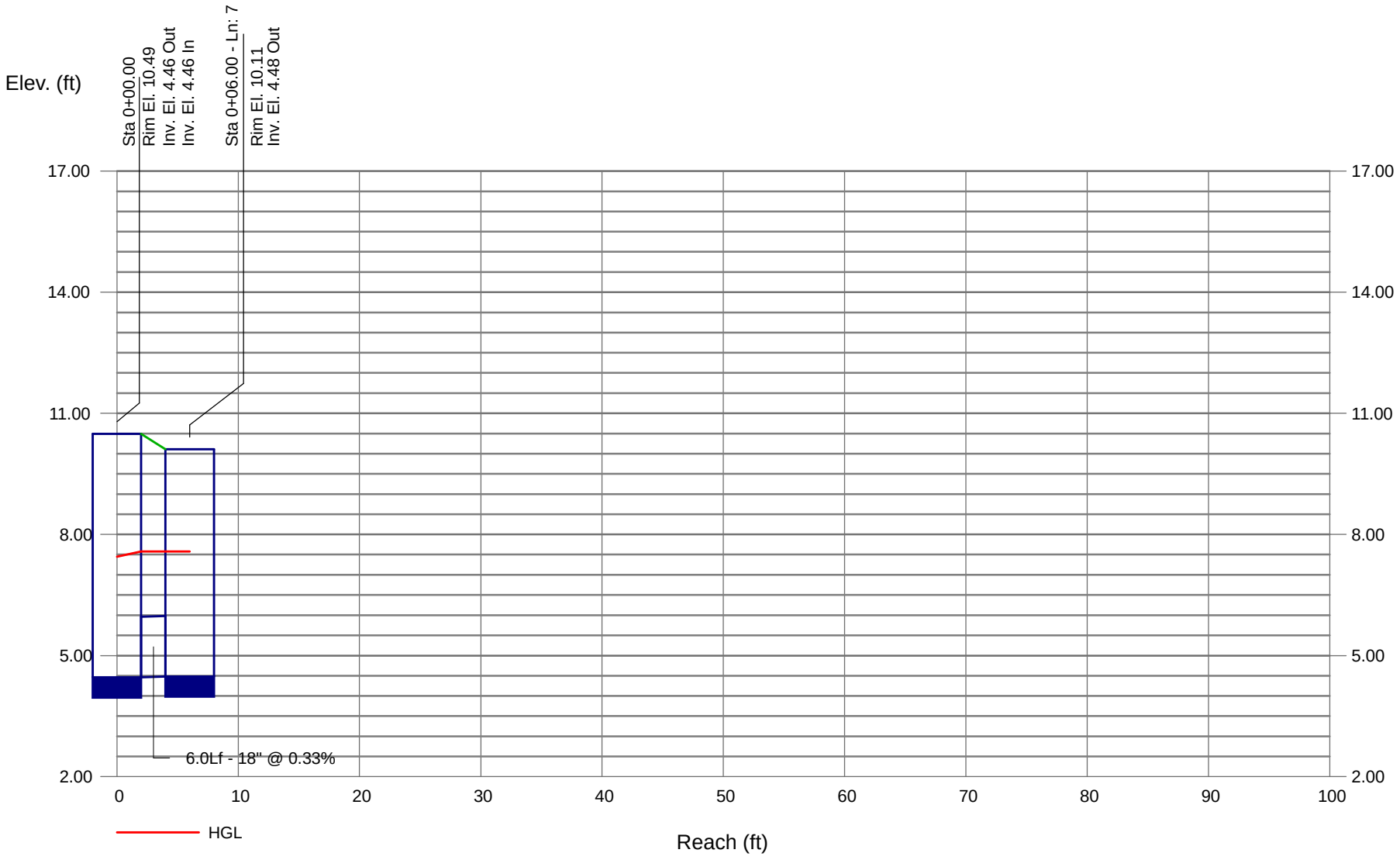
Storm Sewer Profile

Proj. file: System 5.stm



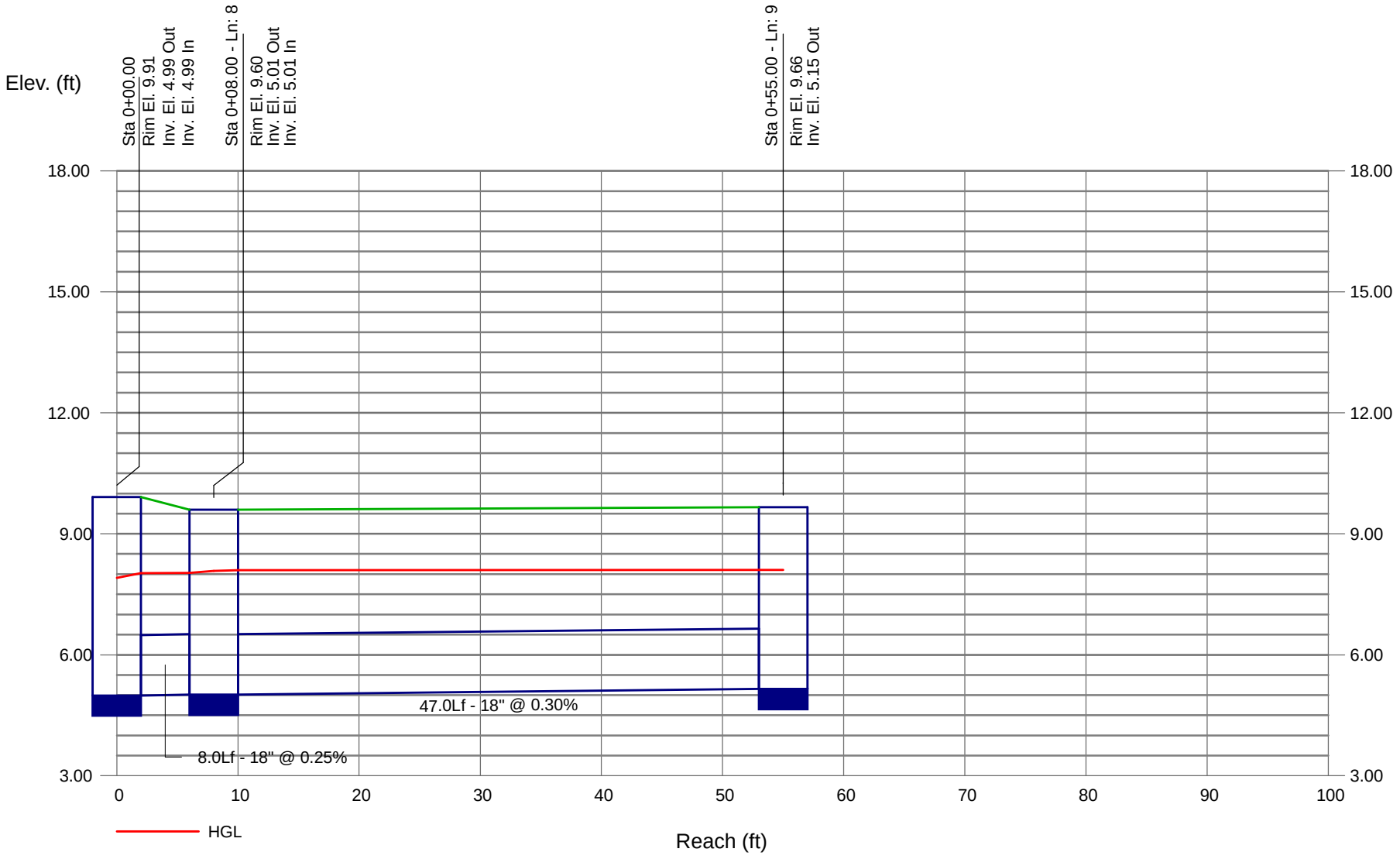
Storm Sewer Profile

Proj. file: System 5.stm



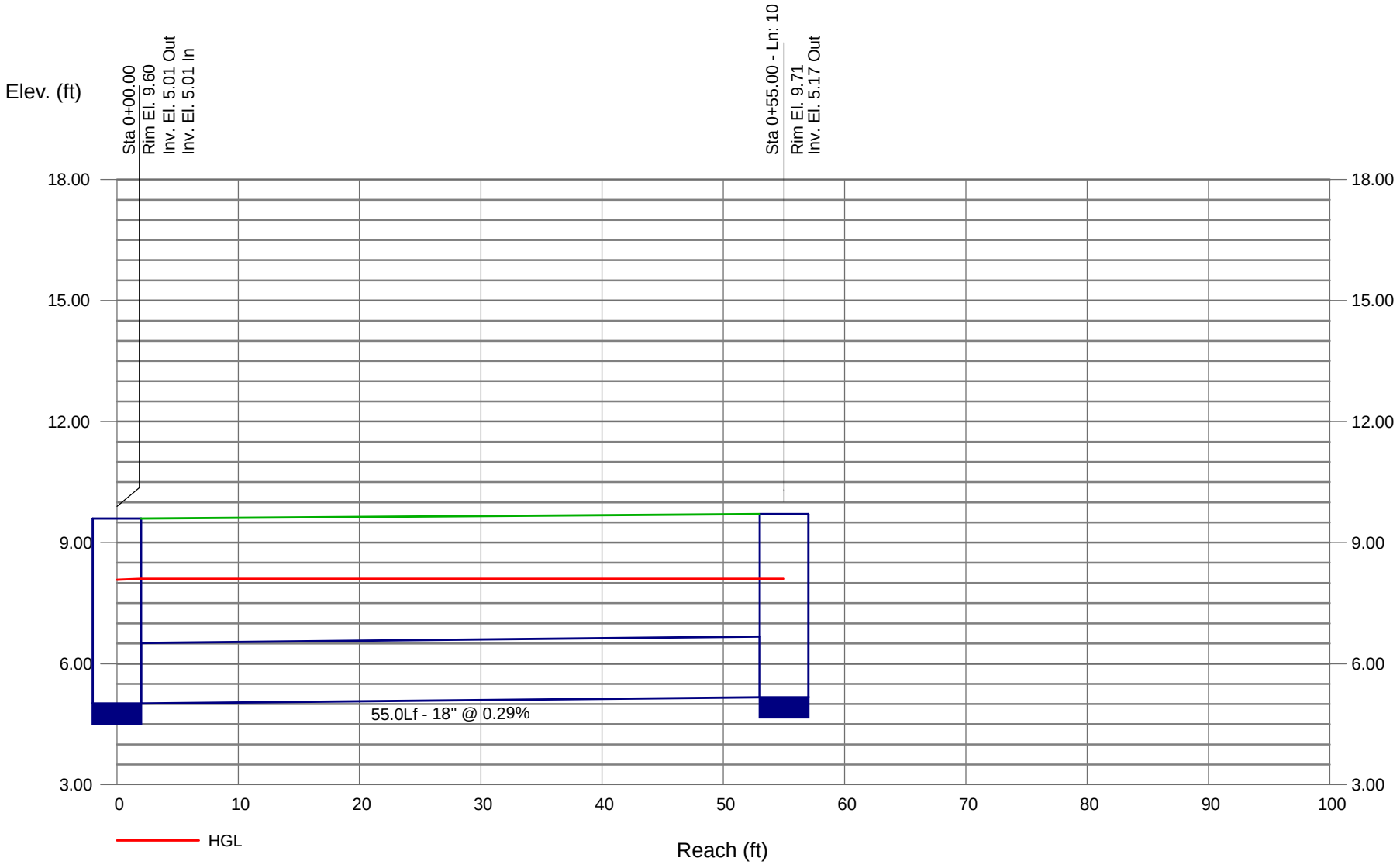
Storm Sewer Profile

Proj. file: System 5.stm



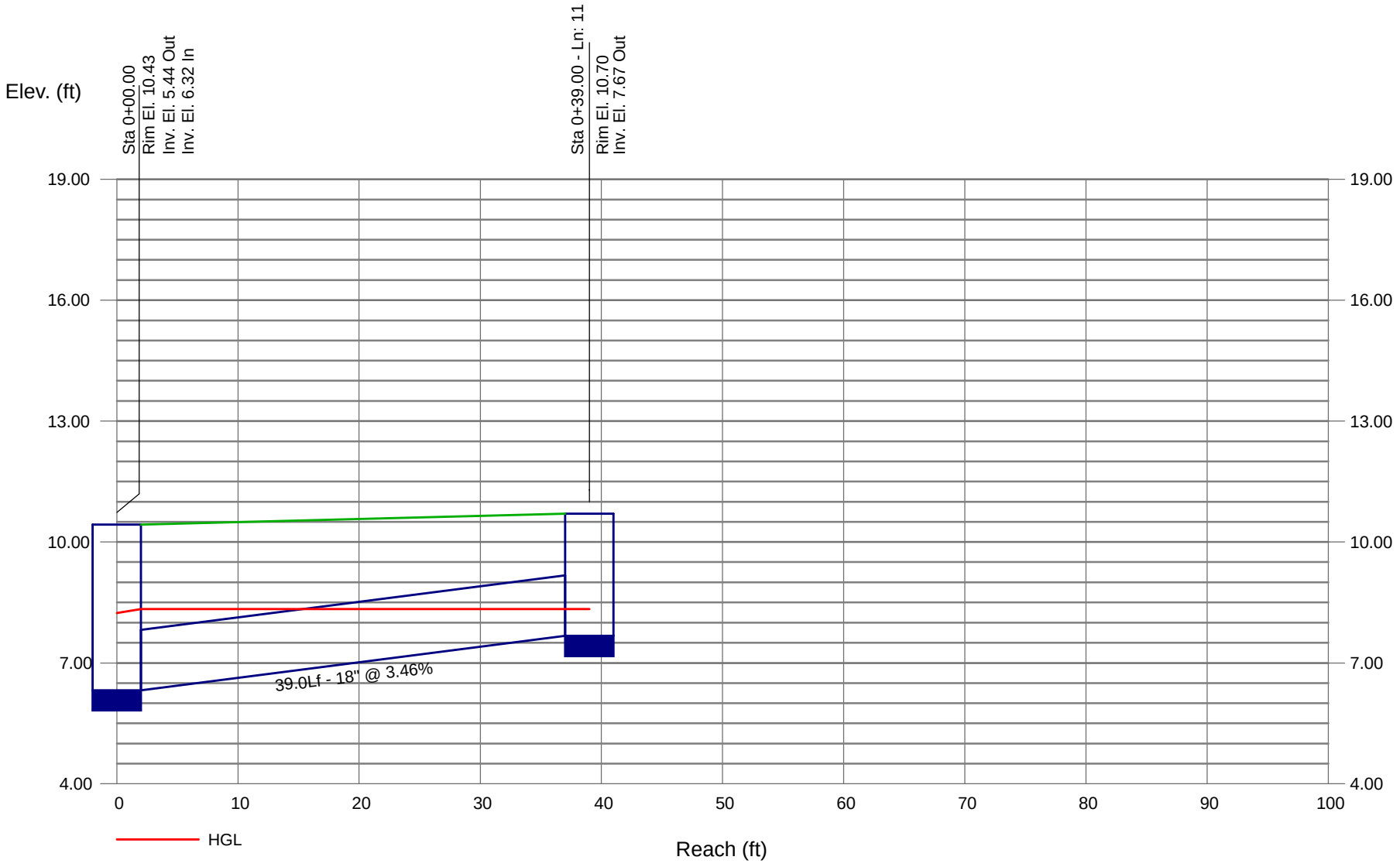
Storm Sewer Profile

Proj. file: System 5.stm



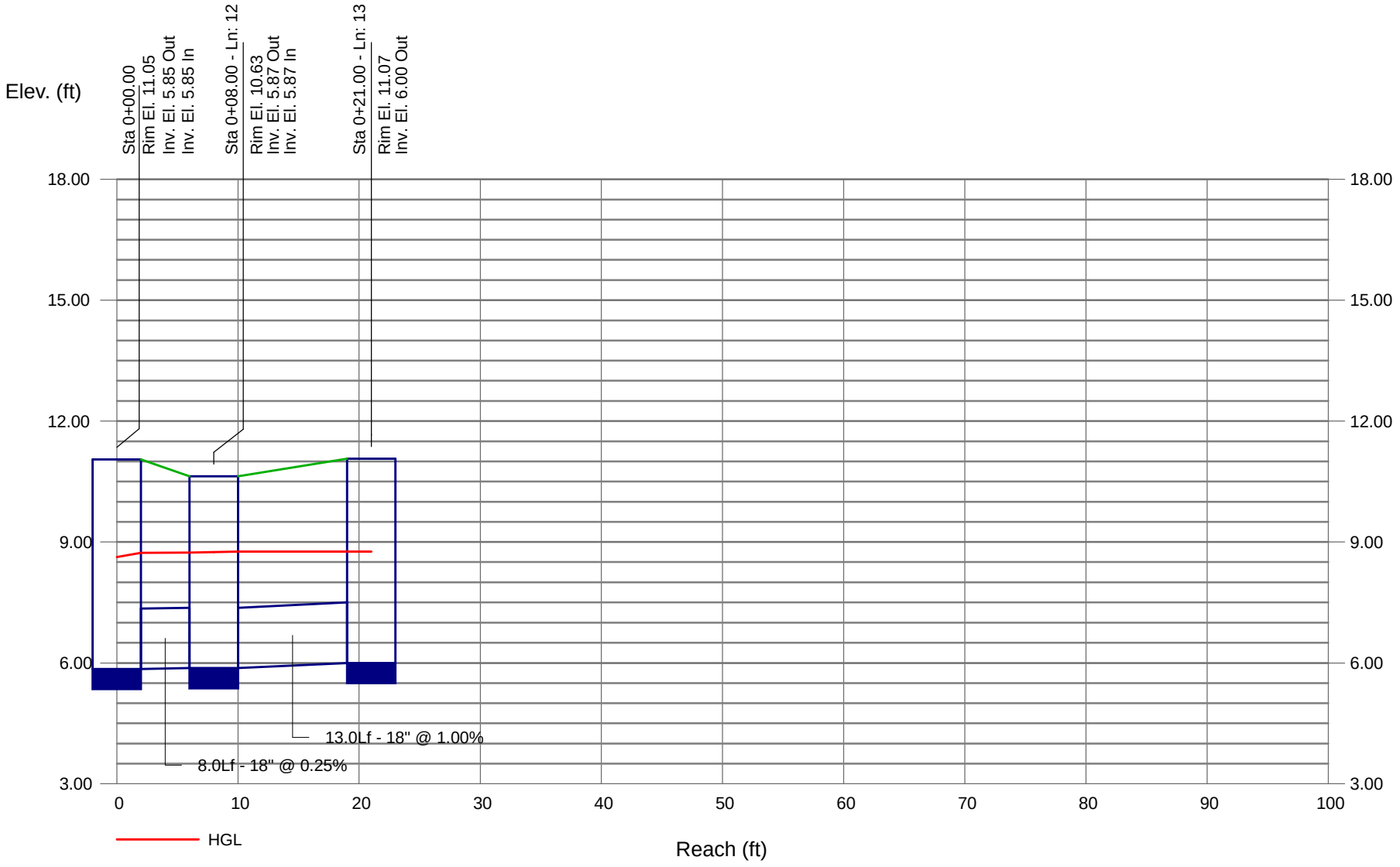
Storm Sewer Profile

Proj. file: System 5.stm

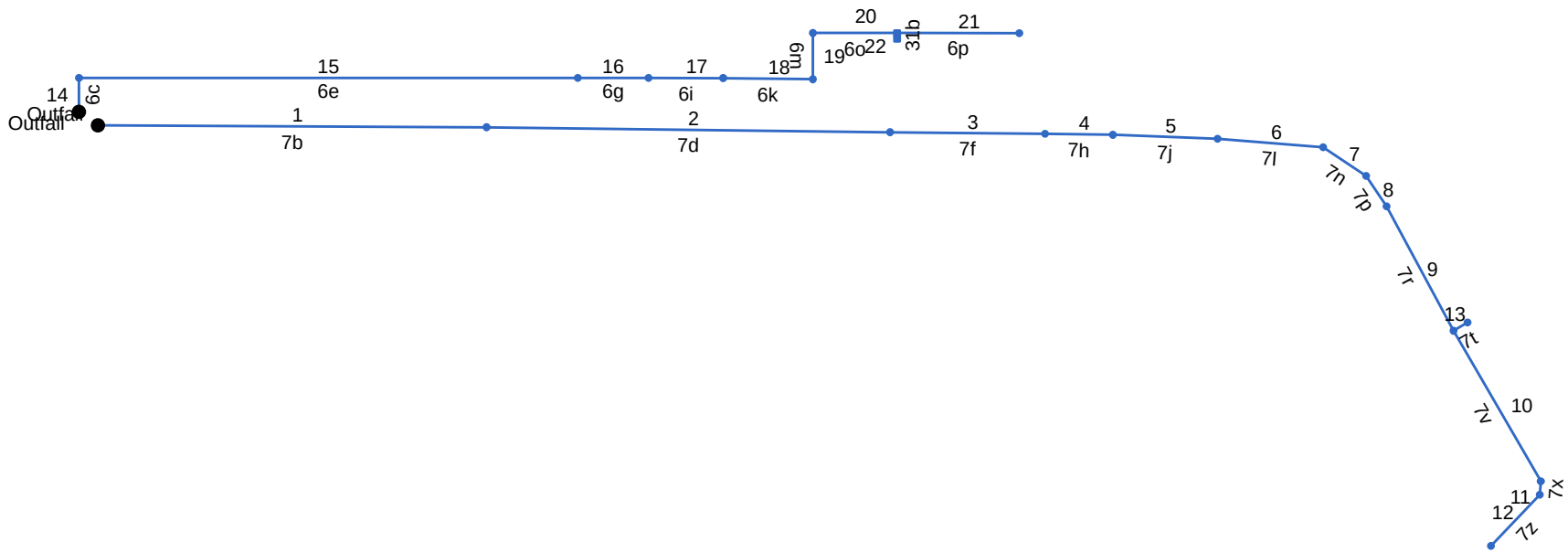


Storm Sewer Profile

Proj. file: System 5.stm



Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: System 6, 7.stm	Number of lines: 22	Date: 04-17-2013

Storm Sewer Tabulation

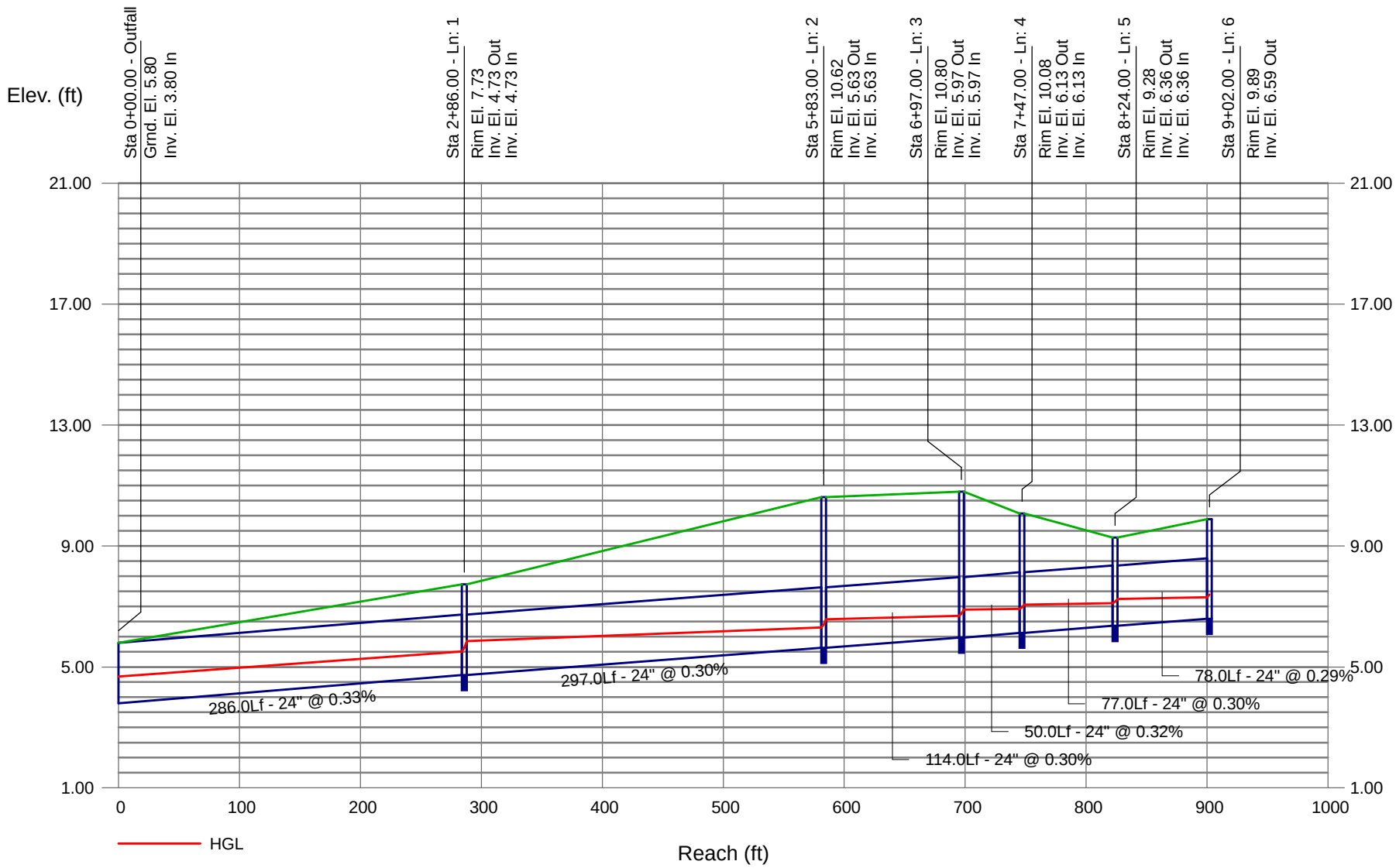
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	286.0	0.78	2.56	0.95	0.74	2.23	5.0	12.0	2.0	4.48	12.90	3.66	24	0.33	3.80	4.73	4.68	5.51	5.80	7.73	7b
2	1	297.0	0.11	1.78	0.97	0.11	1.49	5.0	10.1	2.2	3.25	12.45	2.63	24	0.30	4.73	5.63	5.86	6.31	7.73	10.62	7d
3	2	114.0	0.11	1.67	0.97	0.11	1.38	5.0	9.4	2.3	3.13	12.35	2.61	24	0.30	5.63	5.97	6.57	6.69	10.62	10.80	7f
4	3	50.0	0.15	1.56	0.95	0.14	1.28	5.0	9.0	2.3	2.95	12.79	2.30	24	0.32	5.97	6.13	6.90	6.92	10.80	10.08	7h
5	4	77.0	0.06	1.41	0.71	0.04	1.13	5.0	8.4	2.4	2.71	12.36	2.21	24	0.30	6.13	6.36	7.06	7.11	10.08	9.28	7j
6	5	78.0	0.02	1.35	0.83	0.02	1.09	5.0	7.9	2.5	2.69	12.28	2.35	24	0.29	6.36	6.59	7.24	7.30	9.28	9.89	7l
7	6	38.0	0.00	1.33	0.00	0.00	1.08	5.0	7.6	2.5	2.70	12.17	2.45	24	0.29	6.59	6.70	7.39	7.43	9.89	9.96	7n
8	7	27.0	0.03	1.33	0.65	0.02	1.08	5.0	7.4	2.5	2.73	12.31	2.47	24	0.30	6.70	6.78	7.50	7.52	9.96	10.28	7p
9	8	104.0	0.04	1.30	0.65	0.03	1.06	5.0	6.8	2.7	2.80	12.55	2.56	24	0.31	6.78	7.10	7.66	7.77	10.28	10.66	7r
10	9	128.0	0.00	0.79	0.00	0.00	0.66	5.0	5.4	2.9	1.96	12.32	1.65	24	0.30	7.11	7.49	8.12	8.17	10.66	11.45	7v
11	10	10.0	0.00	0.79	0.00	0.00	0.66	0.0	5.4	3.0	1.97	5.75	2.34	18	0.30	7.50	7.53	8.23	8.24	11.45	11.03	7x
12	11	52.0	0.79	0.79	0.84	0.66	0.66	5.0	5.0	3.1	2.04	5.83	2.33	18	0.31	7.53	7.69	8.33	8.39	11.03	10.00	7z
13	9	12.0	0.47	0.47	0.78	0.37	0.37	5.0	5.0	3.1	1.13	14.54	1.85	18	1.92	7.38	7.61	8.12	8.08	10.66	12.80	7t
14	End	25.0	0.00	2.05	0.00	0.00	1.96	5.0	11.7	2.0	3.97	10.11	1.29	24	0.20	3.80	3.85	5.71	5.72	5.80	11.31	6c
15	14	367.0	0.26	2.05	1.00	0.26	1.96	5.0	8.4	2.4	4.68	10.22	1.83	24	0.20	3.85	4.60	5.74	5.91	11.31	9.59	6e
16	15	52.0	0.19	1.79	1.00	0.19	1.70	5.0	7.9	2.5	4.17	9.92	1.92	24	0.19	4.60	4.70	5.95	5.97	9.59	9.81	6g
17	16	55.0	0.21	1.60	1.00	0.21	1.51	0.0	7.4	2.5	3.82	10.11	1.84	24	0.20	4.70	4.81	6.00	6.03	9.81	10.44	6i
18	17	66.0	0.00	1.39	0.00	0.00	1.30	5.0	6.8	2.6	3.43	10.42	1.77	24	0.21	4.81	4.95	6.05	6.08	10.44	11.77	6k
19	18	34.0	0.00	1.39	0.00	0.00	1.30	5.0	6.5	2.7	3.51	9.50	1.86	24	0.18	4.95	5.01	6.13	6.15	11.77	11.71	6m
20	19	62.0	0.00	1.39	0.00	0.00	1.30	0.0	6.0	2.8	3.66	10.75	1.94	24	0.23	5.01	5.15	6.23	6.26	11.71	12.21	6o
21	20	90.0	0.94	0.94	0.90	0.85	0.85	5.0	5.0	3.1	2.60	11.92	1.56	24	0.28	5.15	5.40	6.33	6.35	12.21	10.33	6p
22	20	4.0	0.45	0.45	1.00	0.45	0.45	5.0	5.0	3.1	1.38	14.85	2.46	18	2.00	5.77	5.85	6.38	6.33	12.21	13.34	31b

Project File: System 6, 7.stm | Number of lines: 22 | Run Date: 04-17-2013

NOTES: Intensity = 6.87 / (Inlet time + 0.10) ^ 0.49; Return period = 25 Yrs. ; c = cir e = ellip b = box

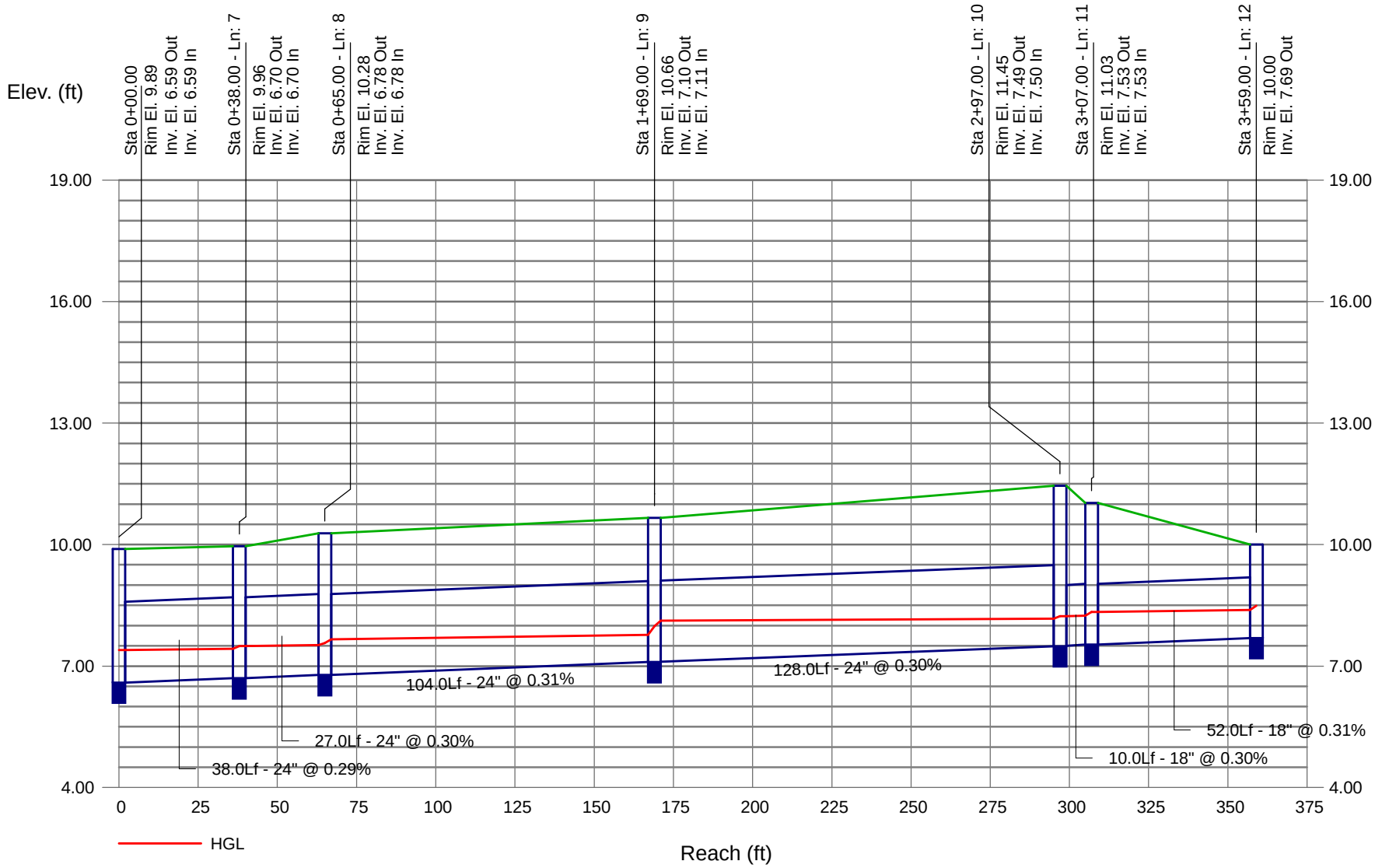
Storm Sewer Profile

Proj. file: System 6, 7.stm



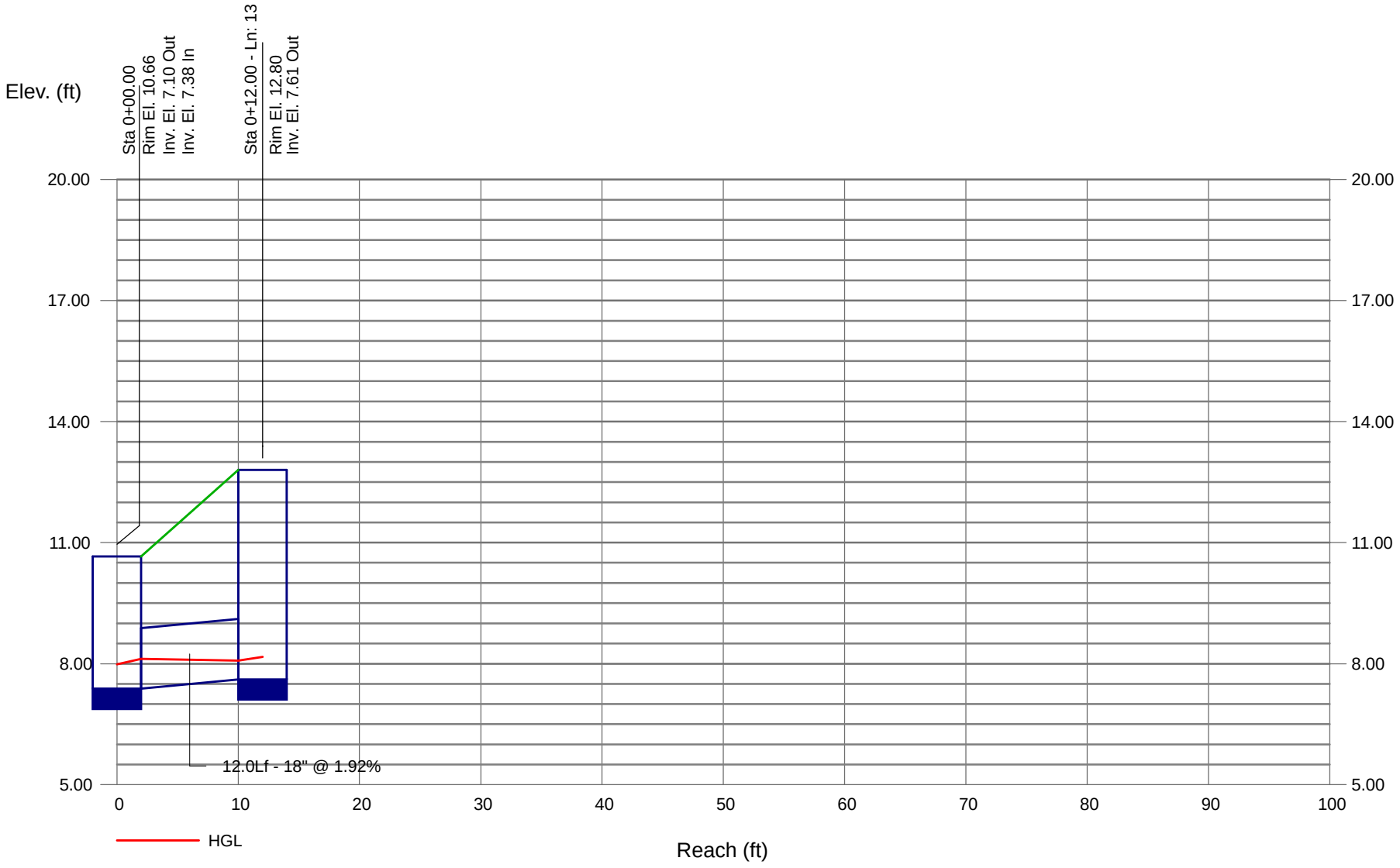
Storm Sewer Profile

Proj. file: System 6, 7.stm



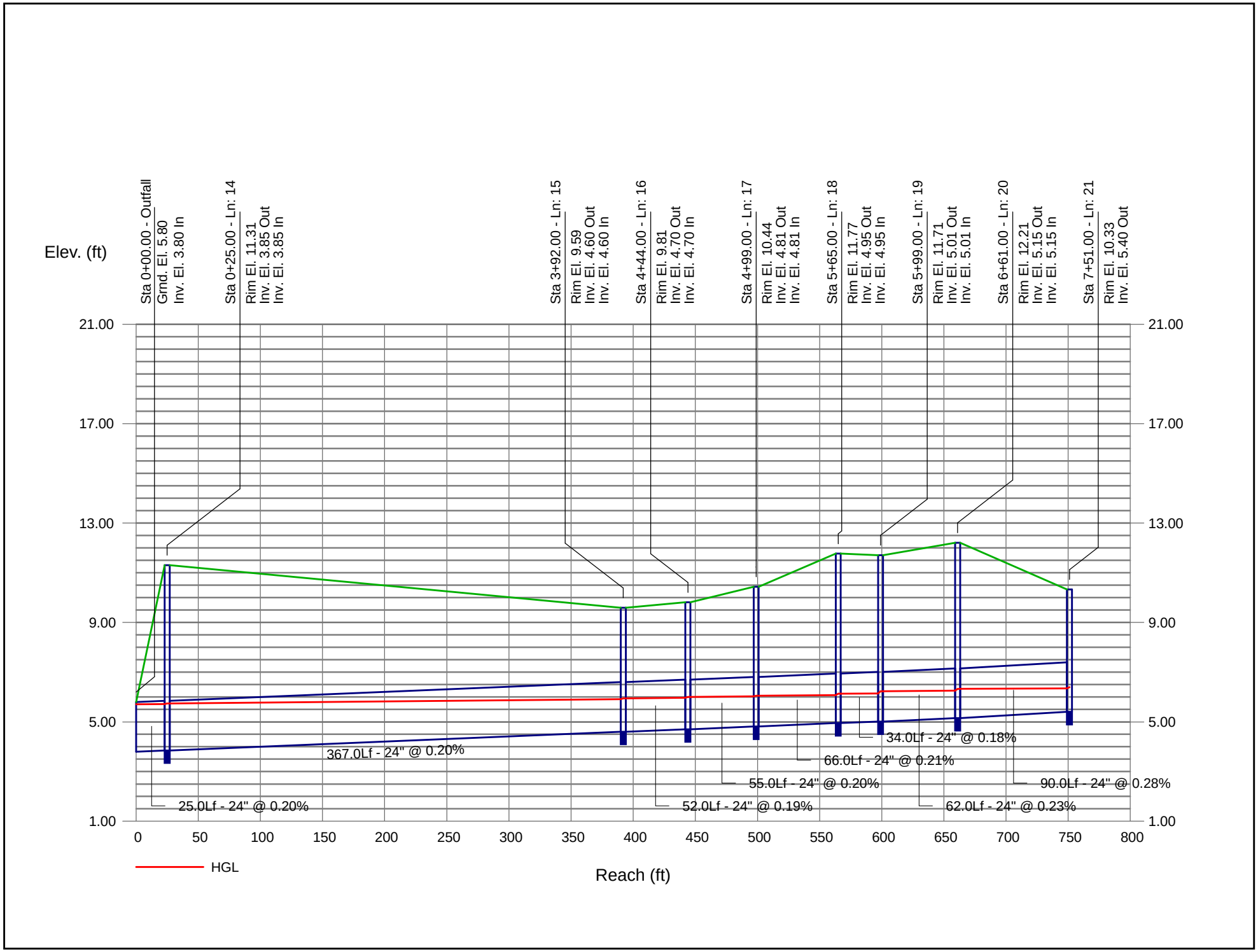
Storm Sewer Profile

Proj. file: System 6, 7.stm



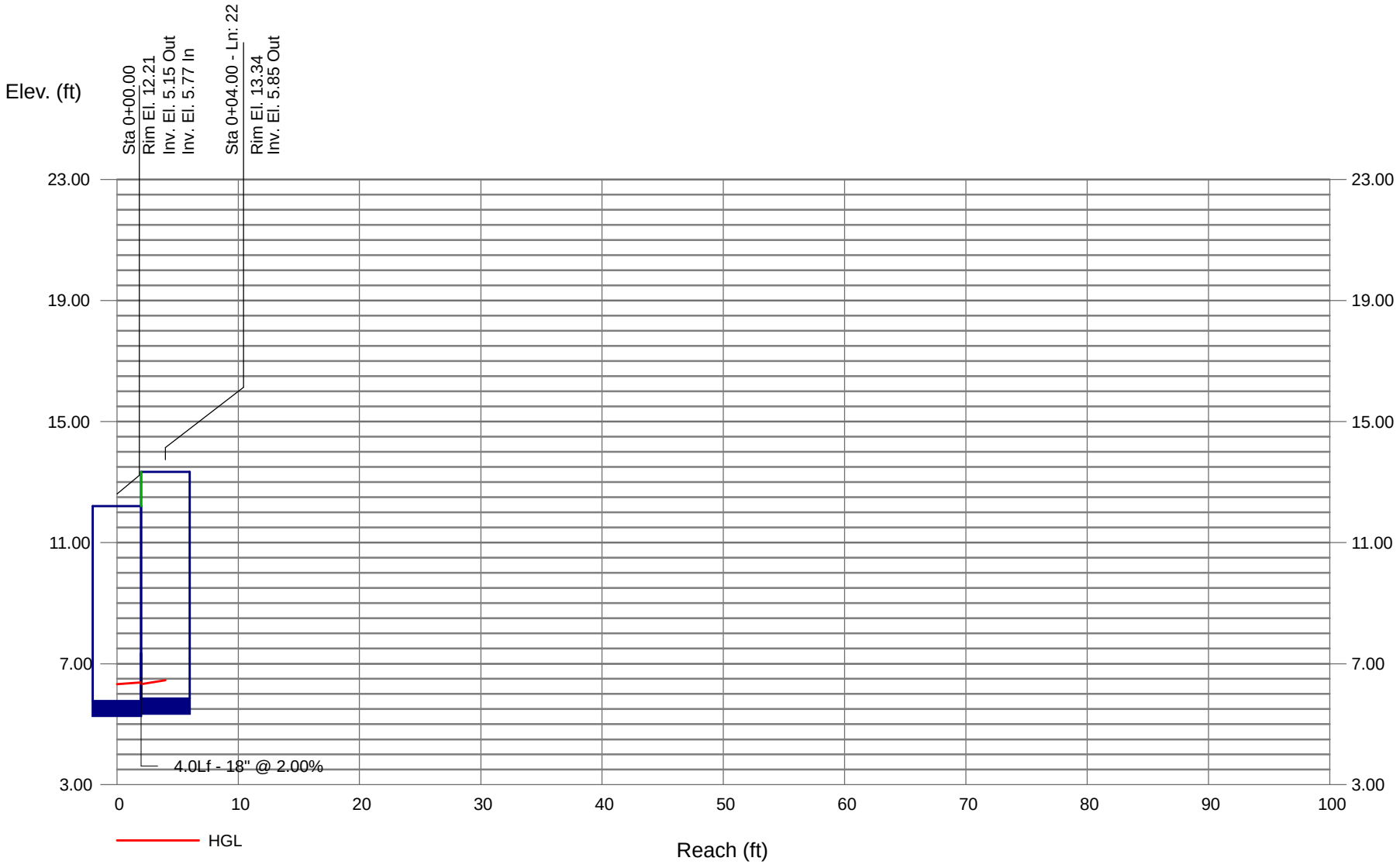
Storm Sewer Profile

Proj. file: System 6, 7.stm

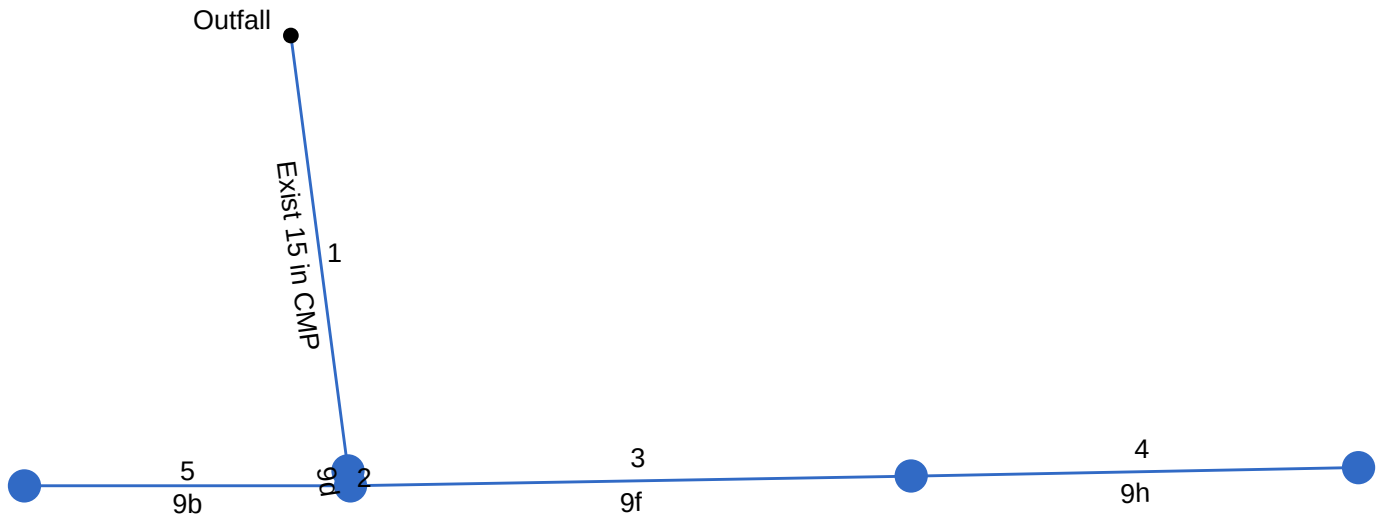


Storm Sewer Profile

Proj. file: System 6, 7.stm



Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: System 9.stm	Number of lines: 5	Date: 04-17-2013

Storm Sewer Tabulation

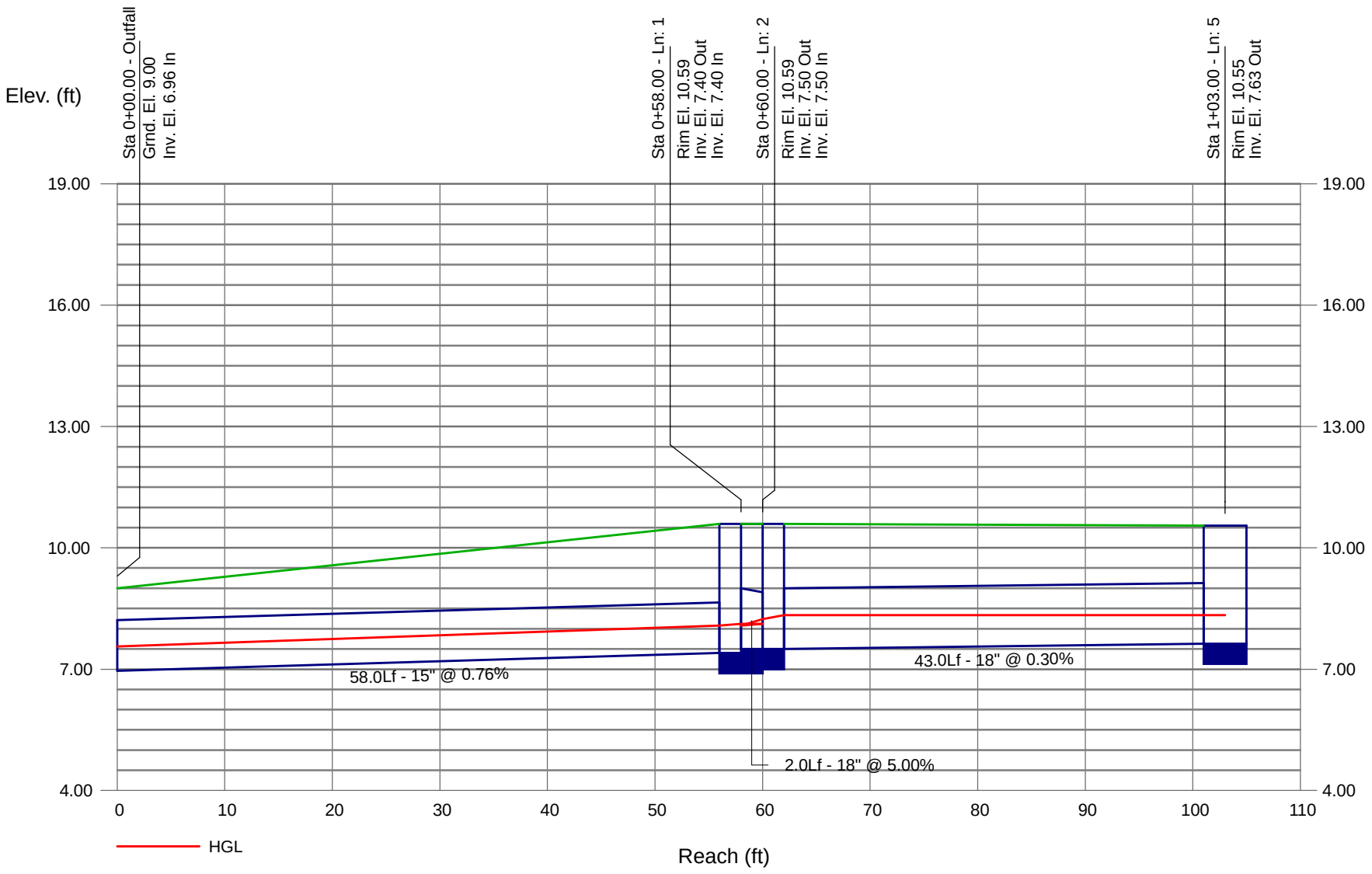
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	58.0	0.00	0.64	1.00	0.00	0.64	5.0	7.3	2.6	1.63	3.05	2.61	15	0.76	6.96	7.40	7.56	8.08	9.00	10.59	Exist 15 in CMP
2	1	2.0	0.09	0.64	1.00	0.09	0.64	5.0	7.3	2.6	1.64	23.48	2.28	18	5.00	7.40	7.50	8.12	8.08	10.59	10.59	9d
3	2	74.0	0.24	0.46	1.00	0.24	0.46	5.0	5.8	2.9	1.31	5.73	1.80	18	0.30	7.50	7.72	8.24	8.30	10.59	10.52	9f
4	3	59.0	0.22	0.22	1.00	0.22	0.22	5.0	5.0	3.1	0.68	5.80	1.19	18	0.31	7.72	7.90	8.35	8.37	10.52	10.65	9h
5	2	43.0	0.09	0.09	1.00	0.09	0.09	5.0	5.0	3.1	0.28	5.77	0.31	18	0.30	7.50	7.63	8.33	8.33	10.59	10.55	9b

Project File: System 9.stm | Number of lines: 5 | Run Date: 04-17-2013

NOTES: Intensity = 6.87 / (Inlet time + 0.10) ^ 0.49; Return period = 25 Yrs. ; c = cir e = ellip b = box

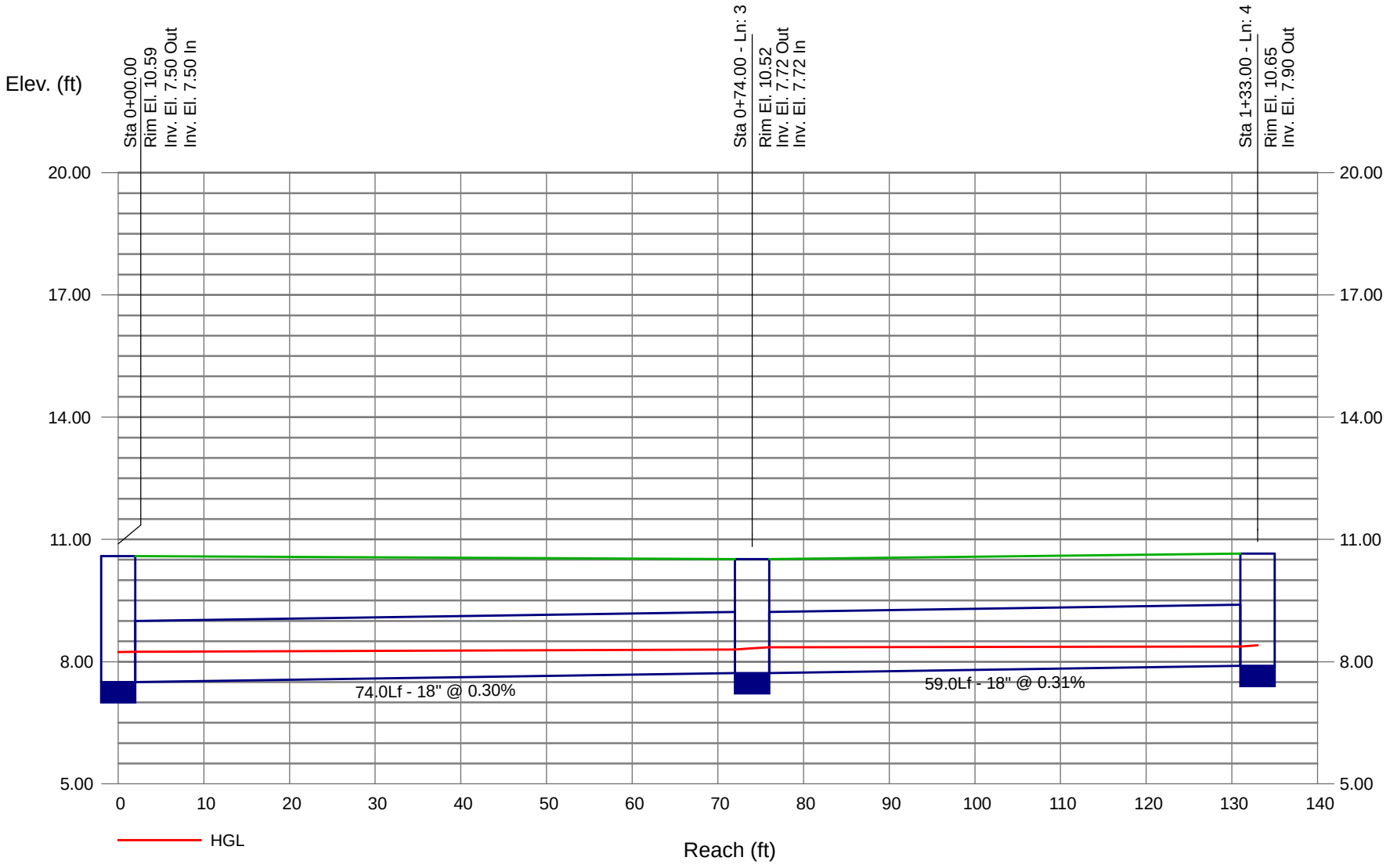
Storm Sewer Profile

Proj. file: System 9.stm

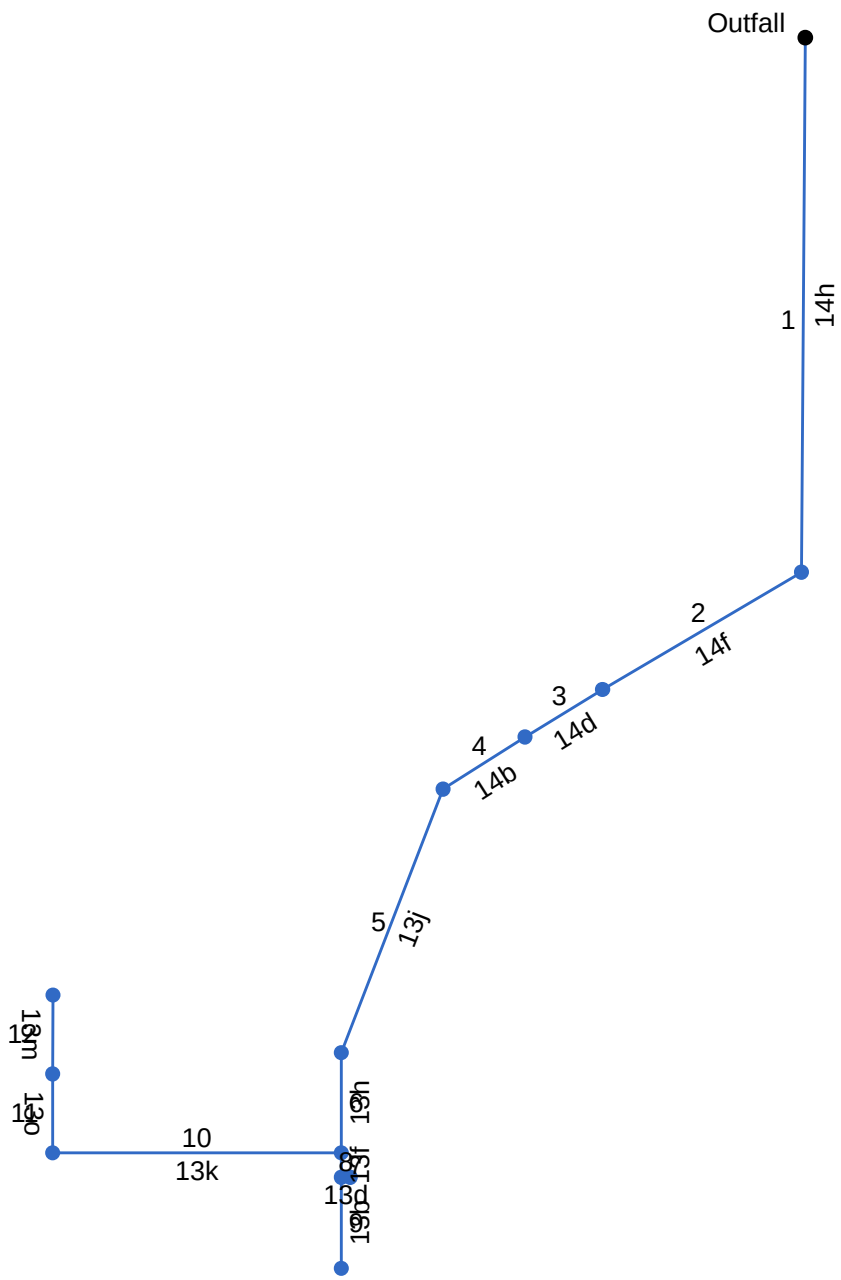


Storm Sewer Profile

Proj. file: System 9.stm



Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: System 13, 14.stm	Number of lines: 12	Date: 04-17-2013

Storm Sewer Tabulation

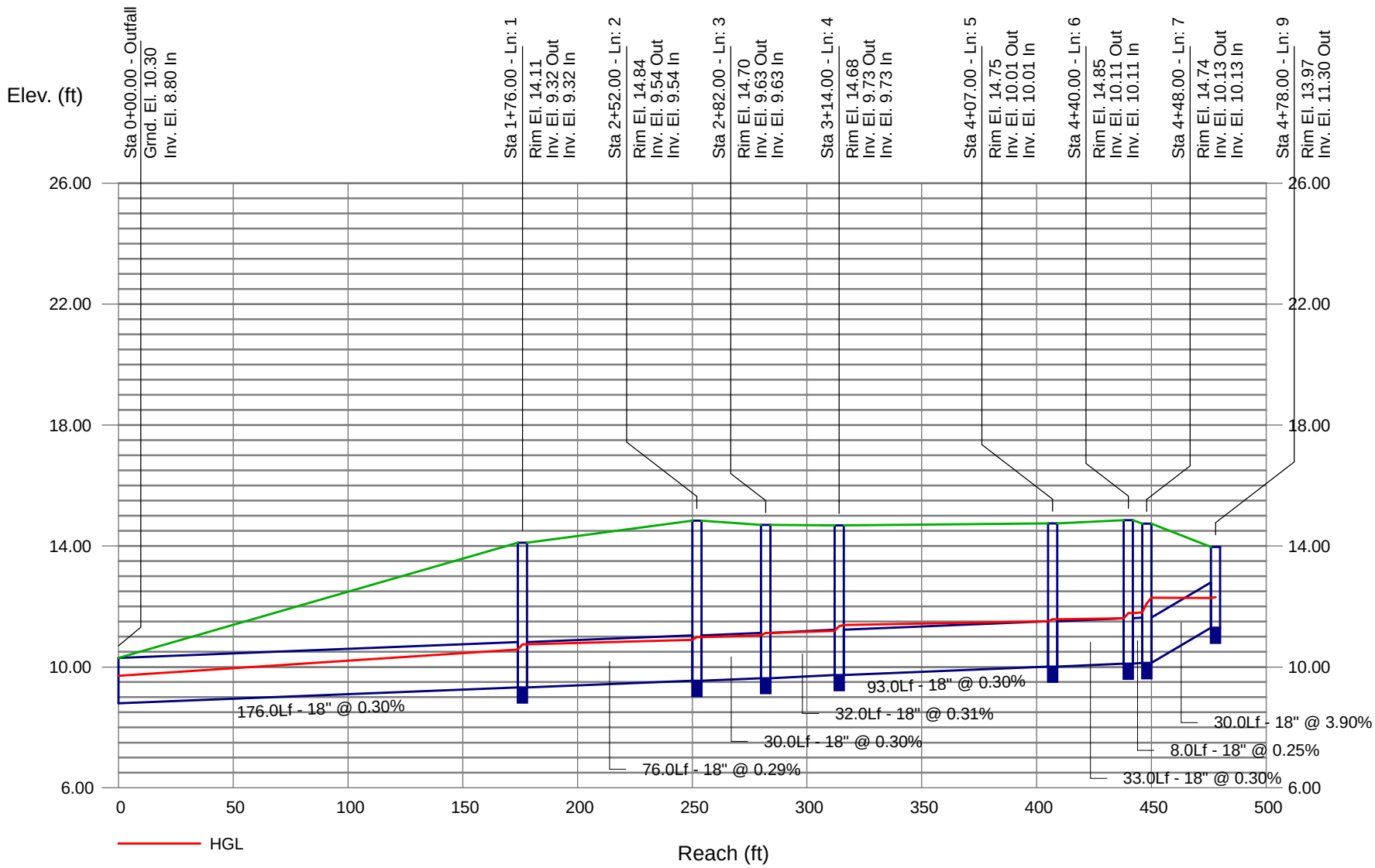
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	176.0	0.08	4.07	0.95	0.08	3.87	5.0	15.6	1.5	5.64	6.18	4.30	18	0.30	8.80	9.32	9.71	10.58	10.30	14.11	14h
2	1	76.0	0.02	3.99	0.95	0.02	3.79	5.0	15.2	1.5	5.59	6.12	3.27	18	0.29	9.32	9.54	10.75	10.90	14.11	14.84	14f
3	2	30.0	0.06	3.97	0.95	0.06	3.77	5.0	15.1	1.5	5.59	6.23	3.22	18	0.30	9.54	9.63	10.99	11.04	14.84	14.70	14d
4	3	32.0	0.57	3.91	0.95	0.54	3.71	5.0	14.9	1.5	5.54	6.36	3.14	18	0.31	9.63	9.73	11.13	11.19	14.70	14.68	14b
5	4	93.0	0.00	3.34	0.95	0.00	3.17	5.0	14.3	1.5	4.81	6.24	2.72	18	0.30	9.73	10.01	11.38	11.51	14.68	14.75	13j
6	5	33.0	0.01	3.34	0.95	0.01	3.17	5.0	14.2	1.5	4.85	6.26	2.74	18	0.30	10.01	10.11	11.58	11.61	14.75	14.85	13h
7	6	8.0	0.00	2.75	0.00	0.00	2.61	0.0	5.6	2.4	6.26	5.69	3.54	18	0.25	10.11	10.13	11.79	11.81	14.85	14.74	13f
8	7	3.0	2.13	2.13	0.95	2.02	2.02	5.0	5.0	2.5	5.11	9.29	2.89	18	0.67	10.13	10.15	12.17	12.17	14.74	15.31	13d
9	7	30.0	0.62	0.62	0.95	0.59	0.59	5.0	5.0	2.5	1.49	22.47	1.03	18	3.90	10.13	11.30	12.29	12.28	14.74	13.97	13b
10	6	95.0	0.32	0.58	0.95	0.30	0.55	5.0	11.2	1.7	0.94	6.18	0.54	18	0.29	10.18	10.46	11.90	11.90	14.85	13.32	13k
11	10	26.0	0.19	0.26	0.95	0.18	0.25	5.0	9.6	1.8	0.46	6.31	0.27	18	0.31	10.46	10.54	11.91	11.91	13.32	13.21	13o
12	11	26.0	0.07	0.07	0.95	0.07	0.07	5.0	5.0	2.5	0.17	6.31	0.10	18	0.31	10.54	10.62	11.91	11.91	13.21	13.32	13m

Project File: System 13, 14.stm | Number of lines: 12 | Run Date: 04-17-2013

NOTES: Intensity = 5.60 / (Inlet time + 0.10) ^ 0.49; Return period = 10 Yrs. ; c = cir e = ellip b = box

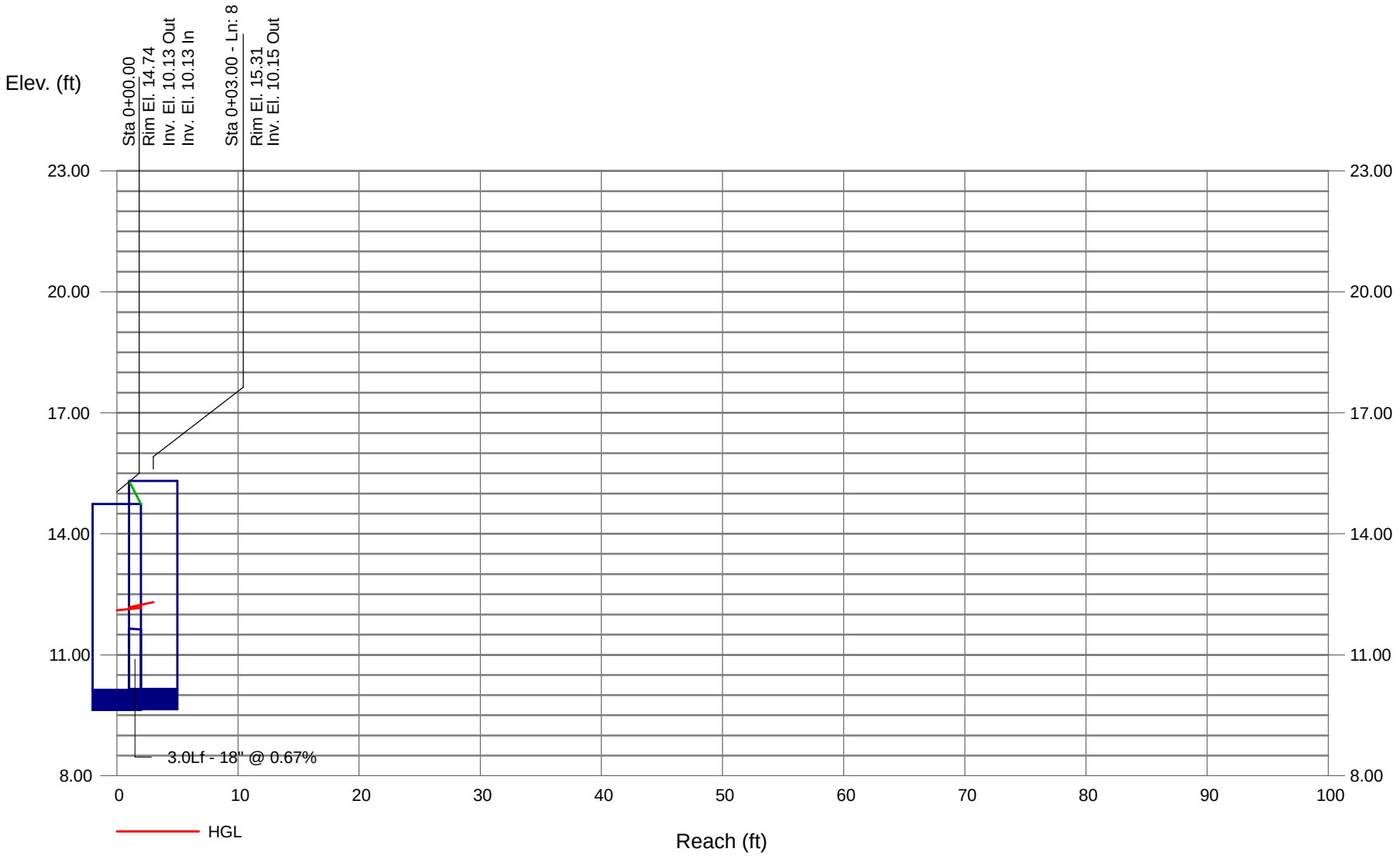
Storm Sewer Profile

Proj. file: System 13, 14.stm



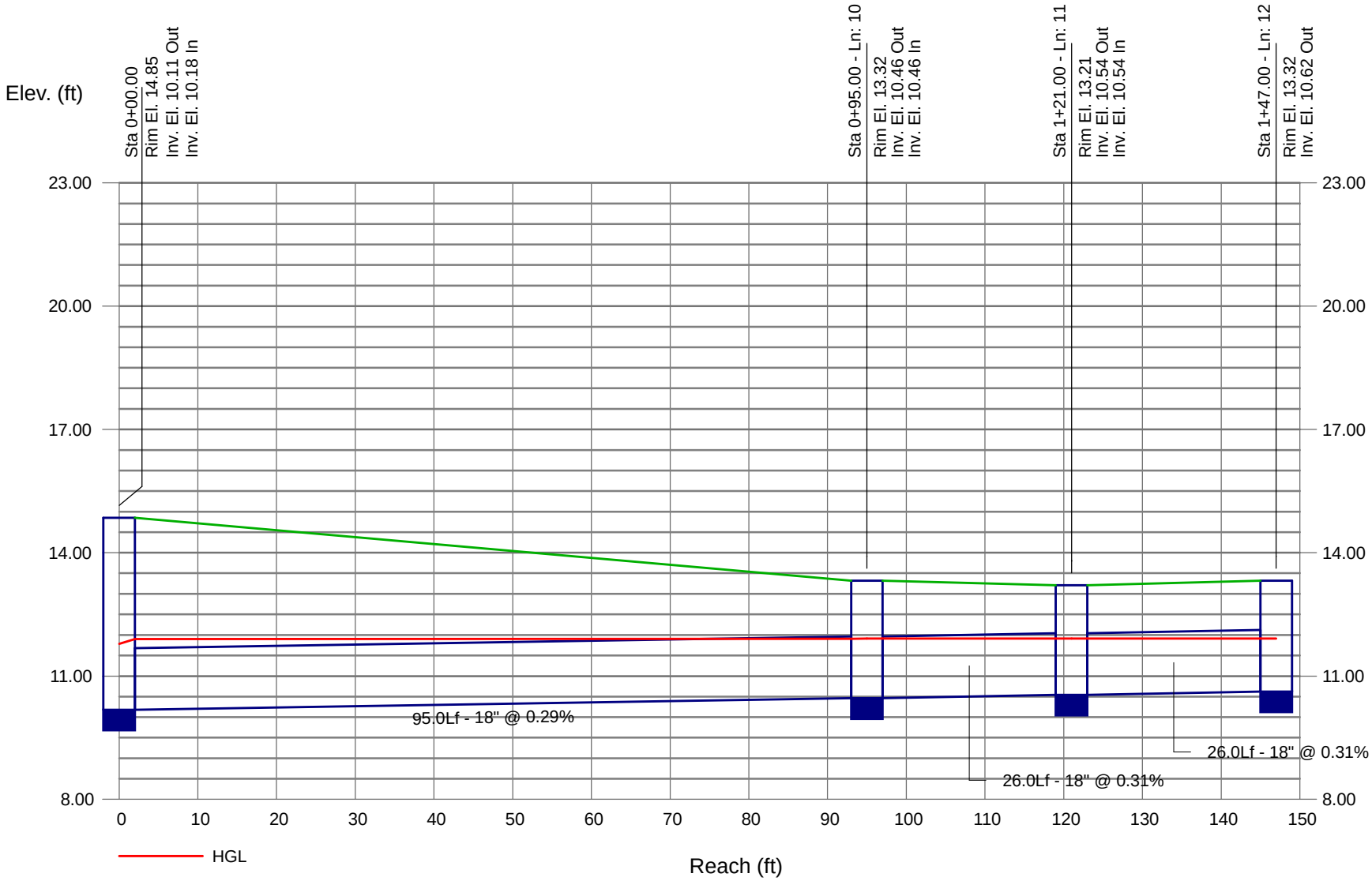
Storm Sewer Profile

Proj. file: System 13, 14.stm

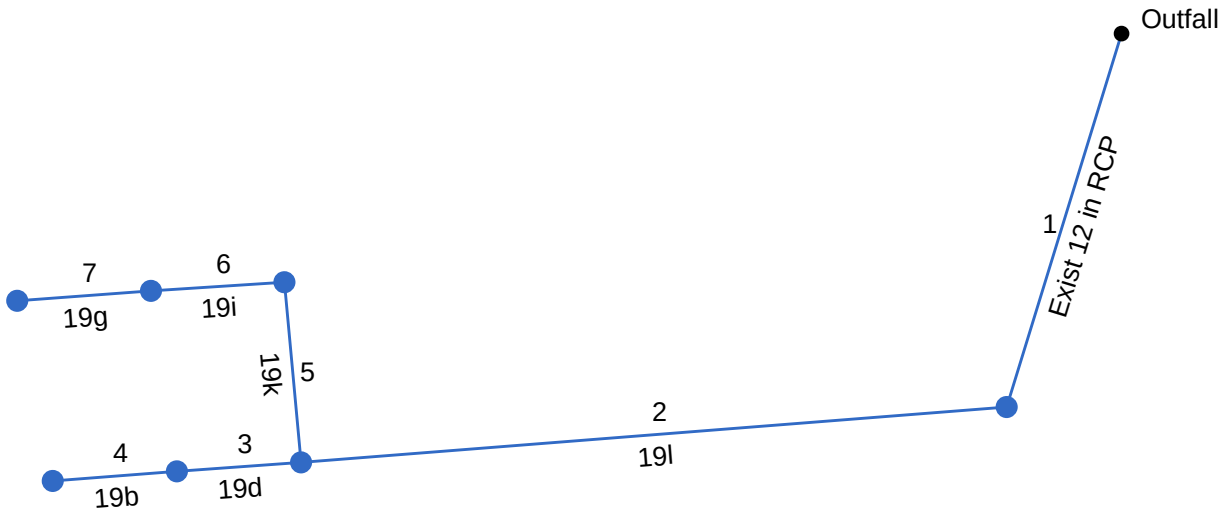


Storm Sewer Profile

Proj. file: System 13, 14.stm



Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: System 19.stm	Number of lines: 7	Date: 04-17-2013

Storm Sewer Tabulation

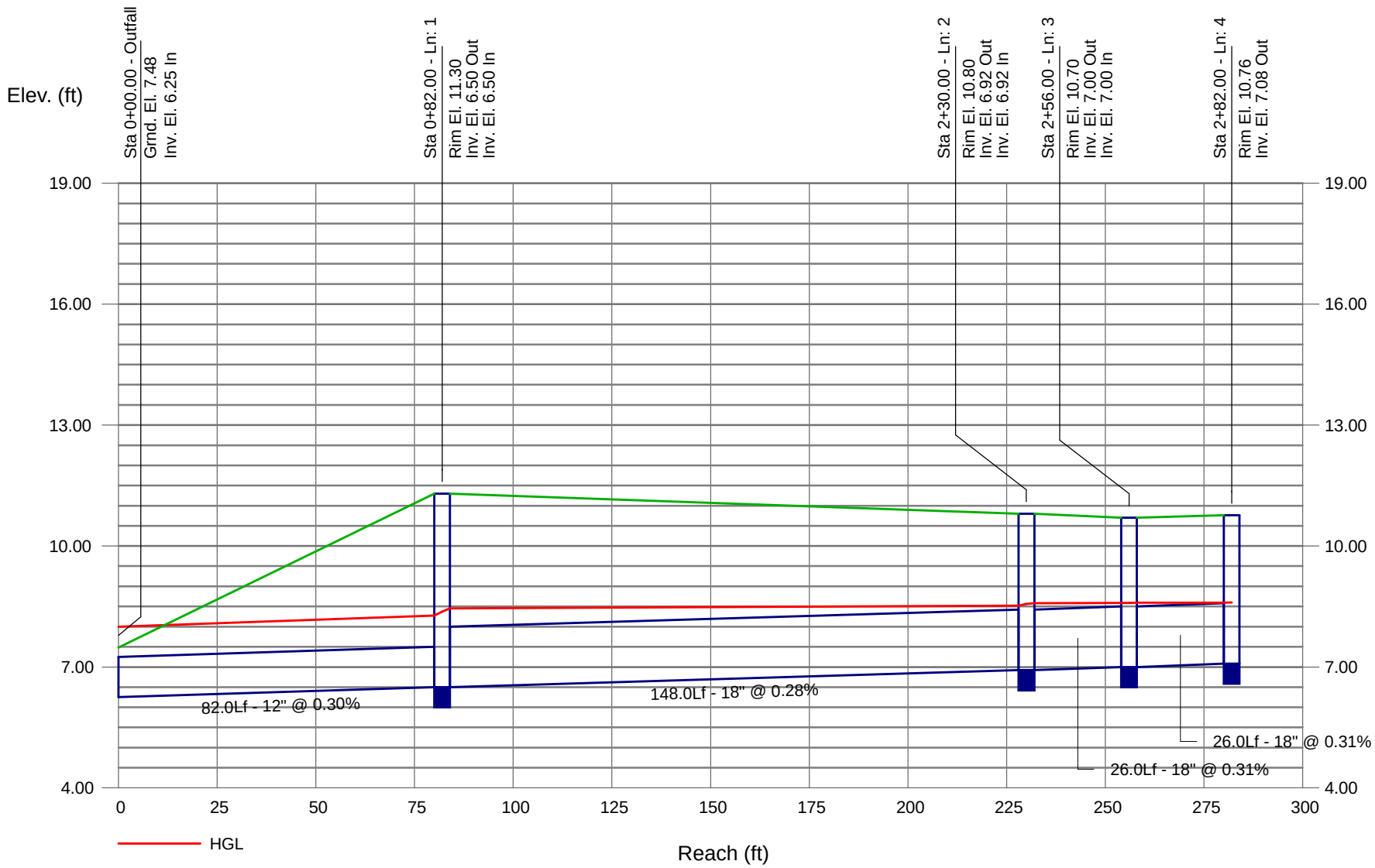
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	82.0	0.00	1.13	0.00	0.00	1.07	0.0	8.9	1.9	2.05	1.97	2.61	12	0.30	6.25	6.50	8.00	8.27	7.48	11.30	Exist 12 in RCP
2	1	148.0	0.18	1.13	0.95	0.17	1.07	5.0	6.9	2.2	2.31	5.59	1.31	18	0.28	6.50	6.92	8.45	8.52	11.30	10.80	19l
3	2	26.0	0.08	0.53	0.95	0.08	0.50	5.0	5.7	2.4	1.19	5.83	0.67	18	0.31	6.92	7.00	8.58	8.59	10.80	10.70	19d
4	3	26.0	0.45	0.45	0.95	0.43	0.43	5.0	5.0	2.5	1.08	5.83	0.61	18	0.31	7.00	7.08	8.59	8.59	10.70	10.76	19b
5	2	38.0	0.08	0.42	0.95	0.08	0.40	5.0	6.2	2.3	0.91	10.22	0.80	18	0.95	7.42	7.78	8.57	8.56	10.80	11.60	19k
6	5	28.0	0.10	0.34	0.95	0.10	0.32	5.0	5.6	2.4	0.77	5.61	0.85	18	0.29	7.78	7.86	8.59	8.59	11.60	11.55	19i
7	6	28.0	0.24	0.24	0.95	0.23	0.23	5.0	5.0	2.5	0.58	5.61	0.72	18	0.29	7.86	7.94	8.60	8.60	11.55	11.66	19g

Project File: System 19.stm | Number of lines: 7 | Run Date: 04-17-2013

NOTES: Intensity = 5.60 / (Inlet time + 0.10) ^ 0.49; Return period = 10 Yrs. ; c = cir e = ellip b = box

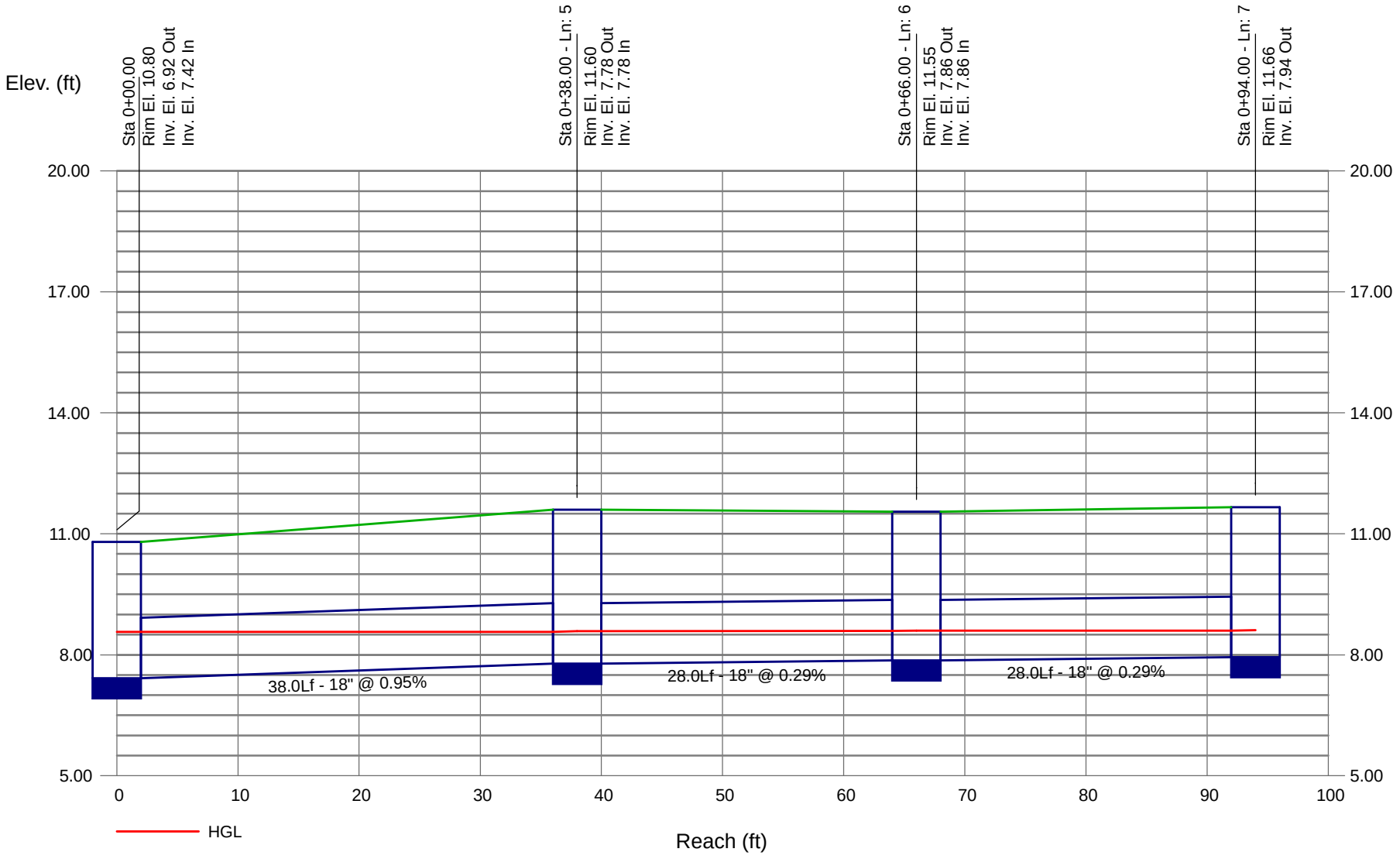
Storm Sewer Profile

Proj. file: System 19.stm

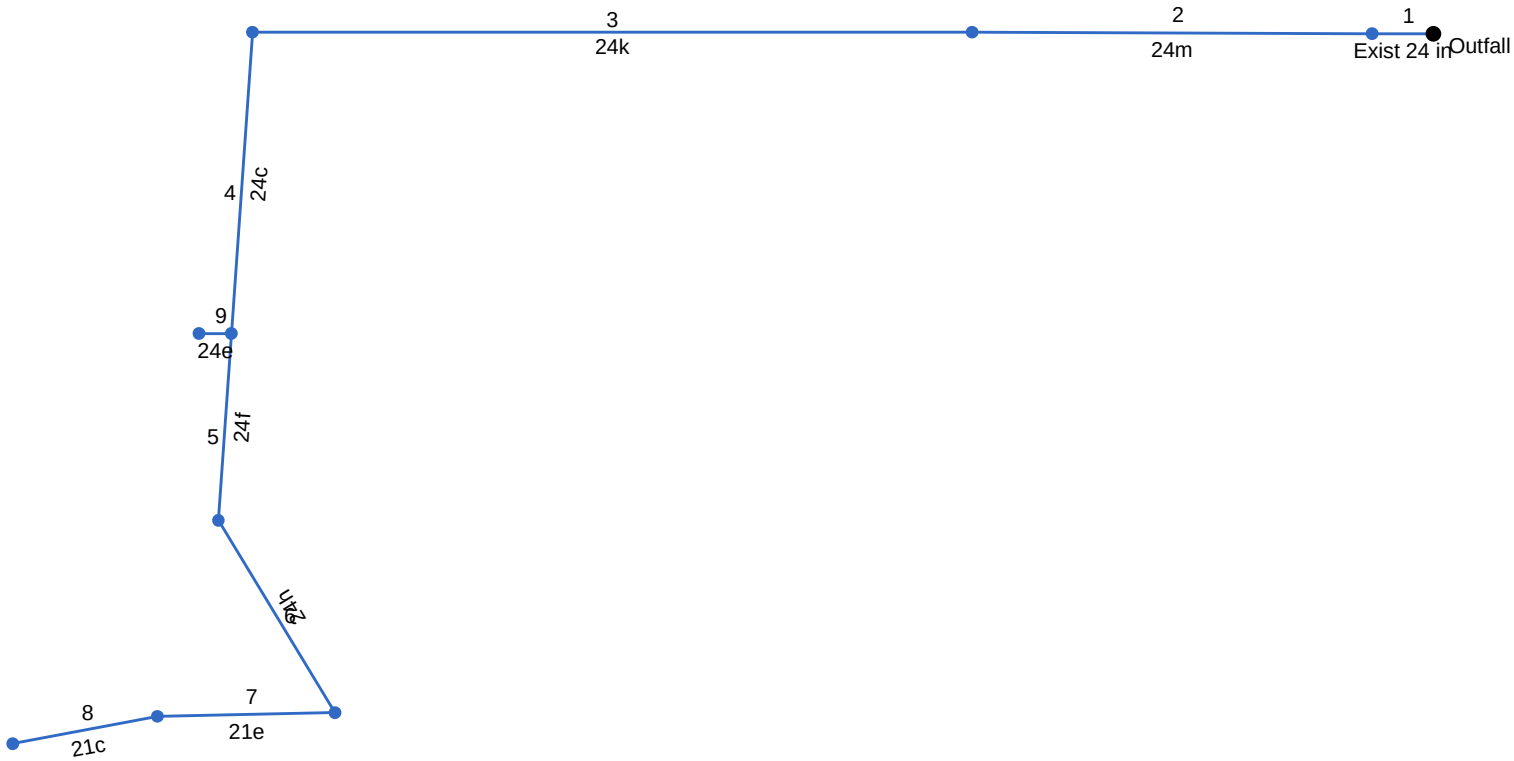


Storm Sewer Profile

Proj. file: System 19.stm



Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: System 20, 21, 24 (25 Year).stm	Number of lines: 9	Date: 04-17-2013

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	24.5	0.52	15.49	0.82	0.43	13.19	0.0	20.8	1.5	20.21	0.00	6.43	24	-1.22	1.60	1.30	5.82	6.49	3.60	8.79	Exist 24 in
2	1	160.0	4.11	14.97	0.75	3.08	12.76	15.0	19.9	1.6	20.01	36.53	2.83	36	0.30	1.70	2.18	7.33	7.47	8.79	6.35	24m
3	2	288.0	0.00	10.86	0.00	0.00	9.68	0.0	17.7	1.7	16.04	36.45	2.27	36	0.30	2.18	3.04	7.58	7.75	6.35	8.93	24k
4	3	121.0	1.18	10.86	1.00	1.18	9.68	5.0	16.9	1.7	16.44	76.93	2.33	36	1.33	3.04	4.65	7.87	7.94	8.93	10.97	24c
5	4	75.0	0.97	9.21	0.82	0.80	8.03	5.0	16.3	1.7	13.87	78.16	2.14	36	1.37	4.69	5.72	8.09	8.10	10.97	11.66	24f
6	5	90.0	2.12	8.24	0.93	1.97	7.23	5.0	15.6	1.8	12.77	37.20	2.18	36	0.31	5.72	6.00	8.18	8.20	11.66	10.37	24h
7	6	71.0	0.68	6.12	0.78	0.53	5.26	5.0	15.2	1.8	9.41	7.10	2.99	24	0.10	6.00	6.07	8.32	8.44	10.37	10.84	21e
8	7	59.0	5.44	5.44	0.87	4.73	4.73	15.0	15.0	1.8	8.51	3.35	4.82	18	0.10	6.07	6.13	8.51	8.90	10.84	8.13	21c
9	4	13.0	0.47	0.47	1.00	0.47	0.47	5.0	5.0	3.1	1.44	7.71	0.82	18	0.54	4.66	4.73	8.14	8.14	10.97	10.80	24e

Project File: System 20, 21, 24 (25 Year).stm

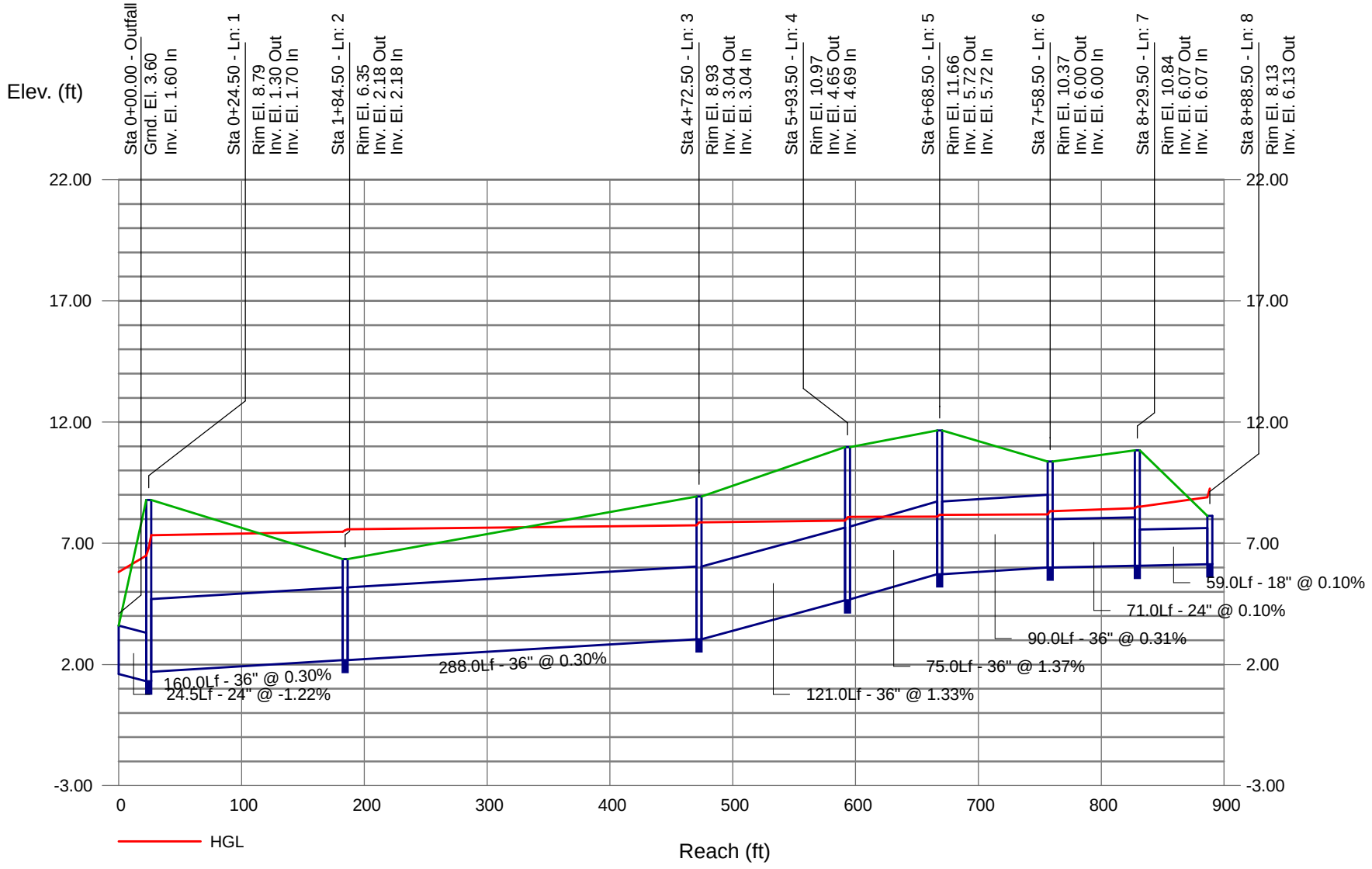
Number of lines: 9

Run Date: 04-17-2013

NOTES: Intensity = 6.87 / (Inlet time + 0.10) ^ 0.49; Return period = 25 Yrs. ; c = cir e = ellip b = box

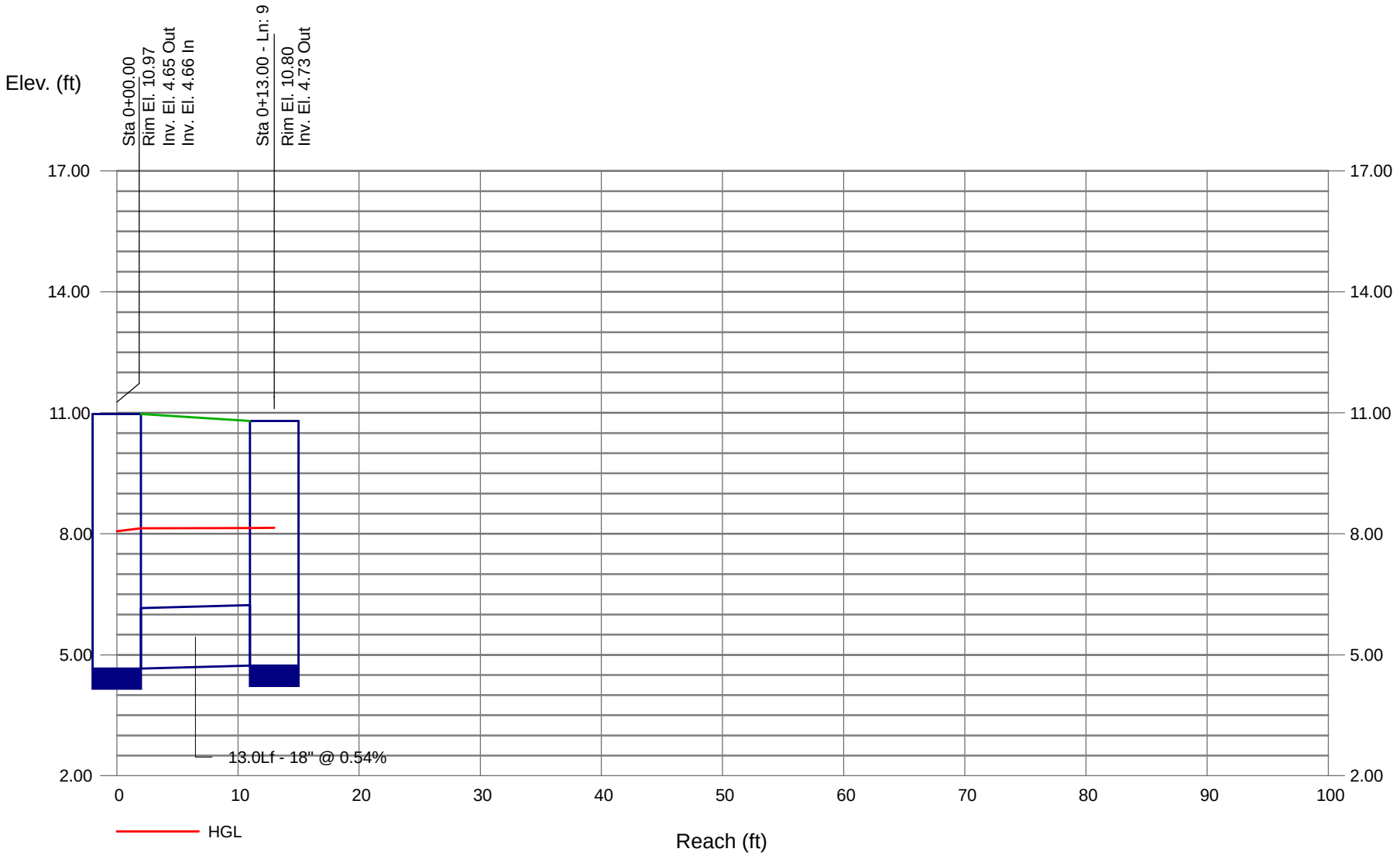
Storm Sewer Profile

Proj. file: System 20, 21, 24 (25 Year).stm

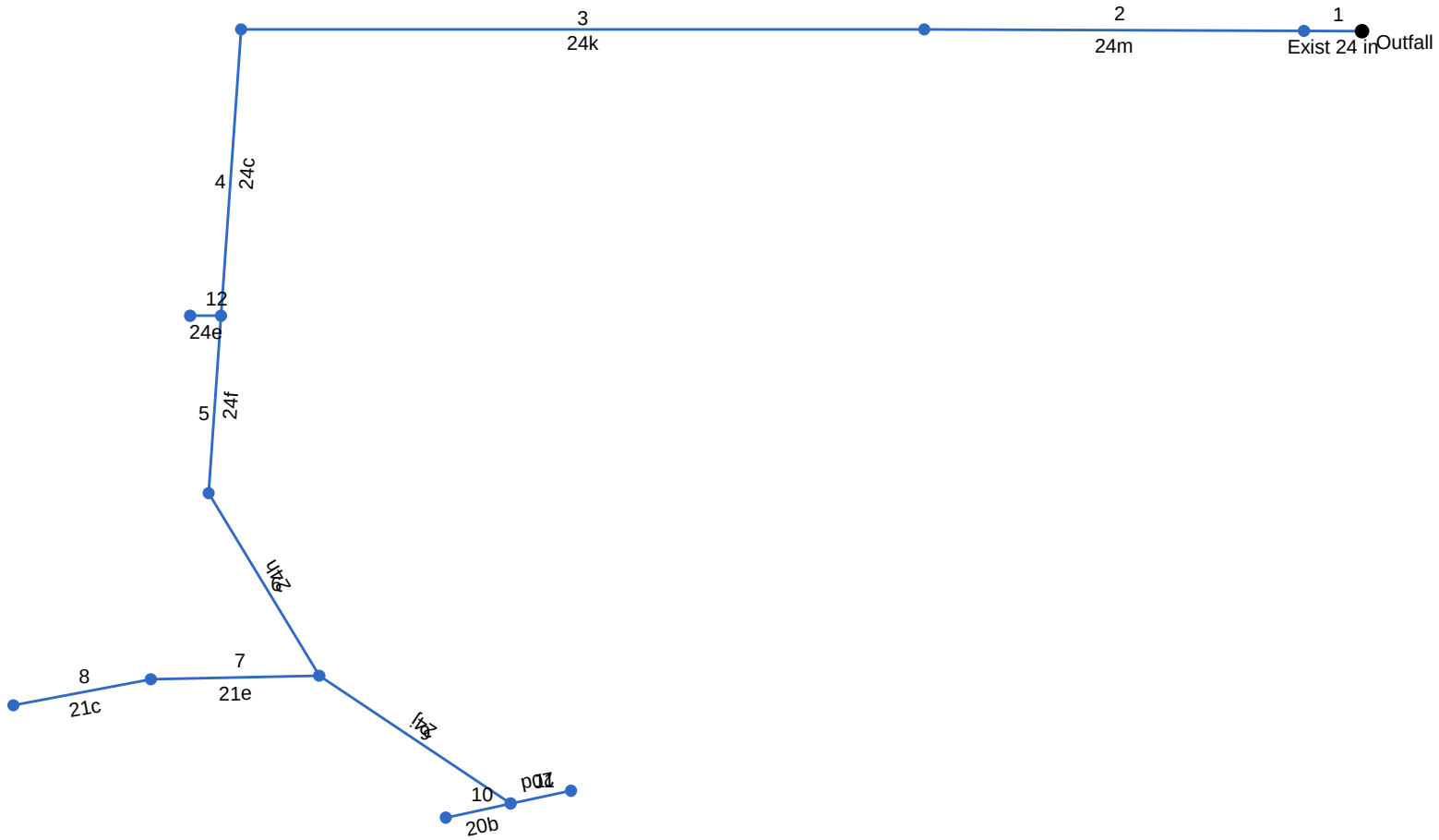


Storm Sewer Profile

Proj. file: System 20, 21, 24 (25 Year).stm



Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: System 20, 21, 24 (10 Year).stm	Number of lines: 12	Date: 04-17-2013

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	24.5	0.52	15.49	0.79	0.41	12.67	0.0	21.6	1.2	15.75	0.00	5.01	24	-1.22	1.60	1.30	5.82	6.23	3.60	8.79	Exist 24 in
2	1	160.0	4.11	14.97	0.73	3.00	12.26	15.0	20.4	1.3	15.67	36.53	2.22	36	0.30	1.70	2.18	6.73	6.82	8.79	6.35	24m
3	2	288.0	0.00	10.86	0.00	0.00	9.26	0.0	17.7	1.4	12.67	36.45	1.79	36	0.30	2.18	3.04	6.89	6.99	6.35	8.93	24k
4	3	121.0	1.18	10.86	0.95	1.12	9.26	5.0	16.7	1.4	13.04	76.93	1.98	36	1.33	3.04	4.65	7.07	7.10	8.93	10.97	24c
5	4	75.0	0.97	9.21	0.79	0.77	7.69	5.0	16.2	1.4	10.99	78.16	2.54	36	1.37	4.69	5.72	7.20	7.14	10.97	11.66	24f
6	5	90.0	0.18	8.24	0.45	0.08	6.92	5.0	15.7	1.5	10.05	37.20	2.98	36	0.31	5.72	6.00	7.30	7.34	11.66	10.37	24h
7	6	71.0	0.68	6.12	0.75	0.51	5.03	5.0	15.3	1.5	7.40	7.10	2.57	24	0.10	6.00	6.07	7.73	7.80	10.37	10.84	21e
8	7	59.0	5.44	5.44	0.83	4.52	4.52	15.0	15.0	1.5	6.71	3.35	3.79	18	0.10	6.07	6.13	7.85	8.09	10.84	8.13	21c
9	6	97.0	0.25	1.94	0.84	0.21	1.82	5.0	5.4	2.4	4.43	16.25	2.96	14 x 23 e	2.54	6.15	8.61	7.78	9.43	10.37	10.22	24j
10	9	28.0	1.31	1.31	0.95	1.24	1.24	5.0	5.0	2.5	3.14	1.90	4.00	12	0.29	8.57	8.65	9.57	9.79	10.22	10.37	20b
11	9	26.0	0.38	0.38	0.95	0.36	0.36	5.0	5.0	2.5	0.91	1.98	1.25	12	0.31	8.57	8.65	9.49	9.50	10.22	10.44	20d
12	4	13.0	0.47	0.47	0.95	0.45	0.45	5.0	5.0	2.5	1.13	7.71	0.64	18	0.54	4.66	4.73	7.27	7.27	10.97	10.80	24e

Project File: System 20, 21, 24 (10 Year).stm

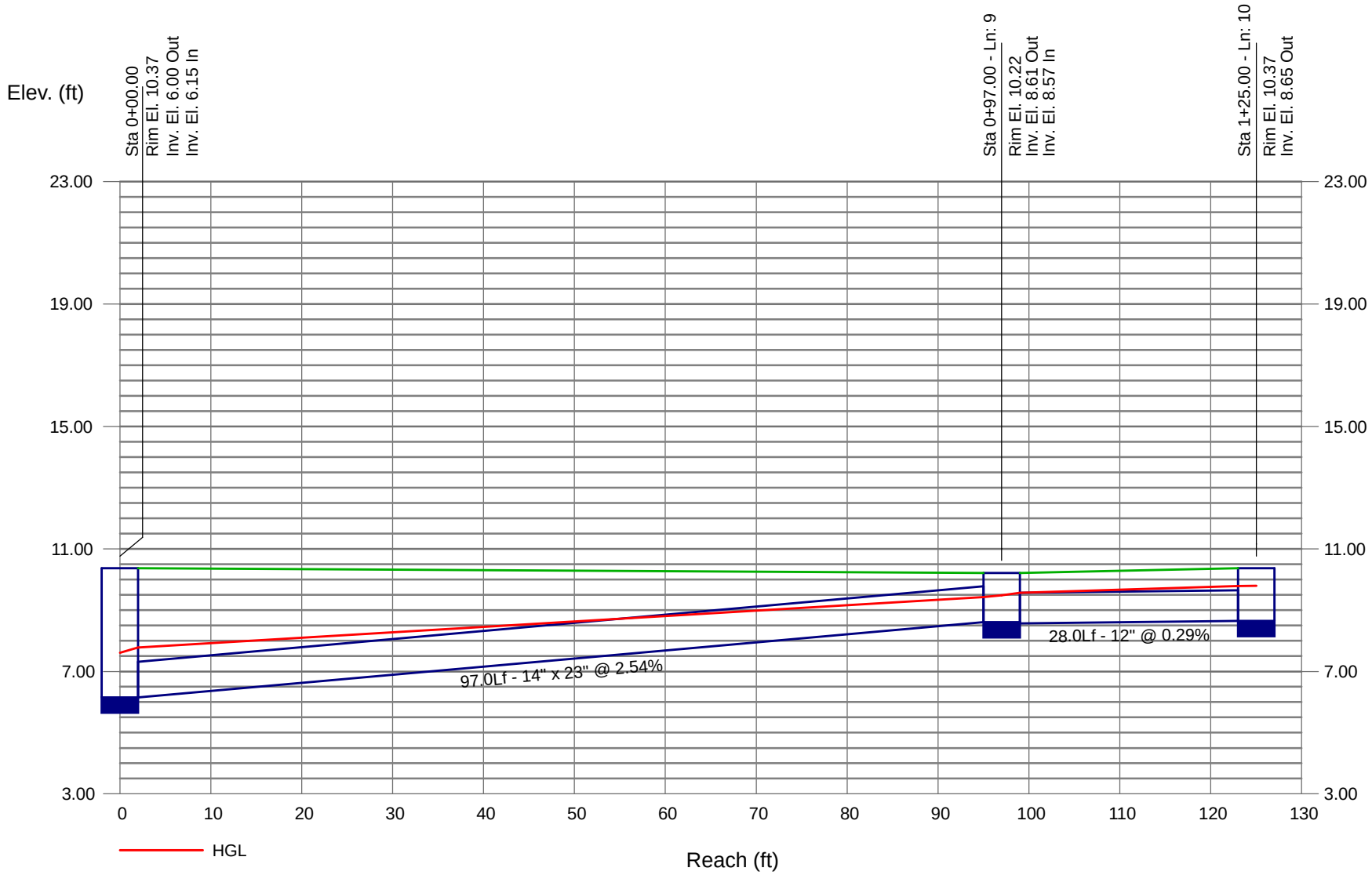
Number of lines: 12

Run Date: 04-17-2013

NOTES: Intensity = 5.60 / (Inlet time + 0.10) ^ 0.49; Return period = 10 Yrs. ; c = cir e = ellip b = box

Storm Sewer Profile

Proj. file: System 20, 21, 24 (10 Year).stm



Storm Sewer Profile

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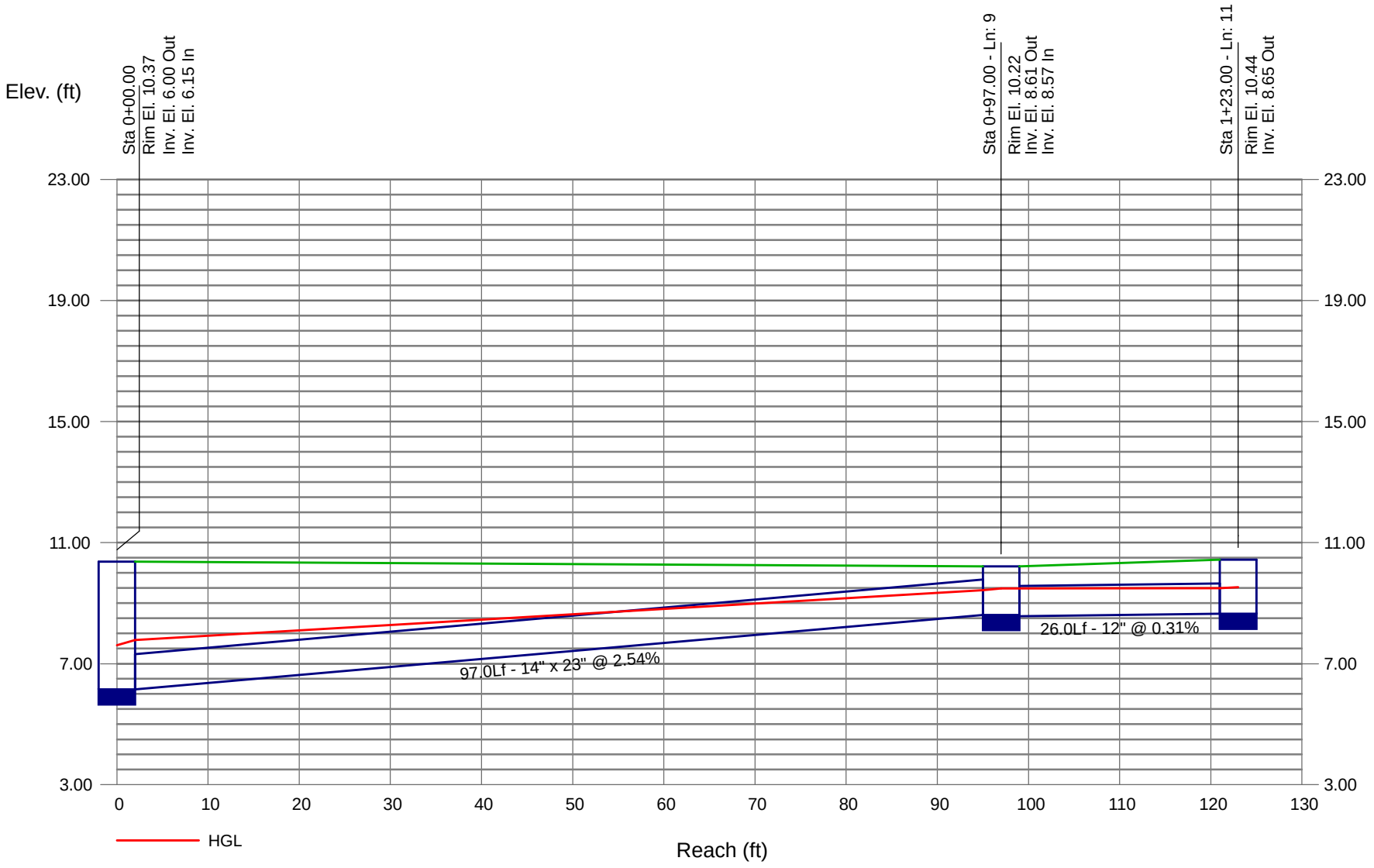
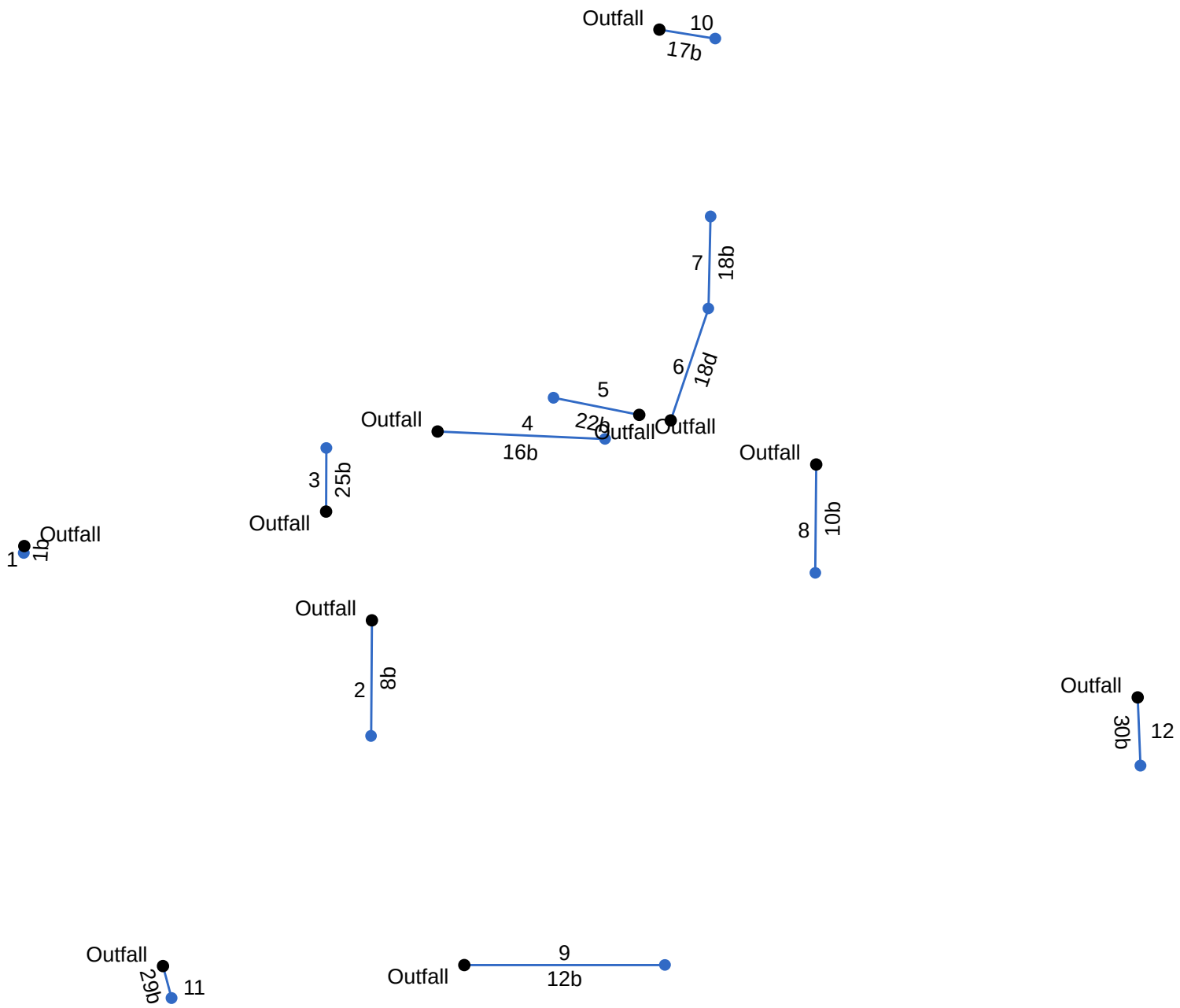


Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2009 Plan



Project File: Systems Downdrains.stm	Number of lines: 12	Date: 04-17-2013

Storm Sewer Tabulation

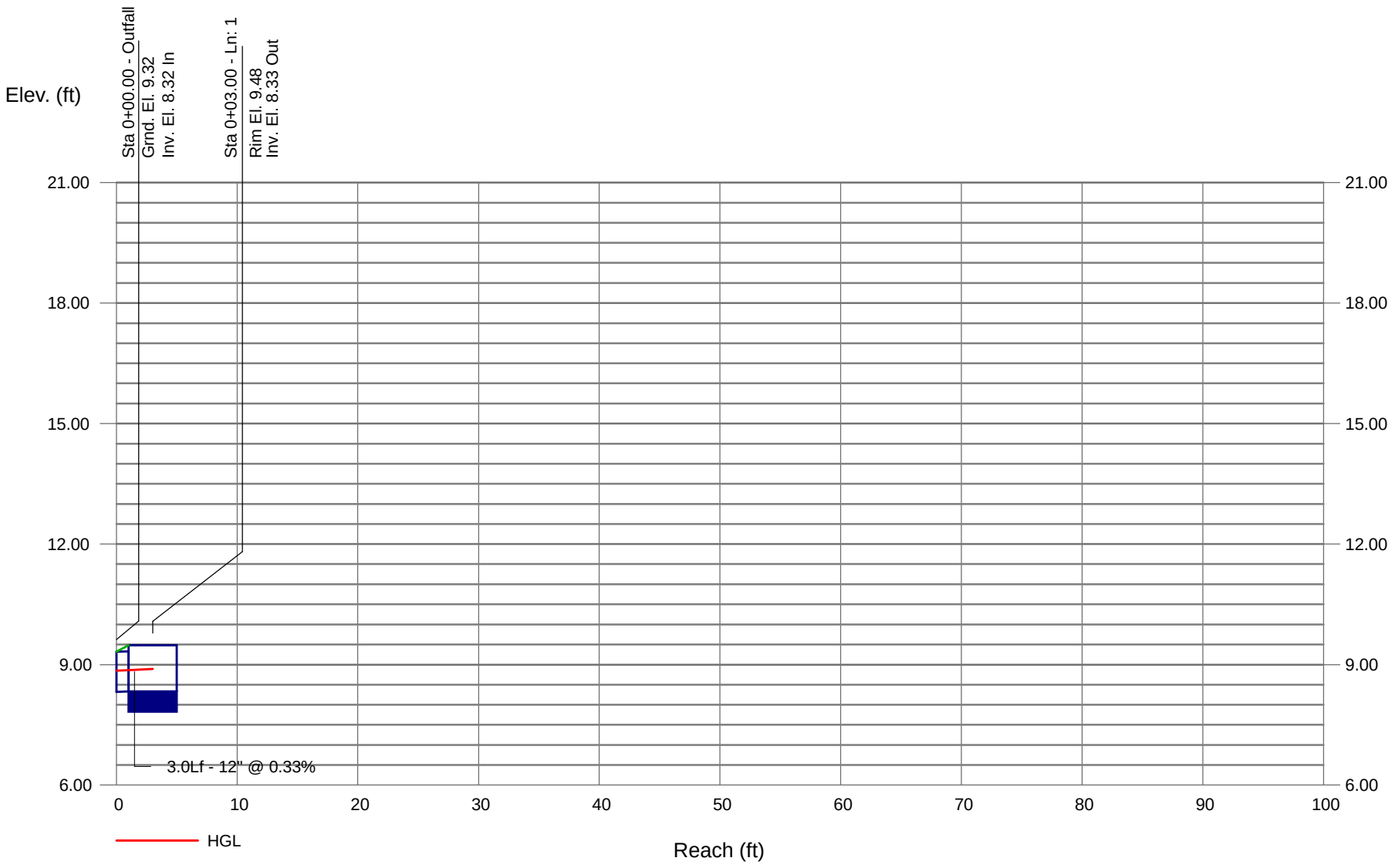
Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	3.0	0.37	0.37	1.00	0.37	0.37	5.0	5.0	3.1	1.14	2.06	2.69	12	0.33	8.32	8.33	8.85	8.86	9.32	9.48	1b
2	End	49.0	0.51	0.51	1.00	0.51	0.51	5.0	5.0	3.1	1.57	10.39	3.23	18	0.98	8.22	8.70	8.70	9.18	9.72	11.20	8b
3	End	27.0	0.18	0.18	1.00	0.18	0.18	5.0	5.0	3.1	0.55	2.06	0.91	12	0.33	8.51	8.60	9.28	9.29	9.51	9.98	25b
4	End	71.0	0.39	0.39	1.00	0.39	0.39	5.0	5.0	3.1	1.20	30.14	2.01	18	8.24	17.17	23.02	18.10	23.44	18.67	25.80	16b
5	End	37.0	0.30	0.30	1.00	0.30	0.30	5.0	5.0	3.1	0.92	14.85	2.74	18	2.00	19.99	20.73	20.36	21.10	21.49	24.87	22b
6	End	50.0	0.00	0.18	0.00	0.00	0.18	0.0	5.3	3.0	0.54	17.88	2.36	18	2.90	8.69	10.14	8.97	10.42	10.19	14.94	18d
7	6	39.0	0.18	0.18	1.00	0.18	0.18	5.0	5.0	3.1	0.55	18.03	2.02	18	2.95	10.14	11.29	10.50	11.57	14.94	14.87	18b
8	End	46.0	0.39	0.39	1.00	0.39	0.39	5.0	5.0	3.1	1.20	5.79	2.56	18	0.30	7.16	7.30	7.63	7.76	8.66	9.43	10b
9	End	85.0	0.44	0.44	1.00	0.44	0.44	5.0	5.0	3.1	1.35	23.32	3.09	18	4.93	12.25	16.44	12.69	16.88	13.75	19.44	12b
10	End	24.0	0.22	0.22	1.00	0.22	0.22	5.0	5.0	3.1	0.68	7.73	2.20	18	0.54	11.07	11.20	11.45	11.52	12.57	13.61	17b
11	End	14.0	0.03	0.03	1.00	0.03	0.03	5.0	5.0	3.1	0.09	2.52	0.12	12	0.50	9.64	9.71	11.75	11.75	13.07	12.21	29b
12	End	29.0	0.21	0.21	0.60	0.13	0.13	5.0	5.0	3.1	0.39	10.50	2.14	18	1.00	9.87	10.16	10.11	10.40	11.37	13.25	30b

Project File: Systems Downdrains.stm | Number of lines: 12 | Run Date: 04-17-2013

NOTES: Intensity = 6.87 / (Inlet time + 0.10) ^ 0.49; Return period = 25 Yrs. ; c = cir e = ellip b = box

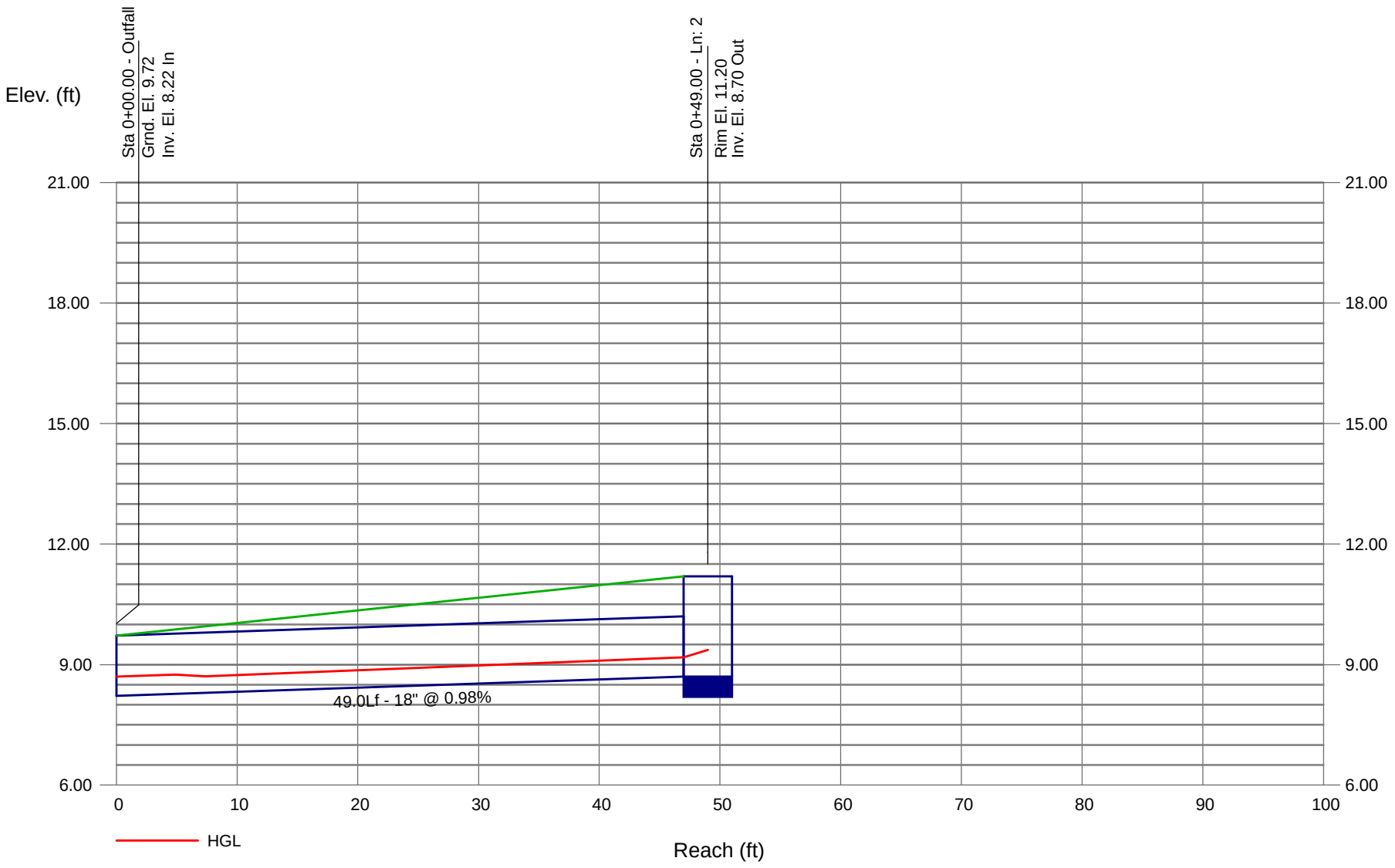
Storm Sewer Profile

Proj. file: Systems Downdrains.stm



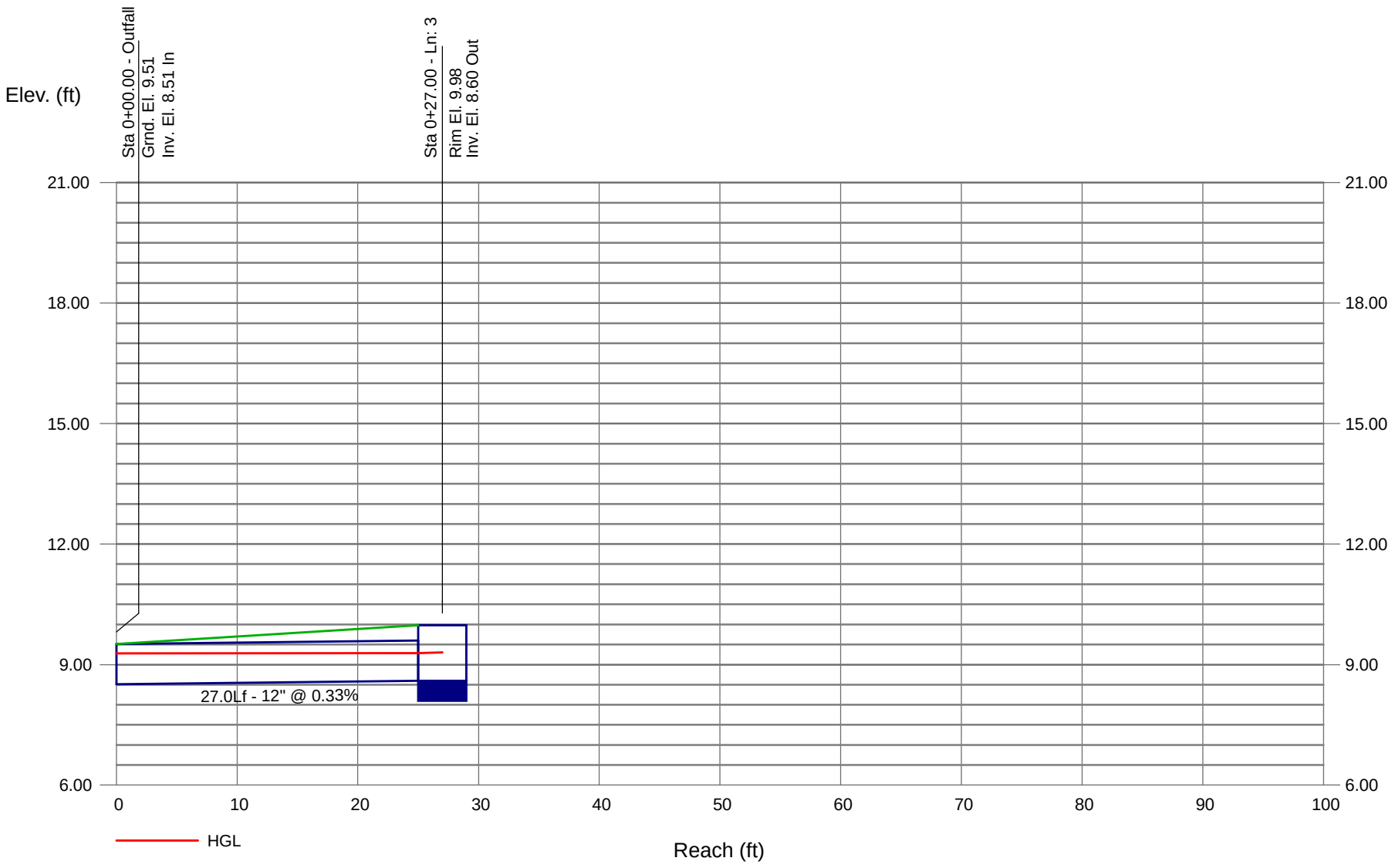
Storm Sewer Profile

Proj. file: Systems Downdrains.stm



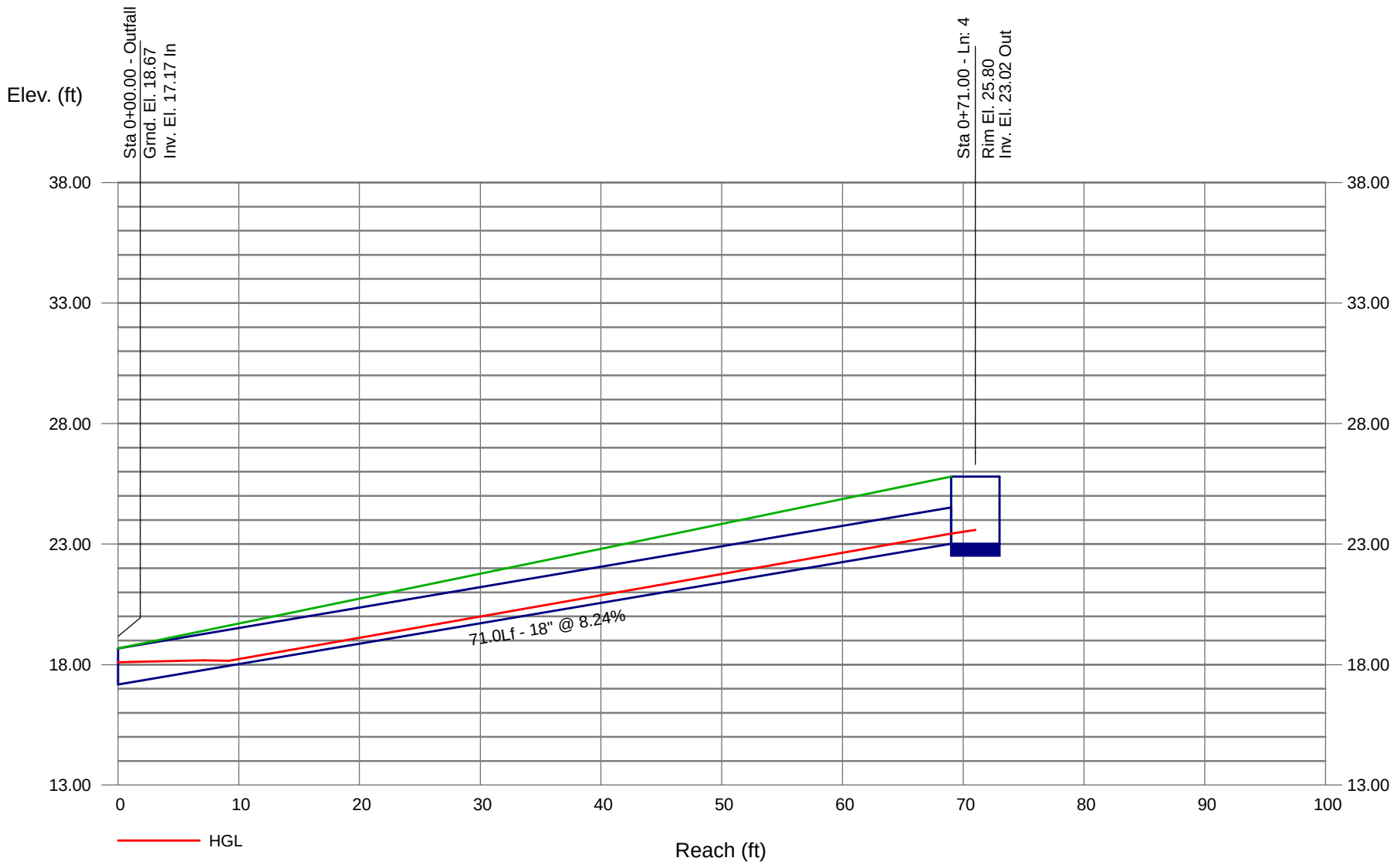
Storm Sewer Profile

Proj. file: Systems Downdrains.stm



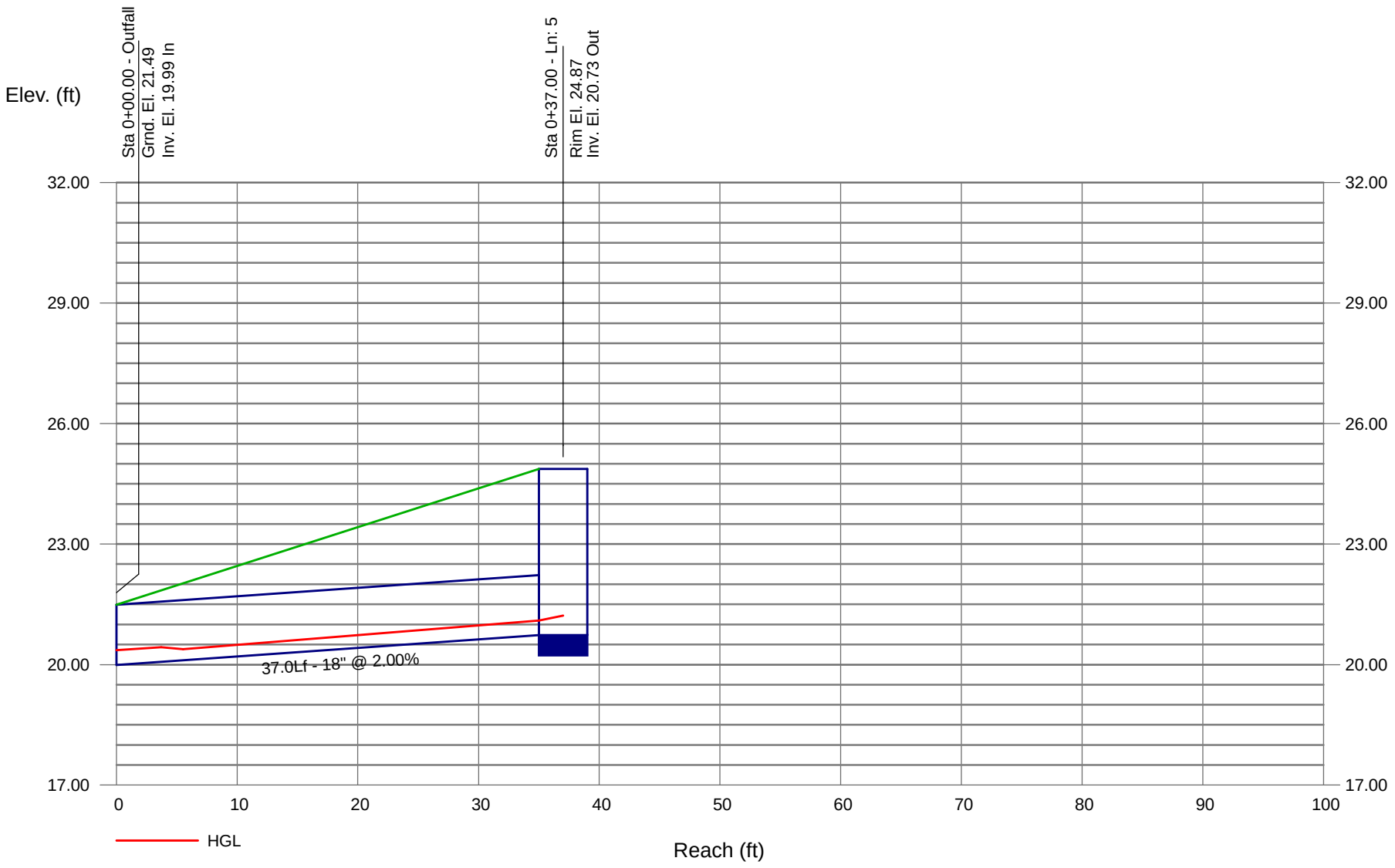
Storm Sewer Profile

Proj. file: Systems Downdrains.stm



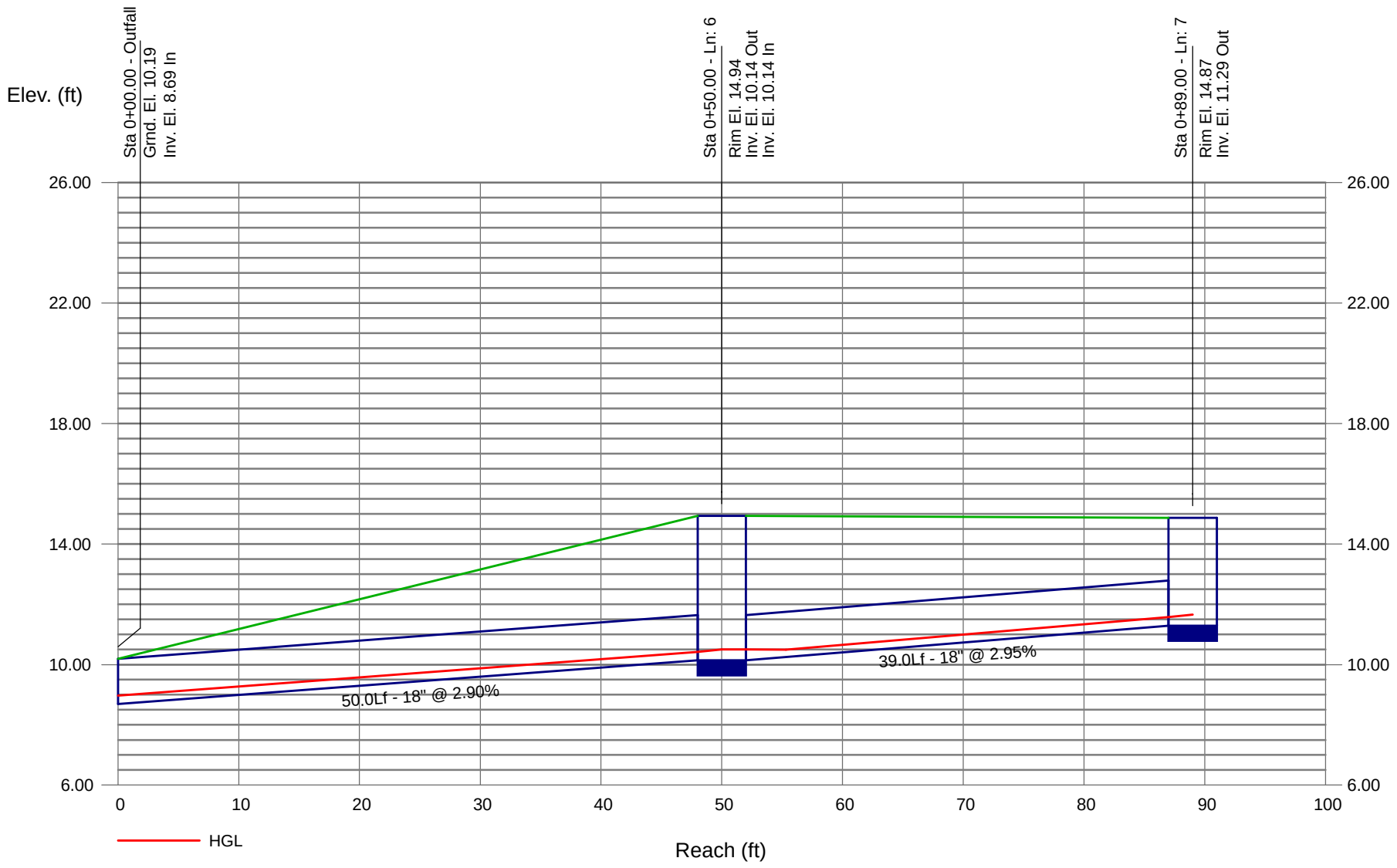
Storm Sewer Profile

Proj. file: Systems Downdrains.stm



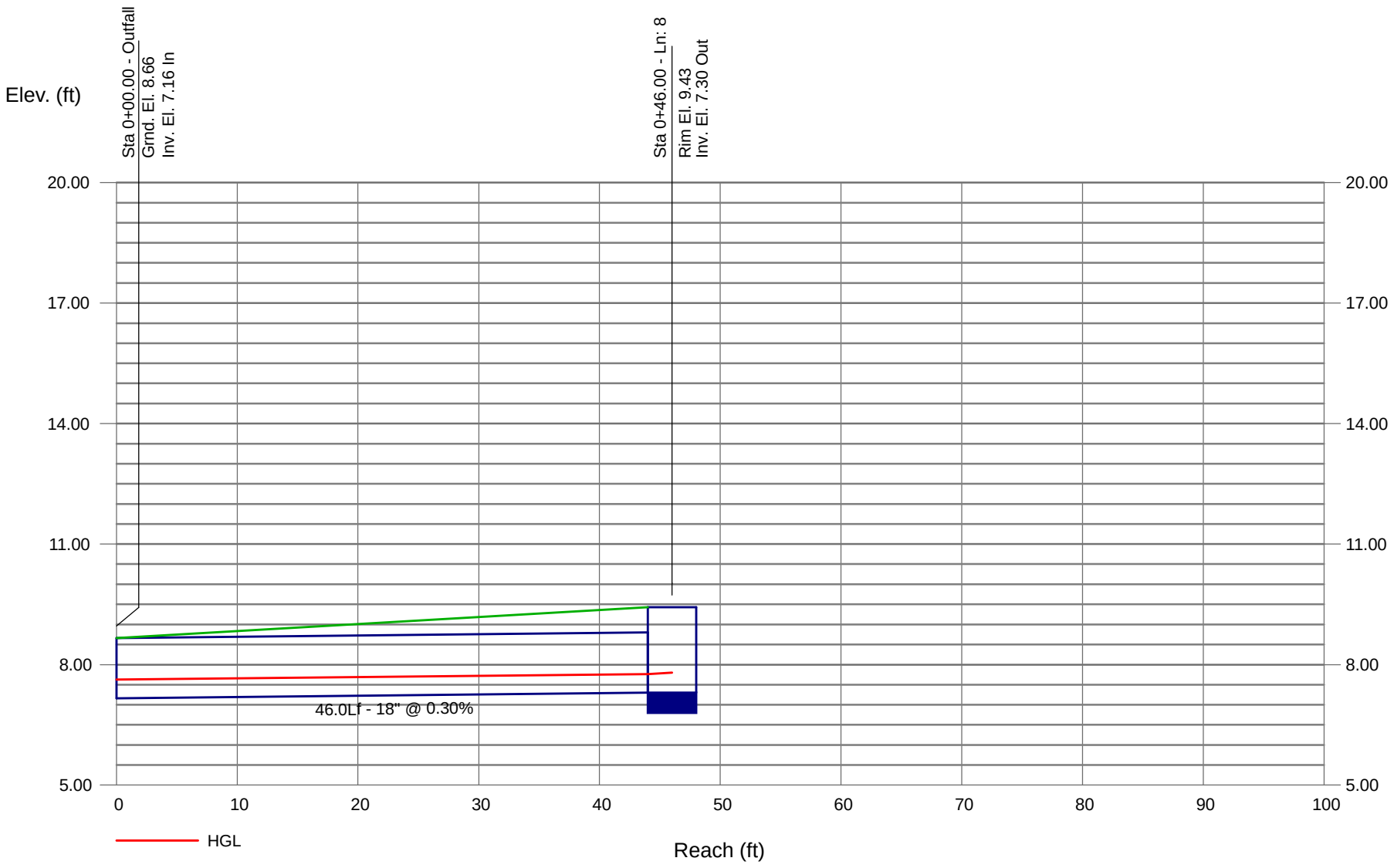
Storm Sewer Profile

Proj. file: Systems Downdrains.stm



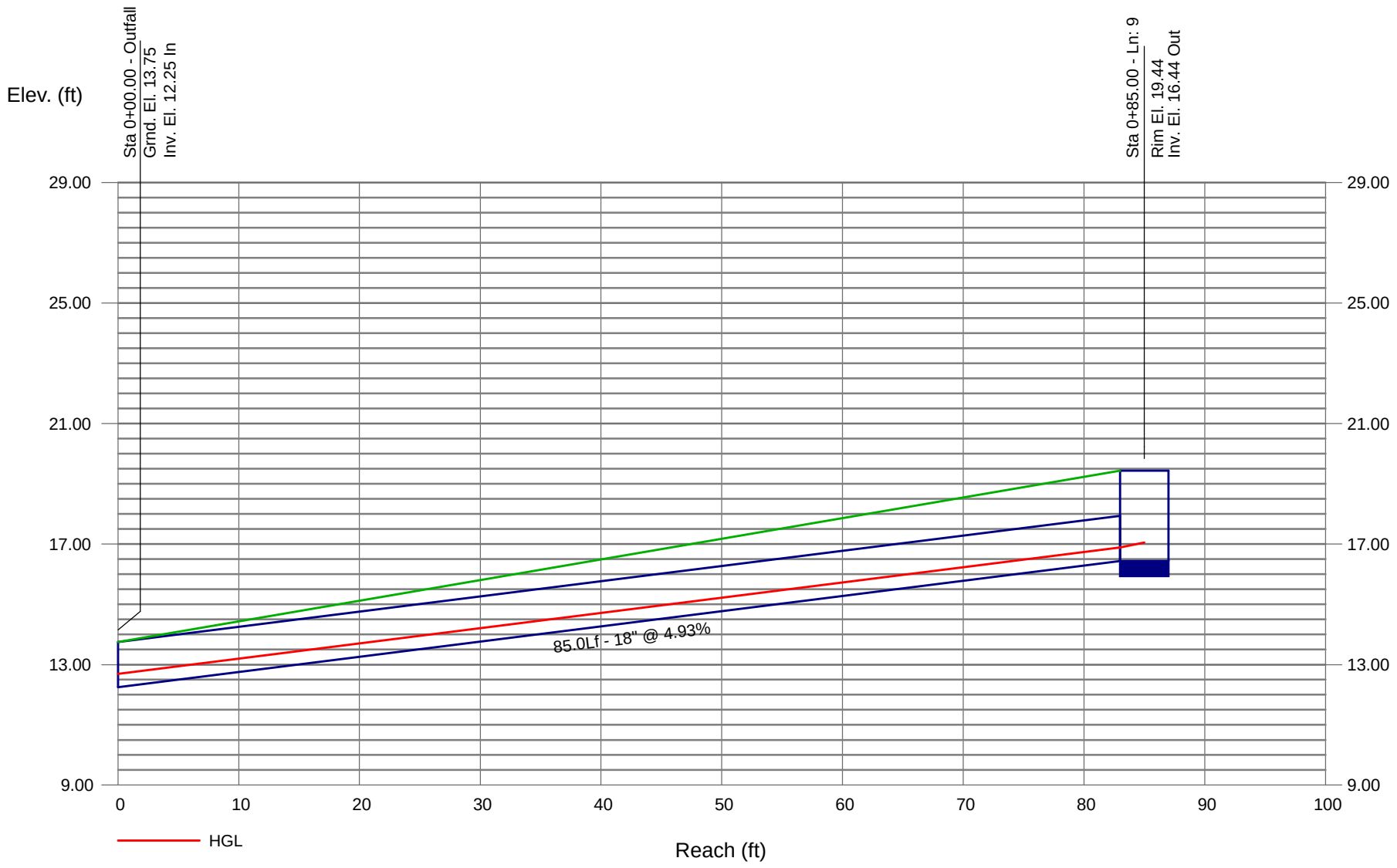
Storm Sewer Profile

Proj. file: Systems Downdrains.stm



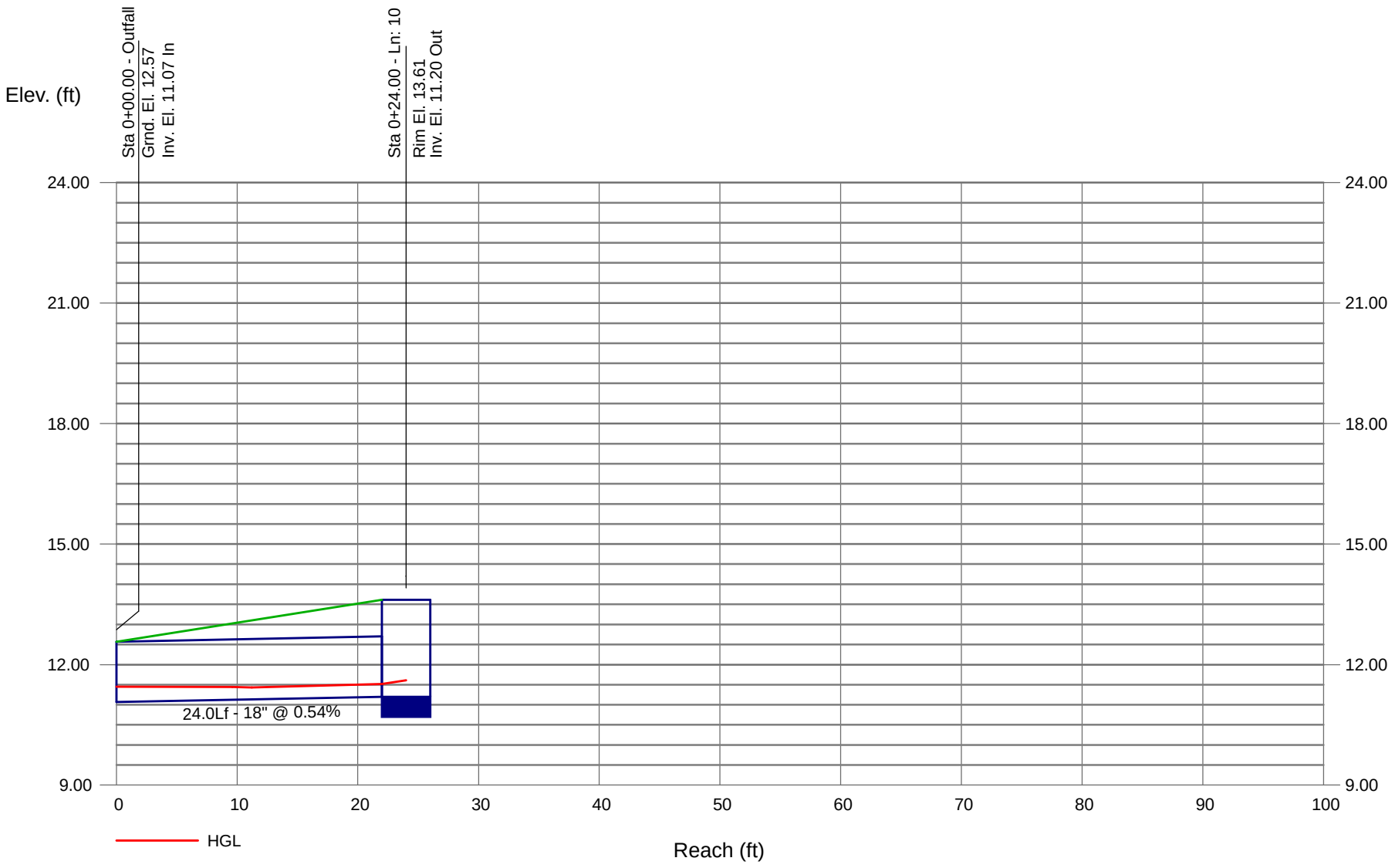
Storm Sewer Profile

Proj. file: Systems Downdrains.stm



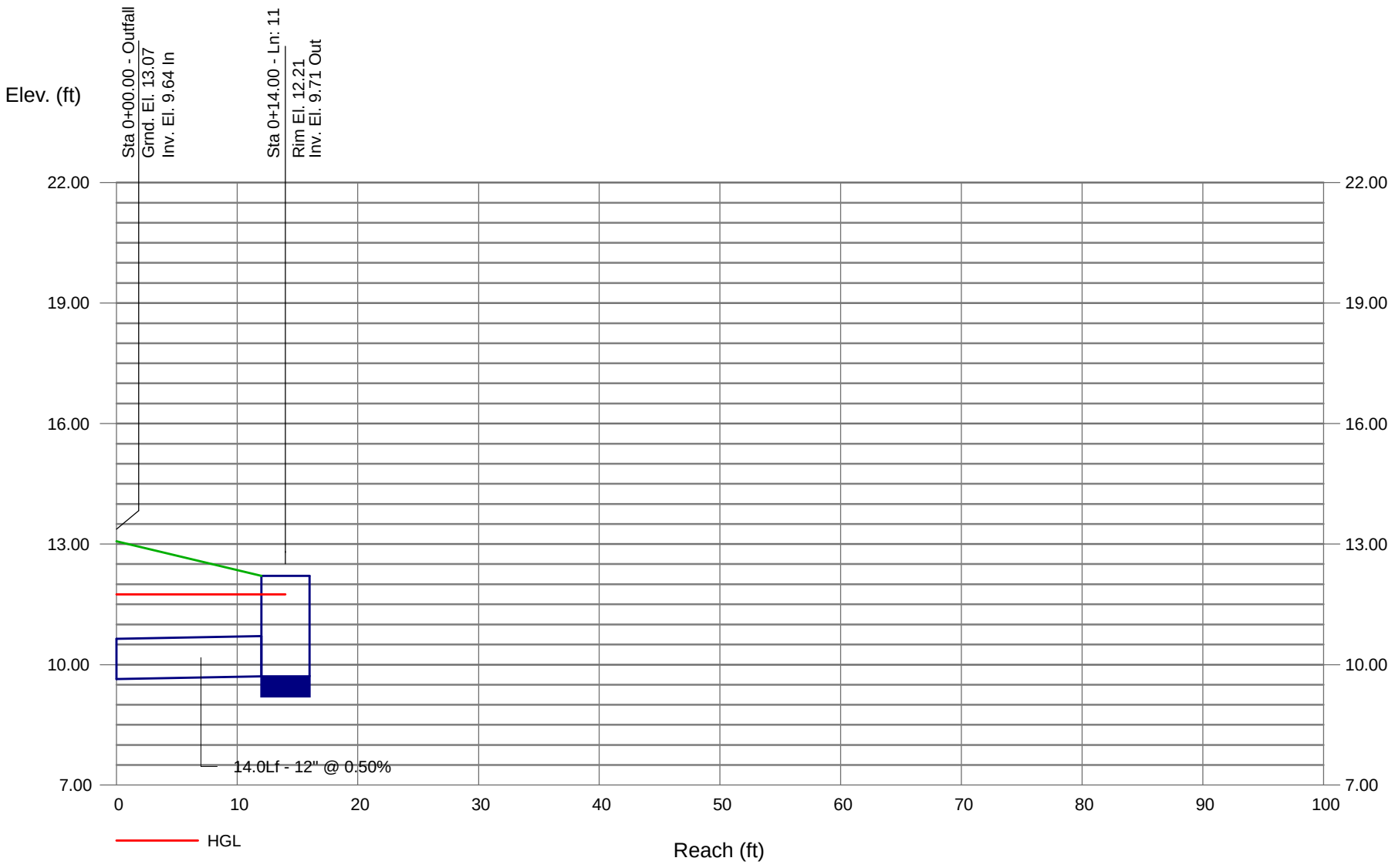
Storm Sewer Profile

Proj. file: Systems Downdrains.stm



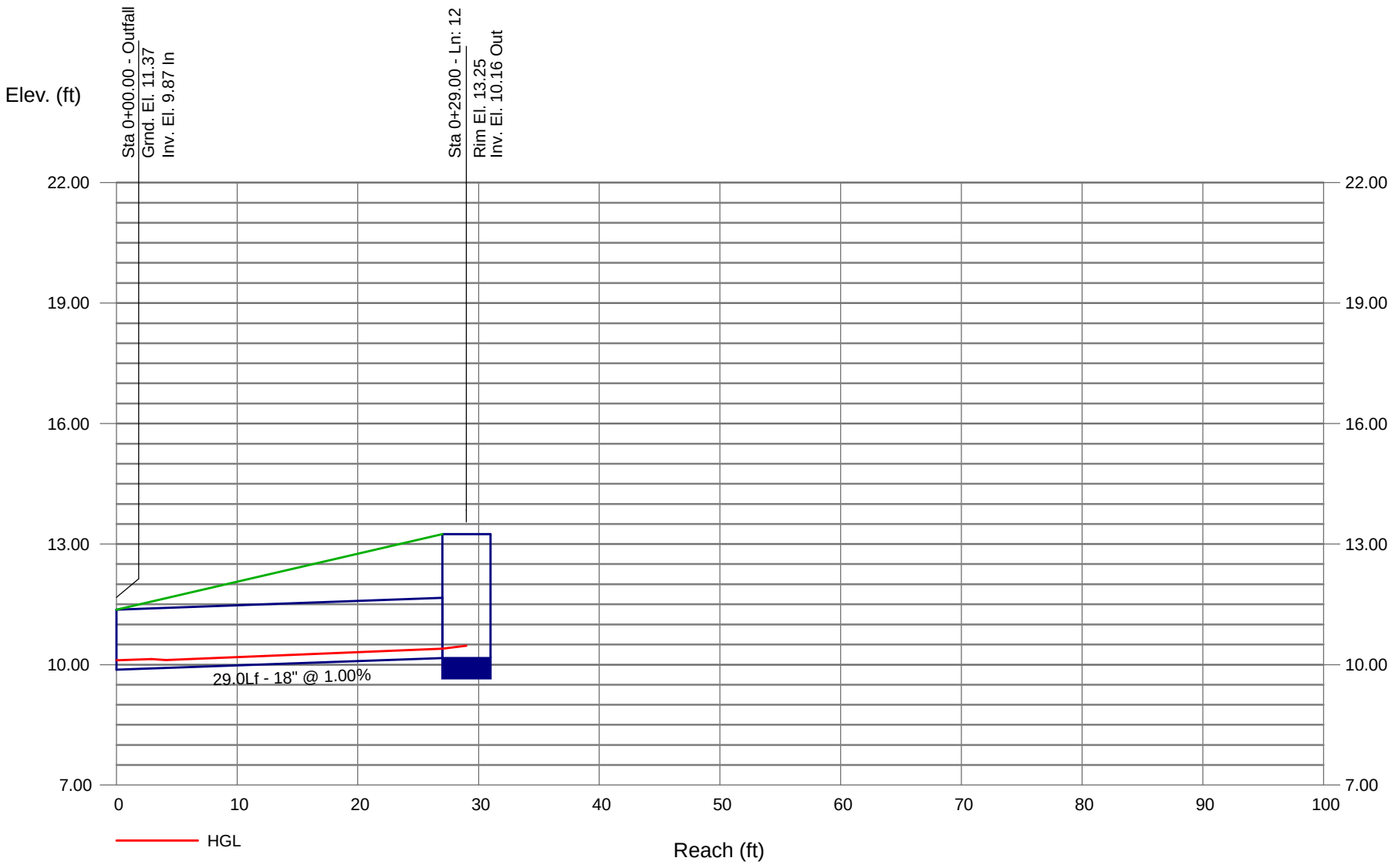
Storm Sewer Profile

Proj. file: Systems Downdrains.stm



Storm Sewer Profile

Proj. file: Systems Downdrains.stm



Appendix G Flood Insurance Rate Maps

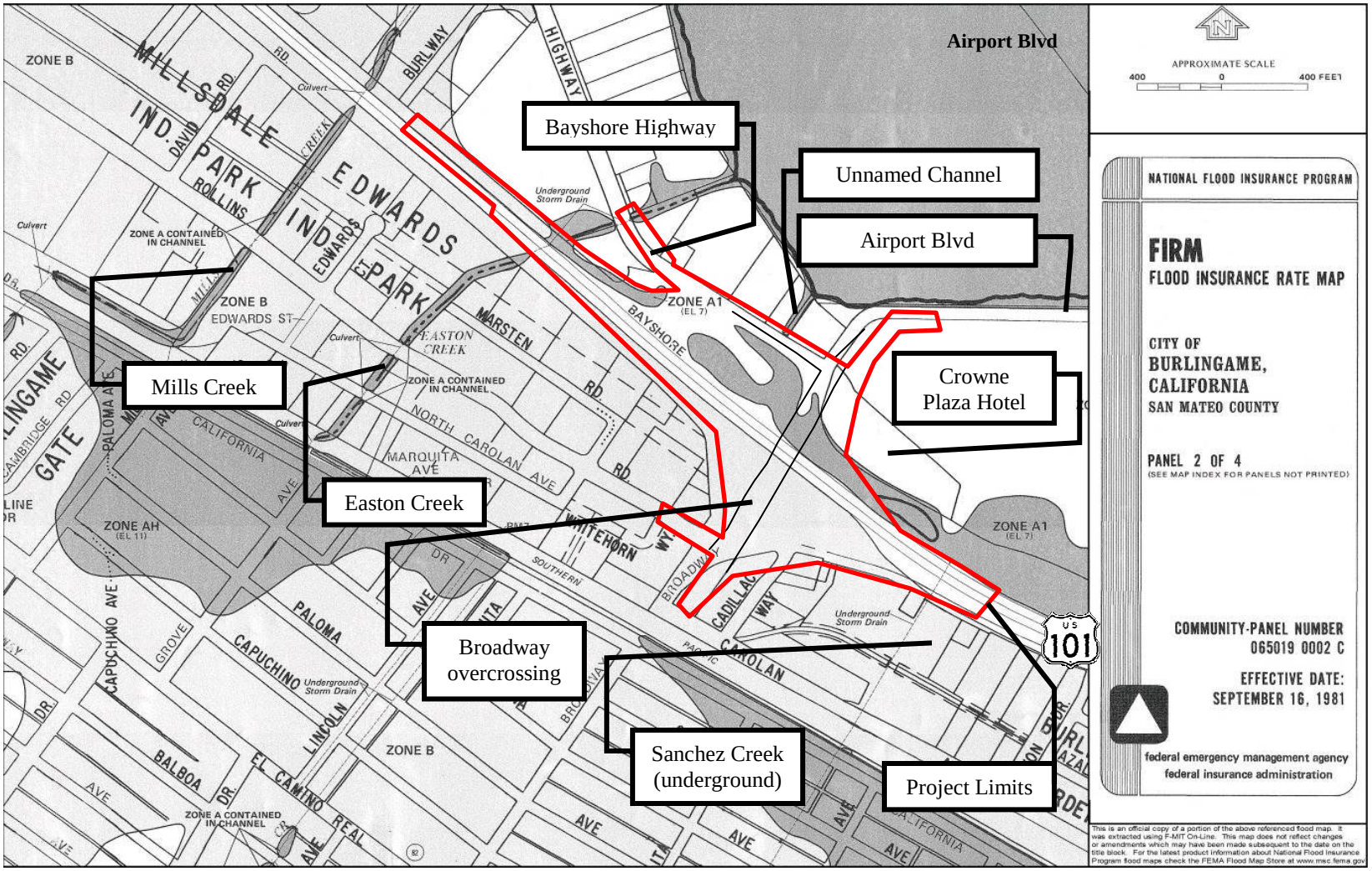


Figure 4. Excerpt from City of Burlingame FIRM

Source: Federal Emergency Management Agency

.

Appendix H Project Photographs

Photo 3. Unlined channel looking west

Photo 4. Unlined channel looking east (berm visible)

Photo 5. Inlet to unlined channel outlet to channel is covered with silt and debris

Photo 6. Existing open channel to be covered by proposed overcrossing

Photo 7. Proposed Broadway overcrossing landing

Photo 8. Ditch adjacent to NB off-ramp

Photo 9. Ditch adjacent to Crowne Plaza hotel and NB off-ramp

Photo 10. Easton Creek between Bayshore Highway and US 101

Photo 11. Easton Creek between Bayshore Highway and San Francisco Bay

Appendix I Email From Caltrans Confirming an LHS is Not Necessary

Terence Xiao

To: Bhoi, Abhijeet
Subject: RE: 101Bdwy - Request Confirmation on No Need for Hydraulic Report

-----Original Message-----
From: Dixon Lau [mailto:dixon_lau@dot.ca.gov]
Sent: Wednesday, May 30, 2012 8:31 AM
To: Kelsey, Scott
Subject: Re: 101Bdwy - Request Confirmation on No Need for Hydraulic Report

Good Morning Scott,

Likewise, I hope you had nice and wonderful long weekend as well.

Based on the reasons you cited in the below e-mail I would like to confirm that no need for Location Hydraulic Study for Easton Creek Box Extension on the 101/Boardway project.

Go luck with your project!

Best,
Dixon Lau
Caltrans-Dist04
Hydraulics
510-286-4854

"Kelsey, Scott" <scott.kelsey@urs.com>

05/29/2012 02:36 PM

To "dixon_lau@dot.ca.gov" <dixon_lau@dot.ca.gov>

cc "al_b_lee@dot.ca.gov" <al_b_lee@dot.ca.gov>, "Bhoi, Abhijeet" <abhijeet.bhoi@urs.com>, "Sathiamurthy, Ramesh" <ramesh.sathiamurthy@urs.com>

Subject 101Bdwy - Request Confirmation on No Need for Hydraulic Report

Hi Dixon –

Greetings. Hope you had a great 3-day weekend. I am requesting confirmation that there is no need for a Location Hydraulic Study (LHS) for the Easton Creek Box Culvert Extension on the 101/Broadway project. As you know, we are extending the box culvert by approximately 33 feet on the east side of the freeway (northbound 101). See attached Layout Sheet and Drainage Detail for box culvert extension details.

This issue was discussed during the PA/ED phase and at that time, it was determined that an LHS was not needed. The following reasons were cited for this conclusion:

1. Upstream Controlling Feature - The controlling feature of this drainage facility is the upstream entrance to the box culvert. This will not change with the proposed improvements.
2. Scour is not an issue – Existing and proposed features at this location include full concrete lined channel, so there would not be a need to do a scour analysis.
3. Pump Station Project – The City has been working on a pump station bypass project that will pump storm drainage from upstream (west of the freeway) to downstream (east of Bayshore). This will bypass storm drain waters from the location of this box culvert extension, making it even less critical. I understand that Phase 3 of this project has recently been completed and that Phase 4 (the last phase) has been started and should be completed within a year. This system should be fully operational well before construction begins on the 101/Broadway project.

Please let me know if this is still the case that we don't need an LHS. I just want to make sure this does not come up in the future when time becomes critical. We currently do not have an LHS included in our scope of work. Thanks, again, for all your help and support on this project.

Best Regards –
Scott

(Embedded image moved to file: pic27206.jpg)Description: Description:
URS_293
Scott C. Kelsey, P.E.
Senior Transportation Manager
URS Corporation
100 West San Fernando Street | Suite 200 San Jose | CA | 95113 Tel (408) 297-9585 | Direct (408) 961-8430 | Fax (408) 297-6962

Please note my new e-mail address: scott.kelsey@urs.com

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(See attached file: 101Bdwy_Easton Creek culvert.pdf)

This e-mail and any attachments contain URS Corporation confidential information that may be proprietary or privileged. If you receive this message in error or are not the intended recipient, you should not retain, distribute, disclose or use any of this information and you should destroy the e-mail and any attachments or copies.

Appendix J Creek Information Provided By the City of Burlingame

Terence Xiao

From: Kelsey, Scott [scott.kelsey@urs.com]
Sent: Tuesday, December 04, 2012 7:27 AM
To: Nham, Huey; Terence Xiao
Cc: Bhoi, Abhijeet
Subject: FW: 101Bdwy - Drainage & HGL Info
Attachments: URSResponseNov30.12.pdf

Hi Huey & Terence –
Requested drainage info is included below. Please let me know if you have any further questions or need additional information.
Thanks –
Scott

From: PW/ENG-Chou, Augustine [mailto:AChou@burlingame.org]
Sent: Friday, November 30, 2012 10:50 AM
To: Kelsey, Scott
Subject: FW:

Scott,

Below and attached is the HGL information you requested. Please take a look at the information and the message by Doug Bell, and feel free to contact me if there are other questions. Regarding the storm drain line at the Valero station, our records show that the existing private line does not connect to any City storm drain lines. The nearest city line connects to a DI at Whitethorn Way and goes across Rollins Road heading north to Millbrae.

Augustine

Augustine Chou
Transportation Engineer

City of Burlingame
501 Primrose Road
Burlingame, CA 94010
(650) 558-7236

From: PW/ENG-Bell, Doug
Sent: Friday, November 30, 2012 8:45 AM
To: PW/ENG-Chou, Augustine
Subject:

Augustine,

Herewith attached is a response to the URS RFI, based on information we have.

We do not have much of the information available as requested by URS.

If URS would like to perform hydraulic calculations on their own, we can provide further information of the physical layout of the City storm drain facilities.

Thanks,

Doug

This e-mail and any attachments contain URS Corporation confidential information that may be proprietary or privileged. If you receive this message in error or are not the intended recipient, you should not retain, distribute, disclose or use any of this information and you should destroy the e-mail and any attachments or copies.

Information per URS Fwy 101 Request of November 8, 2012

Easton Creek

City has "theoretical" hydraulic information available as follows:

a. Flow Rate (Q) for the combined open channel and parallel 66" diameter pipeline system:
    a. Q ten year: 442 cfs
    b. Q thirty year 582 cfs

Attached Figure 1 provides a graphical layout of the water surface elevations within Easton Creek at Q thirty year flow rate (HEC RAS study performed in 2006).

Q 2 year average flow and Q 5 year peak flow values are not available.

Tide level indicated is 5.82' (predicted annual maximum mean high tide level in 2003)

The Marsten Pump Station Project including the 66" dia. discharge pipeline is currently under construction and not in operation.

All information presented above, is based on a wide variety of design assumptions associated with the design of the Marsten Pump Station and discharge pipeline project. Said design assumptions may or may not coincide with design assumptions in regard to the URS project Fwy 101 Project.

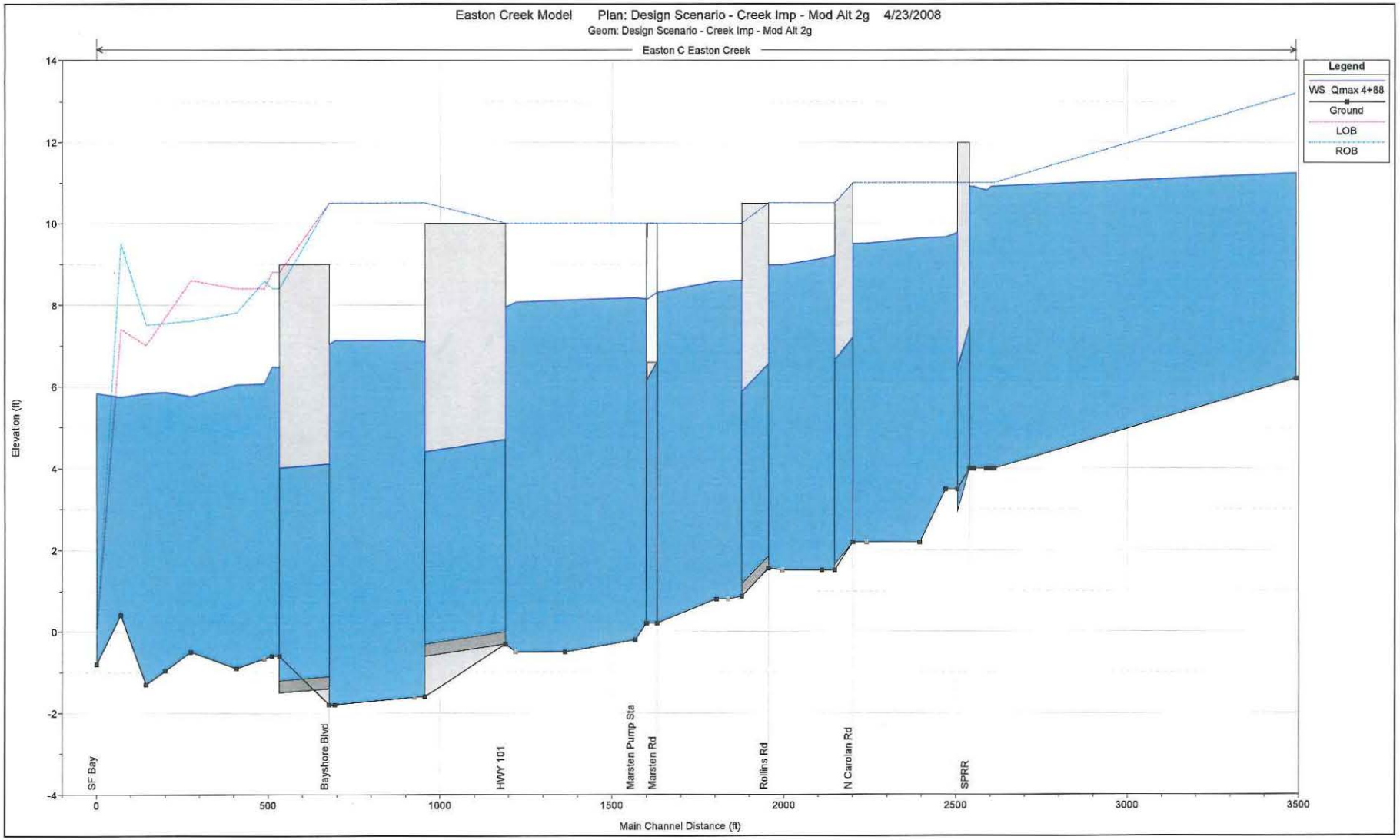
Sanchez Creek

Sanchez Creek flow is contained within a continuous box culvert system starting at Carolan Ave and discharging to the Burlingame Lagoon downstream of Fwy 101. Discharge water elevation would be assumed to be at the level of the coincident tide.

Valero Gas Station

City has no information in regard to the drainage information at the Valero Gas Station at Rollins Rd.

Figure 1


Easton Creek Model Plan: Design Scenario - Creek Imp - Mod Alt 2g 4/23/2008
Geom: Design Scenario - Creek Imp - Mod Alt 2g
Easton C Easton Creek
Legend
WS Qmax 4+88
Ground
LOB
ROB
Elevation (ft)
Main Channel Distance (ft)
SF Bay
Bayshore Blvd
HWY 101
Marsten Pump Sta
Marsten Rd
Rollins Rd
N Carolan Rd
SPRR

US101/BROADWAY INTERCHANGE RECONSTRUCTION PROJECT

PS&E Phase

NON-STORM WATER INFORMATION HANDOUT

April 17, 2013

THE CITY OF BURLINGAME INCORPORATED 1908

SAN MATEO COUNTY Transportation Authority

Caltrans

WRECO

URS

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Appendix A City of Burlingame Municipal Code Title 15, Chapter 15.10
Appendix B City of Burlingame 15.10 Groundwater Discharge Permit Application
Appendix C VOC and Fuel General NPDES Permit (Order No, R2-2012-0012, NPDES No. CAG912002)
Appendix D Water Quality Objectives from Water Quality Control Plan (Basin Plan) for San Francisco Bay Region

Disclaimer

A "Disclaimer" is required specifying that the information provided in the Non-Storm Water Information Handout is just a guideline and is to be used for information purposes only and should not be considered a sole source document to adhere to the requirements of the National Pollutant Discharge Elimination System (NPDES) Waste Discharge Requirements for Discharge or Reuse of Extracted and Treated Groundwater Resulting from the Cleanup of Groundwater Polluted by Volatile Organic Compounds (VOCs), Fuel Leaks and Other Related Wastes (VOC and Fuel General Permit), Order No. R2-2012-0012, NPDES No. CAG912002, or City of Burlingame Municipal Batch Discharge Permit (15.10 Groundwater Discharge Permit). Bidders and contractors are cautioned to make independent investigations and examinations as they deem necessary in respect to the following: possible local material sources, the quality and quantity of material available from the property, and the type and extent of processing that may be required in order to produce material conforming to the requirement of the contract documents.

Acronyms

bgs	Below Ground Surface
BMP	Best Management Practice
Caltrans	California Department of Transportation
CFR	Code of Federal Regulations
CPPP	Coagulant Pollution Prevention Plan
CTR	California Toxics Rule
CWA	Clean Water Act
DDP	Dewatering and Discharge Plan
ESL	Environmental Screening Level
LUST	Leaking Underground Storage Tank
mgd	million gallons per day
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NTR	National Toxics Rule
POTW	Publicly Owned Treatment Works
SFBRWQCB	San Francisco Bay Regional Water Quality Control Board
SIP	State Implementation Policy
SMCTA	San Mateo County Transportation Authority
SWPPP	Storm Water Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TPH	Total Petroleum Hydrocarbon
TPHg	Total Petroleum Hydrocarbon gasoline
VOC	Volatile Organic Compounds
WDR	Waste Discharge Requirement
WPCP	Water Pollution Control Plan
WQO	Water Quality Objectives

1 INTRODUCTION AND BACKGROUND

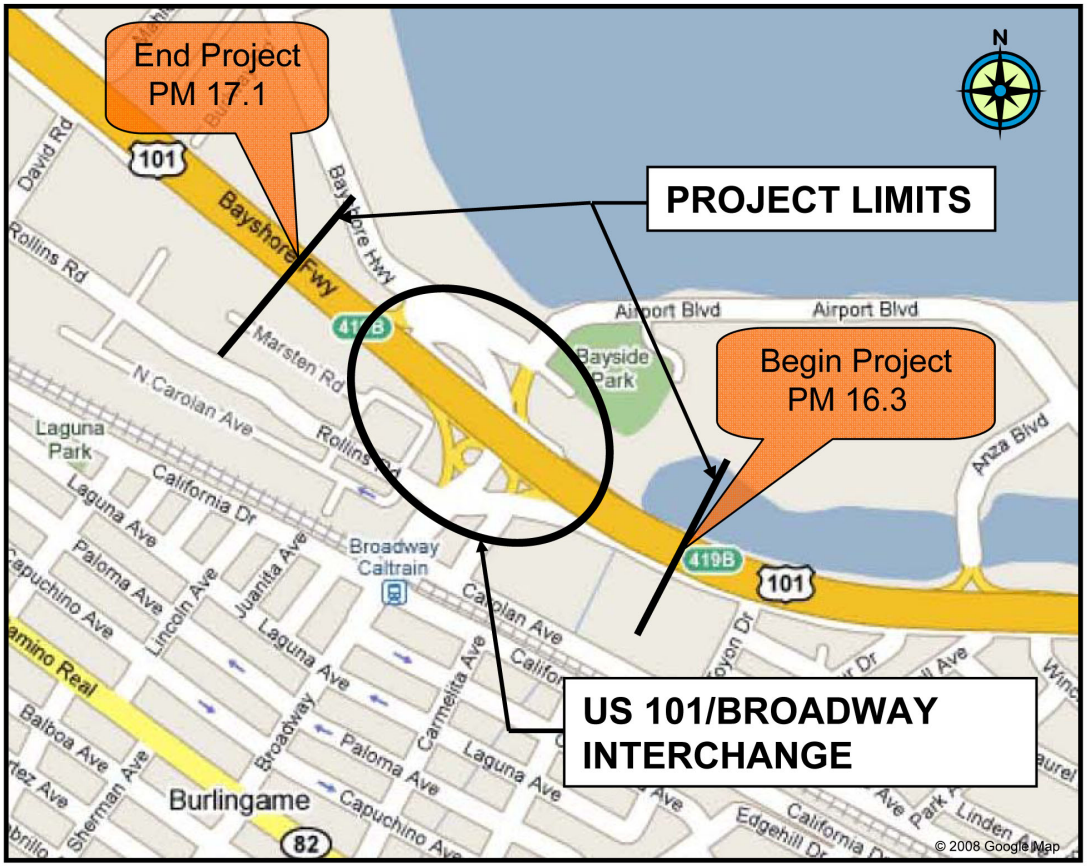
The California Department of Transportation (Caltrans), in cooperation with the San Mateo County Transportation Authority (SMCTA) proposes to reconstruct the United States Highway 101 (US 101)/Broadway Interchange. The Project replaces the existing Broadway overcrossing with a new wider structure, reconfigures all northbound and southbound ramp connections to US 101, and installs ramp meters on the northbound and southbound on-ramps. See Figure 1 for the Project location map.

During construction, it is expected that there will be groundwater inflow into the excavations due to the presence of groundwater above the proposed bottom elevations of the excavations. This groundwater will contribute to the Project non-storm water discharges during construction. Due to the presence of contaminants in groundwater and soils at the Project site, non-storm waters will have to be collected and treated prior to discharge into either the City of Burlingame's (City) sanitary sewer system or the Project drainage system, per applicable regulatory requirements. With Caltrans' prior approval, treated non-storm waters may be used to control dust or be discharged to land for infiltration under the Caltrans National Pollutant Discharge Elimination System (NPDES) Permit. The contractor must develop a Dewatering and Discharge Plan to handle the collection and treatment of non-storm water discharges and to monitor and treat the runoff prior to discharge.

This report presents the applicable Municipal Batch Discharge Permit (15.10 Groundwater Discharge Permit) and NPDES permit that apply to the non-storm water collection, treatment, and discharge activities, as well as the general water resources background data of the Project site.

US101/Broadway Interchange Reconstruction Project in San Mateo County

04-SM-101-PM 16.3/17.1
EA 04-235841



LOCATION MAP

URS

Figure 1. Location Map

2 REGULATORY SETTING

During construction, non-storm water discharges will have to be controlled, monitored, and treated prior to discharge. There are two potential discharge conditions, both of which require treatment of non-storm waters: through the City's sanitary sewer under a 15.10 Groundwater Discharge Permit (Burlingame, California Municipal Code §15.10) or through the Project drainage system under the Volatile Organic Compounds (VOC) and Fuel General NPDES Permit (Order No. R2-2012-0012, NPDES No. CAG912002).

In order to adhere to the requirements of 15.10 Groundwater Discharge Permit and VOC and Fuel General NPDES Permit during construction, non-storm water discharges must be monitored and meet effluent limits. The following sections summarize the discharge criteria for those permits.

2.1 Caltrans NPDES Permit

The State Water Resources Control Board (SWRCB) issued the Caltrans Statewide NPDES Permit Order No. 99-06-DWQ adopted July 15, 1999 (Order No. 99-06-DWQ), to regulate all Caltrans projects and facilities in the State. The permit was reissued (Order No. 2012-0011-DWQ), and the new permit will become effective on July 1, 2013. Because Project non-storm waters are expected to be contaminated, non-storm water discharges at the Project site must be regulated under either the City's 15.10 Groundwater Discharge Permit or the VOC and Fuel General NPDES Permit (Order No, R2-2012-0012, NPDES No. CAG912002).

2.2 15.10 Groundwater Discharge Permit

The City owns a wastewater treatment facility located at 1103 Airport Boulevard that is nearly adjacent to the Project site; see Figure 2. The facility has a design capacity of 5.5 million gallons per day (mgd) and 16 mgd during wet weather. The facility is operated and maintained under a public-private partnership between the City and Veolia Water North America.

Title 15 of the City's Municipal Code contains applicable laws and regulations pertaining to waters and sewers, and Chapter 15.10 (within Title 15) contains sanitary sewer use regulations, including specific narrative and numerical criteria for discharges, prohibited activities, and steps to complete and submit a permit application. (Refer to Section 5.3 and Appendix A for more information). These rules and regulations state:

> "set uniform requirements for discharges into the wastewater collection and treatment system and enable the city to comply with the administrative provisions of the clean water grant regulations, the water quality requirements set by the applicable effluent limitations, national standards of performance, toxic and pretreatment effluent standards and all other discharge criteria which are required or authorized by state or federal law, and to derive the maximum public benefit by regulating the quality and quantity of wastewater discharged into the city of Burlingame's sewer system." (Burlingame, California Municipal Code §15.10.005)

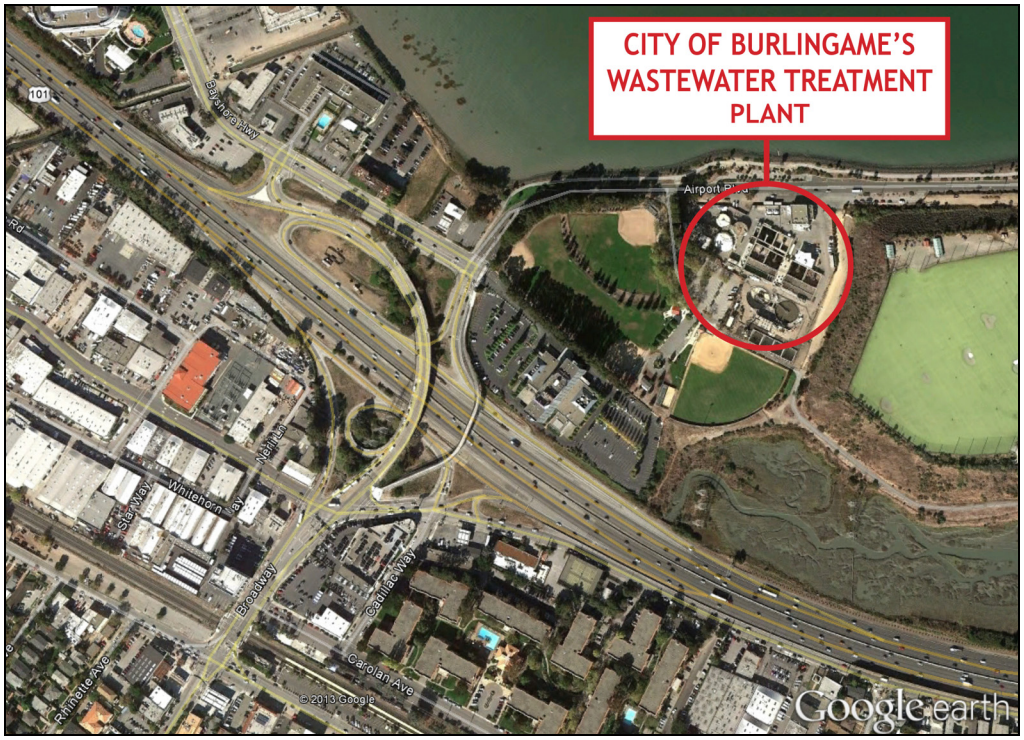


Figure 2. City of Burlingame Wastewater Treatment Plant

2.2.1 Permit Acquisition

All dischargers must complete, file, and pay for the 15.10 Groundwater Discharge Permit prior to dsicahrging non-storm waters to the City's sanitary sewer system. After one year, the 15.10 Groundwater Discharge Permit expires, requiring the contractor to reapply for coverage. Per §15.10.072 of the City's municipal code, the application will contain the following information at a minimum; see Appendix B for a standard 15.10 Groundwater Discharge Permit application.

- Signature, name, and address of both the owner of the property from which the discharge is to occur and the applicant for the permit if other than the owner. The persons signing the application on behalf of an entity shall be at least of the level of vice president, general partner, or an individual responsible for the overall operation of the facility or property and meeting the conditions of the requested permit, or a person meeting the federal requirements for NPDES applications as specified in Title 40 of the CFR;
- Volume of wastewater to be discharged;
- Estimated wastewater constituents and characteristics;
- Time and duration of discharges;
- Average and 30 minute peak wastewater flow rates, including daily, monthly, and seasonal variations, if any;
- Site plans, floor plans, and mechanical and plumbing plans and details, sufficient to show all sewers and appurtenances by size, location, and elevation;

- Description of all activities, facilities, and plant processes on the property that may in any way relate to the discharges, including types of materials that are or could be discharged;
- Each product produced by type, amount, and rate of production that may in any way relate to the discharges; and
- Hours of work and activities at the property.

In addition, samples will need to be collected and analyzed after treatment to ensure adequacy of the treatment system and compliance with the local limits prior to discharge. Once the results are reviewed, discharges to the sanitary sewer system may proceed. (Eva Justimbaste, Environmental Compliance Supervisor at the Burlingame Wastewater Treatment Plant, personal communication, April 9, 2013)

2.2.2 Discharge Criteria

2.2.2.1 Limitations on Wastewater Strength

Discharges in excess of the maximum allowable concentrations listed in Table 1 may not be discharged to the City's sanitary sewer system.

Table 1. Limitations on Wastewater Strength

Substance	Maximum Allowable Concentration (mg/L)
Arsenic	0.08
Biological Oxygen Demand	1,300
Cadmium	0.138
Copper	2.0
Cyanide	0.292
Lead	0.365
Mercury	0.010
Nickel	0.445
Phenol	7.8
Selenium	0.106
Silver	0.200
Total Suspended Solids	1,200
Total Chromium	2.532
Total Petroleum Hydrocarbons	10
Zinc	0.386

Source: Burlingame, California Municipal Code §15.10.050

2.2.2.2 Other Limitations

The City's wastewater treatment plant is currently regulated under the San Francisco Regional Water Quality Control Board (SFBRWQCB) Order No. R2-2012-0096, NPDES No. CA0038849, titled *Waste Discharge Requirements for Mercury and PCBs from Municipal and Industrial Wastewater Discharges to San Francisco Bay*. As such, the wastewater treatment plant is concerned with receiving flows with high concentrations of polychlorinated biphenyls (PCBs; as arochlors) and total mercury. Table 2 lists the effluent limitations on PCBs (as arochlors) and total mercury that apply to the wastewater

treatment plant. (Eva Justimbaste, Environmental Compliance Supervisor at the Burlingame Wastewater Treatment Plant, personal communication, April 9, 2013)

Table 2. Limitations on PCBs and Mercury

Constituent	Average Annual Limit for Mercury (kg/yr)	Average Monthly Effluent Limit (ug/L)	Average Weekly Effluent Limit for Mercury (ug/L)	Maximum Daily Effluent Limit for PCBs (ug/L)
Total Mercury*	0.089	0.066	0.072	N/A
Total PCBs (as arochlors)*	N/A	0.012	N/A	0.017

Source: Waste Discharge Requirements for Mercury and PCBs from Municipal and Industrial Wastewater Discharges to San Francisco Bay (Order No. R2-2012-0096, NPDES No. CA0038849)
NOTES:
*All compliance analyses shall be conducted using current USEPA methods, or that have been approved by the USEPA Regional Administrator pursuant to 40 CFR 136.4 and 40 CFR 136.5, or equivalent methods that are commercially and reasonably available, and that provided quantification of sampling parameters and constituents sufficient to evaluate compliance with applicable effluent (and local) limits.

The City's wastewater treatment plant is currently considering VOC sanitary sewer discharge criteria, and such criteria may be implemented prior to the commencement of construction (URS, 2013). Refer to the City's Municipal Code, §15.10 (referenced as Appendix A), for all other specific and general criteria for sanitary sewer discharges.

2.2.3 Fees

The following fees apply to the Project under the 15.10 Groundwater Discharge Permit:

- $160 permit application fee
- $1,239 permit fee that includes one inspection and one effluent sample
- $6.98 per 1,000 gallons discharged to the City's sanitary sewer system

(Eva Justimbaste, Environmental Compliance Supervisor at the Burlingame Wastewater Treatment Plant, personal communication, April 9, 2013)

2.3 VOC and Fuel General NPDES Permit

This Project is within the SFBRWQCB's jurisdiction. As required by the SFBRWQCB, discharges to surface waters must be covered under an NPDES permit and meet the requirements specified in the permit. The most applicable General Waste Discharge Requirement (WDR)/NPDES Permit for this construction activity is the SFBRWQCB's WDR/NPDES Permit titled *Discharge of Reuse of Extracted and Treated Groundwater Resulting from the Cleanup of Groundwater Polluted by Volatile Organic Compounds (VOC), Fuel Leaks and Other Related Wastes* (VOC and Fuel General Permit; Order No, R2-2012-0012, NPDES No. CAG912002). The VOC and Fuel General Permit was adopted by the SFBRWQCB on February 8, 2012 and expires on March 15, 2017.

However, the SFBRWQCB adopted Resolution No. 88-160 on October 19, 1988, and it urges potential permittees to discharge to a publicly owned treatment works (POTW) system if reuse of extracted and treated groundwater is not economically and/or

technically feasible. If discharging to a POTW is infeasible, and the beneficial uses of the receiving water would not be adversely affected, the VOC and Fuel General Permit would be invoked. To obtain coverage under this permit, the contractor will need to submit a Notice of Intent (NOI) to the SFBRWQCB for approval, prior to the start of non-storm water collection, treatment, and discharge activities.

2.3.1 Effluent Limitations

The effluent must not contain concentrations of toxic pollutants above the concentrations as outlined in the VOC and Fuel General Permit at Monitoring Location EFF-001 as specified in the Authorization to Discharge; see Table 3.

Table 3. Effluent Limitations for Toxics Pollutants

No.	Compound	CAS Number	Column A: Discharge to Drinking Water Areas[1]		Column B: Discharge to Other Surface Water Areas	
			Average Monthly Effluent Limitation (µg/L)	Maximum Daily Effluent Limitation (µg/L)	Average Monthly Effluent Limitation (µg/L)	Maximum Daily Effluent Limitation (µg/L)
1	Benzene	71432	---	1	---	5
2	Carbon Tetrachloride	56235	0.25[2]	0.50	4.4	5
3	Chloroform	67663	---	5	---	5
4	1,1-Dichloroethane	75343	---	5	---	5
5	1,2-Dichloroethane	107062	0.38[2]	0.5	---	5
6	1,1-Dichloroethylene	75354	0.057[2]	0.11[2]	3.2	5
7	Ethylbenzene	100414	---	5	---	5
8	Methylene Chloride	75092	4.7	5	---	5
9	Tetrachloroethylene (PCE)	127184	0.8	1.6	---	5
10	Toluene	108883	---	5	---	5
11	Cis 1,2-Dichloroethylene	156592	---	5	---	5
12	Trans 1,2-Dichloroethylene	156605	---	5	---	5
13	1,1,1-Trichloroethane	71556	---	5	---	5
14	1,1,2-Trichloroethane	79005	0.6	1.2	---	5
15	Trichloroethylene (TCE)	79016	2.7	5	---	5
16	Vinyl Chloride	75014	---	0.5	---	1
17	Total Xylenes	1330207	---	5	---	5
18	Methyl Tertiary Butyl Ether (MTBE)	1634044	---	5	---	5
19	Total Petroleum Hydrocarbons[TPHs (as gasoline or as diesel)]	---	---	50	---	50
20	Ethylene Dibromide (1,2-Dibromoethane)	106934	---	0.05[2]	---	5
21	Trichloro-trifluoroethane	76131	---	5	---	5
22	Total Chlorine Residual	---	---	0.0[3]	---	0.0[3]

Table Notes:
[1] Drinking water areas are defined as surface waters with the existing or potential beneficial uses of "Municipal and Domestic Supply" and "Groundwater Recharge" (the latter includes recharge areas to maintain salt balance or to halt salt water intrusion into fresh water aquifers).
[2] If reported detection level is greater than effluent limit, then a non-detect result using a 0.5 µg/L detection level will not be deemed to be out of compliance.
[3] There shall be no detectable levels of residual chlorine in the effluent (a non-detect result using a detection level equal or less than 0.08 milligram per liter (mg/L) will not be deemed to be out of compliance). This limit only applies to Dischargers that chlorinate their extracted groundwater.

Source: VOC and Fuel General Permit

In addition to Table 3, the following effluent limitations apply.

- The pH of the discharge must not exceed 8.5 or be less than 6.5
- Toxicity: the results of the rainbow trout test fish, in 96 hr static renewal bioassays of the discharge, must be no less than a three sample moving median of 90% survival and a single test value of no less than 70% survival

Discharges must not cause the following conditions to exist in the receiving water:

- Floating, suspended, or deposited macroscopic particulate matter or foam
- Aquatic growth and bottom deposits that are a nuisance or adversely affecting the beneficial uses
- Alteration of temperature, turbidity, taste, odor, and apparent color beyond natural background levels
- Visible, floating, suspended, or deposited oil or other products of petroleum origin
- Toxic or other deleterious substances in concentrations or quantities that would cause deleterious effects on biota; or which would render any of these unfit for human consumption

The discharge must not cause the following limits to be exceeded in the waters of the State, in any place within 1 ft of the water surface:

- Dissolved Oxygen: the median dissolved oxygen for any three consecutive months must be less than 80% of the dissolved oxygen content at saturation.
- Dissolved Sulfide: natural background levels.
- pH: the pH must not be depressed below 6.5 or raised above 8.5, nor caused to vary from normal ambient pH by more than 0.5 pH units.
- Un-ionized Ammonia: 0.025 mg/L as an annual median and 0.4 mg/L as a maximum for San Francisco Bay Lower.
- Nutrients: waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

Discharges must also not cause or contribute to a violation of any water quality standards for receiving waters. Monitoring requirements would be performed during construction per Attachment E of the VOC and Fuel General Permit.

2.3.2 Receiving Waters and Water Quality Objectives

The SFBRWQCB established a *Water Quality Control Plan* (Basin Plan) with goals and policies that apply to the region's water resources regarding beneficial uses and water quality objectives (WQOs). Non-storm water discharges to surface waters should adhere to these objectives, in addition to those under the VOC and Fuel General Permit (Order No, R2-2012-0012, NPDES No. CAG912002).

2.3.2.1 Receiving Water Bodies and Beneficial Uses

Currently, the runoff from the Project area drains to one of five waterways: Mills Creek, Easton Creek, the unlined channel near the intersection of Airport Boulevard and Bayshore Highway, Sanchez Creek, or San Francisco Bay, Lower. Most of the runoff from southbound US 101 within the Project limits north of the Broadway overcrossing drains to Easton Creek through a series of open channels and roadside culverts along US

101. The area to the east of Rollins Road north of the Broadway overcrossing drains to Easton Creek, and the area to the east of Rollins Road south of the Broadway overcrossing drains in an easterly direction under US 101 to an open ditch adjacent to the northbound US 101 off-ramp, which drains into Sanchez Creek and ultimately into Burlingame Lagoon. The area surrounding and beneath the eastern landing of the Broadway overcrossing between US 101 and Airport Boulevard drains to a culvert beneath Bayshore Highway, which drains into an unlined channel whose outlet to the bay has been blocked by a berm. Bayshore Highway drains to the east into Easton Creek. A portion of the northbound US 101 north of Easton Creek drains to an open ditch along northboyund US 101 that eventually drains to Mills Creek located just north of the Project's northern limit. A small portion of Airport Boulevard drains to San Francisco Bay, Lower.

The SFBRWQCB Basin Plan does not designate beneficial uses for Mills Creek, Easton Creek and Sanchez Creek. The San Francisco Bay, Lower is the only receiving water body with identified beneficial uses shown in the SFBRWQCB Basin Plan. These beneficial uses are:

- Fish Spawning (SPWN)
- Industrial Service Supply (IND)
- Ocean, Commercial and Sport Fishing (COMM)
- Shellfish Harvesting (SHELL)
- Estuarine Habitat (EST)
- Fish Migration (MIGR)
- Preservation of Rare and Endangered Species (RARE)
- Wildlife Habitat (WILD)
- Water Contact Recreation (REC-1)
- Non-Contact Recreation (REC-2)
- Navigation (NAV)

Figure 3. Receiving Water Bodies

2.3.2.2 Water Quality Objectives for Surface Waters

According to the SFBRWQCB, there are numerical objectives for surface waters. These WQOs for surface waters are in Chapter 3 of the SFBRWQCB Basin Plan, referenced in Appendix D of this report, and listed below:

- Bacteria
- Bioaccumulation
- Biostimulatory Substances
- Color
- Dissolved Oxygen
- Floating Material
- Oil and Grease
- Population and Community
- Ecology
- pH
- Radioactivity
- Salinity
- Sediment
- Settleable Material
- Suspended Material
- Sulfide
- Tastes and Odors
- Toxicity
- Turbidity
- Un-Ionized Ammonia
- Objectives for Specific Chemical Constituents

Under the SFBRWQCB's Basin Plan, the following limitations for toxic pollutants for marine waters apply.

Table 4. Marine[a] WQOs for Toxic Pollutants for Surface Waters
*All units in ug/L, except as otherwise noted

Compound	4-day Average	1-hr Average	24-hr Average
Arsenic[b, c, d]	36	69	
Cadmium[b, c, d]	9.3	42	
Chromium VI[b, c, d, e]	50	1100	
Copper[c, d, f]			
Cyanide[g]			
Lead[b, c, d]	8.1	210	
Mercury[h]	0.025	2.1	
Nickel[b, c, d]	8.2	74	
Selenium[i]			
Silver[b, c, d]		1.9	
Tributyltin[j]			
Zinc[b, c, d]	81	90	
PAHs[k]			15

Source: SFBRWQCB Basin Plan, 2011

NOTES:

a. Marine waters are those in which the salinity is equal to or greater than 10 parts per thousand 95% of the time, as set forth in Chapter 4 of the Basin Plan. Unless a site-specific objective has been adopted, these objectives shall apply to all marine waters except for the South Bay south of Dumbarton Bridge (where the California Toxics Rule (CTR) applies) or as specified in note h (below). For waters in which the salinity is between 1 and 10 parts per thousand, the applicable objectives are the more stringent of the freshwater (Table 3-4) or marine objectives.
b. Source: 40 CFR Part 131.38 (California Toxics Rule or CTR), May 18, 2000.
c. These objectives for metals are expressed in terms of the dissolved fraction of the metal in the water column.
d. According to the CTR, these objectives are expressed as a function of the water-effect ratio (WER), which is a measure of the toxicity of a pollutant in site water divided by the same measure of the toxicity of the same pollutant in laboratory dilution water. The 1-hr. and 4-day objectives = table value X WER. The table values assume a WER equal to one.
e. This objective may be met as total chromium.
f. Water quality objectives for copper were promulgated by the CTR and may be updated by U.S. EPA without amending the Basin Plan. Note: at the time of writing, the values are 3.1 ug/l (4-day average) and 4.8 ug/l (1-hr. average). The most recent version of the CTR should be consulted before applying these values.
g. Cyanide criteria were promulgated in the National Toxics Rule (NTR) (Note: at the time of writing, the values are 1.0 µg/l (4-day average) and 1.0 µg/l (1-hr. average)) and apply, except that site-specific marine water quality objectives for cyanide have been adopted for San Francisco Bay as set forth in Table 3-3C.
h. Source: U.S. EPA Ambient Water Quality Criteria for Mercury (1984). The 4-day average value for mercury does not apply to San Francisco Bay; instead, the water quality objectives specified in Table 3-3B apply. The 1-hour average value continues to apply to San Francisco Bay.
i. Selenium criteria were promulgated for all San Francisco Bay/Delta waters in the National Toxics Rule (NTR). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and Sacramento-San Joaquin Delta. Note: at the time of writing, the values are 5.0 ug/l (4-day average) and 20 ug/l (1-hr. average).
j. Tributyltin is a compound used as an antifouling ingredient in marine paints and toxic to aquatic life in low concentrations. U.S. EPA has published draft criteria for protection of aquatic life (Federal Register: December 27, 2002, Vol. 67, No. 249, Page 79090-79091). These criteria are cited for advisory purposes. The draft criteria may be revised.
k. The 24-hour average aquatic life protection objective for total PAHs is retained from the 1995 Basin Plan. Source: U.S. EPA 1980.

For San Francisco Bay, WQOs listed in Table 5, Table 6, and Table 7 apply.

Table 5. WQOs for Copper and Nickel in San Francisco Bay (ug/L)

Compound	4-day Average (CCC)[1]	1-hr Average (CMC)[2]	Extent of Applicability
Copper	6.9	10.8	The portion of Lower San Francisco Bay south of the line representing the Hayward Shoals shown on Figure 7.1. and South San Francisco Bay
Copper	6.0	9.4	The portion of the delta located in the San Francisco Bay Region, Suisun Bay, Carquinez Strait, San Pablo Bay, Central San Francisco Bay, and the portion of Lower San Francisco Bay north of the line representing the Hayward Shoals on Figure 7.1.
Nickel	11.9	62.4*	South San Francisco Bay

Source: SFBRWQCB Basin Plan, 2011

NOTES:
1. Criteria Continuous Concentration
2. Criteria Maximum Concentration
* Handbook of Water Quality Standards, 2nd ed. 1994 in Section 3.7.6 states that the CMC = Final AcuteValue/2; 62.4 is the Final Acute Value (resident species database)/2; so the site-specific CMC is lower than the California Toxics Rule value because we are using the resident species database instead of the National Species Database.

Table 6. Marine[a] WQOs for Mercury in San Francisco Bay[b] (ug/L)

Protection of Human Health	0.2 mg mercury per kg fish tissue	Average wet weight concentration measured in the edible portion of trophic level 3 and trophic level 4 fish[c]
Protection of Aquatic Organisms and Wildlife	0.03 mg mercury per kg fish	Average wet weight concentration measured in whole fish 3–5 cm in length

Source: SFBRWQCB Basin Plan, 2011

NOTES:
a. Marine waters are those in which the salinity is equal to or greater than 10 parts per thousand 95% of the time, as set forth in Chapter 4 of the Basin Plan. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable objectives are the more stringent of the freshwater (Table 3-4) or marine objectives.
b. Objectives apply to all segments of San Francisco Bay, including Sacramento/San Joaquin River Delta (within San Francisco Bay region), Suisun Bay, Carquinez Strait, San Pablo Bay, Richardson Bay, Central San Francisco Bay, Lower San Francisco Bay, and South San Francisco Bay (including the Lower South Bay).
c. Compliance shall be determined by analysis of fish tissue as described in Chapter 6, Surveillance and Monitoring.

Table 7. Marine[a] WQOs for Cyanide in San Francisco Bay[b] (ug/L)

Cyanide	Chronic Objective (4-day Average)	2.9
Cyanide	Acute Objective (1-hour Average)	9.4

Source: SFBRWQCB Basin Plan, 2011

NOTES:
a. Marine waters are those in which the salinity is equal to or greater than 10 parts per thousand 95% of the time, as set forth in Chapter 4 of the Basin Plan. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable objectives are the more stringent of the freshwater or marine objectives.
b. Objectives apply to all segments of San Francisco Bay, including Sacramento/San Joaquin River Delta (within San Francisco Bay region), Suisun Bay, Carquinez Strait, San Pablo Bay, Central San Francisco Bay, Lower San Francisco Bay, and South San Francisco Bay.

3 SOILS, GEOLOGY, AND GROUNDWATER

3.1 Soils and Geology

A geotechnical report (2001) prepared by Parikh Consultants, Inc. summarizes soil information at the Project site. Soils at the Project site generally consist of up to 10 feet of artificial fill underlain by 5 to 10 feet of soft organic clay (Bay Mud). Historic borings at the interchange did not encounter bedrock to a maximum depth of 85 feet. It should also be noted that the soils at the site are corrosive.

3.2 Groundwater

The *Hazardous Materials Site Investigation Report* (2013) prepared by URS summarizes pertinent groundwater information. Groundwater is generally encountered at a depth of approximately 4.5 ft to 5 ft below ground surface (bgs) within the Project limits. Given the presence of Bay Mud at the soil/groundwater interface, limited dewatering may be necessary for excavation in these areas due to slow groundwater flow rates. (URS, 2013)

3.2.1 Estimated Groundwater Seepage Rates

A groundwater seepage memo prepared by URS (2013) summarizes the estimated groundwater seepage rates at the Project site. Seepage rates for excavations within the Project site expected to require dewatering were estimated, and these estimations are provided in the following tables.

Table 8. Estimated Seepage at Broadway Overcrossing

Support Location	Footing/Pile Cap Dimensions (ft)	Bottom of Pile Cap Elevation (ft)	Estimated Groundwater Elevation*** bgs (ft)	Approximate Seepage Rate (gallons/day)
Abutment 1	15 x 116.3	5.5	3	20,000
Bent 2	22 x 22*	5.0	5	7,200*
Abutment 3	15 x 123.25	4.5	3	35,000
Abutment 3 Return Wall**	17.5 x 15 15.5 x 13 17 x 11	4.5 8.5 12.5	3	5,000** Dry Dry

Note:
* = Five footings for Bent 2 and seepage estimates are for one footing.
** = Return walls are located on both sides of Abutement 3 and the seepage estimates are for one return wall.
*** = Groundwater table depths are approximate based on available data from Geotracker database and adjacent borings or CPTs.

Table 9. Estimated Seepage at Southbound US 101 On-ramp

Support Location	Footing/Pile Cap Dimensions (ft)	Bottom of Pile Cap Elevation (ft)	Estimated Groundwater Elevation bgs (ft)	Approximate Seepage Rate (gallons/day)
Abutment 1	15 x 67.25	4.5	3	19,000
Abutment 2	12.5 x 47.15	4.5	3	11,000
Abutment 1 RW	15 x 22.3	4.5	3	6,300
Abutment 2 Lt RW	9 x 25	4.5	3	4,200
Abutment 2 Rt RW	9 x 25	4.5	3	4,200

Note:
Lt = left; Rt = right; RW = return wall

Table 10. Estimated Seepage at Retaining Walls

Support Location	Bottom of Footing/Leveling Pad Elevation (ft)	Approximate Seepage Rate (gallons/day)
RW 15	6.92	3,000
RW 38	7.57	9,000
RW 39	7.57	9,000
RW 205	4.41 to 6.91	6,900
RW 209	8.06	1,400
RW 314	8.53	700
RW 315	8.81	300
RW 316	8.38	930

Note:
RW = retaining wall

Table 11. Estimated Seepage at Overhead Sign Locations

Sign Number	Direction	CIDH Pile Diameter (ft)	CIDH Pile Depth (ft)	Estimated Groudwater Elevation bgs (ft)	Approximate Seepage Rate (gallons/day)
SS2-A	Southbound	5	35	3	4,700

Table 12. Estimated Seepage at Sanitary Sewer System Locations

Sanitary Sewer System Number	Elevation of Bottom of Excavation (ft)	Approximate Seepage Rate (gallons/day)
1	1.5 to 3.8	12,000
2	0.76	18,000
3	4.5 to 6.0	6,000
4	3.8 to 4.0	7,500
5	4.08 to 6.35	6,000

3.2.2 Groundwater Quality

Groundwater quality at the Project site is potentially affected by historical land uses and leaking underground storage tanks (LUST) at adjacent properties. There are two active LUST cleanup sites located near the Project site. The most current groundwater monitoring report prepared for the LUST facility at 1000 Broadway indicates that benzene and methyl tertiary butyl ether (MTBE) are present within the well closest to the Project site. Information regarding the extent of the plume was not available. The most recent annual groundwater monitoring report prepared for the LUST facility at 1147 Rollins Road indicates that the plume is located entirely within the parcel and is well defined. Groundwater is not expected to be classified as a California or Resource Conservation and Recovery Act hazardous waste. (URS, 2013)

Groundwater samples were collected adjacent to or downgradient of properties potentially affecting groundwater quality within the Project site and in areas where the possibility of dewatering may occur. Lead, nickel, and zinc were detected in concentrations exceeding the City's criteria for sanitary sewer discharges. Some VOCs were also detected in groundwater samples.

See Table 13 and Table 14 for groundwater quality data collected during the hazardous materials investigation and Phase I site investigation compared to both the City's sanitary sewer discharge criteria and effluent limitations under the VOC and Fuel General Permit.

Table 13. Groundwater Quality Testing Data: Metals

Boring Sample Location ID	Lab Sample ID	Sample Date	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Lead	Mercury	Molybdenum	Nickel	Selenium	Silver	Thallium	Vanadium	Zinc
	EPA Method		6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	6010B	7471A	6010B	6010B	6010B	6010B	6010B	6010B	6010B
	Units		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	15.10 Groundwater Discharge Permit Criteria		NE	0.08	NE	NE	0.138	2.532	NE	2	0.365	0.01	NE	0.445	0.106	0.2	NE	NE	0.386
	VOC and Fuel General NPDES Permit Criteria		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Stage 1																			
N-03-A-GW	Groundwater encountered but not collected due to insufficient recharge.																		
N-17-A-GW	1110096-009A	10/13/2011	0.011	0.023	0.61	<0.005	0.0054	0.16	0.038	0.18	**0.38**	0.00031	0.015	0.18	<0.020	<0.005	<0.010	0.088	**1.9**
S-08-A-GW	Groundwater encountered but not collected due to insufficient recharge.																		
Stage 2																			
S-01-B-GW	Groundwater not encountered within first 6 feet of drilling.																		
S-04-A-GW	Groundwater encountered but not collected due to insufficient recharge.																		
A-07-A-GW	1111097-008A	11/15/2011	0.021	0.077	2.5	<0.005	0.0082	0.58	0.16	0.30	0.29	0.00055	<0.010	**0.67**	0.020	<0.005	<0.010	0.50	**1.8**
Stage 3																			
S-19-B-GW	Groundwater not encountered within first 6 feet of drilling.																		
Stage 4																			
N-20-A-GW	Groundwater not encountered within first 6 feet of drilling.																		

Source: URS, 2013

NOTES:
EPA = U.S. Environmental Protection Agency
NE = Not Established
BOLD indicates an exceedance of a 15.10 Groundwater Discharge Permit effluent limit
The symbol "<" (less than) indicates that the analyte was not detected at a concentration above the laboratory detection limit specified

Table 14. Groundwater Quality Testing Data: Other

Boring Sample Location ID	Lab Sample ID	Sample Date	Tert-Butanol	Diisopropyl ether (DIPE)	TAME	ETBE	Chloroform	Benzene	Toluene	Ethyl Benzene	m,p-Xylene	o-Xylene	n-Butylbenzene	1,2,4-Trimethylbenzene	n-Propylbenzene	Isopropyl Benzene	Other VOCs	TPH as Gasoline	TPH as Diesel	TPH as Motor Oil	MTBE
	EPA Method		8015B	8015B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260B	8260TPH	SW8015B(M)	SW8015B(M)	8260B (TPH)
	Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	mg/L	ug/L
	15.10 Groundwater Discharge Permit Criteria		NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	10 mg/L (aggregate TPH and MTBE)			
	VOC and Fuel General NPDES Permit Criteria – Maximum Daily Effluent Limitation		NE	NE	NE	NE	5	5	5	5	5 (total Xylenes)		NE	NE	NE	NE	NE	50 ug/L (as gasoline or diesel)		NE	5
Stage 1																					
N-03-A-GW	Groundwater encountered but not collected due to insufficient recharge.																				
N-17-A-GW	1110096-009A	10/13/2011	<5.0	<0.50	<0.50	<0.50	0.60	<0.50	<0.50	<0.50	<1.0	<0.50	<0.50	<0.50	<0.50	<0.50	ND	<50	<0.11	0.35	<0.50
S-08-A-GW	Groundwater encountered but not collected due to insufficient recharge.																				
Stage 2																					
S-01-B-GW	Groundwater not encountered within first 6 feet of drilling.																				
S-04-A-GW	Groundwater encountered but not collected due to insufficient recharge.																				
A-07-A-GW	1111097-008A	11/15/2011	<44	<4.4	<4.4	<4.4	<4.4	110	24	<4.4	29	10	60	8.8	5.0	27	ND	**14,000***	2.0*	<0.40*	380*
Stage 3																					
Stage 4																					
N-20-A-GW	Groundwater not encountered within first 3 feet of drilling.																				
Stage 5																					
S-19-B-GW	Groundwater not encountered within first 6 feet of drilling.																				

Source: URS, 2013

NOTES:
EPA = U.S. Environmental Protection Agency
NE = Not Established
BOLD indicates an exceedance of a 15.10 Groundwater Discharge Permit effluent limit
HIGHLIGHT indicates an exceedance of a VOC and Fuel General Permit effluent limit
* = TPH as gasoline, diesel, and motor oil and MTBE exceeded the 15.10 Groundwater Discharge Permit combined effluent limit
The symbol "<" (less than) indicates that the analyte was not detected at a concentration above the laboratory detection limit specified

4 WATER TREATMENT SYSTEM

4.1 Treatment System

Based on the groundwater samples collected for the Project and the applicable effluent limitations, a water treatment system is proposed for non-storm water and groundwater inflows collected during construction. The treatment system must be designed according to site conditions and the anticipated flow rates (see Tables 8 through 11 for estimated groundwater seepage rates), and it must include a means of collection and conveyance, temporary holding tanks, and a discharge method.

At a minimum, the treatment system must be capable of removing sediment, suspended solids, Total Petroleum Hydrocarbons (TPHs), VOCs, and metals; see Tables 13 and 14 for groundwater quality testing results. Primary and secondary treatment may be required, or the design of the system may require combined use various components to achieve effective treatment. The system must have components to:

- Remove sediment, turbidity-producing suspended solids, TPHs, VOCs, and metals with desilting basins, weir tanks, settling tanks, sediment traps, gravity bag filters, sand media filters, pressurized bag filters, cartridge filters, in-line chemical coagulants and flocculants, activated clay filters, activated carbon filters, or any combination necessary to provide primary and secondary treatment.

In addition, the treatment system must adjust pH or dissolved oxygen by:

- Addition of sulfuric, phosphoric, citric, or nitric acid under the supplier's specifications and by the SFBRWQCB to treat high pH (hydrochloric acid may be used if the water is dechlorinated before discharge);
- Filtration through a limestone bed, addition of sodium hydroxide, or diffusion of carbon dioxide to produce carbonic acid to treat low pH; or
- Aeration to treat low dissolved oxygen.

It is assumed that the collection and conveyance system would include a series of drain inlet structures, piping, trenches, and pumps as needed to be defined during the detailed design phase. Pumps and piping must comply with Caltrans Standard Specification 74-2 (2010), and a flow meter must be used to measure all discharges from treatment activities.

All water pumped during the course of dewatering must be stored in temporary holding tanks, such as transportable, closed-top holding tanks or tanker trucks. Each holding tank must have an inlet and outlet capable of receiving and discharging flows at a rate sufficient to dewater the excavations. A sufficient number of holding tanks should be provided based on anticipated flow rates, pumping rates, capacity inefficiencies due to sediment retention, sedimentation rates, sediment removal frequency, and anticipated

water loss or reuse rates to handle all dewatering activities and prevent delay of work. In addition, 1 ft of freeboard must be maintained within each holding tank at all times, and the tanks must be cleaned when 25% of their volume is filled with sediment.

4.2 Discharge Method

The last component of the treatment system would be the discharge method and location. Both permit conditions have discharge requirements in addition to those aforementioned in this section. This subsection provides a summary of those additional requirements.

4.2.1 Discharges under Caltrans NPDES Permit

Under the Caltrans NPDES permit and with Caltrans' prior approval, treated non-storm waters may be used to control dust or be discharged to land where the grade allows for sheet flow and the soil allows for infiltration such that erosion and scour are avoided; velocity dissipaters may be used to slow discharge flows. This option reduces costs associated with discharging to the City's sanitary sewer system and provides the most water quality benefits.

4.2.2 Discharges under 15.10 Groundwater Discharge Permit

Coordination with the City's Public Works Engineering department will be required to address flow rate, maximum volume allowed per day/time, and/or limits to duration of discharge and permitted discharge point. Non-storm waters may not be delivered to the wastewater treatment plant; discharges must occur through a manhole or similar appurtenance. (Eva Justimbaste, Environmental Compliance Supervisor at the Burlingame Wastewater Treatment Plant, personal communication, April 9, 2013)

4.2.3 Discharges under VOC and Fuel General NPDES Permit

Discharges to the Project drainage system may not cause scouring or erosion where the system releases flows into the receiving water, and discharges may not contribute to scouring of banks, excessive sedimentation, or flooding downstream. In addition, discharges may not impact the natural channel bedding and aquatic life.

5 SUBMITTALS, MONITORING, AND REPORTING

Both potential Project discharge conditions require submittals, monitoring, and reporting under the respective permits. The following sections outline these requirements; however, the specific terms and conditions of regulatory compliance will be contained within the permits issued to the Project.

5.1.1 Dewatering and Discharge Plan

Regardless of the discharge condition, the Project requires a Dewatering and Discharge Plan (DDP). DDPs outline all applicable information pertaining to the non-storm water treatment system, including operation, maintenance, spill prevention, inspection, etc. The DDP must be approved by Caltrans and the SFBRWQCB. Construction may begin 30 days after the DPP has been approved by the Project Engineer. The DDP must include the following:

1. Title sheet
2. Table of contents
3. Certification and approval sheet described in Caltrans' Storm Water Pollution Prevention Plan (SWPPP) and Water Pollution Control Plan (WPCP) Preparation Manual
4. Amendment log and format described in Caltrans' SWPPP and WPCP Preparation Manual
5. Description and schedule of the dewatering and discharge operations
6. Discharge alternatives, including:
    a. Dust control
    b. Percolation
    c. Storm sewers
    d. Surface waters
7. Treatment system description and components
8. Anticipated flow rates
9. Operation and maintenance manual for equipment
10. Monitoring, sampling, and reporting plan, including quality assurance and quality control
11. Health and safety plan
12. Spill prevention plan
13. Field-recorded data, visual inspection, calibration procedures, and examples of logs
14. Measuring equipment descriptions
15. Shop drawings showing:
    a. Section and plan views of stormwater effluent treatment systems
    b. Location of sampling points for water quality measurements
    c. Flow path and placement of pipes, hoses, pumps, holding tanks, and other equipment used to convey water
    d. General position of treatment components relative to excavations or other areas requiring dewatering

   e. Point of stormwater discharge
16. Daily inspection report form. The daily inspection report must include:
    a. Discharge volumes
    b. Water quality monitoring records
    c. Discharge point information that includes:
        i. Date and time
        ii. Weather conditions, including wind direction and velocity
        iii. Presence or absence of water fowl or aquatic wildlife
        iv. Color and clarity of the effluent discharge
        v. Erosion or ponding downstream of the discharge site
        vi. Photographs labeled with the time, date, and location
17. Municipal batch discharge permit from a POTW facility, if used
18. Coagulant Pollution Prevention Plan (CPPP) with the DDP if chemical coagulants, in-line flocculants, or both, are used in the treatment system. Chemical coagulants and flocculants proposed for use in the CPPP must comply with Attachment F Provisions D and E in General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (Order No. 2009-0009-DWQ, NPDES No. CAS000002). The CPPP must include:
    a. Description of best management practices to prevent accidental spillage, overfeeding into the treatment system, or other mishandling of coagulant agents
    b. Monitoring plan for all coagulants, flocculants, or both that complies with Attachment F in Order 2009-0009
    c. Description of the agents, including chemical and trade names
    d. Determination of acute and chronic toxicity for aquatic organisms conforming to U.S. Environmental Protection Agency methods for the agents
    e. Monitoring plan to detect a residual agent at concentrations at or below established acute toxicity levels for freshwater and marine conditions for that agent

5.1.2 Notice of Discharge Report

Whenever observations and monitoring equipment confirm that effluent limitations or water quality standards are exceeded, a Notice of Discharge report must be submitted within 48 hours. Included in the report should be documentation regarding the reasons for the exceedance and any corrective actions taken to prevent recurrence.

5.1.3 Daily Inspection Report

Daily Inspection Reports shall be submitted within 24 hours if the non-storm water treatment system is discharging. Records documenting the addition or removal of non-storm water treatment system components must be included.

5.1.4 Requirements under 15.10 Groundwater Discharge Permit

This section only pertains to the discharge condition regulated under the City's 15.10 Groundwater Discharge Permit. All specific submittal, monitoring, and reporting

requirements to maintain compliance with the 15.10 Groundwater Discharge Permit will be specified in the terms and conditions of the permit issued to the Project. As a permit condition, the director may require a permittee to develop and execute a self-monitoring sampling and analysis program to demonstrate compliance with the requirements presented in §15.10 of the City's Municipal Code. The frequency and analyses of monitoring required under the self-monitoring program depends on factors such as flow rates, potential for disturbing treatment processes, pollutants, and prior compliance history. The permit may also specify the type of sampling and flow monitoring equipment that must be installed and used.

All permit holders are required to submit the following reports to the director, at a minimum:

- Baseline monitoring reports
- Compliance reports (to be submitted within 90 days of the compliance date pursuant to applicable standards)
- Periodic discharge reports (describes whether applicable discharge limits are being met)

All wastewater samples submitted in the course monitoring and reporting must be representative of the permittee's discharge. Maintaining all monitoring equipment in good, working order will ensure that sample results are representative of discharges. All monitored discharges should be analyzed and tested according to 40 CFR Part 136, unless otherwise specified in an applicable pretreatment standard. Refer to City's Municipal Code §15.10.098 for applicable monitoring requirements.

5.1.5 Requirements under VOC and Fuel General NPDES Permit

This section only pertains to the discharge condition regulated under the VOC and Fuel General Permit. A monitoring system will be required to continuously monitor the flow rate and the quality of effluent discharged from the temporary treatment system. Flow metering systems will need to be installed throughout the process. All monitoring and reporting activities must comply with the requirements specified in Attachment E of the VOC and Fuel General Permit; see Appendix C.

Dischargers with flow rates exceeding 10 gallons per minute may be required to comply with additional requirements. Any additional requirements will be specified in the Authorization to Discharge letter. These requirements could include:

- Monitoring in response to a complaint received about a facility authorized to discharge under this permit
- Storm water monitoring
- Dioxins and furans monitoring
- Regional Monitoring Program monitoring
- Additional discharge observations
- Additional effluent and ambient priority pollutant scans

6 REFERENCES

Burlingame (California). *Title 15 Waters and Sewers, Chapter 15.10 Sanitary Sewer Use and Regulations.* [Burlingame, California] Municipal Code.

Parikh Consultants, Inc. (May 2001). *Preliminary Geotechnical Report, Broadway Interchange (IC) Reconstruction Project.*

URS. (January 2013). *Hazardous Materials Site Investigation Report.*

URS. (April 2013). *Seepage Estimates for Bridge Foundation, Overhead Sign, Retaining Wall Foundation and Drainage Facility Excavations.*

San Francisco Regional Water Quality Control Board. (2011). *Water Quality Control Plan for San Francisco Bay Basin* (Basin Plan).

Appendix A City of Burlingame Municipal Code Title 15, Chapter 15.10

Chapter 15.10 SANITARY SEWER USE REGULATIONS

15.10.005 Purpose and policy.

These sanitary sewer use rules and regulations are intended to do the following:

(a) Set uniform requirements for discharges into the wastewater collection and treatment system and enable the city to comply with the administrative provisions of the clean water grant regulations, the water quality requirements set by the applicable effluent limitations, national standards of performance, toxic and pretreatment effluent standards and all other discharge criteria which are required or authorized by state or federal law, and to derive the maximum public benefit by regulating the quality and quantity of wastewater discharged into the city of Burlingame's sewer system.

(b) Provide for and regulate the disposal of sanitary sewage into the sanitary sewer system of the city in such a manner and to such an extent as is reasonably necessary to sustain the ability of the sanitary sewer system to handle and dispose of sanitary sewage.

(c) Provide for and regulate the disposal of industrial wastes into the sanitary sewer system of the city in such a manner and to such an extent as may be reasonably necessary to maintain and increase the ability of such system to handle and dispose of industrial waste without decreasing the ability of said system to handle and dispose of all sanitary sewage.

(d) Prevent the introduction of pollutants into the sanitary sewer system which will pass through the treatment works of the city and cooperating agencies or otherwise be incompatible with such works or interfere with the ability of the works to treat, discharge and recycle wastewater, or to use or dispose of bio-solids.

(e) Improve opportunities to recycle and reclaim treated effluent and wastewater sludge.

(f) Protect the physical structures of the sanitary sewer system and the efficient functioning of its component parts.

(g) Protect the city, its citizens, and the personnel working in the sanitary sewage system facilities.

(h) Preserve and protect the health, safety and property of the public.

(i) Protect the environmental health of San Francisco Bay.

(j) Provide a means for determining wastewater volumes, constituents and characteristics, the setting of charges and fees and the issuance of permits to certain users.

(k) Derive revenues to be used to defray the city's cost of operating and maintaining adequate wastewater collection and treatment systems and to provide funds for capital outlay, bond service costs, capital improvements and depreciation. (Ord. 913 § 1 (part), (1970); Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.007 Conflicts with other provisions.

In the event of any conflicts or inconsistencies between the provision of this chapter and any other provisions of this code, the provisions that provide the greatest protection to the sewage works and San Francisco Bay shall prevail as determined by the director of public works. (Ord. 1633 § 2 (part), (2000))

15.10.010 Violation unlawful.

It is unlawful for any person to:

(a) Connect to, construct or install or provide, maintain or use any other means of sewage disposal except by connection to a public sewer as required by this chapter; or

(b) Dispose of any sewage in the city in violation of this chapter or of any permit issued pursuant to this chapter. (Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.015 Definitions.

When used in this chapter or in connection with any resolution, regulation, permit, order, or other action undertaken pursuant to this chapter, the following words shall have the following meanings:

(a) "A" Definitions.

(1) ACT or Act. "ACT" or "Act" means the Federal Water Pollution Control Act, also known as the Clean Water Act, P.L. 92-500, and amendments thereto, as well as any guidelines, limitations, standards, and regulations promulgated by the United States government through the Environmental Protection Agency pursuant to the Act.

(2) Agency. "Agency" means the city when the context so indicates.

(3) Ammonia. "Ammonia" means that form of nitrogen which is chemically definable as NH_3.

(4) Applicant. "Applicant" means the person making application for a permit for a sewer or plumbing installation or discharge, and shall be the owner of the premises to be served by the sewer or plumbing installation or from which the discharge is to occur, or the owner's duly authorized agent.

(5) Audit Protocols. "Audit protocols" mean the procedures to be followed in performing a mass audit study.

(6) Average Concentration. "Average concentration" means the concentration of a pollutant in an industrial user's discharge that is calculated by adding the concentrations of the particular pollutant in all composite samples taken during a given time period, including, but not limited to, self monitoring samples, and dividing the total by the number of samples taken.

(b) "B" Definitions.

(1) Beneficial Uses. "Beneficial uses" mean uses of the waters of the state that may be protected against quality degradation, including domestic, municipal, agricultural, and industrial supply, power generation, recreation, aesthetic enjoyment, navigation, and the preservation and enhancement of fish, wildlife, and other aquatic resources or reserves, and other uses, both tangible or intangible as specified by federal or state law.

(2) Best Management Practices. "Best management practices" mean schedules of activities, prohibitions of practices, maintenance procedures and other management practices to prevent or reduce the introduction of pollutants to the sanitary sewer system which have been determined by the director to be cost effective for particular industry groups, business types, or specific industrial processes.

(3) BOD or Biochemical Oxygen Demand. "BOD" or "biochemical oxygen demand" means the measure of decomposable material in domestic or industrial wastewaters as represented by the oxygen utilized in decomposition

over a period of incubation of five (5) days at twenty (20) degrees centigrade under laboratory conditions pursuant to standard methods.

(4) Building. "Building" means any structure used for a residence, place of business, recreation, or other purpose of human habitation.

(5) Building Sewer. "Building sewer" means that portion of any sewer conveying wastewater from the premises of a user to a community sewer, beginning at the plumbing or drainage outlet of any building and running to the lateral sewer at or near the property line.

(c) "C" Definitions.

(1) Categorical Pretreatment Standards. "Categorical pretreatment standards" means the limitations on pollutant discharges to POTW's promulgated by EPA in accordance with Section 307 of the Act, that apply to

specified process wastewaters of particular industrial categories. [40 CFR 403.6 and Parts 405-471].

(2) COD or Chemical Oxygen Demand. "COD" or "chemical oxygen demand" means the measure of chemically decomposable material in domestic or industrial wastewater as represented by the oxygen utilized as determined by the appropriate procedure described in standard methods.

(3) Code of Federal Regulations or CFR. "Code of Federal Regulations" or "CFR" means the Code of Federal Regulations published by the Office of the Federal Register, National Archives and Records Administration. Whenever a reference is made to any portion of the CFR, or to any other federal regulation, that reference shall include all amendments and additions to that portion of the CFR or regulation, now or hereinafter adopted.

(4) Combined sewer. "Combined sewer" means a sewer receiving both surface runoff and sewage.

(5) Commercial user (COM). "Commercial user" or "COM" means any person who discharges non-domestic wastewater and who provides a service or engages in the purchase or sale of commodities.

(6) Community sewer. "Community sewer" means a sewer owned and operated by the city and tributary to a treatment facility operated by the city.

(7) Compatible pollutant. "Compatible pollutant" means biochemical oxygen demand, suspended solids, pH, and fecal coliform bacteria, plus additional pollutants identified in the city's National Pollutant Discharge Elimination System (NPDES) Permit if the city's treatment plant is designed to treat such pollutants and if, in fact, does remove such pollutants to a substantial degree.

(8) Composite sample. "Composite sample" means a flow-proportional or time-proportional sample, which accurately represents the average pollutant concentration discharged during a continuous time period. A composite sample may be obtained manually or automatically, and discretely or continuously. For manual compositing, at least six (6) individual samples from each sample point shall be combined and mixed to obtain one composite sample; flow-proportion may be obtained either by varying the time interval between each discrete sample and the volume of each discrete sample.

(9) Contamination. "Contamination" means an impairment of the quality of water of the state by waste to a degree that creates a hazard to the public health through poisoning or through the spread of disease. "Contamination" includes any equivalent effect resulting from the disposal of wastewater, whether or not waters of state are affected.

(10) Contractor. "Contractor" means an individual, firm, corporation, partnership, or association licensed by the state to perform the type of work to be done under the permit.

(11) Control authority. "Control authority" means the POTW.

(12) Cost effective. "Cost effective" means that total project costs, if financed over a five (5) year period at the prime interest rate published in the Wall Street Journal plus two (2) percent at the time the project costs are being determined, do not exceed the total savings that would be generated by the project during the same five (5) year period. Project costs shall also be considered cost effective, if financing assistance is available to the discharger, from the city or any other source, at a lower rate and the project costs, if financed over a five (5) year period at that rate, do not exceed the total savings that would be generated by the project during the same five (5) year period.

(13) Critical user. "Critical user" means a discharger whose wastewater contains priority pollutants, or who discharges waste that has the potential to cause interference, excluding sanitary sewage.

(d) "D" Definitions.

(1) Department. "Department" means the city department of public works.

(2) Diluting Waters. "Diluting waters" means noncontact cooling water, boiler blowdown, domestic sewage, groundwater, stormwater, surface drainage, or potable waters which are not a part of an industrial process and which do not contain priority pollutants but which are combined with industrial wastewater prior to the monitoring point for industrial wastewater discharge.

(3) Director. “Director” means the city director of public works, or the director’s designee.

(4) Discharger. “Discharger” means any person who discharges or causes a discharge to a public sewer. See also specific discharger definitions.

(5) Dissolved Solids or Dissolved Matter. “Dissolved solids” or “dissolved matter” means the solid matter in solution in the wastewater and shall be determined by evaporation of a sample from which all suspended matter has been removed by filtration as determined by the procedures in the standard methods.

(6) Domestic Wastewater. “Domestic wastewater” means the water-carried wastes and wastewater produced from noncommercial and nonindustrial activities and that result from normal human living processes.

(e) “E” Definitions.

(1) Effluent. “Effluent” means the liquid outflow of any facility designed to treat, convey, or retain wastewater.

(2) Engineer. “Engineer” means the city director of public works.

(f) Reserved.

(g) “G” Definitions.

(1) Garbage. “Garbage” means wastes from the preparation, cooking and dispensing of foods, and from the handling, storage, and sale of produce.

(2) Grab Sample. “Grab sample” means a single discrete sample collected at a particular time and place which represents the composition of the wastestream only at that time and place with no regard to the flow in the wastestream.

(3) Gravity Separation Interceptor. “Gravity separation interceptor” means any facility designed, constructed, and operated for the purpose of removing and retaining dangerous, deleterious, or prohibited constituents from wastewater by differential gravity separation before discharge to the public sewer.

(4) Grease. “Grease” means ether-soluble matter, and shall include each of the following two (2) types:

(i) Dispersed grease, which means grease which is not floatable grease;

(ii) Floatable grease, which means grease which floats on the surface of quiescent sewage water or other liquid or which floats when mixed or added to water.

(5) Groundwater Discharger. “Groundwater discharger” means a discharger that pumps and treats contaminated groundwater and discharges to the sanitary sewer system. This class of discharger is variable, so that some permits are a year in length while others may be written for a week. Hydrocarbons are the most common pollutants.

(h) “H” Definitions.

(1) Heavy Discharger. “Heavy discharger” means a discharge that may contribute over one hundred fifty (150) pounds per day of BOD or TSS to the sanitary sewer system. Heavy dischargers are classified as SIU’s if the volume of discharge is greater than twenty-five thousand (25,000) gallons/day or they use processes that have the potential to detrimentally affect the processes of the plant.

(2) Holding Tank Waste. “Holding tank waste” means any waste from holding tanks, such as vessels, chemical toilets, trailers, septic tanks, and vacuum-pump tank trucks.

(i) “I” Definitions.

(1) Incompatible Pollutant. “Incompatible pollutant” means any pollutant that is not a “compatible pollutant” as defined above.

(2) Industrial Connection Sewer. “Industrial connection sewer” means the sewer connecting the building sewer or building waste drainage system to the public sewer for the purpose of conveying industrial wastewater.

(3) Industrial User. “Industrial user” means any non-residential user that discharges industrial wastes to the sanitary sewer system.

(4) Industrial Wastes. “Industrial wastes” means the wastes from producing, manufacturing and processing operations of every kind and nature.

(5) Industrial Wastewater. “Industrial wastewater” means all water-carried wastes and wastewater of the community, excluding domestic wastewater and uncontaminated water, and includes all wastewater from any producing, manufacturing, processing, institutional, commercial, agricultural, or other operation where the wastewater discharged includes significant quantities of wastes from non-human origin.

(6) Inspector. A person authorized by the director to inspect wastewater generation, conveyance, processing, disposal, and monitoring facilities.

(7) Interference.

(i) “Interference” means a discharge which alone, or in conjunction with a discharge or discharges from other sources, inhibits or disrupts the processes or operation of the sanitary sewer system, including the POTW, prevents the POTW from using its chosen sludge use/disposal practice, or causes or significantly contributes to a violation of any requirement of the National Pollutant Discharge Elimination System (NPDES) Permit, which is a permit issued to the city pursuant to Section 402 of the Act.

(ii) “Interference” also includes prevention of bio-solids use or disposal by the POTW in accordance with published regulations providing guidelines under Section 405 of the Act [33 U.S.C. §§1251-1387] or in regulations developed pursuant to the Solid Waste Disposal Act (SWDA) [42 U.S.C. §§6901, et seq.], the Toxic Substances Control Act [15 U.S.C. §§2601-2654], or more stringent state regulations (including those contained in any state bio-solids management plan prepared pursuant to Title IV of SWDA) applicable to the method of disposal or use employed by the POTW.

(j) Reserved.

(k) Reserved.

(l) “L” Definitions.

(1) Lateral Sewer. “Lateral sewer” means the portion of a sewer lying within a public right-of-way or easement between the city cleanout and the main sewer to which a building sewer is connected.

(2) Light Discharger. “Light discharger” means a discharger that contributes less than fifty (50) pounds per day of BOD or suspended solids to the sanitary sewer system. This category is often defined by whether or not the discharger has a grease trap.

(m) “M” Definitions.

(1) Main Sewer. “Main sewer” means a public sewer designed to accommodate more than one lateral sewer.

(2) Major Contributing Industry. “Major contributing industry” means any wastewater contributor identified in the Standard Industrial Classification (SIC) Manual in any of Divisions A, B, D, E, and I that:

(i) Has a discharge flow of fifty thousand (50,000) gallons or more per average work day; if seasonal, the average shall be computed on the period of use; or

(ii) Has a flow of or pollutant loading greater than five (5) percent of the total flow to the POTW.

(3) Manager. “Manager” means the city manager.

(4) Mass Audit Study. “Mass audit study” means an investigation of pollution prevention and source reduction measures performed by or for an industrial user, pursuant to audit protocols adopted by the director, to analyze the volume and concentration of nickel, copper, and/or any other priority pollutant identified in regulations adopted by the director in an industrial user’s process streams and discharge, and to identify the maximum feasible reduction measures available to the industrial user.

(5) Maximum Allowable Concentration. “Maximum allowable concentration” means the highest permissible concentration or other measure of pollutant magnitude taken at a specific point in time.

(6) Maximum Feasible Reduction Measures.

(i) "Maximum feasible reduction measures" mean all individual measures, and all functionally interdependent measures, of reducing the mass of specified pollutants in an industrial user's discharge, which the director finds would be cost effective if installed by the industrial user.

(ii) For the purpose of this chapter, individual measures which are not cost effective shall nonetheless be considered part of a functionally interdependent group of cost-effective measures if they substantially reduce the mass of pollutants discharged, and the other measures with which they are grouped are their functional prerequisite.

(7) Moderate Discharger. "Moderate discharger" means a discharger that contributes fifty (50) to one hundred fifty (150) pounds per day of BOD or suspended solids to the sanitary sewer system. This category is generally defined by the presence of a grease interceptor or one or more grease traps.

(n) "N" Definitions.

(1) New Source. "New source" means any wastewater generating processes constructed after the publication of proposed Pretreatment Standards that are applicable to that source and that are independent of an existing source.

(2) Non-Conventional Discharger. "Non-conventional discharger" means a discharger involved in any business or manufacturing where the possibility exists that hazardous or toxic material may be discharged to the sewer system.

(o) "O" Definitions.

(1) Outlet. "Outlet" means the end of a house plumbing system three (3) feet outside the foundation of the building.

(p) "P" Definitions.

(1) Pass-Through. "Pass-through" means a discharge that exits the sewage treatment system to the waters of the United States in quantities or concentrations that alone, or in conjunction with other discharges, causes a sewage authority to violate its NPDES permit.

(2) Peak Flow Rate. "Peak flow rate" means the average rate at which wastewater is discharged to a public sewer during the highest thirty (30) minute flow period in the preceding twelve (12) months.

(3) Permit. "Permit" means any written authorization required pursuant to this or any other ordinance or regulation of the city for the installation of any sewer or the discharge of waste into the sewer system.

(4) pH. "pH" means the logarithm of the reciprocal of the concentration of hydrogen ions in moles per liter of solution.

(5) Plant. "Plant" means the city POTW.

(6) Plumbing System. "Plumbing system" means all plumbing fixtures and traps or soil, waste, special waste and vent pipes, and all sanitary sewer pipes within a building and extending to the building sewer connection three (3) feet outside the building foundation.

(7) Pollution. "Pollution" means the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water.

(8) POTW. "POTW" means the city treatment works, which is a treatment works as defined by Section 212 of the Act. This definition includes any devices and systems used in the storage, treatment, recycling and reclamation of municipal sewage or industrial wastes of a liquid nature. It also includes sewers, pipes and other conveyances only if they convey wastewater to the POTW.

(9) Premises. "Premises" means a single-family dwelling, duplex, triplex, quadplex, apartment house, commercial building, industrial building, or other structure used or useful for habitation or other occupancy of human beings.

(10) Pretreatment or Treatment. "Pretreatment" or "treatment" means the reduction of the amount of pollutants, or the alteration of the nature of pollutant properties in wastewater to a less harmful state prior to or in

lieu of discharging or otherwise introducing such chemical or biological processes, or process changes by other means, except as prohibited by 40 CFR Section 403.6(d).

(11) Priority Pollutants. “Priority pollutants” mean all pollutants as defined by the “General Pretreatment Regulations” of the Environmental Protection Agency, found at 40 CFR 401 and 403.

(12) Process Flow. “Process flow” means the daily, twenty-four (24) hour, flow of wastewater from any kind or nature of production, manufacturing or processing operation, including industrial and commercial operations where water is used for the removal of any type of waste other than sanitary sewage. Process flow does not include diluting waters.

(13) Publicly Owned Treatment Works or POTW. “Publicly owned treatment works” or “POTW” means a treatment works as defined by Section 212 of the Act [33 U.S.C. Section 1292], which is owned by the city. This definition includes any sewers that convey wastewater to the POTW treatment plant, but does not include pipes, sewer, or other conveyances not connected to a facility providing treatment. For the purposes of this chapter, “POTW” shall also include any sewers that convey wastewaters to the POTW from persons outside the city who are, by contract or agreement with the city, users of the city POTW.

(14) Public Sewer. “Public sewer” means any sewer dedicated to public use and whose use is controlled by a public corporation.

(q) Reserved.

(r) “R” Definitions.

(1) Reasonable Control Measures. “Reasonable control measures” mean control technologies, best management practices, source control practices and waste minimization procedures which prevent or reduce the introduction of pollutants to the sanitary sewer system and are determined by the director to be cost effective for particular industry groups, business types, or specific industrial processes.

(s) “S” Definitions.

(1) Sanitary Sewer. “Sanitary sewer” means a sewer that carries sanitary sewage to which storm, surface, and groundwater are not intentionally admitted.

(2) Sanitary Sewage. “Sanitary sewage” means water-carried wastes from residences, business buildings, institutions, and industrial establishments, excluding ground, surface and storm waters, subsurface drainage and also excluding industrial waste.

(3) Sanitary Sewer System or Sewerage System. “Sanitary sewer system” or “sewerage system” means all sewers, treatment plants, and other facilities owned or operated by the city for carrying, collecting, pumping, treating, and disposing of sanitary sewage and industrial wastes.

(4) Sewage. “Sewage” means a combination of water-carried waste from residences, business buildings, public buildings, institutions, and industrial establishments.

(5) Sewage Pumping Plant. “Sewage pumping plant” means any facility designed and constructed to raise wastewater in elevation or to overcome head losses due to pipeline friction.

(6) Sewer. “Sewer” means a pipe or conduit for carrying sewage.

(7) Sewerage. “Sewerage” means any and all facilities used for collecting, conveying, pumping, treating, and disposing of wastewater.

(8) Side Sewer. “Side sewer” means the sewer line beginning at the house outlet and terminating at the main seer and includes the building sewer and the lateral sewer.

(9) Significant Change. “Significant change” means any change in an industrial user’s operation that results in a flow that exceeds the expected peak flow as shown in the sewage treatment plant expansion connection charge calculation for the property on which the industrial user is located.

(10) Significant Industrial User or SIU. “Significant industrial user” or “SIU” means:

(i) A discharger subject to categorical pretreatment standards; or

(ii) A non-categorical discharger that in the opinion of the manager, requires special regulation or source control; or

(iii) A non-categorical discharger that contributes a process wastestream that makes up five (5) percent or more of the average dry weather capacity of the POTW treatment plant, or that discharges an average of twenty-five thousand (25,000) gallons or more per day of process wastewater to the POTW; or

(iv) A non-categorical discharger that contributes more than one hundred fifty (150) pounds per day of BOD or suspended solids.

(11) Significant Non-Compliance. "Significant non-compliance" means a compliance status assigned to an industrial discharger meeting any of the following criteria:

(i) Chronic violations of wastewater discharge limits are those violations in which sixty-six (66) percent or more of all the measurements taken for the same pollutant parameter during a six (6) month period exceeds (by any magnitude) a numeric pretreatment standard or requirement, including instantaneous limits, as defined by 40 CFR 403.3(1); or

(ii) Technical review criteria (TRC) violations of wastewater discharge limits, defined here as those violations in which thirty-three (33) percent or more of measurements taken for each pollutant parameter during a six (6) month period equal to or exceed the product of the numeric pretreatment standard or requirement, including instantaneous limits, as defined by 40 CFR 403.3(1) multiplied by the applicable TRC value (TRC = 1.4 BOD, TSS, fats, oil and grease and 1.2 for all other pollutants except pH); or

(iii) Any other violation of a pretreatment standard or requirement as defined by 40 CFR 403.3(1) (daily maximum, long-term average, instantaneous limit, or narrative standard) that the POTW determines has caused, alone or in combination with other discharges, interference or pass through (including endangering the health of POTW personnel or the general public); or

(iv) A discharge of imminent endangerment to human health, welfare, or the environment, or has resulted in the POTW's exercise of its emergency authority under 40 CFR 403.8(f)(1)(vi)(B) to halt or prevent such discharge; or

(v) Failure to meet, within ninety (90) days of the scheduled date, a compliance schedule milestone contained in an individual wastewater discharge permit or enforcement order for starting construction, completing construction, or attaining final compliance; or

(vi) Failure to provide within forty-five (45) days after the due date, any required reports, including baseline monitoring reports, ninety (90) day compliance reports, periodic self-monitoring reports, and reports on compliance schedules; or

(vii) Failure to accurately report non-compliance; or

(viii) Any other violation or group of violations, which may include a violation of best management practices (BMPs), which the director determines will adversely affect the operation or implementation of the local pretreatment program.

(12) Single-family Unit. "Single-family unit" means the place of residence of single-family. Property improved for multi-family purposes shall constitute the number of units that the facilities thereon provide in number of single-family units. When such improvements are for other than residential purposes, the number of units shall be determined by dividing the total number of persons regularly using or occupying those premises by four (4). When this property is unsubdivided, it shall be deemed to have four (4) lots to the acre, unless the city council, in its sole discretion, specially fixes some other number of lots therefor.

(13) Slug Load or Slug Discharge. "Slug load" or "slug discharge" means any discharge at a flow rate or concentration, which could cause a violation of prohibited discharge standards in Section 15.10.040 of this chapter. A slug discharge is any discharge of a non-routine, episodic nature, including, but not limited to, an accidental spill or a non-customary batch discharge, which has a reasonable potential to cause interference or pass through, or in

any other way violate the POTW's regulations, local limits or permit conditions.

(14) Standard Methods. "Standard methods" mean the procedures set forth in the Code of Federal Regulations unless another method for the analysis of industrial wastewater has been approved in writing in advance of use of the procedure by the director. The current edition of Standard Methods for the Examination of Water and Wastewater as published by the American Public Health Association. All analyses shall be performed by a laboratory certified by the State for the specific pollutants and matrix to be analyzed, unless otherwise approved in writing, by the director, prior to performance of a sample analysis.

(15) Storm Sewer or Storm Drain. "Storm sewer" or "storm drain" means a sewer that carries storm and surface or groundwaters and drainage, but excludes sewage and polluted industrial wastes.

(16) Stormwaters. "Stormwaters" mean the flow resulting from rainfall.

(17) Street. "Street" means any public highway, public road, public street, public avenue, public alley, public way, public place, public easement, or public right-of-way.

(18) Suspended Solids or Suspended Matter. "Suspended solids" or "suspended matter" means solids that either float on the surface of, or are in suspension in, water, sewage, or other liquids and that removable by laboratory filtration in accordance with procedures described in Standard Methods.

(t) "T" Definitions.

(1) Technical Review Criteria or TRC. "Technical review criteria" or "TRC" means the multipliers used to gauge the degree or severity of violations.

(2) Total Toxic Organics. "Total toxic organics" (TTOs) means the sum of the concentrations for each of the regulated toxic organic compounds listed at 40 CFR 401.15 and which are found in the discharge at a concentration greater than ten (10) micrograms per liter.

(3) Toxic Pollutant. "Toxic pollutant" means any pollutant or any combination of pollutants listed as toxic in regulations promulgated by the EPA under the provisions of CWA 307(a) or other statutes.

(4) Trucked or Hauled Waste. "Trucked or hauled waste" means any waste discharged into the sanitary sewer system after being placed in a motorized vehicle for removal from the location where the waste was generated or produced.

(5) Trunk Sewer. "Trunk sewer" means a sewer constructed, maintained, and operated by the city that conveys wastewater and into which lateral and collecting sewers discharge.

(u) "U" Definitions.

(1) Uncontaminated Water. "Uncontaminated water" means any wasted water of the community not contaminated or polluted with wastewater and that is suitable or could readily be suitable for discharge to the city's stormwater drainage system.

(2) User. "User" means any person responsible for payment of sewer service charges.

(v) Reserved.

(w) "W" Definitions.

(1) Wastewater. Wastewater means the liquid- and water-carried industrial or domestics wastes from dwellings, commercial buildings, industrial facilities, and institutions, whether treated or untreated, that is contributed into or permitted to enter the POTW. (Ord. 1633 § 2 (part), (2000); Ord. 1791 § 2, (2006); Ord. 1868 § 2, (2011))

15.10.017 Abbreviations.

When used in this chapter or in connection with any resolution, regulation, permit, order, or other action undertaken pursuant to this chapter, the following abbreviations shall have the following meanings:

BOD —	Biochemical Oxygen Demand
CFR —	Code of Federal Regulations
COD —	Chemical Oxygen Demand
EPA —	Environmental Protection Agency
L —	Liter
mg —	Milligrams
mg/L —	Milligrams per Liter
NPDES —	National Pollutant Discharge Elimination System
SIC —	Standard Industrial Classification
SWDA —	Solid Waste Disposal Act [42 U.S.C. Section 6901 et seq.]
USC —	United States Code
TSS —	Total Suspended Solids

(Ord. 1633 § 2 (part), (2000))

15.10.020 Sewer required.

The owner of any premises occupied or used by humans and containing any plumbing installation whatsoever is required at the owner's expense to connect the building or structure directly to the city sewerage works, in accordance with the provisions of this chapter, Chapter 15.08, and Title 18, within ninety (90) days from completion of the plumbing installation. (Ord. 913 § 1 (part), (1970); Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.021 Occupancy prohibited.

No building, industrial facility nor other structure shall be occupied or used until and unless the owner of the premises has complied with all applicable rules and regulations of this chapter. (Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.24 Planning, design, and construction standards.

Public sewers and side sewers shall be planned, designed, constructed, installed, and repaired in accordance with the plans and specifications established by the director of public works. (Ord. 1825 § 2, (2008))

15.10.025 Construction permit required.

(a) Approval Required. No person shall construct or cause to be constructed, or alter or cause to be altered, any public sewer, lateral sewer, house connection or industrial connection sewer, sewage pumping plant, pollution control plant, or other sewerage facility in the city where existing or proposed wastewater flows will discharge directly or indirectly to city facilities without first obtaining approval of the sewerage construction from the city. This subsection shall not apply to duly authorized city employees or persons contracted to the city to perform the work for the city.

(b) Permit Required or Construction of Sewer or Sewer Connection.

(1) No person shall construct a building sewer or lateral sewer or make any connection with or opening into, use, alter, or disturb any public sewer or appurtenances or perform any work on any lateral or building sewer without first obtaining a written permit from the city and paying all fees and connection charges therefor.

(2) A person legally entitled to apply for and receive such a permit shall make application on forms provided by the city for that purpose. The applicant shall give a description of the character of the work to be done, and the location, ownership, occupancy, and use of the premises related to the work. The director may require plans, specifications, or drawings, and such other information as the director may deem necessary in the director's professional judgment.

(3) If the director determines that the plans, specifications, drawings, description, and information furnished in connection with the application are in compliance with this code and the ordinances, rules, and regulations governing the proposed work and installation, the director shall issue the permit upon payment of the required fees and charges. The director may attach conditions to the permit that are reasonably necessary to ensure compliance with this code and the ordinances, rules, and regulations governing the proposed work and installation.

(c) Compliance With Permit. After issuance of the permit, no change shall be made in the location of the sewer, the grade, materials, or other details from those described in the permit and as shown in the approved plans and specifications for which the permit was issued nor any deviation shall occur from any condition attached to the approved permit except with written authorization from the department, the inspector, or other duly authorized city employee.

(d) Agreement. The applicant's signature on an application for a permit pursuant to this section shall constitute an agreement by the applicant and any person whom the applicant represents in connection with the application to comply with the terms, requirements, and conditions of this code, the ordinances, rules, and regulations governing the proposed work and installation, with the approved plans and specifications for the work, if any, and with the conditions placed on the permit as well as any corrections or modifications that may be ordered or permitted by the

city. This agreement shall be binding on the successors and assigns of the applicant and the persons whom the applicant represents in connection with the application.

(e) Costs Paid by Owner. All costs and expenses incident to the installation and connection of any sewer or other work for which a permit has been issued pursuant to this section shall be borne by the owner of the premises to be served by the work. The owner shall indemnify the city and its officers and employees from any loss or damage that may directly or indirectly be caused by the work.

(f) Additional Permits. The persons seeking to do the work under a permit issued pursuant to this section shall be solely responsible for obtaining all other permits from any agency or permission from any person necessary to performing the work, including any excavation or encroachment permit from the city.

(g) Liability. Neither the city, nor any of its officers, employees, or agents, shall be answerable for any liability for injury or death to any person or damage to any property arising during or growing out of the performance of work performed under any permit issued pursuant to this section. The permitholder shall be answerable for and save the city, its officers, employees, and agents harmless from any liability imposed by law upon the city, its officers, employees, and agents, and from any claims that may be made against the city, its officers, employees, and agents, including all costs, expenses, attorney fees, fees, and interest incurred in defending any such liability or claims. The permit holder shall be responsible for any defects in the design or performance of work under the permit or any failure that may develop in that work. (Ord. 1633 § 2 (part), (2000))

15.10.028 Construction requirements.

(a) Minimum Size. The minimum size of a building sewer shall be six (6)-inch diameter. However, in any building designed or to be used exclusively for residential occupancy of six (6) dwelling units or less, the minimum size shall be four (4)-inch diameter. The director may order or authorize a different size of building sewer

consistent with the California Plumbing Code as amended by this code.

(b) Public Safety. All excavations for a lateral sewer installation shall be adequately guarded with barricades or lights so as to protect the public from hazard. Any public property disturbed in the course of the work shall be restored to a condition that is as good or better than existed before the work began.

(c) The requirements of subsection (a) above shall not apply retroactively, but any replacement of an existing sewer shall conform to subsection (a). (Ord. 1633 § 2 (part), (2000))

15.10.029 Installation of backwater protection.

(a) Definitions.

"Backwater protection" means a backwater valve, ejector or pump system, or relief valve or a combination of two (2) or more of these devices that is approved by the building official and intended to prevent sewage from backflowing into a structure.

"Drainage unit fixture" means a drainage unit fixture listed in table 7-3 of the 1998 California Plumbing Code.

"Inadequate height differential" means that the flood level rim of a drainage unit fixture on a property's sanitary sewage drainage system is less than one foot above the next upstream manhole or flushing inlet cover on the sanitary sewer main serving the fixture's drainage piping.

"Licensed professional" means a person authorized under California law to render an applicable certification to the property owner and the city regarding a specific question under this section.

(b) Ongoing Responsibility. In addition to installing backwater protection when required pursuant to Title 18, a property owner shall ensure that backwater protection is installed and fully operable in the building sewer or sewers serving the property owner's real property whenever an inadequate height differential situation exists on the property.

(c) Addition of Drainage Unit Fixture. Whenever any drainage fixture unit is to be added to real property, the property owner shall obtain and file with the building official at the time of application for a building permit for the fixture unit a written certification by a licensed professional determining whether an inadequate height differential situation exists on the real property. If such a situation exists, the property owner shall provide the backwater protection described in section 18.12.080 or permanently remove the drainage unit fixture or fixtures that have an inadequate height differential before completion of installation of the additional drainage unit fixture.

(d) Proof of Previous Installation. Instead of providing certification pursuant to subsections (c) as applicable, a property owner may file a certification from a licensed professional demonstrating that backwater protection as approved by the building official has been installed on the property's sewage drainage system and is fully operable. This certification is subject to inspection confirmation by the city.

(e) Maintenance. Property owners are responsible for ensuring that backwater protection is properly maintained and functioning at all times. Backwater protection is subject to inspection by the city at any reasonable time, and failure to properly install and maintain this protection may result in suspension of sewer service.

(f) Compliance with Titles 15 and 18. Any installation of backwater protection or modification to any sewer shall be performed and inspected under the requirements of titles 15 and 18 of this code and established city procedures. (Ord. 1710 § 2, (2003); Ord. 1723 § 2, (2003))

15.10.030 Inspection.

(a) All sewer construction work, building sewers, plumbing and draining systems shall be inspected by an inspector authorized by the city to insure compliance with all city requirements. No sewer shall be covered until it has been inspected and passed. No sewer shall be connected to the city's public sewer until the work

encompassed within the applicable permit has been completed, inspected, and approved by the city inspector. If the test proves satisfactory and the seer has been cleaned of all debris accumulated from construction operations, the inspector shall issue a certificate of satisfactory completion.

(b) It shall be the duty of the person doing the work authorized by permit to notify the department that the work is ready for inspection. This notification shall be given at least twenty-four (24) hours before the work is to be inspected. The person doing the work shall ensure that the work will stand the tests required by the city before making a request for inspection.

(c) All building sewers and lateral sewers shall be tested in the presence of the city inspector by filling the line with water or air and inspecting for excessive leakage. Fittings, plugs, water, and labor for testing shall be furnished by the person constructing the sewer. If the existing lateral is to remain, it shall be tested as specified above. All lines showing excessive leakage shall be repaired or replaced at the sole expense of the person controlling the work to the satisfaction of the city inspector.

(d) When work has been inspected pursuant to this section and the work has not passed, a written notice to that effect will be given instructing the owner of the work to repair the sewer or other work authorized by the permit in accordance with the permit requirements. (Ord. 913 § 1 (part), (1970); Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.032 Maintenance of sewer laterals.

(a) The city shall not be responsible for maintenance or repair of any lateral sewer unless the lateral sewer conforms to all of the requirements of this chapter and other applicable city regulations and the city has expressly determined to provide this maintenance or repair.

(b) The city shall have the right to enter onto private property for the purpose of inspection, maintenance, repair, rehabilitation, or replacement of the portion of the lateral sewer that may be maintained by the city. (Ord. 1633 § 2 (part), (2000); Ord. 1825 § 3, (2008))

15.10.034 Limitation on point of discharge.

(a) No person shall discharge, cause or allow or permit to be discharged any substance into a manhole or other opening in a community sewer except through an approved building sewer, unless that person has first obtained a permit to do so from the city.

(b) No person shall discharge, cause or allow or permit to be discharged any sewage, industrial waste, or other polluted waters into any storm drain or natural outlet or creek or stream or channel without first obtaining a valid National Pollutant Discharge Elimination System (NPDES) permit. (Ord. 1633 § 2 (part), (2000))

15.10.036 Prohibited activities.

No person shall maliciously, willfully, or negligently break, damage, destroy, uncover, deface, or tamper with any structure, appurtenance, or equipment that is part of the sewerage works or any sampling device. (Ord. 1633 § 2 (part), (2000))

15.10.038 Generally prohibited wastes.

(a) No person shall discharge or cause to be discharged to a public sanitary sewer any substance or waste that contains substances or has characteristics that either alone or by interaction with other wastewaters cause or threaten to cause interference or pass-through.

(b) No person shall discharge to any public sewer any wastes, if in the opinion of the city, those wastes may have any adverse or harmful effect on sewers, maintenance personnel or equipment, wastewater treatment

personnel or equipment, treatment plant effluent quality, public or private property, aquatic life in any waters receiving effluent from the sanitary sewer system, or create a hazard in the use or disposal of sewage sludge, or may otherwise endanger the public, the local environment, or create a public nuisance.

(c) No person shall discharge or cause to be discharged to a public sewer any waste, including any fats, oils, or grease, that creates a stoppage, plugging, breakage, any reduction in the sewer capacity, or any other damage to sewers or sewerage facilities of the city. (Ord. 1633 § 2 (part), (2000); Ord. 1825 § 4, (2008))

15.10.040 Specifically prohibited wastes.

No person shall discharge or cause to be discharged to a public sanitary sewer any of the following wastes:

(a) Any wastewater containing any flammable liquid, solid, vapor, or gas or other substance, including but not limited to any substance having a closed cup flashpoint of

less than one hundred forty (140) degrees Fahrenheit or sixty (60) degrees Celsius, using the test methods specified in 40 CFR 261.21. Prohibited materials include but are not limited to gasoline, kerosene, naphtha, benzene, toluene, xylene, ethers, alcohols, ketones, aldehydes, peroxides, chlorates, perchlorates, bromates, carbides, hydrides, and sulfides, and any other substances that the city, the state, or the EPA has notified the user is a fire or explosive hazard or a hazard to the system; or

(b) Any waste having a pH lower than 5.0 or having any corrosive or detrimental characteristic that may cause injury to any person operating, maintaining, repairing, or constructing the sanitary sewer system or any part thereof, or working in or about the sanitary sewer system, or any damage to any part of the sanitary sewer system, or any waste with a pH high enough to cause alkaline incrustations on sewer walls; or

(c) Any solids or viscous substances of such size or in such quantity that they may cause flow obstruction in any part of the sewer or be detrimental to proper wastewater treatment plant operations. Such substances include but are not limited to, asphalt, cement, dead animals, offal, ashes, sand, mud, straw, industrial process shavings, metal, glass, rages, feathers, tar, plastics, wood, whole blood, paunch manure, bones, hair and fleshings, entrails, fats, oils, grease, paper dishes, paper cups, milk containers, or similar paper products, either whole or ground, and resins; or

(d) Any wastes with excessively high BOD, COD, or decomposable organic content that will cause interference with the sanitary sewer system; or

(e) Any waste containing heat in amounts that will inhibit biological activity at the POTW resulting in interference, but in no event, no liquid, solid, vapor, gas, or thing having or developing a temperature of one hundred fifty (150) degrees Fahrenheit or more, or that may cause the temperature at the POTW to exceed one hundred four (104) degrees Fahrenheit or

(f) Any non-biodegradable cutting oils, commonly called soluble oil; or

(g) Any petroleum oil, non-biodegradable oil, or refined petroleum product; or

(h) Any waste containing toxic or poisonous solids, liquids, or gases in such quantity that alone, or in combination with other waste substances, may create a hazard to humans, animals, or the local environment, interfere with the wastewater treatment processes, cause a public nuisance, or cause any condition hazardous to health and safety in the sewerage system; or

(i) Any substance promoting or causing the promotion of toxic gases; or

(j) Any waste requiring an excessive quantity of chlorine or other chemical compound used for disinfection purposes; or

(k) Any excessive amounts of chlorinated hydrocarbon or organic phosphorous type compounds; or

(l) Any excessive amount of deionized water, steam condensate, or distilled water; or

(m) Any wastewater producing excessive discoloration of wastewater or treatment plant effluent, such as dye wastes and vegetable tanning solutions; or

(n) Any wastes containing excessive quantities of iron, boron, chromium, phenols, plastic resins, copper, nickel, zinc, lead, mercury, cadmium, selenium, arsenic, or any other objectionable materials toxic to humans, animals, the local environment, or to the biological or other wastewater; or

(o) Any blow-down or bleed water from cooling towers or other evaporation coolers exceeding one-third of the make-up water; or

(p) Any single pass cooling water; or

(q) Any quantities of radioactive material wastes; or

(r) Recognizable portions of the human anatomy; or

(s) Any strongly odorous waste or waste tending to create odors; or

(t) Any waste containing greater than 0.1 mg/L of dissolved sulfides; or

(u) The use or addition of any chemical or biological agent used for the maintenance of grease traps and interceptors. This includes enzymes, emulsifiers, and bacterial cultures. (Ord. 913 § 1 (part), (1970); Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000); Ord. 1791 § 3, 2006); Ord. 1825 § 5, (2008))

15.10.042 Prohibition on trucked and hauled wastes.

No person shall discharge, cause, allow or permit any trucked or hauled waste to be discharged into the sanitary sewer system, except at a site specifically designated in a wastewater discharge permit issued pursuant to this chapter. (Ord. 1633 § 2 (part), (2000))

15.10.044 Prohibition on garbage.

(a) No person shall discharge, deposit, or throw, or cause, allow or permit to be discharged, deposited, or thrown into the sanitary sewer system, or any part thereof, any garbage, or any fruit, vegetable, animal or other solid material from any food-processing plant or other industrial plant, food establishment or restaurant, or retail grocery store, irrespective of whether or not it shall have been first passed through a mechanical grinder.

(b) No person shall install, operate, use or maintain upon the premises of any food-processing plant, or any other industrial plant or retail grocery store, any mechanical grinder or waste grinder that is connected directly or indirectly to the sanitary sewer system, or any part thereof. (Ord. 1633 § 2 (part), (2000))

15.10.046 Prohibition on use of diluting waters.

The use of diluting waters as a partial or complete substitute for adequate treatment, to achieve compliance, or to meet local limitations for wastewater as set forth in this chapter, or to avoid or minimize any requirements imposed in a wastewater discharge permit is prohibited. (Ord. 1633 § 2 (part), (2000))

15.10.048 Suspended solids—Dissolved matter.

No person shall discharge, cause, allow or permit to be discharged into the sanitary sewer system or any part thereof, any liquid containing suspended solids or dissolved matter of such character and quantity that unusual attention or expense is required to handle, process, or treat such matter at the Plant. (Ord. 1633 § 2 (part), (2000))

15.10.050 Limitations on wastewater strength.

No person shall discharge, cause, allow, or permit to be discharged into a public sanitary sewer or any part thereof, any waste containing an excess in concentration of the following substances:

Substance	Maximum Allowable Concentration
Arsenic	0.08 mg/L
BOD	1300 mg/L
Cadmium	0.138 mg/L
Copper	2.0 mg/L
Cyanide	0.292 mg/L
Lead	0.365 mg/L
Mercury	0.010 mg/L
Nickel	0.445 mg/L
Phenol	7.8 mg/L
Selenium	0.106 mg/L
Silver	0.200 mg/L
TSS	1200 mg/L
Total Chromium	2.532 mg/L
Zinc	0.386 mg/L

These limitations are subject to amendment at any time, and no permit granted under this chapter shall constitute any vested right of any kind to continue to maintain concentrations at this or any other level. (Ord. 1633 § 2 (part), (2000); Ord. 1791 § 4, (2006))

15.10.052 Limitation on other pollutants.

No person shall discharge or cause or allow or permit to be discharged any pollutant, including oxygen demanding

pollutants to be released at a flow rate or a pollutant concentration, or both, that a user knows or has reason to know will cause interference to the POTW. In no event shall a person discharge or cause or allow or permit a discharge to have a slug load with a flow rate or contain a concentration or qualities of pollutants that exceeds for any time period of more than five (5) times the average twenty-four (24) hour concentration quantities or flow during normal operation. (Ord. 1633 § 2 (part), (2000))

15.10.054 Holding tank wastes.

(a) No person shall discharge any holding tank waste into a community sewer unless that person has obtained a permit to do so from the city. Unless otherwise specifically allowed under the terms of a city permit, a separate permit shall be required for each separate discharge.

(b) No person shall discharge or cause or allow or permit to be discharged directly or indirectly to a public sewer any wastes originating from a recreational vehicle, boat, camper, mobile home, trailer, portable toilet, chemical toilet, or any temporary or mobile sanitation facility except pursuant to permit issued by the city at a facility designed and operated for this type of discharge. (Ord. 1633 § 2 (part), (2000))

15.10.056 Stormwaters, surface water, groundwater.

(a) No person shall discharge, cause or allow or permit any stormwater, roof or yard drainage, foundation, underdrainage, or groundwater to be discharged into the sanitary sewer system without first obtaining a permit from the city to do so. Such a permit shall only be granted in exceptional cases of public necessity when no other reasonable alternative is available.

(b) No plumbing or piping shall be connected or designed in such a manner as to make possible the discharge of storm, surface and underground waters into the sanitary sewer system without first obtaining a permit from the city as described in subsection (a). (Ord. 1633 § 2 (part), (2000))

15.10.058 Medical wastes.

(a) Hospitals, medical clinics, offices of medical doctors, and convalescent homes may discharge to the sanitary sewer system through a city-approved grinder installation with inlet size and design features suitable for its intended use and so construct that all particles pass through a maximum three-eighths-inch opening wastes of the following category:

(1) Infectious wastes defined as follows:

(A) Laboratory and surgical operating room wastes except as excluded in subsection (b); and

(B) Wastes from outpatient areas and emergency rooms similar those included in subsection (A) above with the same exclusions; and

(C) Solid wastes generated in the rooms of patients who are not isolated because of a suspected or diagnosed communicable disease.

(b) In no event shall any person discharge, or cause or allow or permit the following wastes to be discharged to the sewer by any means:

(1) Equipment, instruments, utensils, and other materials of a disposable nature that may harbor or transmit pathogenic organisms and that are used in the rooms of patients having a suspected or diagnosed communicable disease which by the nature of the disease is required to be isolated; or

(2) Any recognizable portions of the human anatomy; or

(3) Wastes excluded by other provisions of this chapter except as specifically permitted pursuant to subsection (a); or

(4) Any solid waste not specifically described in subsection (a). (Ord. 1633 § 2 (part), (2000))

15.10.060 Quantity of wastes.

The rate of discharge of industrial wastes to the sewer system shall be limited to the capacity of the lateral and main sewers flowing as open-channel conduits. Facilities shall be provided for dampening or equalizing “slug” discharges in order to comply with concentration restrictions as defined in this chapter. (Ord. 913 § 1 (part), (1970); Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.062 Protection from accidental and slug discharges.

(a) Each industrial user shall provide protection from accidental discharge of prohibited materials or other wastes regulated by this chapter into either the storm sewer or sanitary sewer systems. The city shall evaluate whether each SIU needs an accidental discharge/slug discharge control plan or other action to control slug discharges. The city may require any user to develop, submit for approval, and implement such a plan or take such other action that may be necessary to control slug discharges.

(b) Facilities to prevent accidental discharge of prohibited materials shall be provided and maintained at the industrial user's expense.

(c) Any direct or indirect connection or entry point for deleterious wastes to the discharger's plumbing or drainage system shall be eliminated through reasonable disconnection or barriers as necessary to ensure protection to the system.

(d) Significant industrial users are required to notify the city immediately of any changes at its facility affecting the potential for a slug load/slug discharge. (Ord. 1868 § 3, (2011))

15.10.064 Pretreatment of industrial waste.

(a) An industrial wastewater pretreatment system or device may be required by the city to treat industrial flows prior to discharge to the sewer when it is necessary to restrict or prevent the discharge to the sewer of certain waste constituents, to distribute more equally over a longer time period any peak discharges of industrial wastewaters or to accomplish any pretreatment result required by the city. All pretreatment systems or devices shall be approved by the city but such approval shall not absolve the industrial discharger of the responsibility of meeting any industrial effluent limitation required by the city, county, state, or federal government. In special cases, the city may require construction of sewer lines by the discharger to convey certain industrial wastes to a specific city trunk sewer. All pretreatment systems judged by the city to require engineering design shall have plans prepared and signed by an engineer of suitable discipline licensed in the state.

(b) Normally a gravity separation interceptor, equalizing tank neutralization chamber and control manhole will be required respectively to remove prohibited settleable and floatable solids, to equalize wastewater streams varying greatly in quantity and/or quality, to neutralize low or high pH flows and to facilitate inspection, flow measurement and sampling. Floor drains from commercial or manufacturing buildings, warehouses, multi-use structures, areas where any waste requiring pretreatment is involved shall not discharge directly into the sewer, but shall first discharge to a gravity separation interceptor. Where preliminary treatment facilities are provided for any waters or wastes, they shall be maintained continuously in satisfactory and effective operation by the owner at owner's expense.

(c) The city may adopt additional rules and regulations by resolution, after a public hearing, for administration of this section.

(d) Any petroleum-contaminated groundwater shall be processed through an activated carbon pretreatment system approved by the city prior to discharge to the sanitary sewer system. This discharge shall only be done under permit. (Ord. 913 § 1 (part), (1970); Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.066 Interceptors required.

(a) Any type of business or establishment where grease or other objectionable materials may be discharged into a public or private sewage main or disposal system shall have a grease removal device of a size and design approved by the director.

(b) Each grease removal device shall be so installed and connected that it shall be at all times easily accessible for inspection, cleaning and removal of grease.

(c) The grease removal device should be situated on the discharger's premises but when such a location would be impractical or cause undue hardship on the discharger, the city may issue an encroachment permit to allow the device to be installed in the public street or sidewalk area and located so that it will not be obstructed by landscaping or parked vehicles. However, such a device shall not at any time pose a hazard or obstruction to public use of the street or sidewalk area.

(d) Waste discharge from fixtures and equipment in establishments which may contain grease or other

objectionable materials including, but not limited to, scullery sinks, pot and pan sinks, dishwashers, food waste disposals, soup kettles, and floor drains located in areas where such objectionable materials may exist, may be drained into the sanitary waste through the grease removal device when approved by the director provided, however, that toilets, urinals, wash basins, and other fixtures containing fecal material shall not flow through the grease removal device. Interceptors shall be located upstream of any dishwashers or discharges exceeding one hundred ten (110) degrees Fahrenheit.

(e) Grease removal devices shall be maintained in efficient operating condition by periodic removal of the accumulated grease. The use of chemicals to dissolve grease is specifically prohibited. No accumulated grease shall be introduced into any drainage piping or public or private sewer. Users with oil and grease removal devices shall maintain them in good operating condition at all times.

(f) The discharger shall develop and maintain a record of periodic maintenance, and pumping of the removal device records shall be retained for a period of not less than three (3) years.

(g) Pumping shall be sufficiently frequent to prevent objectionable odors, surcharge of the removal device, or interference with the operation of the sanitary sewer system.

(h) Abandoned grease removal devices shall be emptied and filled as required for abandoned septic tanks. (Ord. 913 § 1 (part), (1970); Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.068 Screened industrial wastes.

No person shall discharge, cause, allow or permit to be discharged into the sanitary sewer system or any part thereof, any garbage, or any fruit, vegetable, animal, or

other solid industrial wastes resulting from the processing, packaging, or canning of fruits, vegetables, or other foods or products. (Ord. 1633 § 2 (part), (2000))

15.10.070 Wastewater discharge permit required.

No person shall discharge, or cause or allow or permit to be discharged any industrial wastewaters directly or indirectly to sewage facilities owned by the city without first obtaining a city permit for industrial wastewater discharge. (Ord. 1633 § 2 (part), (2000))

15.10.072 Permit application.

Any person seeking a wastewater discharge permit, other permit, or amendment to a permit under this chapter shall complete and file an application on the form prescribed by the director and accompanied by all applicable fees and charges. The application shall contain the following information at a minimum:

(a) Signature, name, and address of both the owner of the property from which the discharge is to occur and the applicant for the permit if other than the owner. The persons signing the application on behalf of an entity shall be at least of the level of vice president, general partner, or an individual responsible for the overall operation of the facility or property and meeting the conditions of the requested permit, or a person meeting the federal requirements for NPDES applications as specified in Title 40 of the CFR; and

(b) Volume of wastewater to be discharged; and

(c) Estimated wastewater constituents and characteristics; and

(d) Time and duration of discharges; and

(e) Average and thirty (30) minute peak wastewater flow rates, including daily, monthly, and seasonal variations, if any; and

(f) Site plans, floor plans, and mechanical and plumbing plans and details, sufficient to show all sewers and appurtenances by size, location, and elevation; and

(g) Description of all activities, facilities, and plant processes on the property that may in any way relate to the discharges, including types of materials that are or could be discharged; and

(h) Each product produced by type, amount, and rate of production that may in way relate to the discharges; and

(i) Hours of work and activities at the property.

The director may require such additional information as the director needs in order to determine whether the proposed discharge will comply with the requirements of this chapter. (Ord. 1633 § 2 (part), (2000))

15.10.074 Determination on permit application.

(a) Following review of the application and receipt of such information as the director may require, the director shall determine whether to approve or deny the permit or permit amendment being sought. The director will grant the permit if:

(1) The applicant has complied with all applicable requirements of this chapter and applicable city, county, state, and federal regulations, laws, and orders regarding the proposed discharge; and

(2) The applicant has furnished all information requested by the director; and

(3) The director determines that there are adequate devices, equipment, chemicals, personnel, and other facilities to sample, meter, convey, treat, and dispose of the proposed discharges; and

(4) The persons to be responsible for treatment and control of the proposed discharges are adequately trained and capable of consistently complying with permit requirements; and

(5) The applicant and the property owner have expressly agreed to the conditions applied by the director pursuant to subsection (b).

(b) In granting such an application, the director will condition the permit in order to ensure compliance with this chapter and applicable city, county, state, and federal regulations, laws, and orders regarding the proposed discharge, which may include, but are not limited to, the following:

(1) Limits on the average and maximum wastewater constituents and characteristics;

(2) Requirements for installation and maintenance of flow monitoring, inspection, and sampling facilities;

(3) Specifications and pretreatment requirements for monitoring programs which may include sampling locations, frequency of sampling, number, types and standards for tests and reporting schedule;

(4) Compliance schedules;

(5) Requirements for submission of technical reports or discharge reports;

(6) Requirements for maintaining and retaining plant records relating to wastewater discharge as specified by the city and affording the city access thereto;

(7) Requirements for notification to the city of any new introduction of wastewater constituents or any significant change in the volume or character of the wastewater constituents being introduced into the wastewater stream;

(8) Requirements and plans for protection against accidental discharges, including, but not limited to, berming of chemicals and waste materials. The review and approval of such plans and operating procedures shall not relieve the user from the responsibility of modifying the facility as necessary to provide the protection necessary to meet the requirements of this code or other state or federal regulations;

(9) Requirements for notification of accidental discharges;

(10) Requirements for notification of slug discharges;

(11) Requirements to control slug discharges, if determined by the city to be necessary. (Ord. 1633 § 2 (part), (2000); Ord. 1868 § 4, (2011))

15.10.076 Permit denial.

(a) Notwithstanding Section 15.10.074, the director shall deny a wastewater discharge permit, other permit, or amendment to a permit under this chapter if the director determines that one or more of the following exist:

(1) The application is not accompanied by required fees and charges; or

(2) The application contains incomplete, false or misleading information; or

(3) The issuance of the requested permit would result in the discharge of wastewater or other substances that would endanger the public health or safety or public or private property; or

(4) The issuance of the requested permit would cause the plant or the sewerage system to violate any applicable permit conditions, laws, regulations, or orders of the city, county, state or federal government; or

(5) The applicant has not provided sufficient information to establish that its discharge will comply all requirements of this chapter and with such other terms and conditions as the director deems necessary to apply to the requested permit; or

(6) The applicant has not provided plans for sufficient protection from accidental discharges to the land, storm sewer system, or sanitary sewer system. (Ord. 1633 § 2 (part), (2000))

15.10.078 Non-transferability.

No permitholder shall assign, transfer, sell any permit issued under this chapter nor use any such permit for or on any premises or for facilities or operations or discharges not expressly encompassed within the underlying permit. No person shall discharge any industrial wastewaters in excess of the quality or quantity limitations set by the terms and conditions of the permit without first obtaining approval of an amendment to the permit pursuant to this chapter. (Ord. 1633 § 2 (part), (2000))

15.10.080 Permit amendment.

(a) Any permitholder may apply at any time for an amendment to a permit issued under this chapter to amend the terms and conditions of the permit. Such an application will be processed in the same manner as an original application.

(b) Each permit issued pursuant to this chapter shall be automatically amended to include any more stringent, applicable federal or state requirements, regulations, laws, or orders for discharges than are contained in the permit or in this chapter. The director will endeavor to give notice of changes in reporting requirements, but the permitholder shall be responsible for complying with more stringent limitations with or without notice from the city.

(c) In order to protect the health and safety of the community or to comply with an applicable federal, state, or county order, regulation, or law, the director may order an amendment to an existing permit at any time upon reasonable notice. Reasonableness of the notice will be determined by the urgency of the danger or the terms of the federal or state order, regulation, or law. (Ord. 1633 § 2 (part), (2000))

15.10.081 Reclassification from significant industrial user.

At any time, the director may on the director's own initiative or in response to a petition from the industrial user or POTW determine that the industrial user should not be classified as a significant industrial user in accordance with 40 C.F.R. Section 403.8(f)(6) even though the industrial user meets the definition of a significant industrial user, if the director determines the following:

(a) The industrial user has no reasonable potential for adversely affecting operation of the POTW; and

(b) The industrial user has no reasonable potential for violating any pretreatment standards or requirements.

(Ord. 1791 § 5, (2006))

15.10.082 New sources.

(a) New sources of industrial waste discharges shall be in full compliance with the provisions of this chapter at the time of commencement of discharge. Dischargers of new sources, upon request of the director, shall complete a waste minimization study in accordance with guidelines published by the director, and shall certify that measures have been taken to minimize toxic constituents in the discharge.

(b) The owner of every newly constructed, remodeled, or converted commercial or industrial facility shall comply with the following requirements upon commencement of discharge. These requirements shall apply to remodeled or converted facilities to the extent that the portion of the facility being remodeled or converted is related to the subject of the requirement:

(1) Interior (indoor) floor drains to the sewer system may not be placed in areas where hazardous materials, hazardous wastes, industrial wastes, industrial process water, lubricating fluids, vehicle fluids or vehicle equipment cleaning wastewater are used or stored, unless secondary containment is provided for all such materials and equipment. The director may allow an exception to this requirement under the following circumstances:

(A) When the drain is connected to a wastewater treatment unit approved by the director;

(B) (For safety showers) When the drain is installed with a temporary plug which remains closed except when the shower is in use, or when the drain is protected from spills by either a covered sump or berm system. If a sump is used, the capacity shall be at least as large as the largest chemical container in the laboratory;

(C) For industrial process equipment, if the equipment does not contain hazardous waste and if all floor drains are equipped with fail-safe valves which shall be kept closed during periods of operation.

(2) Exterior (outdoor) drains may be connected to the sewer only if the area in which the drain is located is covered or protected from rainwater run-on by berms and/or grading, and appropriate wastewater treatment approved by the director is provided. Any loading dock area with a sanitary sewer drain shall be equipped with a fail-safe

valve, which shall be kept closed during periods of operation.

(3) Interior floor drains shall not be connected to the storm drain.

(4) Exterior drains shall be connected to the storm drain. Such connections shall not be permitted within the following areas:

(A) Equipment or vehicle washing areas;

(B) Areas where chemicals, hazardous materials, or other uncontained materials are stored unless secondary containment is provided;

(C) Equipment or vehicle fueling areas or fluid changing areas;

(D) Loading docks where chemicals, hazardous materials, grease, oil, or waste products are handled.

(5) Fueling areas shall have impermeable floors and rain covers that extend a minimum of ten (10) feet in each direction from each pump.

(6) Roof drains may discharge to the storm drain system, provided that all roof equipment, tanks, and pipes containing other than potable water, cooling system water, or heating system hot water have secondary containment.

(7) Boiler drain lines shall be connected to the sewer system and may not be discharged to storm drain system

(8) Condensate lines shall not be connected or allowed to drain to the storm drain system.

(9) Copper, copper alloys, lead and lead alloys, including brass, shall not be used in the sewer lines, connectors, or seals coming in contact with sewage, except for sink traps and associated connecting pipes.

(10) Secondary containment shall be provided for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas. The director may allow a drain for work areas (but not for hazardous storage areas) if the secondary containment area is covered and if the drain is connected to a wastewater treatment facility approved by the director.

(11) Sacrificial zinc anodes are not permitted to be in contact with the water supply in a water distribution system.

(12) Aspirators connected to laboratory sink faucets are prohibited; however, aspirators designed and used for transferring acids and bases from stationary permanent laboratory sinks to treatment facilities shall be allowed.

(13) Laboratory countertops and laboratory sinks shall be separated by a lip which prevents hazardous materials spilled on the countertop from draining to the sink.

(14) Sewer traps below laboratory sinks shall be made of glass or other approved transparent materials to allow inspection and to determine frequency of cleaning. Alternatively, a removable plug for cleaning the trap may be provided, in which case a cleaning frequency shall be established by the director. In establishing the cleaning frequency, the director shall consider the recommendations of the facility. The director will grant an exception to this requirement for areas where mercury will not be used; provided, that in the event such an exception is granted and mercury is subsequently used in the area, the sink trap shall be retrofitted to meet this requirement prior to use of the mercury.

(15) Swimming pool discharge drains shall not be connected directly to the storm drain system or to the sewer system. When draining is necessary, a hose or other temporary system shall be directed into a sewer (not storm drain system) clean out. A sewer clean out shall be installed in a readily accessible area.

(16) Food service facilities shall have a sink or other area for cleaning floor mats, containers, and equipment, which is connected to a grease interceptor and the sanitary sewer. The sink or cleaning area shall be large enough to clean the largest mat or piece of equipment to be cleaned. New buildings constructed to house food service facilities shall include a covered, bermed area for a dumpster.

(17) Parking garage floor drains on interior levels shall be connected to an interceptor and to the sanitary sewer system. (Ord. 1633 § 2 (part), (2000))

15.10.084 Compliance schedules.

In the event that an industrial waste discharge permitholder or applicant should be affected by a newly promulgated waste discharge standard or an existing discharge permitholder is reclassified as being subject to the categorical standards provided in the pretreatment regulations due to process changes, or an inspection reveals the presence of regulated processes, or new information becomes available that justifies or requires a reclassification, the discharger shall, within ninety (90) days of the effective date of a categorical standard or reclassification, file a baseline monitoring report [BMR]. If additional pretreatment or additional operation at and maintenance procedures or installation of facilities, equipment or improvement, will be required to meet the pretreatment regulations, the discharger shall include a compliance time schedule which specifies the shortest schedule by which the discharger will provide such additional pretreatment procedures or facilities, equipment or improvements to attain compliance For purposes of pretreatment regulations, the completion date in this schedule shall not be later than the established compliance date provided by the applicable pretreatment regulations. (Ord. 1633 § 2 (part), (2000))

15.10.088 Revocation, suspension, or modification of permit.

(a) In addition to any other remedies that may be provided to enforce the provisions of this chapter, any

permit issued pursuant to this chapter may be revoked, made subject to additional terms or conditions, modified or suspended by the director in addition to other remedies provided by law, when such action is necessary in order to stop a discharge or a threatened discharge which presents a hazard or a threat of hazard to the public health, safety, welfare, natural environment, sewer system, or which violates this chapter, or which action is intended to implement programs or policies required or requested of the city by appropriate state or federal regulatory agencies.

(b) Any discharger notified of the city's intent to revoke, make subject to additional terms or conditions, modify, or suspend the discharger's permit shall immediately comply with directives of the director or cease and desist the discharge of all industrial wastes or such portion of said wastes as will eliminate the wrongful discharge to the sewer system pending any hearing that the discharger may request as set forth in this chapter.

(c) The director shall reissue or reinstate any industrial wastes permit or modified permit upon proof of satisfactory ability to comply and/or compliance with all discharge requirements, and the payment of any costs, fines, or penalties which may be assessed. The director may require any permitholder to develop and implement a compliance schedule for any proposed modification to permit terms and conditions.

(d) The city will have the authority to comply with the public participation requirements of 40 CFR part 25 in the enforcement of National Pretreatment Standards by annually providing public notification in local newspapers. This notification may consist of a list of industrial users that, during the previous twelve (12) months, were in significant non-compliance of applicable pretreatment standards or other pretreatment requirements. (Ord. 1633 § 2 (part), (2000))

15.10.090 Appeal of decision of director.

(a) Any person dissatisfied with the decision of the director to issue, deny, condition, amend, suspend, revoke, or modify any permit pursuant to this chapter may file a written appeal with the city manager. Such an appeal shall only be effective if the appeal is filed in writing together with any applicable fees with the city manager no more than ten (10) days following the date of the decision by the director.

(b) The director shall give the industrial waste discharger applicant or permitholder ten (10) calendar days' written notice of intent to issue or deny the application or to revoke, make subject to additional terms or conditions, modify or suspend the discharger's permit. The director shall post a copy of such notice at city hall for interested persons. The notice shall set forth specifically the grounds for the director's intention to deny, revoke, or suspend and shall inform the applicant or permitholder or members of the public that they have ten (10) days from the date of receipt of the notice to file a written request for a hearing. The application shall be issued or denied or the permit shall be revoked, modified or suspended if a hearing request is not received within the ten-day period.

(c) If the applicant or permitholder or interested party or parties file(s) a timely hearing request, the city manager, or manager's designee, shall within ten calendar days from the receipt of the request, set a time and place for the hearing. All parties involved shall have the right to offer testimonial, documentary, and tangible evidence bearing on the issues and to be represented by counsel. The decision of the city manager, or the manager's manger's designee, whether to issue or deny the application or revoke, make subject to additional terms and conditions, modify or suspend the permit shall be final. (Ord. 913 § 1 (part), (1970); Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.092 Public access and confidentiality of information.

(a) It is the intent of this chapter that the procedures and enforcement conducted pursuant to this chapter be conducted openly and publicly whenever possible. Pursuant to state law, the information filed and submitted by applicants, permitholders, and other interested persons shall be public record and open for public review.

(b) However, when permitted by state law, information submitted to the city pursuant to this chapter may be claimed as confidential by the applicant or permitholder. Any such claim must be asserted at the time of

submission in the manner prescribed on the application form or, in the case of other submissions, by stamping the words "confidential business information" on each page containing such information. Information submitted prior to the inclusion of this section in the chapter may be withdrawn and replaced by submittals stamped "confidential business information." If no such claim is made at the time of submission, the information may be made available to the public without further notice. Upon receipt of a request for the release of information to the public which includes information which the applicant or permitholder has notified the city is claimed to be a trade secret as provided herein, the city shall notify the discharger in writing of the request by certified mail, return receipt requested. The city shall release the information to the public, but not earlier than thirty (30) days after the date of mailing the notice of the request for information, unless, prior to the expiration of the thirty (30) day period, the applicant or permitholder files an action in an appropriate court for a declaratory judgment that the information is subject to protection under the laws of the state of California or for an injunction prohibiting disclosure of the information to the public and immediately notifies the city of that action. This section does not permit any person to refuse to disclose the information required pursuant to this chapter to the city.

(c) Information and data provided to the city pursuant to this section that constitutes a description of wastewater constituents and characteristics, effluent or flow data, and effluent concentrations shall be available to the public without restriction. A discharger may be prohibited from discharging a substance unless its composition is made known to the city.

(d) Notwithstanding subsection (b), the information shall be made available upon written request to other governmental agencies for uses related to this chapter, the NPDES permitting system, or other similar pollution regulatory programs. (Ord. 1633 § 2 (part), (2000))

15.10.094 Reporting requirements.

(a) All permitholders shall submit periodic reports to the director. Specific reporting requirements will be specified in the underlying permit or in controlling directives or violation notices. Minimum reports required will be:

(1) Baseline monitoring reports (BMR);

(2) Compliance reports, which will be submitted within ninety (90) days of the compliance date calculated pursuant to the applicable pretreatment standards or local standards;

(3) Periodic discharge reports, which may include, but not be limited to, nature of process, volume, rate of flow, mass emission rate, production quantities, hours of operations, number and classification of employees, or other information that relates to the generation of waste including wastewater discharge. These reports will indicate whether applicable pretreatment standards and discharge limits are being met during the reporting period. These reports may also include the chemical constituents and quantity of liquid or gaseous materials stored on-site, even though they are not normally discharged.

(A) Except as specified in 40 CFR 403.12(e)(1), all significant industrial users must, at a frequency determined by the director submit no less than twice per year June and December (or on dates specified), reports indicating the nature and concentration of all pollutants in the discharge which are limited by pretreatment standards and the measured or estimated average and maximum daily flows for the reporting period. In cases where the pretreatment standard requires compliance with best management practices (BMP) or pollution prevention alternatives, the user must submit documentation required by the director or the pretreatment standard necessary to determine the compliance status of the user,

(B) Significant non-categorical industrial users may be required to submit to the director at least once every six (6) months (or on dates specified) a description of the nature, concentration, and flow of the pollutants required to be reported by the city. These reports shall be based on sampling and analysis performed in the period covered by the report, and performed in accordance with the techniques described in 40 CFR Part 136 and amendments thereto. Where 40 CFR Part 136 does not contain sampling or analytical techniques for the pollutant in question, or where the administrator determines that the Part 136 and sampling and analytical techniques are inappropriate for the pollutant in question, sampling and analysis shall be performed by using validated analytical methods or any

other applicable sampling and analytical procedures, including suggested by the city or other persons, approved by the city. This sampling and analysis may be performed by the city or a duly authorized city representative in lieu of the significant non-categorical industrial user. Monitoring frequencies and parameters, as specified in the underlying permit, must be followed in the event that the significant non-categorical industrial user is required to conduct self-monitoring;

(4) All wastewater samples must be representative of the user's discharge. Wastewater monitoring and flow measurement facilities shall be properly operated, kept clean, and maintained in good working order at all times. The failure of a user to keep its monitoring facility in good working order shall not be grounds for the user to claim that sample results are unrepresentative of its discharge;

(5) If sampling by a user indicates a violation, the user must notify the city within twenty-four (24) hours of becoming aware of the violation. The user shall also repeat the sampling and analysis and submit the results of the repeat analysis to the city within thirty (30) days after becoming aware of the violation. Resampling by the user is not required if the city or any authorized representative of the city performs sampling at the user between the time when the initial sampling was conducted and the time when the user of the district receives the results of this sampling, or if the city or authorized representative has performed the sampling and analysis in lieu of the user. (b) A zero discharge report may be required to certify that a discharger does not discharge industrial waste to the sanitary sewer system.

(c) In order to be complete, any report filed pursuant to this section shall contain a certification statement reading as follows:

I certify under penalty of perjury that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

This certification statement shall be signed by the responsible corporate officer, manager, general partner, or duly authorized representative of the discharger and makes that person legally accountable for the information submitted.

(d) It is a violation of the underlying permit to fail to timely file or refuse to file a report required pursuant to this section. (Ord. 913 § 1 (part), (1970); Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000); Ord. 1868 § 5, (2011))

15.10.096 Water conservation.

The director may require a discharger to evaluate water conservation measures for industrial process water as a part of any pre-construction audit, industrial wastewater discharge permit application, mass audit study (MAS), reasonable control measures plan (RCMP), best management practices (BMP) or at any other time deemed necessary by the director. The director may require implementation of water conservation measures that are found to be cost effective. (Ord. 1633 § 2 (part), (2000))

15.10.098 Monitoring.

(a) All monitored discharges shall be analyzed and tested according to procedures outlined in 40 CFR Part 136 and amendments thereto, unless otherwise specified in an applicable categorical pretreatment standard.

(b) Each discharger shall provide at its own expense monitoring facilities to allow inspection, sampling, and

flow measurements of the building sewer and internal drainage systems. The monitoring facility should normally be located on the discharger's premises, but the city may, when such a location would be impractical or cause undue hardship on the discharger, allow the facility to be located in the public street or sidewalk area, so long as an encroachment permit is first obtained and it will not pose any hazard or inconvenience to vehicle or pedestrian traffic.

(c) A monitoring facility shall allow ample room to allow accurate sampling and preparation of samples for analysis and shall be located so that it is not obstructed by landscaping or parked vehicles. The facility, sampling, and measuring equipment shall be maintained in a safe and proper operating condition at all times at the expense of the discharger.

(d) Samples collected to satisfy reporting requirements must be based on data obtained through appropriate sampling and analysis performed during the period covered by the report, based on data that is representative of conditions occurring during the reporting period.

(1) Except as indicated in subsections (d)(2) and (3), the user must collect wastewater samples using twenty-four (24) hour flow-proportional composite sampling techniques, unless time-proportional composite sampling or grab sampling is authorized by the director. Where time-proportional composite sampling or grab sampling is authorized by the director, the samples must be representative of the discharge. Using protocols (including appropriate preservation) specified in 40 CRF Part 136 and appropriate EPA guidance, multiple grab samples collected during a twenty-four (24) hour period may be composited prior to the analysis as follows: for cyanide, total phenols, and sulfides the samples may be composited in the laboratory or in the field; for volatile organics and oil and grease, the samples may be composited in the laboratory. Composite samples for other parameters unaffected by the compositing procedures as documented in approved EPA methodologies may be authorized by the city, as appropriate. In addition, grab samples may be required to show compliance with instantaneous limits.

(2) Samples for oil and grease, temperature, pH, cyanide, total phenols, sulfides, and volatile organic compounds must be obtained using grab collection techniques.

(3) For sampling required in support of baseline monitoring and ninety (90) day compliance reports required in Section 15.10.094(a)(2) and (3), a minimum of four (4) grab samples must be used for pH, cyanide, total phenols, oil and grease, sulfide and volatile organic compounds for facilities for which historical sampling data do not exist; for facilities for which historical sampling data are available, the director may authorize a lower minimum. For the reports required by Section 15.10.094(a)(3)(A) through (C), the user is required to collect the number of grab samples necessary to assess and assure compliance by with applicable pretreatment standards and requirements or specified in the underlying permit. (Ord. 1633 § 2 (part), (2000); Ord. 1868 § 6, (2011))

15.10.100 Self-monitoring.

(a) As a permit condition, the director may require the discharger to conduct a sampling and analysis program of discharger's industrial waste of a frequency and type required by the director to demonstrate compliance with the requirements of this chapter. The discharge permit shall specify the minimum frequency and type of samples, flow monitoring, measuring, and analyses to be conducted by the discharger. The permit may also specify the type of sampling equipment and flow monitoring equipment which must be installed and used. The required self-monitoring program will depend on factors such as flow, potential for the discharge to cause interference, pass-through, or upset of treatment processes, pollutants present, and prior compliance history (if any) of the discharger. Additional monitoring may be required by the director for violation follow-up, assisting the city in evaluating effects of the discharge, or as part of a compliance directive or notice of violation.

(b) The director may require self-monitoring for facilities for which a permit has not been issued. In addition, the director may require investigations or studies to determine methods of reducing toxic constituents in the discharge. The director may also request that information be submitted within a reasonable time concerning the chemical or biological constituents of any substance or chemical product that could potentially be discharged to the sewer system or the storm drain system or which the director determines may, alone or in accumulation with other

discharges, contribute to a violation by the plant of any applicable water quality standards or of any of its NPDES permits or contribute to an upset of plant processes.

(c) If a discharger is subject to the reporting requirements in Section 15.10.094(a)(3)(A) monitors any regulated pollutant at the appropriate sampling location more frequently than required by the city, using the procedures prescribed in Section 15.10.098, the results of this monitoring shall be included in the report. (Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000); Ord. 1868 § 7, (2011))

15.10.102 Inspection and sampling.

(a) The director, or any authorized representative of the director, county health officer, or state or federal government agency related to pollution regulation, may conduct all inspection, surveillance, sampling, photographing, measuring, observing, and monitoring procedures necessary to assure compliance with applicable sections of this chapter, any applicable permit issued pursuant to this chapter, and applicable county, state, and federal orders, regulations and laws.

(b) The director and these authorized representatives shall be authorized, and the owner and occupants of any premises where wastewater is discharged or created shall allow these representatives to enter without unreasonable delay during all hours of discharge and hours of operation of the premises to conduct these procedures.

(c) The director and these authorized representatives shall further have the right, and the owner and occupants of any premises where wastewater is discharged or created shall allow these representatives to set up on the premises any devices necessary to conducting sampling, inspection, compliance monitoring, or metering operations.

(d) The director and these authorized representatives shall further have the right to inspect and copy any and all records related to the quantity and quality of wastewater discharges, building systems, and chemical and hazardous material usage, as well as those records supporting any reports submitted by the discharger or required by the underlying discharge permit. These records shall be made available by the discharger at either the premises themselves, the department of public works, or another location within the city designated in writing by the dischargers.

(e) Any unreasonable refusal to provide access and records as required by this section shall be grounds to terminate all sewer service or revoke the underlying permit, or both. (Ord. 1633 § 2 (part), (2000))

15.10.104 Charges and fees.

The city council may adopt charges and fees to implement this chapter. Those fees and charges may include civil penalties. (Ord. 1633 § 2 (part), (2000))

15.10.106 Accidental discharges.

Dischargers shall notify the city immediately upon accidentally discharging wastes in violation of this chapter or the discharger's permit in order to enable countermeasures to be taken by the city and other government agencies to minimize damage to the community sewer, plant, treatment processes, and waters of the city and the state. The discharger shall file a detailed written statement with the city within fifteen (15) days of the accidental discharge that describes the causes of the discharge and the measures being taken to prevent any further occurrence. Compliance with this section will not relieve the discharger of liability for any expense, loss, or damage to the sewer system, plant, or treatment process, or for any fines imposed on the city on account thereof under the Water Code or Fish and Game Code. (Ord. 1633 § 2 (part), (2000))

15.10.108 Employee training and notice.

(a) Permitholders shall inform appropriate employees of the provisions of this chapter by conducting orientation of new employees involved in permit-related activities and annual training.

(b) Permitholders shall provide areas for posting of information regarding pollution control, and in all cases, shall post signs or notices indicating approved methods for disposition of wastes and reporting requirements for accidental or slug discharges and increased loadings with telephone numbers for appropriate response agencies. (1633 § 2 (part), (2000); Ord. 1868 § 8, (2011))

15.10.110 Disposal of unacceptable waste.

Waste not permitted to be discharged into the community sewer shall be transported to a state-approved disposal site. The required waste haulers report shall be completed and a copy furnished within thirty (30) days to the city by the discharger. (Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.112 Protection of streams and watercourses.

It is unlawful to discharge to any stream or watercourse any sewage, industrial wastes or other polluted waters. (Ord. 1633 § 2 (part), (2000))

15.10.113 Illegal sewer uses.

Any use of any sanitary sewer system that does not conform to the regulations established in this chapter is illegal. Within thirty (30) days following notice by the city engineer that an illegal use exists, corrective measures to eliminate the illegal use shall be made by the owner or responsible party except that in cases where extensive or exceptional repairs or replacements to existing installations are required, the city engineer may grant extensions of time or consent to temporary remedial arrangements. (Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.114 Agreements in exceptional cases.

(a) Discharge of wastes not meeting the requirements stated in this title may be permitted by special agreement between the discharger and the city, so long as the agreement conforms to state and federal limitations.

(b) The city shall have the right to disallow exceptional discharges, prescribe pretreatment of some types of industrial wastes and to establish surcharges based on the cost of handling exceptional wastes in the city's sewage collection and treatment system. (Ord. 1250 § 2 (part), (1983); Ord. 1633 § 2 (part), (2000))

15.10.116 Civil penalties.

(a) Pursuant to Government Code Section 53069.4, the city may impose civil penalties on persons who violate the provisions of this chapter in addition to any other remedies that the city or any other government agency may have. Civil penalties of up to ten thousand dollars ($10,000.00) per day for each violation may be imposed.

(b) The process by which such civil penalties are determined and reviewed will be the same as and a part of the process by which a violation of the sanitary sewer use rules and regulations is determined and reviewed as adopted by the council by resolution from time to time.

(c) If such a process is not applicable, any person may appeal the imposition of a civil penalty under this chapter by filing a notice of appeal with the city manager within fifteen (15) days of the notice of imposition of a civil penalty. The city manager will fix a time and place for hearing the appeal and give notice in writing to the appellant of the time and place of hearing by serving it personally or by depositing it in the United States mail, postage prepaid, addressed to such person at the address appearing on the notice of appeal. At the hearing on the appeal, the city manager shall receive testimony from the appellant and the city officers or employees

recommending the penalties. The decision of the city manager shall be in writing, shall be served on the appellant in the same manner as prescribed for the notice of hearing, and shall be a final administrative decision.

(d) Any civil penalties imposed under this chapter may be collected in the same manner as other sanitary sewer charges and fees. The imposition of civil penalties shall not preclude in any way the imposition of additional requirements, charges, damages, or criminal sanctions that may be required or imposed by the city or any other person.

(e) Any person contesting a decision on a civil penalty shall be bound by the requirements of Government Code Section 53069(b).

(f) The city may petition the superior court to impose, assess, and recover these civil penalty sums. In determining whether to enforce the civil penalties, the court will take into consideration all relevant circumstances, including, but not limited to, the extent of harm caused by the violation, the nature and persistence of the violation, the length of time over which the violations occurred, and corrective action, if any, taken. (Ord. 1572 § 3, (1997); Ord. 1633 § 2 (part), (2000))

15.10.118 Show cause hearing.

(a) The director may order any user who causes or allows an unauthorized discharge to enter the sanitary sewer system to show cause before the city manager or the city council why a proposed enforcement action should not be taken. A notice will be served on the user specifying the time and place of the hearing and the proposed enforcement action and reasons therefore. The notice will be served personally or by registered or certified mail at least ten (10) days before the scheduled hearing.

(b) After reviewing the evidence and testimony presented at the hearing, the city manager or the city council, as applicable, may make such orders as the manager or council deems appropriate with due regard to the violations, if any. (Ord. 1633 § 2 (part), (2000))

15.10.120 Abatement.

(a) In addition to any other remedies provided by law, the director shall have the power to disconnect the user sewer system from the sewerage works. Upon disconnection, the city will estimate the cost of the re-connection to the system, and this user shall deposit the cost of disconnection and estimate re-connection before the user is reconnected to the system. The city will refund any part of the deposit remaining after payment of all costs of disconnection and re-connection.

(b) During the period of disconnection, any habitation or occupancy of the premises shall constitute a public nuisance. (Ord. 1633 § 2 (part), (2000))

15.10.122 Correction of violation and emergency action.

(a) In order to enforce the provisions of this chapter, the city may correct any violation. The cost of such correction, including installation of additional pretreatment facilities shall be added to any sewer service charges and fees on the premises and collected in the same manner as other sewer service charges and fees.

(b) In case of emergency, the city may take such steps and obtain such warrants as necessary to enter and correct any illegal discharge or permit violation that pose an imminent threat to public health or safety.

(c) Any sewer or sewerage maintenance expenses attributable to a violation of this chapter or a permit issued under this chapter, including excessive preventative maintenance or cleaning, will be charged to the offending discharger by the city. Any refusal to pay such maintenance expenses duly authorized by the city shall constitute a violation of this code. (Ord. 1633 § 2 (part), (2000))

15.10.124 Injunction.

In addition to any other remedy provided in this code or by law, the city may petition the superior court or the federal district court for the issuance of a temporary restraining order, preliminary injunction, or permanent injunction, as may be appropriate, restraining any person from a violation of this chapter. (Ord. 1633 § 2 (part), (2000))

15.10.126 Falsifying information or tampering with processes.

(a) It is unlawful to:

(1) Knowingly or recklessly make any false statement, representation, record, report, plan, or other document filed with the city in connection with this chapter; or

(2) Falsify, tamper with, or knowingly or recklessly render inaccurate, any monitoring device or method or access point; or

(3) Divert flow from any monitoring device or equipment installed or operated pursuant to this chapter or any permit issued under this chapter.

(b) In addition to any other remedy provided in this code or by law, any such illegal activity will be grounds for revocation of the underlying permit. (Ord. 1633 § 2 (part), (2000))

15.10.128 Compliance with federal pretreatment regulations.

Notwithstanding any provision in this chapter, no industrial user shall discharge, cause, allow or permit any discharge into the sanitary sewer system in violation of any federal or state regulation regulating discharges by such users, including, but not limited to, the federal pretreatment regulations found in Title 40 of the CFR. Any pretreatment facilities required by those regulations or this chapter shall be provided, operated, and maintained at the user's expense. (Ord. 1633 § 2 (part), (2000))

Appendix B City of Burlingame 15.10 Groundwater Discharge Permit Application

The City of Burlingame

Office of Environmental Compliance
1103 Airport Blvd
650-342-3727

City Hall
501 Primrose Road
Burlingame, CA 94010

Corporation Yard
650-558-7670

GROUNDWATER DISCHARGE PERMIT APPLICATION

Name of Business: _____ **Telephone:** _____
Name of Person Responsible for Permit Compliance: _____
Work Site Address: _____

(Section 1 parts c and d below should be completed only if construction work is being performed or if pretreatment equipment is being installed on site.)

1. The applicant must submit the following information in order for the application to be accepted. All plans and forms submitted must be complete and accurate.
   a. Wastewater Discharge Survey (supplied by the City).
   b. A plan for the property showing all sewers and drains now existing.
   c. Plans and specifications covering any work proposed to be performed under this permit
   d. The name and address of the person or firm who will perform the work covered by this permit.

2. In consideration of granting this permit, the undersigned agrees:
   a. To furnish any additional information relating to the installation or use of the industrial sewer for which this permit is sought as may be required by the *City*.
   b. To abide by all provisions of Title 15 of the Municipal Code, Chapter 15.14, know as the Storm Water Management and Discharge Control Ordinance and all other pertinent ordinances or regulations that may be adopted in the future.
   c. To operate and maintain any waste pretreatment facilities, as may be required as a condition of the acceptance into the wastewater treatment system of the industrial wastes involved, in an efficient manner at all times, and at no expense to the *City*.
   d. To cooperate at all times with the *City* and its representatives in their inspection, sampling, and study of the industrial wastes, and any facilities provided for pretreatment.
   e. To notify the wastewater treatment facility immediately in the event of any accident, or other occurrence resulting in discharge of any wastewater or substances prohibited or not covered in this permit.
   f. To dispose any sludges or by-products of wastewater pretreatment processes in a legal manner in accordance with applicable federal and state regulations.

Applicant Signature: _____
Print Name: _____
Title: _____
Date: _____

FEE PAID $160.00
Sewer and Industrial Waste Application Filing Fee IWD-3

The City of Burlingame

Office of Environmental Compliance
1103 Airport Blvd
650-342-3727

City Hall
501 Primrose Road
Burlingame, CA 94010

Corporation Yard
650-558-7670

Ground Water Discharge Application

SECTION A. APPLICATION

Return the completed application by: _____

A1. Applicant's business name: _____

A2. Address of discharge location:

_____ _____
Street *City*

A3. Mailing address (if different from above):

_____ _____
Street *City*

A4. Name of company treating and discharging groundwater:

_____ (____)_____ (____)_____
Print Name *Contact #* ***Day*** *Contact #* ***Night***

A5. Person to be contacted about this application or in case of emergency:

_____ _____ (____)_____
Print Name *Title* *Contact #* ***Day***

_____ (____)_____
Name of Company *Contact #* ***Night***

A6. Name of business requesting or required to implement clean-up.

_____

A7. Name of person (from above business) to contact about this project.

_____	_____	(___)_____
Print Name	*Title*	Contact #

SECTION B. DISCHARGE DESCRIPTION

B1 Describe the activity that resulted in the soil or groundwater contamination at this site:

_____
_____
_____

B2. Briefly describe the type of treatment system to be used at this location.

_____
_____
_____

B3. Estimated volume (in gallons) of groundwater to be discharged: _____

B4. Circle below for each discharge site **IF** it is an **Underground Storage Tank (UST)** or an **Excavated Tank Pit (ETP)** and if the tank contained: **Gasoline (GAS)**, **Diesel Fuel (DF)** or **Other (OT)**. If **Other**, please describe.

	Number of gallons to discharge	Type of Site		Tank Contents			Describe
Site #1:	_____	UST	ETP	Gas	DF	OT	_____
Site #2:	_____	UST	ETP	Gas	DF	OT	_____
Site #3:	_____	UST	ETP	Gas	DF	OT	_____
Site #4:	_____	UST	ETP	Gas	DF	OT	_____
Site #5:	_____	UST	ETP	Gas	DF	OT	_____

B5. List all constituents of water to be discharged from each tank or pit*:

_____
_____
_____
_____
_____
_____

*Use additional sheet if necessary.

<u>NOTE:</u> Submit analytical results of tank or pit contents. Analysis required for the following constituents.

- Total Lead
- Total Petroleum Hydrocarbon (Gas or Diesel)
- Benzene
- Toluene
- Ethylbenzene
- Xylene
- MTBE

B6. Proposed discharged: Date: _____ Time: _____

B7. Reason for discharge to the sanitary sewer:

_____
_____
_____

B8. Submit drawing showing locations of discharge sites on premise, sites of sanitary sewer and storm sewer. Attach to the application form.

B9. Comments - Discuss anything that may affect the approval of this permit.

_____
_____
_____

B10. Describe any activities or procedures to be implemented to prevent stormwater pollution from migrating from this site.

_____
_____
_____
_____

SECTION C. CERTIFICATION

"I certify under penalty of perjury that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete."*

_____	_____
Signature	Date
_____	_____
Print Name	*Title*

This certification statement shall be signed by the responsible corporate officer, manager, general partner, or duly authorized representative of the discharger and makes that person legally accountable for the information submitted per the Sanitary Sewer Use Regulations, Chapter 15.10.

Appendix C VOC and Fuel General NPDES Permit (Order No, R2-2012-0012, NPDES No. CAG912002)

Matthew Rodriquez
Secretary for Environmen Protection

California Regional Water Quality Control Board
San Francisco Bay Region

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Edmund G. Brown Jr.
Governor

ORDER NO. R2-2012-0012
NPDES NO. CAG912002

GENERAL WASTE DISCHARGE REQUIREMENTS FOR:
Discharge or Reuse of Extracted and Treated Groundwater Resulting from the Cleanup of Groundwater Polluted by Volatile Organic Compounds (VOC), Fuel Leaks and Other Related Wastes (VOC and Fuel General Permit)

Table 1. Administrative Information

This Order was adopted by the Regional Water Quality Control Board on:	**February 8, 2012**
This Order shall become effective on:	**March 15, 2012**
This Order shall expire on:	**March 15, 2017**
CIWQS Regulatory Measure Number:	**383087**
The U.S. Environmental Protection Agency (USEPA) and the Regional Water Quality Control Board have classified the discharges under this General National Pollutant Discharge Elimination System (NPDES) Permit as minor discharges based on the discharges' impacts to receiving water bodies.	
To obtain coverage under this General Permit, dischargers must submit a Notice of Intent (NOI) Form as described in Attachment B and a filing fee equivalent to the first year's annual fee. If the NOI is complete, Authorization to Discharge will be issued by the Regional Water Quality Control Board Executive Officer.	
Authorized dischargers who need to continue discharging after the expiration date of this Order shall file a completed NOI form no later than 180 days in advance of this Order's expiration date. Such dischargers for whom coverage is extended will become subject to the new Order upon authorization by the Executive Officer.	

I, Bruce H. Wolfe, Executive Officer, do hereby certify that this Order with all attachments is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, San Francisco Bay Region, on the date indicated above.

_____

Bruce H. Wolfe, Executive Officer

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Attachment B – Notice of Intent Application Form and Instructions
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Attachment F – Fact Sheet

I. SCOPE OF GENERAL PERMIT

Facilities that may be covered under this Order are groundwater treatment facilities located at active or closed sites, such as service stations or construction sites. These groundwater treatment facilities are in operation to extract and treat groundwater polluted by volatile organic compounds (VOC), fuel, and fuel additives. This Order covers discharges from these facilities to all surface waters such as creeks, streams, rivers including flood control channels, lakes, or San Francisco Bay. Such discharges may occur directly to surface waters or through constructed storm drain systems.

II. FINDINGS

The California Regional Water Quality Control Board, San Francisco Bay Region (hereinafter, the Regional Water Board), finds:

A. Background. There are 20 permittees authorized (as of November 2011) to discharge pursuant to Order No. R2-2006-0075, NPDES Permit No. CAG912002 (General Waste Discharge Requirements for Discharge or Reuse of Extracted and Treated Groundwater Resulting from the Cleanup of Groundwater Polluted by Fuel Leaks and Other Related Waste at Service Stations and Similar Sites). Of this group, 18 submitted Notices of Intent (NOI) applications and applied for an NPDES permit to continue their discharge of treated wastewater from their groundwater extraction and treatment facilities (hereinafter Facility or Facilities).

In addition, there are 56 permittees currently authorized to discharge pursuant to Order No. R2-2009-0059, NPDES Permit No. CAG912003 (General Waste Discharge for Discharge or Reuse of Extracted and Treated Groundwater Resulting from the Cleanup of Groundwater Polluted by VOC). Order No. R2-2009-0059 will not be reissued upon expiration on September 30, 2014, and permittees with a continued need to discharge shall seek coverage under this General Permit.

For the purposes of this Order, references to the "Discharger" or "permittee" in applicable federal and State laws, regulations, plans, or policy are held to be equivalent to references to the Discharger(s) herein. A discharger who is authorized under this Order is hereinafter a Discharger.

B. Facility Description. Dischargers typically use aeration and/or granular activated carbon (GAC) systems to treat their groundwater prior to discharge. Facilities that use other types of treatment systems that are effective at removal of VOC or fuel pollutants may be covered by this Order subject to the approval of the Executive Officer. Treated wastewaters are typically discharged through storm drain systems, rivers, and/or creeks to San Francisco Bay. To obtain coverage under this Order, a discharger must include a complete description of the treatment system installed at its facility in the Notice of Intent (NOI) application form (Attachment B).

C. Regional Water Board Preference for Reuse or Discharge to POTW: The Regional Water Board adopted Resolution No. 88-160 on October 19, 1988. The Resolution urges dischargers of extracted groundwater from site cleanup projects to reuse their treated groundwater. When reuse is not technically and/or economically feasible, to discharge to a publicly owned treatment works (POTW). Only if neither reuse nor discharge to a POTW is technically or economically feasible, and if beneficial uses of the receiving water are not adversely affected, the Regional Water

Board may authorize the discharge of treated extracted groundwater in accordance with the requirements of this Order.

D. Legal Authorities. This Order is issued pursuant to Clean Water Act (CWA) section 402 and implementing regulations adopted by the U.S. Environmental Protection Agency (USEPA) and chapter 5.5, division 7 of the California Water Code (CWC) (commencing with section 13370). It shall serve as an NPDES permit for point source discharges from each Facility, regulated under this Order, to surface waters. This Order also serves as General Waste Discharge Requirements (GWDRs) pursuant to CWC article 4, chapter 4, division 7 (commencing with section 13260).

States may request authority to issue general NPDES permits pursuant to title 40 of the Code of Federal Regulations (40 CFR) section 122.28. On June 8, 1989, the State Water Resources Control Board (State Water Board) submitted an application to USEPA requesting revisions to its NPDES Program in accordance with 40 CFR 122.28, 123.62, and 403.10. The application included a request to add general permit authority to its approved NPDES Program. On September 22, 1989, USEPA Region 9 approved the State Water Board's request and granted authorization for the State to issue general NPDES permits.

E. Background and Rationale for Requirements. The Regional Water Board developed the requirements in this Order based on information submitted as part of NOIs, through monitoring and reporting programs, and other available environmental information. The Fact Sheet (Attachment F), which contains background information and rationale for Order requirements, is hereby incorporated into this Order and constitutes part of the Findings for this Order. Attachments A through F are also incorporated into this Order.

F. California Environmental Quality Act (CEQA). Under CWC section 13389, this action to adopt an NPDES permit is exempt from Chapter 3 of CEQA.

G. Technology-based Effluent Limitations. CWA section 301(b) and NPDES regulations at 40 CFR 122.44 require that permits include conditions meeting applicable technology-based requirements, at a minimum, and any more stringent effluent limitations necessary to meet applicable water quality standards. Discharges authorized by this Order must meet technology-based effluent limitations based on Best Professional Judgment (BPJ) in accordance with 40 CFR 125.3. A detailed discussion of the technology-based effluent limitations development and BPJ is included in the Fact Sheet (Attachment F).

H. Water Quality-Based Effluent Limitations. CWA section 301(b) and NPDES regulations at 40 CFR 122.44(d) require that permits include limitations more stringent than applicable federal technology-based requirements where necessary to achieve applicable water quality standards. NPDES regulations at 40 CFR122.44(d)(1)(i) mandate that permits include effluent limitations for all pollutants that are or may be discharged at levels that have the reasonable potential to cause or contribute to an exceedance of a water quality standard, including numeric and narrative objectives within a standard. Where reasonable potential has been established for a pollutant, but there is no numeric criterion or objective for the pollutant, WQBELs must be established using: (1) USEPA criteria guidance under CWA section 304(a), supplemented where necessary by other relevant information; (2) on an indicator parameter for the pollutant of concern; or (3)

using a calculated numeric water quality criterion, such as a proposed state criterion or policy interpreting the state's narrative criterion, supplemented with other relevant information, as provided in 40 CFR 122.44(d)(1)(vi).

I. Water Quality Control Plans. The *Water Quality Control Plan for the San Francisco Bay Basin* (Basin Plan) is the Regional Water Board's master water quality control planning document. It designates beneficial uses and water quality objectives (WQOs) for waters of the State, including surface waters and groundwater. It also includes programs of implementation to achieve WQOs. The Basin Plan was duly adopted by the Regional Water Board and approved by the State Water Board, Office of Administrative Law, and USEPA.

The Basin Plan states that the beneficial uses of any specifically identified water body generally apply to its tributary streams. The Basin Plan may not specifically identify beneficial uses for every receiving water regulated under this permit, but may identify present and potential uses for the downstream water body, to which the receiving water, via an intermediate water body, is tributary. These potential and existing beneficial uses are municipal and domestic supply, fish migration and fish spawning, industrial service supply, navigation, industrial process supply, marine habitat, agricultural supply, estuarine habitat, groundwater recharge, shellfish harvesting, water contact and non-contact recreation, ocean, commercial, and sport fishing, wildlife habitat, areas of special biological significance, cold freshwater and warm freshwater habitat, and preservation of rare and endangered species for surface waters and municipal and domestic supply, industrial service supply, industrial process supply, agricultural supply, and freshwater replenishment for groundwaters. In addition, the Basin Plan implements State Water Board Resolution No. 88-63, which established State policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply. Requirements of this Order implement the Basin Plan.

On September 18, 1975, the State Water Board adopted the *Water Quality Control Plan for Control of Temperature in the Coastal Interstate Waters and Enclosed Bays and Estuaries of California* (hereinafter the Thermal Plan). The Thermal Plan contains objectives governing cooling water discharges, providing different and specific numeric and narrative water quality objectives for new and existing discharges.

The State Water Board's *Water Quality Control Plan for Enclosed Bays and Estuaries—Part 1, Sediment Quality* became effective on August 25, 2009. This plan supersedes other narrative sediment quality objectives and establishes new sediment quality objectives and related implementation provisions for specifically defined sediments in most bays and estuaries.

J. National Toxics Rule (NTR) and California Toxics Rule (CTR). USEPA adopted the NTR on December 22, 1992, and later amended it on May 4, 1995, and November 9, 1999. About 40 criteria in the NTR apply in California. On May 18, 2000, USEPA adopted the CTR. The CTR promulgated new toxics criteria for California and, in addition, incorporated the previously adopted NTR criteria that were applicable in the State. The CTR was amended on February 13, 2001. These rules contain water quality criteria (WQC) for priority pollutants.

K. State Implementation Policy. On March 2, 2000, the State Water Board adopted the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of*

California (State Implementation Policy or SIP). The SIP became effective on April 28, 2000, with respect to the priority pollutant criteria promulgated for California by USEPA through the NTR and to the priority pollutant objectives established by the Regional Water Board in the Basin Plan. The SIP became effective on May 18, 2000, with respect to the priority pollutant criteria promulgated by USEPA through the CTR. The State Water Board adopted amendments to the SIP on February 24, 2005, that became effective on July 13, 2005. The SIP establishes implementation provisions for priority pollutant criteria and objectives and provisions for chronic toxicity control. Requirements of this Order implement the SIP.

L. Recycled Water Policy. The State Water Board adopted Resolution No. 2009-0011 (*Policy for Water Quality Control for Recycled Water*) on February 3, 2009. The policy is intended to promote sustainable local water supplies by increasing the acceptance and promoting the use of recycled water. It sets a goal of increasing recycled water use statewide by at least one million acre feet per year by 2030. The policy also requires Regional Water Boards to exercise their authority to the fullest extent possible to encourage recycled water use and to develop watershed-based salt and nutrient management plans to ensure that groundwater resources are not degraded by recycled water use.

M. Alaska Rule. On March 30, 2000, USEPA revised its regulation that specifies when new and revised state and tribal water quality standards (WQS) become effective for CWA purposes. [40 CFR 131.21; 65 Fed. Reg. 24641 (April 27, 2000)] Under the revised regulation (also known as the Alaska rule), new and revised standards submitted to USEPA after May 30, 2000, must be approved by USEPA before being used for CWA purposes. The final rule also provides that standards already in effect and submitted to USEPA by May 30, 2000, may be used for CWA purposes, whether or not approved by USEPA.

N. Stringency of Requirements for Individual Pollutants. This Order contains both technology-based and water quality-based effluent limitations (WQBELs) for individual pollutants. Derivation of these limitations is discussed in the Fact Sheet (Attachment F.) This Order's technology-based pollutant restrictions on benzene, carbon tetrachloride, chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethylene, ethylbenzene, methylene chloride, tetrachloroethylene, toluene, cis-1,2-dichloroethylene, trans-1,2-dichloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethylene, vinyl chloride, total xylenes, methyl tertiary butyl ether, total petroleum hydrocarbons, and trichlorotrifluoroethane implement the minimum applicable federal technology-based requirements and meet requirements of the Basin Plan.

WQBELs have been derived to implement WQOs that protect beneficial uses. Both the beneficial uses and the WQOs have been approved pursuant to federal law and are the applicable federal water quality standards. To the extent that toxic pollutant WQBELs were derived from the CTR, the CTR is the applicable standard pursuant to 40 CFR 131.38. The procedure for calculating individual WQBELs for priority pollutants is based on the SIP. Most beneficial uses and WQOs contained in the Basin Plan were approved under State law and submitted to and approved by USEPA. Any WQOs and beneficial uses submitted to USEPA prior to May 30, 2000, but not approved by USEPA before that date, are nonetheless "applicable water quality standards for the purposes of the CWA" pursuant to 40 CFR 131.21(c)(1).

O. Antidegradation Policy. NPDES regulations at 40 CFR 131.12 require that state water quality standards include an antidegradation policy consistent with the federal policy. The State Water Board established California's antidegradation policy in State Water Board Resolution No. 68-16, which incorporates the federal antidegradation policy where the federal policy applies under federal law and requires that existing quality of waters be maintained unless degradation is justified based on specific findings. The Basin Plan implements, and incorporates by reference, both the State and federal antidegradation policies.

P. Anti-Backsliding Requirements. CWA sections 402(o)(2) and 303(d)(4) and 40 CFR 122.44(l) prohibit backsliding in NPDES permits. These anti-backsliding provisions require that effluent limitations in a reissued permit be as stringent as those in the previous permit, with some exceptions where limitations may be relaxed. This Order retains effluent limitations no less stringent than those established by previous orders.

Q. Endangered Species Act. This Order does not authorize any act that results in the taking of a threatened or endangered species or any act that is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code sections 2050 to 2097) or the federal Endangered Species Act (16 U.S.C.A. sections 1531 to 1544). This Order requires compliance with effluent limits, receiving water limits, and other requirements to protect the beneficial uses of waters of the State. Dischargers are responsible for meeting all requirements of applicable State and federal law pertaining to threatened and endangered species.

R. Monitoring and Reporting. NPDES regulations at 40 CFR 122.48 require that all NPDES permits specify requirements for recording and reporting monitoring results. CWC sections 13267 and 13383 authorize the Regional Water Board to require technical and monitoring reports. The Monitoring and Reporting Program establishes monitoring and reporting requirements to implement federal and State requirements. This Monitoring and Reporting Program is provided in Attachment E.

S. Standard and Special Provisions. Standard Provisions, which apply to all NPDES permits in accordance with 40 CFR section 122.41, and additional conditions applicable to specified categories of permits in accordance with 40 CFR 122.42 and as modified for this General Permit, are provided in Attachment D. Dischargers must comply with all standard provisions and with those additional conditions that are applicable under 40 CFR 122.42. The Regional Water Board has also included in this Order special provisions applicable to the Dischargers. The attached Fact Sheet (Attachment F) provides rationale for the special provisions contained in this Order.

T. Provisions and Requirements Implementing State Law. The provisions/requirements in subsections IV.B (Reclamation Specifications) and V.B (Groundwater Limitations) of this Order are included to implement State law only. These provisions/requirements are not required or authorized under the federal CWA; consequently, violations of these provisions/requirements are not subject to the enforcement remedies that are available for NPDES violations.

U. Notification of Interested Parties. The Regional Water Board notified the Dischargers and interested agencies and persons of its intent to prescribe GWDRs for the discharge and has

provided them with an opportunity to submit their written comments and recommendations. The Fact Sheet (Attachment F) provides details of the notification.

V. Consideration of Public Comment. The Regional Water Board, in a public meeting, heard and considered all comments pertaining to the discharge. The Fact Sheet (Attachment F) provides details of the public hearing.

IT IS HEREBY ORDERED, that this Order supersedes Order No. R2-2006-0075 and, effective September 30, 2014, Order No. R2-2009-0059, except for enforcement purposes, and in order to meet the provisions contained in CWC Division 7 (commencing with section 13000) and regulations adopted thereunder, and the provisions of the federal CWA and regulations and guidelines adopted thereunder, the Discharger shall comply with the following requirements in this Order.

III. DISCHARGE PROHIBITIONS

A. The discharge of extracted and treated groundwater polluted by fuel, fuel components, VOC, and related wastes to surface waters from service stations, construction sites, and similar sites, is prohibited unless an NOI application for proposed discharge has been submitted, and the Executive Officer has provided the Discharger with an Authorization to Discharge.

B. Discharges other than the following are prohibited: extracted groundwater treated only with treatment chemicals approved by the Executive Officer and added in a manner consistent with the proper operation and maintenance of the treatment facility.

C. The discharge of extracted and treated groundwater from a specific site in excess of the flow rate specified by the Executive Officer in the Authorization to Discharge is prohibited.

D. Discharges to a storm drain shall not cause scouring or erosion at the point where the storm drain discharges into the receiving water and shall not cause or contribute to scouring of banks, excessive sedimentation, or flooding of the storm drain system or receiving water downstream of the point of discharge.

E. Neither the treatment nor the discharge of pollutants shall create a pollution, contamination, or nuisance, as defined by CWC section 13050.

F. Bypass or overflow of untreated or partially treated groundwater polluted by fuel, fuel components, VOC, or other related wastes to waters of the State either at the treatment system or from any of the collection or transport systems or pump stations tributary to the treatment system is prohibited, except as provided for in the conditions stated in section I.G.2 and I.G.4 of Attachment D.

IV. EFFLUENT LIMITATIONS AND DISCHARGE SPECIFICATIONS

A. Effluent Limitations (For Dischargers to Surface Water Only)

1. **Toxic Pollutants:** The discharge of treated groundwater shall maintain compliance with the following effluent limitations at Monitoring Location EFF-001 as specified in the Authorization to Discharge:

Table 2. Effluent Limitations for Toxic Pollutants

No.	Compound	CAS Number	Column A: Discharge to Drinking Water Areas[1]		Column B: Discharge to Other Surface Water Areas	
			Average Monthly Effluent Limitation (µg/L)	Maximum Daily Effluent Limitation (µg/L)	Average Monthly Effluent Limitation (µg/L)	Maximum Daily Effluent Limitation (µg/L)
1	Benzene	71432	---	1	---	5
2	Carbon Tetrachloride	56235	0.25[2]	0.50	4.4	5
3	Chloroform	67663	---	5	---	5
4	1,1-Dichloroethane	75343	---	5	---	5
5	1,2-Dichloroethane	107062	0.38[2]	0.5	---	5
6	1,1-Dichloroethylene	75354	0.057[2]	0.11[2]	3.2	5
7	Ethylbenzene	100414	---	5	---	5
8	Methylene Chloride	75092	4.7	5	---	5
9	Tetrachloroethylene (PCE)	127184	0.8	1.6	---	5
10	Toluene	108883	---	5	---	5
11	Cis 1,2-Dichloroethylene	156592	---	5	---	5
12	Trans 1,2-Dichloroethylene	156605	---	5	---	5
13	1,1,1-Trichloroethane	71556	---	5	---	5
14	1,1,2-Trichloroethane	79005	0.6	1.2	---	5
15	Trichloroethylene (TCE)	79016	2.7	5	---	5
16	Vinyl Chloride	75014	---	0.5	---	1
17	Total Xylenes	1330207	---	5	---	5
18	Methyl Tertiary Butyl Ether (MTBE)	1634044	---	5	---	5
19	Total Petroleum Hydrocarbons[TPHs (as gasoline or as diesel)]	---	---	50	---	50

No.	Compound	CAS Number	Column A: Discharge to Drinking Water Areas[1]		Column B: Discharge to Other Surface Water Areas	
			Average Monthly Effluent Limitation (µg/L)	Maximum Daily Effluent Limitation (µg/L)	Average Monthly Effluent Limitation (µg/L)	Maximum Daily Effluent Limitation (µg/L)
20	Ethylene Dibromide (1,2-Dibromoethane)	106934	---	0.05[2]	---	5
21	Trichloro-trifluoroethane	76131	---	5	---	5
22	Total Chlorine Residual	---	---	0.0[3]	---	0.0[3]

Table Notes:
[1] Drinking water areas are defined as surface waters with the existing or potential beneficial uses of "Municipal and Domestic Supply" and "Groundwater Recharge" (the latter includes recharge areas to maintain salt balance or to halt salt water intrusion into fresh water aquifers).
[2] If reported detection level is greater than effluent limit, then a non-detect result using a 0.5 µg/L detection level will not be deemed to be out of compliance.
[3] There shall be no detectable levels of residual chlorine in the effluent (a non-detect result using a detection level equal or less than 0.08 milligram per liter (mg/L) will not be deemed to be out of compliance). This limit only applies to Dischargers that chlorinate their extracted groundwater.

2. **pH:** The pH of the discharge shall not exceed 8.5 nor be less than 6.5.

3. **Acute Toxicity:**

   a. Representative samples of the discharge, with compliance measured at Monitoring Location EFF-001 as described in the Authorization to Discharge, shall meet the following limits for acute toxicity. Bioassays shall be conducted in compliance with Section V.A of the Monitoring and Reporting Program (Attachment E).

   The survival of test fish in 96-hour static renewal bioassays with the discharge shall be not less than a three sample moving median of 90% survival and a single test value of not less than 70% survival.

   b. These acute toxicity limitations are further defined as follows:

   (1) 3-sample median. A bioassay test showing survival of less than 90 percent represents a violation of this limitation, if one or more of the past two or less bioassay tests show less than 90 percent survival.

   (2) Single sample. A bioassay test showing survival of less than 70 percent represents a violation of this limitation.

   c. Bioassays shall be performed using the most up-to-date USEPA protocol. Bioassays shall be conducted using rainbow trout as the test species in compliance with *Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms*, currently 5th Edition (EPA-821-R-02-012), with exceptions granted

to the Discharger by the Executive Officer and the Environmental Laboratory Accreditation Program (ELAP) upon the Discharger's request with justification.

B. Groundwater Reuse Specifications (For Dischargers that Reuse All or a Portion of Treated Groundwater)

1. **Reuse Policy:** As noted in the findings, the Regional Water Board adopted Resolution No. 88-160 on October 19, 1988. The Resolution urges dischargers of extracted groundwater from site cleanup projects to reuse their effluent and that when reuse is not technically and/or economically feasible, to discharge to a POTW.

2. **Reuse Allowed:** This Order permits reuse of extracted treated groundwater in conjunction with the discharge to surface water. Reuse of extracted treated groundwater can take many forms, such as irrigation of landscaping or agriculture, dust control or soil compaction on construction sites, and industrial water supply.

3. **Water Reuse Specifications (Water Reuse Only)**

   a. Water for beneficial reuse shall meet the requirements in Section IV.A - Effluent Limitations.

   b. Water reuse activities shall be described in the Discharger's NOI, including the method of any additional treatment and the location and type of water reuse.

   c. The reuse of treated groundwater shall not impair the quality of waters of the State, nor shall it create a nuisance as defined by CWC section 13050(m).

   d. Adequate measures shall be taken to minimize public contact with the reused groundwater and to prevent the breeding of flies, mosquitoes, and other vectors of public health significance during or after the process of reuse.

   e. Appropriate public warnings must be posted to advise the public that the water is not suitable for drinking. Signs must be posted in the area, and all reused water valves and outlets appropriately labeled.

   f. There shall be no cross-connection between the potable water supply and piping containing treated groundwater intended for reuse.

   g. Water reuse consisting of recharge or reinjection is not authorized under this Order. Any reinjection must be performed in accordance with a cleanup order approved by the Regional Water Board, or another lead oversight agency.

V. RECEIVING WATER LIMITATIONS

A. Surface Water Limitations

Discharges shall not cause the following in surface receiving waters:

1. The discharge of waste shall not cause the following conditions to exist in waters of the State at any place:

a. Floating, suspended, or deposited macroscopic particulate matter or foam;

b. Bottom deposits or aquatic growths to the extent that such deposits or growths cause nuisance or adversely affect beneficial uses;

c. Alteration of temperature, turbidity, or apparent color beyond present natural background levels;

d. Visible, floating, suspended, or deposited oil or other products of petroleum origin; and

e. Toxic or other deleterious substances to be present in concentrations or quantities that will cause deleterious effects on aquatic biota, wildlife, or waterfowl, or which render any of these unfit for human consumption either at levels created in the receiving waters or as a result of biological concentration.

2. The discharge of waste shall not cause the following limits to be exceeded in waters of the State in any place within one foot of the water surface:

a. Dissolved oxygen:

<u>For all tidal waters</u>:

In the Bay downstream of Carquinez Bridge - 5.0 mg/L minimum

Upstream of Carquinez Bridge - 7.0 mg/L minimum

<u>For nontidal waters</u>:

Waters designated as cold water habitat - 7.0 mg/L minimum

Waters designated as warm water habitat - 5.0 mg/L minimum

<u>For all inland surface waters</u>:

The median dissolved oxygen concentration for any three consecutive months shall not be less than 80% of the dissolved oxygen content at saturation. When natural factors cause concentrations less than that specified above, the discharge shall not cause further reduction in ambient dissolved oxygen concentrations.

b. Dissolved Sulfide

Natural background levels

c. pH:	The pH shall not be depressed below 6.5 nor raised above 8.5, nor caused to vary from normal ambient pH by more than 0.5 pH units.
d. Un-ionized Ammonia	0.025 mg/L as an annual median; 0.16 mg/L as a maximum for Central Bay and upstream; 0.4 mg/L as a maximum for Lower Bay.
e. Nutrients	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

3. Discharges shall not cause or contribute to a violation of any applicable water quality standard for receiving waters adopted by the Regional Water Board or the State Water Board as required by the CWA and regulations adopted there under. If more stringent applicable water quality standards are promulgated or approved pursuant to CWA section 303, or amendments thereto, the Regional Water Board will revise and modify this Order in accordance with such more stringent standards.

B. Groundwater Limitations – No discharges to groundwater authorized by this Order

VI. PROVISIONS

A. Standard Provisions

Dischargers shall comply with federal Standard Provisions included in Attachment D of this Order.

B. Monitoring and Reporting Program Requirements

1. Dischargers shall comply with the Monitoring and Reporting Program (Attachment E), and future revisions thereto, including applicable sampling and reporting requirements in the standard provisions listed in VI.A, above.

2. Dischargers authorized under this Order, especially those Dischargers with flow rates exceeding 10 gallons per minute, may be required to comply with additional monitoring requirements. The Executive Officer will specify such additional monitoring requirements in the Authorization to Discharge letter. Examples of additional monitoring that may be required are listed below:

a. Monitoring in response to a complaint received about a facility authorized to discharge under this permit,
b. Storm water monitoring,
c. Dioxins and furans monitoring,
d. Regional Monitoring Program (RMP) monitoring,
e. Additional discharge observations, and
f. Additional effluent and ambient priority pollutant scans.

C. Special Provisions

1. Reopener Provisions

The Regional Water Board may modify or reopen this Order prior to its expiration date in any of the following circumstances as allowed by law:

a. If present or future investigations demonstrate that the discharges governed by this Order have or will have a reasonable potential to cause or contribute to, or will cease to have, adverse impacts on water quality or beneficial uses of the receiving waters.

b. If new or revised WQOs or total maximum daily loads (TMDLs) come into effect for the San Francisco Bay Estuary and contiguous water bodies (whether statewide, regional, or site-specific). In such cases, effluent limitations in this Order will be modified as necessary to reflect updated WQOs and waste load allocations in TMDLs. Adoption of effluent limitations contained in this Order is not intended to restrict in any way future modifications based on legally adopted WQOs or TMDLs, or as otherwise permitted under federal regulations governing NPDES permit modifications.

c. If State Water Board precedential decisions, new policies, new laws, or new regulations on chronic toxicity or total chlorine residual become available.

d. If an administrative or judicial decision on a separate NPDES permit or WDRs addresses requirements similar to this discharge.

e. The Discharger may request permit modification based on any of the circumstances described above. In any such request, the Discharger shall include an antidegradation and anti-backsliding analysis.

f. The California Department of Public Health established a notification level for 1, 4-dioxane in November 2010 and has determined that it is reasonably anticipated to be a human carcinogen. Although this Order does not provide an effluent limit for 1,4-dioxane, the Regional Water Board may reopen this Order prior to its expiration to revise permit provisions pertaining to 1,4-dioxane.

g. Or as otherwise authorized by law.

2. **NOI or Modified NOI Application.** The NOI or Modified NOI application for each point of proposed discharge to a storm drain system shall contain the information required in the NOI Application as explained in Attachment B of this Order and as may be amended by the Executive Officer.

3. **NOI Review.** Upon receipt of a complete NOI application package for proposed discharge, the Executive Officer will review the application to determine whether the proposed Discharger is eligible to discharge waste under this Order. The application package shall document that:

a. The proposed discharge results from the cleanup of groundwater polluted by fuel leaks,

VOC leaks, and other related wastes;

b. The proposed Discharger has met the provisions of Regional Water Board Resolution No. 88-160 (*Regional Water Board Position on the Disposal of Extracted Groundwater from Groundwater Cleanup Projects*); and

c. The proposed treatment system and associated operation, maintenance, and monitoring plans are capable of ensuring that the discharge will meet the provisions, prohibitions, effluent limitations, and receiving water limitations of this Order.

4. **Discharge Authorization.** If the Regional Water Board Executive Officer determines that the proposed Discharger is eligible to discharge waste under this Order, the Executive Officer will issue an Authorization to Discharge. This Authorization to Discharge may be terminated by the Executive Officer at any time.

5. **Non-Compliance Is A Violation.** Upon receipt of the Regional Water Board Executive Officer's Authorization to Discharge, the Discharger shall comply with all applicable conditions and limitations of this Order and its Attachments. Any noncompliance (violations of requirements in this Order or Monitoring Program) constitutes a violation of the CWA and the CWC and is grounds for enforcement action and/or termination or modification of authorization to discharge.

6. **Triggers.** The following triggers are not effluent limitations and must not be construed as such. Instead, the triggers are levels above which additional investigation is required to determine further action. If any constituent in the discharge exceeds the corresponding trigger as listed in Table 3, below, the Discharger shall take monthly influent and effluent samples for three consecutive months for each exceeded constituent and conduct activities as required in Provisions VI.C.7 or VI.C.8. If additional monitoring has already been completed, the Discharger shall summarize the results including a description of plans underway to address the previous exceedance, such as details of source elimination, changes in operation of existing treatment units, or the re-design of any treatment unit.

Table 3. Trigger Pollutants

Pollutant	Chemical Abstract Service (CAS) Number	Trigger (µg/L)[1],[2]
Antimony	7440360	6
Arsenic	7440382	10
Beryllium	7440417	4
Cadmium	7440439	1.1
Chromium (VI)	18540299	11[3]
Copper[4]	7440508	5.9
Copper[5]	7440508	3.4
Copper[6]	7440508	4.7
Lead	7439921	3.2
Mercury	7439976	0.025
Nickel[4]	7440020	30
Nickel[5]	7440020	13
Nickel[6]	7440020	19
Selenium	7782492	5
Silver	7440224	2.2
Thallium	7440280	1.7
Zinc	7440666	86
Cyanide	57125	2.9

Pollutant	Chemical Abstract Service (CAS) Number	Trigger (µg/L)[1],[2]
Acrylonitrile	107131	0.059
Bromoform	75252	4.3
Chlorodibromomethane	124481	0.401
Dichlorobromomethane	75274	0.56
1,2-Dichloropropane	78875	0.52
1,3-Dichloropropylene	542756	0.5
1,1,2,2-Tetrachloroethane	79345	0.17
Pentachlorophenol	87865	0.28
2,4,6-Trichlorophenol	88062	2.1
Benzidine	92875	0.00012
Benzo(a)anthracene	56553	0.0044
Benzo(a)pyrene	50328	0.0044
Benzo(b)fluoranthene	205992	0.0044
Benzo(k)fluoranthene	207089	0.0044
Bis(2-chloroethyl)ether	111444	0.031
Bis(2-ethylhexyl)phthalate	117817	1.8
Chrysene	218019	0.044
Dibenzo(a,h)anthracene	53703	0.0044
3,3'-Dichlorobenzidine	91941	0.04
2,4-Dinitrotoluene	121142	0.11
1,2-Diphenylhydrazine	122667	0.040
Hexachlorobenzene	118741	0.00075
Hexachlorobutadiene	87683	0.44
Hexachloroethane	67721	1.9
Indeno(1,2,3-c,d)pyrene	193395	0.0044
N-nitrosodimethylamine	62759	0.00069
N-nitrosodi-n-propylamine	621647	0.005
Aldrin	309002	0.00013
alpha-BHC	319846	0.0039
beta-BHC	319857	0.014
gamma-BHC	58899	0.019
Chlordane	57749	0.00057
4,4-DDT	50393	0.00059
4,4-DDE	72559	0.00059
4,4-DDD	72548	0.00083
Dieldrin	60571	0.00014
alpha-Endosulfan	959988	0.0087
beta-Endosulfan	33213659	0.0087
Endrin	72208	0.0023
Endrin aldehyde	7421934	0.76
Heptachlor	76448	0.00021
Heptachlor epoxide	1024573	0.00010
PCBs, sum	1336363	0.00017
Toxaphene	8001352	0.0002
1,4-dioxane	123911	3
Turbidity (NTU)	---	5
Odor-Threshold (Units)	---	3
Oxygenates Other than MTBE	---	5
TPHs (other than gasoline and diesel)	---	50[7]
Sulfate	---	250,000
Foaming agents	---	500
Color (Units)	-	15

Table Notes:

[1] Units are in µg/L unless noted otherwise right after the name of pollutant

[2] If a discharger is reporting non-detect monitoring data with a reporting level higher than the trigger, the reason for the higher detection level shall be consistent with Appendix 4 of the SIP (Minimum Levels) and must be explained within the monitoring report. Please refer to the Regional Water Board web site for the latest version of SIP.

[3] If total chromium concentration exceeds 11 µg/L, then analysis for chromium (VI) shall also be conducted.

[4] Applicable to Suisun Bay and San Pablo Bay segments of San Francisco Bay.

[5] Applicable to Central Bay and Lower Bay segments of San Francisco Bay

[6] Applicable to South San Francisco Bay, south of Hayward Shoals.

[7] If a discharger is reporting monitoring data with a detection level higher than 50 µg/L, the reason for the higher

Pollutant	Chemical Abstract Service (CAS) Number	Trigger (µg/L)[1],[2]
detection level shall be explained within the monitoring report. In case of Bunker C Fuel, any non-detect result with reporting levels not exceeding 100 µg/L will not be deemed to be out of compliance with the 50 ug/L trigger level.		

7. **Trigger Case 1:** If the results of all three additional discharge samples **do not** exceed the triggers, the Discharger shall report the results in the next Monitoring Report and shall return to the schedule of sampling and analysis in the attached Monitoring and Reporting Program (Attachment E).

8. **Trigger Case 2:** If the results of **at least one of the three** additional discharge samples show exceedance of the same trigger, the Discharger shall investigate the source (e.g., comparing influent and discharge sample results) and investigate source control and/or treatment options for each triggered pollutant. The Discharger shall document its progress on these efforts in the Annual Self-Monitoring Report required by section IX.B of the Monitoring and Reporting Program (Attachment E). Until the Executive Officer determines that the "triggered pollutants" investigation is complete, the Discharger must implement the following monitoring schedule for the triggered pollutants:

   a. In case of a triggered inorganic pollutant, the Discharger shall accelerate monitoring of the discharge to quarterly and provide information, updated annually, confirming that pollutant source is background and explain the reasons why treatment of that pollutant is not feasible. Specifically, the annual monitoring reports shall include site-specific background groundwater concentrations, types of treatment available, and costs of treatment systems for each triggered inorganic pollutant, and

   b. In case of a triggered organic pollutant, the Discharger shall accelerate monitoring of the discharge to every two weeks and provide information, updated annually, confirming the reason(s) why that pollutant could not be treated to the level not exceeding the trigger for that pollutant.

9. The Executive Officer may require the Discharger to perform additional investigations or take additional actions if the Discharger: (1) exceeds a trigger value for the same pollutant and confirms (Trigger Case 2 above) the exceedance greater than two times in one calendar year; and (2) is not pursuing resolution of trigger exceedances in a timely fashion in the judgment of the Executive Officer. These two trigger exceedances do not include the data collected to verify the trigger (i.e., effluent data collected to confirm the trigger exceedance). These conditions are also grounds for termination of the Authorization to Discharge.

10. **Individual NPDES Permit May Be Required.** The USEPA Administrator may request the Regional Water Board Executive Officer to require any Discharger authorized to discharge waste by the General Permit to apply for and obtain an individual NPDES permit. The Executive Officer may require any Discharger authorized to discharge waste by the General Permit to apply for and obtain an individual NPDES permit. Cases where an individual NPDES permit may be required include the following:

a. The Discharger is not in compliance with the conditions of this Order or as authorized by the Executive Officer;

b. A change has occurred in the availability of demonstrated technology or practices for the control or abatement of pollutants applicable to the point source;

c. Effluent limitation guidelines are promulgated for point sources covered by the General NPDES Permit; or

d. A water quality control plan containing requirements applicable to such point sources is approved.

11. Treatment Reliability. Dischargers shall, at all times, retain a professional engineer certified in the State of California to oversee the design and operation and maintenance of the treatment system to properly operate and maintain all facilities that are used by the Dischargers to achieve compliance with this Order. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. All of these procedures shall be described in an Operation and Maintenance (O&M) Manual. The Discharger shall keep in a state of readiness all systems necessary to achieve compliance with the conditions of this Order. All systems, both those in service and reserve, shall be inspected and maintained on a regular basis. Records shall be kept of the tests (e.g., analytical or treatment system tests) and made available to the Regional Water Board for at least five years. Additional requirements for compliance with this provision are explained in Attachments B and C of the Order.

12. No Preemption. This Order permits the discharge of treated groundwater to waters of the State subject to the prohibitions, effluent limitations, and provisions of this Order. It does not preempt or supersede the authority of municipalities, flood control agencies, or other local agencies to prohibit, restrict, or control discharges of waste to storm drain systems or other watercourses subject to their jurisdiction. For example, this Order provides no water or groundwater rights and does not preempt the authority of any local or State agency as relates to water rights.

VII. COMPLIANCE DETERMINATION

Compliance with the effluent limitations contained in Section IV of this Order will be determined as specified below:

A. General

Compliance with effluent limitations for priority pollutants shall be determined using sample reporting protocols defined in the Monitoring and Reporting Program and Attachment A of this Order. For purposes of reporting and administrative enforcement by the Regional and State Water Boards, the Discharger shall be deemed out of compliance with effluent limitations if the concentration of the priority pollutant in the monitoring sample is greater than the effluent limitation and greater than or equal to the reporting level (RL).

B. Multiple Sample Data

When determining compliance with an Average Monthly Effluent Limitation (AMEL) **or** Maximum Daily Effluent Limitation (MDEL) for priority pollutants and more than one sample result is available, the Discharger shall compute the arithmetic mean unless the data set contains one or more reported determinations of "Detected, but Not Quantified" (DNQ) or "Not Detected" (ND). In those cases, the Discharger shall compute the median in place of the arithmetic mean in accordance with the following procedure:

1. The data set shall be ranked from low to high, ranking the reported ND determinations lowest, DNQ determinations next, followed by quantified values (if any). The order of the individual ND or DNQ determinations is unimportant.

2. The median value of the data set shall be determined. If the data set has an odd number of data points, then the median is the middle value. If the data set has an even number of data points, then the median is the average of the two values around the middle unless one or both of the points are ND or DNQ, in which case the median value shall be the lower of the two data points where DNQ is lower than a value and ND is lower than DNQ.

ATTACHMENT A – ACRONYMS AND DEFINITIONS

Acronyms

CIWQS	California Integrated Water Quality System
AMEL	Average Monthly Effluent Limitation
Basin Plan	Water Quality Control Plan for the San Francisco Bay Basin
BPJ	Best Professional Judgment
CFR	Code of Federal Regulations
CTR	California Toxics Rule
CV	Coefficient of Variation
CWA	Federal Clean Water Act
DNQ	Detected, but Not Quantified
DO	Dissolved oxygen
ECA	Effluent Concentration Allowance
EFF	Effluent
MDEL	Maximum Daily Effluent Limitation
MDL	Method Detection Limit
ML	Minimum Level
MTBE	Methyl Tertiary Butyl Ether
ND	Not Detected
NTR	National Toxics Rule
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
PCE	Tetrachloroethylene
POTW	Publicly Owned Treatment Work
RL	Reporting Level
RPA	Reasonable Potential Analysis
SIP	State Implementation Policy
SSTs	Site-Specific Translators
TCE	Trichloroethylene
TPHG	Total Petroleum Hydrocarbons as Gasoline
TPHD	Total Petroleum Hydrocarbons as Diesel
µg/L	Microgram per Liter
USEPA	U.S. Environmental Protection Agency
VOC	Volatile Organic Compounds

Definitions

Arithmetic Mean (µ), also called the average, is the sum of measured values divided by the number of samples. For ambient water concentrations, the arithmetic mean is calculated as follows:

Arithmetic mean = $\mu = \Sigma x / n$ where: Σx is the sum of the measured ambient water concentrations, and n is the number of samples.

Average Monthly Effluent Limitation (AMEL) is the highest allowable average of daily discharges over a calendar month, calculated as the sum of all daily discharges measured during a calendar month divided by the number of daily discharges measured during that month.

Bioaccumulative pollutants are those substances taken up by an organism from its surrounding medium through gill membranes, epithelial tissue, or from food and subsequently concentrated and retained in the body of the organism.

Carcinogenic pollutants are substances that are known to cause cancer in living organisms.

Coefficient of Variation (CV) is a measure of the data variability and is calculated as the estimated standard deviation divided by the arithmetic mean of the observed values.

Detected, but Not Quantified (DNQ) are those sample results less than the RL, but greater than or equal to the laboratory's MDL.

Dilution Credit is the amount of dilution granted to a discharge in the calculation of a water quality-based effluent limitation, based on the allowance of a specified mixing zone. It is calculated from the dilution ratio or determined through conducting a mixing zone study or modeling of the discharge and receiving water.

Duly Authorized Representative is one whose:

a. Authorization is made in writing by a principal executive officer or ranking elected official;

b. Authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as general partner in a partnership, sole proprietor in a sole proprietorship, the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company (A duly authorized representative may thus be either a named individual or any individual occupying a named position).

Effluent Concentration Allowance (ECA) is a value derived from the water quality criterion/objective, dilution credit, and ambient background concentration that is used, in conjunction with the coefficient of variation for the effluent monitoring data, to calculate a long-term average (LTA) discharge concentration. The ECA has the same meaning as waste load allocation (WLA) as used in USEPA guidance (Technical Support Document For Water Quality-based Toxics Control, March 1991, second printing, EPA/505/2-90-001).

Estimated Chemical Concentration is the estimated chemical concentration that results from the confirmed detection of the substance by the analytical method below the ML value.

Field Blank is defined as an individual sample demonstrated to be free from the contaminants of interest and other potentially interfering substances, and treated as a sample in all respects, including exposure to grab-sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the field blank is to determine if the field or sample transporting procedures and

environments have contaminated the sample.

Flow Sample is defined as the accurate measurement of the average daily flow volume using a properly calibrated and maintained flow-measuring device.

Grab Sample is defined as an individual sample collected in a short period of time not exceeding 15 minutes. Grab samples shall be collected during normal peak loading conditions for the parameter of interest, which may or may not be during hydraulic peaks. It is used primarily in determining compliance with maximum daily limits and average monthly limits. Grab samples represent only the condition that exists at the time the wastewater is collected.

Instantaneous Maximum Effluent Limitation is the highest allowable value for any single grab sample or aliquot (i.e., each grab sample or aliquot is independently compared to the instantaneous maximum limitation).

Instantaneous Minimum Effluent Limitation is the lowest allowable value for any single grab sample or aliquot (i.e., each grab sample or aliquot is independently compared to the instantaneous minimum limitation).

Maximum Daily Effluent Limitation (MDEL) means the highest allowable daily discharge of a pollutant, over a calendar day (or 24-hour period). For pollutants with limitations expressed in units of mass, the daily discharge is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the daily discharge is calculated as the arithmetic mean measurement of the pollutant over the day.

Median is the middle measurement in a set of data. The median of a set of data is found by first arranging the measurements in order of magnitude (either increasing or decreasing order). If the number of measurements (n) is odd, then the median = $X_{(n+1)/2}$. If n is even, then the median = $(X_{n/2} + X_{(n/2)+1})/2$ (i.e., the midpoint between the n/2 and n/2+1).

Method Detection Limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero, as defined in title 40 of the Code of Federal Regulations, Part 136, Attachment B, revised as of July 3, 1999.

Minimum Level (ML) is the concentration at which the entire analytical system must give a recognizable signal and acceptable calibration point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.

Not Detected (ND) are those sample results less than the laboratory's MDL.

Ocean Waters are the territorial marine waters of the State as defined by California law to the extent these waters are outside of enclosed bays, estuaries, and coastal lagoons. Discharges to ocean waters are regulated in accordance with the State Water Board's California Ocean Plan.

Quality Assurance Officer is a qualified individual who was not otherwise involved in sample collection, transport, or analysis (please refer to the following web site for a more detailed description: http://www.waterboards.ca.gov/swamp/docs/swampqapp_template032404.doc) to investigate the cause of data error.

Persistent Pollutants are substances for which degradation or decomposition in the environment is nonexistent or very slow.

Reporting Level (RL) is the ML (and its associated analytical method) chosen by the Discharger for reporting and compliance determination from the MLs included in this Order. The MLs included in this Order correspond to approved analytical methods for reporting a sample result that are selected by the Regional Water Board either from Appendix 4 of the SIP in accordance with section 2.4.2 of the SIP or established in accordance with section 2.4.3 of the SIP. The ML is based on the proper application of method-based analytical procedures for sample preparation and the absence of any matrix interferences. Other factors may be applied to the ML depending on the specific sample preparation steps employed. For example, the treatment typically applied in cases where there are matrix-effects is to dilute the sample or sample aliquot by a factor of ten. In such cases, this additional factor must be applied to the ML in the computation of the RL.

Source of Drinking Water is any water designated as municipal or domestic supply (MUN) in a Regional Water Board Basin Plan.

Standard Deviation (σ) is a measure of variability that is calculated as follows:

$$\sigma = (\sum[(x - \mu)^2]/(n - 1))^{0.5}$$

where:

x is the observed value;

μ is the arithmetic mean of the observed values; and

n is the number of samples.

Toxicity Reduction Evaluation (TRE) is a study conducted in a step-wise process designed to identify the causative agents of effluent or ambient toxicity, isolate the sources of toxicity, evaluate the effectiveness of toxicity control options, and then confirm the reduction in toxicity. The first steps of the TRE consist of the collection of data relevant to the toxicity, including additional toxicity testing, and an evaluation of facility operations and maintenance practices, and best management practices. A Toxicity Identification Evaluation (TIE) may be required as part of the TRE, if appropriate. (A TIE is a set of procedures to identify the specific chemical(s) responsible for toxicity. These procedures are performed in three phases (characterization, identification, and confirmation) using aquatic organism toxicity tests.)

ATTACHMENT B – NOTICE OF INTENT (NOI) APPLICATION FORM AND INSTRUCTIONS

Complete and submit this NOI to apply for Authorization or Reauthorization to Discharge and/or reuse extracted and treated groundwater resulting from the cleanup of groundwater polluted by volatile organic compounds (VOC), fuel leaks, and other related waste under the requirements of NPDES Permit No. CAG912002
(VOC and Fuel General Permit)

I certify under penalty of law that this document and all attachments are prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the design engineer whose signature and engineering license number is documented in this notice, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of a fine and imprisonment.

_____ _____
Name (print) Signature and Date

_____ _____
Title/Organization Address of Responsible Official

This Application is for the Groundwater Treatment Facility located at (provide street address):

_____

This NOI form and all required attachment shall be uploaded to Geo-Tracker, http://www.waterboards.ca.gov/ust/electronic_submittal/index.shtml (contact Lourdes Gonzales at (510) 622-2365 or lgonzales@waterboards.ca.gov if you have any questions). If electronic submittal is not possible, applicants may submit the NOI package to the following address: California Regional Water Quality Control Board, San Francisco Bay Region, 1515 Clay Street, Suite 1400, Oakland, California 94612. Please include a check for $11,195 (as of December 2011), or the most current fee amount, payable to the State Water Resources Control Board.

Table B-1. Mark only one as applicable

1	**This is a new discharge.**	
2	**This discharge is currently authorized under Order No. R2-2009-0059 (VOC General Permit)**, which requires authorized dischargers, who need to continue discharging after September 30, 2014, to file a completed NOI form no later than April 3, 2014.	
3	**This discharge is currently authorized under this Order (VOC and Fuel General Permit)**, which requires authorized dischargers who **need to continue** discharging after January 11, 2017, to file a completed NOI form no later than July 15, 2016.	
4	**This discharge is currently authorized under this Order (VOC and Fuel General Permit)** and this Form is submitted for **modification** of the current Authorization to Discharge.	

Table B-2. Mark or provide information as applicable

1	I have contacted the local sanitary sewer agency serving the above address and determined that discharging to the local sanitary sewer system is not a feasible option.	
2	I have contacted the local agencies having jurisdiction over the use of the storm drain system or watercourse and inform them about this proposed discharge.	
3	Approximately, what percentage of the total effluent is reused or will be reused?	%

Table B-3. Facility and Professional Engineer(s) information

1	Facility Name Discharger Name Discharger's Contact Person Name, Mail Address, Phone number, and Email Address	
2	Authorized Person to Sign & Submit Reports	
3	Billing Information Contact Person Name, Mail Address, Phone number, and Email Address	
4	Design Professional Engineer's Name, California License Number, Mail Address, Phone Number, and Email Address	
5	Operation and Maintenance Professional Engineer's Name, California License Number, Mail Address, Phone Number, and Email Address	
6	Groundwater treatment system design capacity as certified by Professional Engineer in gallons per minute (gpm).	_____ gpm
7	Attach design capacity certification report including flow schematics showing every components of the treatment system to this application. The Professional Engineer shall affix his/her stamp including signature and engineering license number to the certification report.	
8	Type of Site or Project. For example: active service station, closed service station, solvent spills/leaks active or closed groundwater cleanup sites, short term dewatering project, long term dewatering Project, or other (please explain if "other")	

9	Watershed. To determine the watershed, refer to the State of California Watershed Browser located online at www.conservation.ca.gov/dlrp/watershedportal/Watershed Browser/Pages/WatershedBrowser.aspx or the Guide to San Francisco Bay Area Creeks located online at http://museumca.org/creeks/index.html.	
10	Discharge path to Receiving Water. Please list the complete path of the discharge and attach an aerial map [e.g., the discharge would travel about a quarter of a mile inside a storm drain system before reaching a river (provide the name of the river), and then would travel two miles in the river before reaching the bay].	
11	Project Brief Description and Tentative Completion Date	

Table B-4. Treatment System Description

	Unit	**Number**	**Size or capacity (e.g. pounds of GAC) and Further Description (If Applicable)**
1	Total number of extraction well(s) on site		
2	Extraction Wells with Dedicated Treatment Unit(s)		
3	Wellhead Treatment Unit(s)		
4	Settling Tank(s) in series		
5	Settling Tank(s) in parallel		
6	Oil/Water Separator(s)		
7	Filter(s) for particulates in groundwater		
8	Air Strippers with Air Filters		
9	Air Strippers without Air Filters		
10	Other Treatment Unit(s) (e.g. units installed for removing 1,4-dioxane)		
11	Granular Activated Carbon (GAC) Vessel(s) in Series		
12	GAC Vessel(s) in Parallel		
13	Chemical Additives		
14	Effluent Reuse Tank(s)		

Table B-5. Discharge location information

Discharge Point Location	Discharge Point Latitude	Discharge Point Longitude	Receiving Water
Storm Drain Location where discharge enters:	_____° _____' _____"	_____° _____' _____"	Not applicable (complete the row below)
Location where discharge enters receiving water either directly or via storm drain system:	_____° _____' _____"	_____° _____' _____"	

Table B-6. List of pollutants (For new and existing discharges. For existing discharges, complete one table for influent and one for effluent)

Monitoring data since effective date of the initial discharge authorization letter, or estimated from groundwater monitoring data for new discharges	Pollutant 1	Pollutant 2	Pollutant 3	Add Columns and/or tables as needed (all detected pollutants with effluent limitations and all triggered pollutants exceeding the triggers shall be listed in this table)
Number of Samples				
Maximum Concentration				
Average Concentration (average of detected pollutants only)				
Number of times the effluent limitation was exceeded				
Median Concentration				
Minimum Concentration				
Number of Non-Detects				
Lowest Reporting Limit				
Highest Reporting Limit				
Number of Samples with Lowest Reporting Limit				
Most recent sample Date, Method Number				

Note: The Regional Water Board may modify this form at any time to reflect any new fees and other needed improvements as applicable.

ATTACHMENT C – NOTICE OF TERMINATION

Complete and Submit to Request Termination of Coverage Under Requirements of General Waste Discharge Requirements for Discharge or Reuse of Extracted and Treated Groundwater resulting from the Cleanup of Groundwater Polluted by Volatile Organic Compounds (VOC), Fuel Leaks, and Other Related Wastes NPDES Permit No. CAG912002 (VOC and Fuel General Permit)

For the Groundwater Treatment Facility located at:

_____ _____

Facility Street Address, City, Zip Code CIWQS Place Identification Number

A PDF electronic copy of this form shall be uploaded on GeoTracker and a confirmation email shall be sent to the responsible staff member at this office, currently Lourdes Gonzales, at lgonzales@waterboards.ca.gov.

Table C-1. Mark only one as applicable

1	Temporary groundwater dewatering project, e.g., during a construction project, has been completed.	
2	Groundwater cleanup work has been completed.	
3	Method of groundwater cleanup has been changed with no need to discharge treated groundwater.	
4	Extract and treat method of groundwater cleanup will be stopped for a while and only monitoring of groundwater will occur at this site. Please attach documentation that the agency overseeing cleanup has no objection to cessation of groundwater extraction and treatment.	
5	Other reason. Please specify below (e.g., discharge to POTW has been granted):	

Table C-2. Agency Approval (applicable if Table C-1 row 2, 3, or 4 marked)

	Name, address, email, and phone number of the agency and agency staff overseeing the cleanup work	Have you provided a copy of this termination notice to this staff? (Yes/No. If No, please explain the reason)
1		

I, the Discharger, certify under penalty of law that this notice is prepared under my direction or supervision and last/final date of this discharge was _____. I am aware that discharging without a discharge authorization is in violation of California Water Code.

_____

Name (print) Signature and Date

_____

Title/Organization (Discharger's Organization) Address, email, and phone number

Note: The Regional Water Board may modify this form at any time to reflect new requirements and other needed improvements.

ATTACHMENT D –STANDARD PROVISIONS

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ATTACHMENT D –STANDARD PROVISIONS

I. STANDARD PROVISIONS – PERMIT COMPLIANCE

A. Duty to Comply

1. The Discharger must comply with all of the conditions of this Order. Any noncompliance constitutes a violation of the Clean Water Act (CWA) and the California Water Code and is grounds for enforcement action, for permit termination, revocation and reissuance, or modification; or denial of a permit renewal application. (40 CFR § 122.41(a).)

2. The Discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this Order has not yet been modified to incorporate the requirement. (40 CFR § 122.41(a)(1).)

B. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a Discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this Order. (40 CFR § 122.41(c).)

C. Duty to Mitigate

The Discharger shall take all reasonable steps to minimize or prevent any discharge in violation of this Order that has a reasonable likelihood of adversely affecting human health or the environment. (40 CFR § 122.41(d).)

D. Proper Operation and Maintenance

The Discharger shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the Discharger to achieve compliance with the conditions of this Order. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems that are installed by a Discharger only when necessary to achieve compliance with the conditions of this Order. (40 CFR § 122.41(e).)

E. Property Rights

1. This Order does not convey any property rights of any sort or any exclusive privileges. (40 CFR § 122.41(g).)

2. The issuance of this Order does not authorize any injury to persons or property or invasion of other private rights, or any infringement of state or local law or regulations (40 CFR § 122.5(c)).

F. Inspection and Entry

The Discharger shall allow the Regional Water Board, State Water Board, United States Environmental Protection Agency (USEPA), and/or their authorized representatives (including an authorized contractor acting as their representative), upon the presentation of credentials and other documents, as may be required by law, to (40 CFR § 122.41(i); Wat. Code, § 13383):

1. Enter upon the Discharger's premises where a regulated facility or activity is located or conducted, or where records are kept under the conditions of this Order (40 CFR § 122.41(i)(1));

2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this Order (40 CFR § 122.41(i)(2));

3. Inspect and photograph, at reasonable times, any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this Order (40 CFR § 122.41(i)(3)); and

4. Sample or monitor, at reasonable times, for the purposes of assuring Order compliance or as otherwise authorized by the CWA or the Water Code, any substances or parameters at any location. (40 CFR § 122.41(i)(4).)

G. Bypass

1. Definitions

   a. "Bypass" means the intentional diversion of waste streams from any portion of a treatment facility. (40 CFR § 122.41(m)(1)(i).)

   b. "Severe property damage" means substantial physical damage to property, damage to the treatment facilities, which causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production. (40 CFR § 122.41(m)(1)(ii).)

2. Bypass of extracted groundwater. During a dewatering project, the Discharger may allow any bypass of uncontaminated extracted groundwater to occur which originates from uncontaminated extraction well(s). The Discharger shall monitor the water quality of these extractions wells to confirm that the extracted water remains uncontaminated. The Discharger may also allow any bypass to occur which does not cause exceedances of effluent limitation, but only if it is for essential maintenance to assure efficient operation. In this case, weekly monitoring results of pollutants of concern shall be reported in the quarterly monitoring reports.

3. Prohibition of bypass. Bypass is prohibited, and the Regional Water Board may take enforcement action against a Discharger for bypass, unless (40 CFR § 122.41(m)(4)(i)):

a. Bypass was unavoidable to prevent loss of life, personal injury, or severe property damage (40 CFR § 122.41(m)(4)(i)(A));

b. There were no feasible alternatives to the bypass, such as turning off the extraction wells pump(s), discharge to a POTW, retention of untreated wastes, maintenance during normal periods of equipment downtime, or the use of auxiliary treatment facilities. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that occurred during normal periods of equipment downtime or preventive maintenance (40 CFR § 122.41(m)(4)(i)(B)); and

c. The Discharger submitted notice to the Regional Water Board as required under Standard Provisions – Permit Compliance I.G.5 below. (40 CFR § 122.41(m)(4)(i)(C).)

4. The Regional Water Board may not take enforcement action against a Discharger for bypass, if the Regional Water Board determines that the three conditions listed in Standard Provisions – Permit Compliance I.G.3 above have been met. (40 CFR § 122.41(m)(4)(ii).)

5. Notice

a. Anticipated bypass of uncontaminated extracted groundwater. If the Discharger knows in advance of the need for a bypass of uncontaminated extracted groundwater, it shall submit the necessary information in the initial or modified Notice of Intent, if possible at least 45 days before the date of the bypass. The necessary information includes but not limited to the name and number of extraction wells, flow rates for each well, the distance to other contaminated wells, and monitoring data such as turbidity, color, conductivity, pH, temperature, metals, TPH, VOC, SVOC, PAHs, Oxygenates.

b. Unanticipated bypass. The Discharger shall submit notice of an unanticipated bypass as required in Standard Provisions - Reporting V.E below (24-hour notice). (40 CFR § 122.41(m)(3)(ii).)

H. Upset

Upset means an exceptional incident in which there is unintentional and temporary noncompliance with technology based permit effluent limitations because of factors beyond the reasonable control of the Discharger. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventive maintenance, or careless or improper operation. (40 CFR § 122.41(n)(1).)

1. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with such technology based permit effluent limitations if the requirements of Standard Provisions – Permit Compliance I.H.2 below are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review. (40 CFR § 122.41(n)(2)).

2. Conditions necessary for a demonstration of upset. A Discharger who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs or other relevant evidence that (40 CFR § 122.41(n)(3)):

   a. An upset occurred and that the Discharger can identify the cause(s) of the upset (40 CFR § 122.41(n)(3)(i));

   b. The permitted facility was, at the time, being properly operated (40 CFR § 122.41(n)(3)(ii));

   c. The Discharger submitted notice of the upset as required in Standard Provisions – Reporting V.E.2.b below (24-hour notice) (40 CFR § 122.41(n)(3)(iii)); and

   d. The Discharger complied with any remedial measures required under Standard Provisions – Permit Compliance I.C above. (40 CFR § 122.41(n)(3)(iv).)

3. Burden of proof. In any enforcement proceeding, the Discharger seeking to establish the occurrence of an upset has the burden of proof. (40 CFR § 122.41(n)(4).)

II. STANDARD PROVISIONS – PERMIT ACTION

A. General

This Order may be modified, revoked and reissued, or terminated for cause. The filing of a request by the Discharger for modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not stay any Order condition. (40 CFR § 122.41(f).)

B. Duty to Reapply

If the Discharger wishes to continue an activity regulated by this Order after the expiration date of this Order, the Discharger must submit a completed Notice of Intent form (see Attachment B), 180 days in advance of the Order expiration date, **to** obtain a new permit. (40 CFR § 122.41(b).)

C. Transfers

Any authorization to discharge issued under this Order is not transferable to any person except after filing a modified Notice of Intent with the Regional Water Board. If the new Discharger has a different professional engineer, the modified Notice of Intent shall be revised accordingly.\

III. STANDARD PROVISIONS – MONITORING

A. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity. (40 CFR § 122.41(j)(1).)

B. Monitoring results must be conducted according to test procedures under 40 CFR Part 136 or other test procedures specified in this Order. (40 CFR § 122.41(j)(4); § 122.44(i)(1)(iv).)

IV. STANDARD PROVISIONS – RECORDS

A. The Discharger shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this Order, and records of all data used to complete the application for this Order, for a period of at least three (3) years from the date of the sample, measurement, report or application. This period may be extended by request of the Regional Water Board Executive Officer at any time (40 CFR § 122.41(j)(2).)

B. Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements (40 CFR § 122.41(j)(3)(i));
2. The individual(s) who performed the sampling or measurements (40 CFR § 122.41(j)(3)(ii));
3. The date(s) analyses were performed (40 CFR § 122.41(j)(3)(iii));
4. The individual(s) who performed the analyses (40 CFR § 122.41(j)(3)(iv));
5. The analytical techniques or methods used (40 CFR § 122.41(j)(3)(v)); and
6. The results of such analyses. (40 CFR § 122.41(j)(3)(vi).)

C. Claims of confidentiality for the following information will be denied (40 CFR § 122.7(b)):

1. The name and address of any permit applicant or Discharger (40 CFR § 122.7(b)(1)); and
2. Permit applications and attachments, permits and effluent data. (40 CFR § 122.7(b)(2).)

V. STANDARD PROVISIONS – REPORTING

A. Duty to Provide Information

The Discharger shall furnish to the Regional Water Board, State Water Board, or USEPA within a reasonable time, any information which the Regional Water Board, State Water Board, or USEPA may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this Order or to determine compliance with this Order. Upon request, the Discharger shall also furnish to the Regional Water Board, State Water Board, or USEPA copies of records required to be kept by this Order. (40 CFR § 122.41(h); California Water Code (CWC), § 13267.)

B. Signatory and Certification Requirements

1. All applications, reports, or information submitted to the Regional Water Board, State Water Board, and/or USEPA shall be signed and certified in accordance with Standard Provisions – Reporting V.B.2, V.B.3, V.B.4, and V.B.5 below. (40 CFR § 122.41(k).)
2. All permit applications shall be signed by a responsible person as explained below:
   a. **For a corporation.** All permit applications shall be signed by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means: (i) A president, secretary, treasurer, or vice-president of the corporation in charge of a

principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures. (40 CFR § 122.22(a)(1).)

b. **For a partnership or sole proprietorship.** All permit applications shall be signed by a general partner or the proprietor, respectively. (40 CFR § 122.22(a)(2).)

c. **For a municipality, State, federal, or other public agency.** All permit applications shall be signed by either a principal executive officer or ranking elected official. For purposes of this provision, a principal executive officer of a federal agency includes: (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of USEPA). (40 CFR § 122.22(a)(3).).

3. All reports required by this Order and other information requested by the Regional Water Board, State Water Board, or USEPA shall be signed by a person described in Standard Provisions – Reporting V.B.2 above, or by a duly authorized representative of that person. A person is a duly authorized representative only if:

   a. The authorization is made in writing by a person described in Standard Provisions – Reporting V.B.2 above (40 CFR § 122.22(b)(1));

   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.) (40 CFR § 122.22(b)(2)); and

   c. The written authorization is submitted to the Regional Water Board. (40 CFR § 122.22(b)(3).)

4. If an authorization under Standard Provisions – Reporting V.B.3 above is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of Standard Provisions – Reporting V.B.3 above must be submitted to the Regional Water Board and State Water Board prior to or together with any reports, information, or applications, to be signed by an authorized representative. (40 CFR § 122.22(c).)

5. Any person signing a document under Standard Provisions – Reporting V.B.2 or V.B.3 above shall make the following certification:

   "I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." (40 CFR § 122.22(d).)

C. Monitoring Reports

1. Monitoring results shall be reported at the intervals specified in the Monitoring and Reporting Program (Attachment E) in this Order. (40 CFR § 122.22(l)(4).)

2. Monitoring results must be reported on a Discharge Monitoring Report (DMR) form (40 CFR § 122.41(l)(4)(i).) or paper or electronic forms provided or specified by the Regional Water Board or State Water Board.

3. If the Discharger monitors any pollutant more frequently than required by this Order using test procedures approved under Part 136 or as specified in this Order, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR or other reporting form specified by the Regional Water Board. (40 CFR § 122.41(l)(4)(ii).)

4. Calculations for all limitations, which require averaging of measurements, shall utilize an arithmetic mean unless otherwise specified in this Order. (40 CFR § 122.41(l)(4)(iii).)

D. Compliance Schedules

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule of this Order, shall be submitted no later than 14 days following each schedule date. (40 CFR § 122.41(l)(5).)

E. Twenty-Four Hour Reporting

1. The Discharger shall report any noncompliance that may endanger health or the environment. Any information shall be provided orally within 24 hours from the time the Discharger becomes aware of the circumstances. A written submission shall also be uploaded on GeoTracker (**http://www.waterboards.ca.gov/ust/electronic_submittal/index.shtml)** within five (5) days of the time the Discharger becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to

reduce, eliminate, and prevent reoccurrence of the noncompliance. (40 CFR § 122.41(l)(6)(i).)

2. The following shall be included as information that must be reported within 24 hours under this paragraph (40 CFR § 122.41(l)(6)(ii)):

   a. Any unanticipated bypass that exceeds any effluent limitation in this Order. (40 CFR § 122.41(l)(6)(ii)(A).)

   b. Any upset that exceeds any effluent limitation in this Order. (40 CFR § 122.41(l)(6)(ii)(B).)

3. The Regional Water Board may waive the above-required written report under this provision on a case-by-case basis if an oral report has been received within 24 hours. (40 CFR § 122.41(l)(6)(iii).)

F. Planned Changes

The discharger shall file with the Executive Officer an amended Notice of Intent at least 60 days before making any material change in the character, location, or volume of the discharge. In case of proposing any change of treatment system or operation and maintenance procedures, a professional engineer certified in State of California shall certify the adequacy of the design and/or the procedures. A modified Notice of Intent is required under this provision only when (40 CFR § 122.41(l)(1)) the alteration or addition could significantly change the nature or increase the quantity of pollutants discharged (pollutants regulated or not regulated by this Order). Three examples of significant changes are a change in discharge location, a change of the engineer responsible for the design and/or operation and maintenance of the treatment system, and an increase in discharge flow rates.

G. Anticipated Noncompliance

The Discharger shall give advance notice to the Regional Water Board or State Water Board of any planned changes in the permitted facility or activity that may result in noncompliance with the requirements in this Order. (40 CFR § 122.41(l)(2).)

H. Other Noncompliance

The Discharger shall report all instances of noncompliance not reported under Standard Provisions – Reporting V.C, V.D, and V.E above at the time monitoring reports are submitted. The reports shall contain the information listed in Standard Provision – Reporting V.E above. (40 CFR § 122.41(l)(7).)

I. Other Information

When the Discharger becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or in any report to the Regional Water Board, State Water Board, or USEPA, the Discharger shall promptly submit such facts or information. (40 CFR § 122.41(l)(8).)

VI. STANDARD PROVISIONS – ENFORCEMENT

The Regional Water Board is authorized to enforce the terms of this permit under several provisions of the Water Code, including, but not limited to, sections 13385, 13386, and 13387.

VII. ADDITIONAL PROVISIONS – NOTIFICATION LEVELS

A. Non-Municipal Facilities

Existing manufacturing, commercial, mining, and silvicultural Dischargers shall notify the Regional Water Board as soon as they know or have reason to believe (40 C.F.R. § 122.42(a)):

1. That any activity has occurred or will occur that would result in the discharge, on a routine or frequent basis, of any toxic pollutant that is not limited in this Order, if that discharge will exceed the highest of the following "notification levels" (40 C.F.R. § 122.42(a)(1)):

    a. 100 micrograms per liter (µg/L) (40 C.F.R. § 122.42(a)(1)(i));

    b. 200 µg/L for acrolein and acrylonitrile; 500 µg/L for 2,4-dinitrophenol and 2-methyl-4,6-dinitrophenol; and 1 milligram per liter (mg/L) for antimony (40 C.F.R. § 122.42(a)(1)(ii));

    c. Five (5) times the maximum concentration value reported for that pollutant in the Report of Waste Discharge (40 C.F.R. § 122.42(a)(1)(iii)); or

    d. The level established by the Regional Water Board in accordance with section 122.44(f). (40 C.F.R. § 122.42(a)(1)(iv).)

2. That any activity has occurred or will occur that would result in the discharge, on a non-routine or infrequent basis, of any toxic pollutant that is not limited in this Order, if that discharge will exceed the highest of the following “notification levels" (40 C.F.R. § 122.42(a)(2)):

    a. 500 micrograms per liter (µg/L) (40 C.F.R. § 122.42(a)(2)(i));

    b. 1 milligram per liter (mg/L) for antimony (40 C.F.R. § 122.42(a)(2)(ii));

    c. Ten (10) times the maximum concentration value reported for that pollutant in the Report of Waste Discharge (40 C.F.R. § 122.42(a)(2)(iii)); or

    d. The level established by the Regional Water Board in accordance with section 122.44(f). (40 C.F.R. § 122.42(a)(2)(iv).)

ATTACHMENT E – MONITORING AND REPORTING PROGRAM

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ATTACHMENT E – MONITORING AND REPORTING PROGRAM

National Pollutant Discharge Elimination System (NPDES) regulations at 40 CFR 122.48 require that all NPDES permits specify monitoring and reporting requirements. California Water Code (CWC) Sections 13267 and 13383 also authorize the Regional Water Quality Control Board (Regional Water Board) to require technical and monitoring reports. This Monitoring and Reporting Program establishes monitoring and reporting requirements that implement the federal and State regulations.

I. GENERAL MONITORING PROVISIONS

A. The Discharger shall comply with this Monitoring and Reporting Program. The Executive Officer may amend this Monitoring and Reporting Program pursuant to 40 CFR 122.62, 122.63, and 124.5.

B. The Discharger shall conduct all monitoring in accordance with Attachment D, section III, and all tests must be performed by laboratories certified for the analyses in accordance with the California Water Code Section 13176. Equivalent test methods must be more sensitive than those specified in 40 CFR 136 and must be specified in the permit or in the related discharge authorization letter.

C. Monthly discharge flow volume, total quarterly flow, and annual flow shall be recorded.

D. The number and frequency of bypasses and accidental spills shall be recorded.

E. A copy of this Order, a complete copy of the Notice of Intent (NOI) filed, documentation of the Authorization to Initiate Discharge received from the Regional Water Board, a full copy of the Operation and Maintenance (O&M) Manual, and any other documents relevant to the operation and maintenance of the treatment facility shall be stored at or near the treatment facility, and made available to Regional Water Board staff, USEPA staff, or their contractors upon request. The Discharger shall inspect its facility as frequently as required by the O&M Manual.

II. MONITORING LOCATIONS

The Discharger shall establish the following monitoring locations to demonstrate compliance with the effluent limitations, discharge specifications, and other requirements in this Order:

Table E-1. Monitoring Station Locations

Discharge Point Name (if applicable)	Monitoring Location Name	Monitoring Location Description (include Latitude and Longitude when available)
---	INF-001	At a point in the extraction system immediately prior to inflow to the treatment unit.
001	EFF-001	At a point in the discharge line immediately following treatment and before it joins or is diluted by any other waste stream, body of water, or substance.
---	RSW-001U	At a point 50 feet upstream from the point of discharge into the receiving water, or if access is limited, at the first point upstream which is accessible.
---	RSW-001D	At a point 50 feet downstream from the point of discharge into the receiving water, or if access is limited, at the first point downstream which is accessible.

Discharge Point Name (if applicable)	Monitoring Location Name	Monitoring Location Description (include Latitude and Longitude when available)
---	REU-001	At a point immediately prior to reuse location. Not applicable if effluent is not reused or reclaimed.

III. INFLUENT MONITORING REQUIREMENTS

The Discharger shall monitor influent to the facility at Monitoring Location INF-001 in accordance with the schedule shown on Column 1 of Table E.2.

IV. EFFLUENT MONITORING REQUIREMENTS

Dischargers shall monitor discharges of treated wastewater from the facility at Monitoring Location EFF-001, in accordance with the schedule shown on Column 2 of Table E.2. Effluent sampling shall occur concurrently (within 30 minutes) with influent sampling.

A. Monitoring during bypass. When any type of bypass occurs, grab samples shall be collected on a daily basis for all constituents at all affected discharge points that have effluent limits for the duration of the bypass.

B. Required Actions After Any Effluent Violation. If the analytical results show violation of any effluent limitation, the Discharger shall take a confirmation effluent sample, together with receiving water samples (see Column 3 of Table E-2) within 24 hours of becoming aware of the violation of effluent limit. The Discharger must have the confirmation sample analyzed by expedited methods and obtain results within 24 hours of sample collection. If the analytical results are also in violation of the effluent limit, the Discharger shall terminate the discharge until it has corrected the cause of violation. In this case, both the initial and confirmed results are violations. However, if the confirmation effluent sampling shows compliance, the Regional Water Board will consider only the initial exceedance as a violation.

V. WHOLE EFFLUENT ACUTE TOXICITY TESTING REQUIREMENTS

The Discharger shall monitor acute toxicity at EFF-001 as follows:

A. Compliance with the acute toxicity effluent limitations of this Order shall be evaluated by measuring survival if test organisms to 96-hour static renewal bioassays at Monitoring Location EFF-001.

B. Test organisms shall be rainbow trout unless the Executive Officer specifies otherwise in writing.

C. All bioassays shall be performed according to the most up-to-date protocols in 40 CFR 136m currently in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Water to Freshwater and Marine Organisms*, 5th Edition.

D. If specific identifiable substances in the discharge can be demonstrated by the Discharger as being rapidly rendered harmless upon discharge to the receiving water, compliance with the acute toxicity limitation may be determined after the test samples are adjusted to remove the influence of those substances. Written approval from the Executive Officer must be obtained to authorize such an adjustment.

E. The sample may be taken from effluent prior to chlorination. Monitoring of the bioassay water shall include, on a daily basis, the following parameters: pH, dissolved oxygen, ammonia, (if toxicity is observed), temperature, hardness, and alkalinity. These results shall be reported. If a violation of acute toxicity requirements occurs, the bioassay test shall be repeated with new fish as soon as practical and shall be repeated until a test fish survival rate of 90 percent or greater is observed. If the control fish survival rate is less than 90 percent, the bioassay test shall be restarted with new fish and shall continue as soon as practical until an acceptable test is completed (i.e., control fish survival rate is 90 percent or greater).

VI. RECLAMATION MONITORING REQUIREMENTS

The Discharger shall monitor reuse effluent at Monitoring Location REU-001 as shown on Column 2 of Table E.2.

VII. RECEIVING WATER MONITORING REQUIREMENTS – SURFACE WATER AND GROUNDWATER

The Discharger shall monitor receiving water at Monitoring Locations RSW-001U and RSW-001D as shown on Column 3 of Table E.2.

A. Receiving water sampling shall occur concurrently with effluent sampling.

B. Receiving water samples shall be collected at each station on each sampling day during the period within 1 hour following low slack water, if relevant. Where sampling at lower slack water period is not practical, sampling shall be performed during higher slack water period. Samples shall be collected within the discharge plume and 50 feet down current of the discharge point so as to be representative, unless otherwise stipulated.

C. Samples should be collected within one foot below the surface of the receiving water body. Explanation shall be provided in the monitoring report if this specification could not be met.

Table E-2. Schedule for Sampling, Measurements, and Analysis

Required Analytical Test Method Number, Technique, Standard Methods (SM), USEPA Method Number (EPA), 40 CFR Part (or equivalent)/Sampling Station	Column 1 Minimum Sampling Frequency for Influent INF-001	Column 2 Minimum Sampling Frequency for Effluent EFF-001 or Effluent for Reuse REU-001	Column 3 Minimum Sampling Frequency for Receiving Surface Water RSW-001U and RSW-001D
Unit is "µg/L" and Type of Sample is "Grab" unless noted otherwise	**Grab**	**Grab**	**Grab**
Discharge Flow (gpm & gpd)	-	Continuous	-
Reclamation Flow Rate (gpm & gpd or gallons reclaimed during the calendar quarter if reclamation is not continuous)	-	Continuous	-
Fish Toxicity, 96-hr (% survival), EPA-821-R-02-012 Test, Method 2019.0	-	Q/Y	-
All Applicable Standard Observations (No Unit)	D/M	D/M	V
Volatile Organic Compounds, EPA 8260b for discharges from sites contaminated with fuel leaks and other related wastes	Y	Y	V
Volatile Organic Compounds, EPA 8260b for dischargers from sites contaminated with VOC	2/Y	D/M	V
1,4-Dioxane (See Note 3), EPA 8270c	-	2/Y	-

Required Analytical Test Method Number, Technique, Standard Methods (SM), USEPA Method Number (EPA), 40 CFR Part (or equivalent)/Sampling Station	**Column 1 Minimum Sampling Frequency for Influent INF-001**	**Column 2 Minimum Sampling Frequency for Effluent EFF-001 or Effluent for Reuse REU-001**	**Column 3 Minimum Sampling Frequency for Receiving Surface Water RSW-001U and RSW-001D**
Unit is "µg/L" and Type of Sample is "Grab" unless noted otherwise	**Grab**	**Grab**	**Grab**
Semi Volatile Organic Compounds except PAHs (See Note 1), EPA 8270c	D/Q	D/M	-
Turbidity	-	D/Q/Y	-
pH	D/M/Q/Y	D/M/Q/Y	V
Dissolved Oxygen (mg/L)	-	-	V
Total Dissolved Solids (mg/L) (construction and dewatering projects)	-	D/M	-
Temperature (ºC)	-	D/M/Q/Y	-
Electrical Conductivity	-	D/M/Q/Y	-
Hardness (mg/L as $CaCO_3$)	-	-	T
Salinity (parts per thousand)	-	-	T
Ethylene Dibromide (EDB) (See Note 1), 504	D/Q	D/M	V
Benzene, Toluene, Ethylbenzene, and/or Total Xylenes (See Note 1), EPA 8020	D/Q	D/M	V
Methyl Tertiary Butyl Ether (MTBE) (See Note 1), EPA 8020	D/Q	D/M	V
Total Petroleum Hydrocarbons as Gasoline (See Note 1), EPA 8015 Modified	D/Q	D/M	V
Total Petroleum Hydrocarbons as Diesel (See Note 1), EPA 8015 Modified	D/Q	D/M	V
Total Petroleum Hydrocarbons other than Gasoline and Diesel (required if Petroleum Hydrocarbons other than Gasoline and Diesel present in the soil and groundwater) (See Note 1), EPA 8015 Modified	D/Q	D/M	V
Polynuclear Aromatic Hydrocarbons (PAHs) (See Note 1), 8310	D/Q	D/M	V
Tertiary Amyl Methyl Ether (TAME), DiIsopropyl Ether (DIPE), Ethyl Tertiary Butyl Ether (ETBE), Tertiary Butyl Alcohol (TBA), Ethanol, and/or Methanol (See Note 1)	D/Y	D/Y	-
Total Chlorine Residual (See Note 1), (Field Kit, EPA 330 or SM 4500-Cl)	D/Q	D/M	V
Antimony (EPA 204.2), Arsenic (EPA 206.3), Beryllium (GFAA or ICPMS), Cadmium (GFAA or ICPMS), Hexavalent and Total Chromium (SM 3500), Copper (EPA 200.9), Cyanide (SM 4500-CN C or I), Lead (EPA 200.9), Mercury (EPA 1631), Nickel (EPA 249.2), Selenium (SM 3114B OR C), Silver (EPA 272.2), Thallium (EPA 279.2), and Zinc (EPA 200.8) (See Note 2) for dischargers from sites contaminated with VOC		3Y	
Antimony (EPA 204.2), Arsenic (EPA 206.3), Beryllium (GFAA or ICPMS), Cadmium (GFAA or ICPMS), Hexavalent and Total Chromium (SM 3500), Copper (EPA 200.9), Cyanide (SM 4500-CN C or I), Lead (EPA 200.9), Mercury (EPA 1631), Nickel (EPA 249.2), Selenium (SM 3114B OR C), Silver (EPA 272.2), Thallium (EPA 279.2), and Zinc (EPA 200.8) (See Note 2) for discharges from sites contaminated with fuel leaks and other related wastes	-	D/Y	-
Other pollutants such as non VOC-related odor, sulfate and foaming agents (See Note 1), SM	D/Q/Q/Y	D/M/Q/Y	V

Notes:
Note 1: if known to be present in the influent.
Note 2: Inorganic compounds samples shall be analyzed for total (unfiltered) constituents with the reporting levels not exceeding the following: 0.002 ug/L for Mercury; 0.25 ug/L for Cadmium and Silver; 1 ug/L for Nickel, Thallium, and Zinc; 2.0 ug/L for Arsenic and Selenium; 1 ug/L for Cyanide; and 0.5 ug/L for Antimony, Beryllium, Total Chromium, Copper, and Lead (SIP Appendix 4 Minimum Levels

http://www.waterboards.ca.gov/iswp/docs/final.pdf). If the Discharger cannot attain the reporting levels for Zinc, Arsenic, or Total Chromium, the reason(s) along with any supporting documentation shall be documented in the monitoring reports. Water Board staff shall make a compliance determination based on data provided. If the Discharger exceeds the trigger for mercury of 0.025, the Discharger may consider re-sampling and re-analyzing another sample using ultra-clean techniques as described in USEPA methods 1669 and 1631 to eliminate the possibility of artifactual contamination of the sample. For pollutants not listed in Appendix 4 of the SIP, the Discharger shall provide the reason for the higher detection level along with any supporting documentation in the monitoring reports. Water Board staff shall make a compliance determination based on data provided. Note 3: Use techniques such as selective ion mode or isotope dilution to achieve reporting levels not exceeding 1 ug/l.
Definitions: ug/L = microgram per liter or parts per billion (ppb); g/day = grams per day; gpm = gallons per minute; mg/L = milligram per liter or parts per million (ppm); gpd = gallons per day; MFL = million fibers per liter GC = Gas Chromatography; GCMS = Gas Chromatography/Mass Spectrometry; FAA = Flame Atomic Absorption; GFAA = Graphite Furnace Atomic Absorption; Hydride = Gaseous Hydride Atomic Absorption; ICP = Inductively Coupled Plasma; and ICPMS = Inductively Coupled Plasma/Mass Spectrometry.
Legends: D/M Once during the first and fifth day of startup; monthly thereafter. For VOC, if a discharger has no VOC detected in the influent or the effluent other than Total Petroleum Hydrocarbons, Benzene, Toluene, Ethylbenzene, Xylenes, Tertiary Amyl Methyl Ether (TAME), DiIsopropyl Ether (DIPE), Ethyl Tertiary Butyl Ether (ETBE), Tertiary Butyl Alcohol (TBA), Ethanol, or Methanol then frequency of VOC monitoring may be reduced to once a year. D/Q Once during the first and fifth day of startup; quarterly thereafter. Y Once during the first week of startup; annually thereafter. 3Y Once during the first week of startup; every three years thereafter. 2/Y Once during the first week of startup; twice per year thereafter. D/Y Once during the first and fifth day of startup; annually thereafter. Q/Y Quarterly for first year of operation, annually thereafter. D/Q/Y Once during the first and fifth day of startup; quarterly for first year of operation, annually thereafter. D/M/Q/Y Once during the first and fifth day of startup; monthly for first year of operation, quarterly for the second year, and annually thereafter. In case of pH analysis, this monitoring requirement is only for facilities with a treatment process that would cause no pH variances in the effluent. If any chemical used in the treatment process may cause pH variances in the effluent, the frequency of pH monitoring in the effluent shall be increased to twice per week for the first month of operation and weekly thereafter if pH monitoring data for the first month of operation demonstrate compliance with pH effluent limits. V Receiving Waters sampling must be performed together (on the same calendar day) with the required effluent confirmation sampling that is required when a violation of an effluent limit is known, and the sample analyzed for that specific violated parameter and the Dissolved Oxygen level. In no case, should a Discharger continue discharging in known violation of effluent limits just to comply with this receiving water sampling requirement. T Sampling shall be performed when Cadmium, Chromium (total), Copper, Lead, Nickel, Silver, or Zinc triggers are exceeded.

VIII. OTHER MONITORING REQUIREMENTS

A. Startup Phase Monitoring. During the original startup for the treatment system, sampling of the effluent must occur on the first day and fifth day of operation (weekend days may be excluded).

1. On the first day of the original startup, the system shall be allowed to run until at least three to five well volumes are removed and until three consecutive readings for pH, conductivity, and temperature are within five percent of each other; then, the influent and effluent shall be sampled and submitted for analyses. Prior to receipt of the results of the initial samples, all effluent shall be discharged into a holding tank (that is contained, not discharged to the receiving water) or discharged to the sanitary sewer until the results of the analyses show the discharge to be within the effluent limits established in this Order and/or as authorized by the Executive Officer. The treatment system may be shut down after the first day's sampling to await the analyses results and thereby reduce the amount of storage needed. If the treatment system is shut down more than 120 hours during the original startup (awaiting analyses results, etc.), the original startup procedures and sampling must be repeated. For the stored effluent, if the results of the analyses show the discharge to be in violation, the effluent shall: (1) be retreated until the retreated effluent is in compliance, or (2) be disposed of in accordance with the applicable provisions of California Code of Regulations.

2. If the first day's sampling shows compliance, the treatment system shall be operated for a total of five days with the discharge to the storm sewer or other conveyance system leading to the receiving water, and be sampled again during the fifth day. While the fifth day's

samples are being analyzed, the effluent may be discharged to the receiving water as long as the analyses are received within 120 hours of sampling, and then, continue to be discharged to the receiving water if the analyses show compliance. Otherwise, the original startup procedures and sampling must be repeated. In case of a temporary shutdown, if the facility reported effluent limit violation(s) during the previous three years, then any re-startup shall follow the original startup procedures.

B. Chemical Additives Monitoring: If applicable, monitoring related to chemical usage shall be conducted by the Discharger as required in its treatment system design specification and Operation and Maintenance Manual.

C. Standard Observations for Receiving Water

1. Floating and suspended materials (e.g., oil, grease, algae, and other macroscopic particulate matter): presence or absence, source, and size of affected area.

2. Discoloration and turbidity: description of color, source, and size of affected area.

3. Odor: presence or absence, characterization, source, distance of travel, and wind direction.

4. Beneficial water use: presence of water-associated waterfowl or wildlife, fisherperson, and other recreational activities in the vicinity of each sampling station.

5. Hydrographic condition, if relevant:

    a. Time and height of corrected high and low tides (corrected to nearest National Oceanic and Atmospheric Administration location for the sampling date and time of sample and collection).

    b. Depth of water columns and sampling depths.

6. Weather condition:

    a. Air temperature.

    b. Wind direction and estimated velocity.

    c. Total precipitation during the five days prior to observation.

D. Standard Observations for Onsite Usage of Reclaimed Water

1. Floating and suspended materials of waste origin (to include oil, grease, algae, and other macroscopic particulate matter): presence or absence, source, and size of affected area.

2. Discoloration and turbidity: description of color, source, and size of affected area.

3. Odor: presence or absence, characterization, source, distance of travel, and wind direction.

4. Weather condition:

a. Air temperature.

b. Wind direction and estimated velocity.

c. Total precipitation during the previous five days and on the day of observation.

5. Deposits, discolorations, and/or plugging in the conveyance system that could adversely affect the system reliability and performance.

6. Operation of the valves, outlets, sprinkler heads, and/or pressure shutoff valves in conveyance system.

E. Standard Observations for Groundwater Treatment System

1. Odor: presence or absence, characterization, source, distance of travel, and wind direction.

2. Weather condition: wind direction and estimated velocity.

3. Deposits, discolorations, and/or plugging in the treatment system (stripping tower, carbon filters, etc.) that could adversely affect the system reliability and performance.

4. Operation of the float and/or pressure shutoff valves installed to prevent system overflow or bypass.

IX. REPORTING REQUIREMENTS

A. General Monitoring and Reporting Requirements

The Discharger shall comply with all Standard Provisions (Attachment D) and in this document related to monitoring, reporting, non-compliance reporting, and record keeping.

B. Self Monitoring Reports (SMRs)

1. **SMR Format.** At any time during the term of this Order, the State or Regional Water Board may notify the Discharger to electronically submit SMRs using the State Water Board's California Integrated Water Quality System (CIWQS) Program Web site (http://www.waterboards.ca.gov/ciwqs/index.html). The CIWQS website will provide additional directions for SMR submittal. In the interim, Dischargers shall submit SMRs using the submittal method specified in the Authorization to Discharge letter.

2. **SMR Due Dates and Contents.** The Discharger shall submit SMRs by the due dates, and with the contents, specified below:

   a. The Discharger shall submit quarterly SMRs no later than 45 days after the end of each calendar quarter, including the results of all required monitoring.

   b. The Discharger shall submit annual reports by February 15 of each year, covering the previous calendar year. The annual report shall contain all data required for the fourth quarter in addition to summary data required for annual reporting. This report may be submitted in lieu of the report for the fourth quarter of a calendar year.

c. The Discharger shall report in the SMR the results for all monitoring specified in this Monitoring and Reporting Program under sections III through VIII. If there has been no discharge during the entire reporting period, quarterly and annual reports must still be submitted to report that has been the case.

d. The Discharger shall attach a cover letter to the monitoring reports. The information contained in the cover letter shall clearly identify number of permit violations; discuss corrective actions taken or planned; and the proposed time schedule for corrective actions. Identified violations must include a description of the requirement that was violated and a description of the violation. In the cover letter, the Discharger shall also document the volume of the effluent reused during that reporting period.

e. The Discharger shall arrange all reported data in a tabular format. The data shall be summarized to clearly illustrate whether the facility is operating in compliance with the effluent limitations. The Discharger shall not include laboratory reports unless requested.

f. Monitoring reports must be submitted to the Regional Water Board signed, certified, and using the submittal method specified by the Authorization to Discharge letter.

g. The monitoring reports shall also include a description of operation and maintenance (O&M) of the groundwater extraction and treatment system consistent with the O&M manual, which shall be available to all personnel who are responsible for operation and maintenance activities.

h. The monitoring reports shall include the results of analyses and observations as follows:

(1) Calculations for all limitations that require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this permit.

(2) A table identifying by method number the analytical procedures used for analyses. Any special methods shall be identified and should have prior approval of the Regional Water Board's Executive Officer.

(3) Laboratory results shall be summarized in tabular form but actual laboratory reports do not need to be included in the report. A summary of quality assurance/quality control activities data such as field, travel, and laboratory blanks shall be reported for each analyzed constituent or group of constituents.

(4) A summary of the monitoring data to include information such as source of the sample (influent, effluent, or receiving water); the constituents; the methods of analysis used; the laboratory reporting limits in µg/L; the sample results (µg/L); the date sampled; and the date sample was analyzed.

(5) Flow (in gpm) and mass removal data (in kilograms).

(6) Summary of treatment system status during the reporting period (e.g., in operation/on standby) and reason(s) for non-routine treatment system shut down.

(7) The annual reports shall contain tabular summary of the monitoring data obtained during the previous year. In addition, the annual reports shall contain a comprehensive discussion of the compliance record and the corrective actions taken or planned which may be needed to bring the Discharger into full compliance with the waste discharge requirements including any trigger study required by Special Provision VI.C.6 and the progress in satisfaction of Special Provisions VI.C.7 and VI.C.8 of this Order. The annual report shall document that the annual fee has been paid.

(8) If, during any calendar quarter, a Discharger becomes aware that any monitoring data obtained for compliance with this Order may be invalid, the Discharger shall submit a claim of invalid monitoring data, as uploaded on GeoTracker, with a confirmation email to the Regional Water Board staff in charge of this permit, within 45 days after end of that calendar quarter. The Discharger shall include with this claim, the name, phone number, and email of its assigned staff to investigate the cause(s) of errors and the corrective actions taken, or date when actions will be completed to eliminate or reduce future data errors. The Discharger shall also provide, in this claim, a date that the O&M manual will be updated to include errors prevention measures. These preventive measures shall include but not be limited to accelerated monitoring (e.g., twice a month monitoring for at least one month) to provide valid monitoring data indicating the effectiveness of the proposed preventive measures.

i. Additional Specifications for Submitting SMRs to CIWQS — If the Discharger submits SMRs to CIWQS, it shall submit analytical results and other information using one of the following methods:

Table E-3. SMR Reporting for CIWQS

Parameter	Method of Reporting	
	EDF/CDF data upload or manual entry	**Attached File**
All parameters identified in influent, effluent, and receiving water monitoring tables (except Dissolved Oxygen and Temperature)	Required for All Results	
Dissolved Oxygen Temperature	Required for Monthly Maximum and Minimum Results Only (1)	Discharger may use this method for all results or keep records
Cyanide Arsenic Cadmium Chromium Copper Lead Mercury Nickel Selenium Silver Zinc Dioxins and Furans (by U.S. EPA Method 1613)	Required for All Results (2)	

Antimony Beryllium Thallium Pollutants by U.S. EPA Methods 601, 602, 608, 610, 614, 624, and 625	Not Required (unless identified in influent, effluent, or receiving water monitoring tables), But Encouraged (1)	Discharger may use this method and submit results with application for permit reissuance, unless data submitted by CDF/EDF upload
Analytical Method	Not Required (Discharger may select "data unavailable") (1)	
Collection Time Analysis Time	Not Required (Discharger may select "0:00") (1)	

Notes for Table E-3:

[1] The Discharger shall continue to monitor at the minimum frequency specified in the monitoring tables, keep records of the measurements, and make the records available upon request.

[2] These parameters require EDF/CDF data upload or manual entry regardless of whether monitoring is required by this Monitoring and Reporting Program or other provisions of this Order (except for biosolids, sludge, or ash provisions).

3. Monitoring periods and reporting for all required monitoring shall be completed according to the following schedule:

Table E-4. Monitoring Periods and Reporting Schedule

Sampling Frequency	Monitoring Period Begins On…	Monitoring Period
Continuous	Effective startup date	All
Daily	Effective startup date	(Midnight through 11:59 PM) or any 24-hour period that reasonably represents a calendar day for purposes of sampling.
Weekly	Effective startup date	Effective startup day through one week after Effective startup date
Monthly	First day of calendar month following the last day of the startup date	1st day of calendar month through last day of calendar month
Quarterly	Closest of January 1, April 1, July 1, or October 1 following (or on) the last day of the startup date	January 1 through March 31 April 1 through June 30 July 1 through September 30 October 1 through December 31
Semiannually	Closest of January 1 or July 1 following (or on) the last day of the startup date	January 1 through June 30 July 1 through December 31
Annually	January 1 following (or on) the last day of the start -up date	January 1 through December 31

4. The Discharger shall report with each sample result the applicable Reporting Level (RL) and the current Method Detection Limit (MDL), as determined by the procedure in 40 CFR Part 136. The Discharger shall report the results of analytical determinations for the presence of chemical constituents in a sample using the following reporting protocols:

   a. Sample results greater than or equal to the RL shall be reported as measured by the laboratory (i.e., the measured chemical concentration in the sample).

   b. Sample results less than the RL, but greater than or equal to the laboratory's MDL, shall

be reported as "Detected, but Not Quantified," or DNQ. The estimated chemical concentration of the sample shall also be reported. For the purposes of data collection, the laboratory shall write the estimated chemical concentration next to DNQ as well as the words "Estimated Concentration" (may be shortened to "Est. Conc."). The laboratory may, if such information is available, include numerical estimates of the data quality for the reported result. Numerical estimates of data quality may be percent accuracy (± a percentage of the reported value), numerical ranges (low to high), or any other means considered appropriate by the laboratory.

c. Sample results less than the laboratory's MDL shall be reported as "Not Detected," or ND.

d. Dischargers are to instruct laboratories to establish calibration standards so that the Minimum Level (ML) value (or its equivalent if there is differential treatment of samples relative to calibration standards) is the lowest calibration standard. At no time is the Discharger to use analytical data derived from *extrapolation* beyond the lowest point of the calibration curve.

C. Discharge Monitoring Reports (DMRs) - Not Applicable

D. Other Reports

1. Startup Report: A report on the startup phase shall be included in the first quarterly monitoring report. This report shall include a certification that a professional engineer certified in the State of California oversees the treatment system operation and maintenance activities including the startup work.

2. Spill Reports: If any hazardous substance is discharged in or on any waters of the state, or discharged and deposited where it is, or probably will be discharged in or on any waters of the state, the Discharger shall report such a discharge to this Regional Water Board, at (510) 622-2369, and to the California Emergency Management Agency, at (800) 852-7550, within 24 hours of becoming aware of the spill. A written report shall be uploaded on GeoTracker, with an confirmation email to staff, within five working days and shall contain information relative to:

a. Nature of waste or pollutant,

b. Quantity involved,

c. Duration of incident,

d. Cause of spilling,

e. Spill Prevention, Control, and Countermeasure Plan (SPCC) in effect, if any,

f. Estimated size of affected area,

g. Nature of effects (i.e., fish kill, discoloration of receiving water, etc.),

h. Corrective measures that have been taken or planned, and a schedule of these activities, and

i. Persons/agencies notified.

3. Reports of Treatment Unit Bypass and Permit Violation: In the event the Discharger violates or threatens to violate the conditions of the waste discharge requirements and prohibitions or intends to permit a treatment unit bypass, the Discharger shall notify the Regional Water Board within 24 hours of when the Discharger or Discharger's agent has knowledge of the incident and confirm this notification in writing and uploaded on GeoTracker with a confirmation email to Regional Water Board staff, within 5 working days of the initial notification. The written report shall include time, date, duration and estimated volume of waste bypassed, method used in estimating volume and person notified of the incident. The report shall include pertinent information explaining reasons for the noncompliance and shall indicate what steps were taken to prevent the problem from recurring.

A treatment unit bypass may occur due to:

a. Maintenance work, power failures, or breakdown of waste treatment equipment,

b. Accidents caused by human error or negligence,

c. The self-monitoring program results exceeding effluent limitations,

d. Any activity that would result in a frequent or routine discharge of any toxic pollutant not limited by this Order, or

e. Other causes, such as acts of nature.

4. Additional Reporting: If a violation of the effluent limitations should occur, the Discharger shall direct the effluent to a holding tank and contained, or the extraction and treatment system shall be shut down. The confirmation sampling shall be conducted when the discharge is directed to a holding tank and contained or right before the extraction and treatment system is shut down. The content of the holding tank shall be retreated until the retreated effluent is in compliance, be discharged to a publicly owned treatment works (POTW), or be disposed in accord with the provisions of applicable California Code of Regulations. The Discharger shall obtain permission from the POTW for any temporary or permanent discharges to the sanitary sewer. All confirmation sampling results shall be reported.

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ATTACHMENT F – FACT SHEET

As described in Section II of this Order, this Fact Sheet includes the legal requirements and technical rationale that serve as the basis for the requirements of this Order. This Order has been prepared under a standardized format to accommodate a broad range of discharge requirements for dischargers in California. Except where identified as "not applicable", all sections or subsections are applicable to the discharges regulated under this Order.

This Order is intended to cover discharges of extracted and treated groundwater resulting from the cleanup of groundwater polluted by volatile organic compounds (VOC), fuel leaks, and other related wastes. This Order combines two previously issued Regional Water Board orders:

a. R2-2006-0075, NPDES General Permit for the discharge of extracted and treated groundwater resulting from the cleanup of groundwater polluted by fuel leaks and other related wastes at service stations and similar sites (**Fuel General Permit**), and

b. R2-2009-0059, NPDES General Permit for the discharge of extracted and treated groundwater resulting from the cleanup of groundwater polluted by volatile organic compounds (**VOC General Permit**). The VOC General Permit remains in effect and the dischargers authorized under this permit will need to seek coverage under this Order no later than April 3, 2014.

I. PERMIT INFORMATION

From 1980 to date, approximately 11,000 sites with underground fuel or VOC storage tanks in the San Francisco Bay Region are known to be leaking or to have leaked. Historically, a number of these sites were cleaned-up by extracting and treating contaminated groundwater and discharging treated groundwater to surface water. Because the number of such applications exceeded the capacity of available Regional Water Board staff to develop and bring individual waste discharge requirements to the Regional Water Board for adoption, in the early 1990s, the Regional Water Board issued National Pollutant Discharge Elimination System (NPDES) General Permits to cover such discharges.

In 1991, the Regional Water Board issued the Fuel General Permit. This permit was reissued in 1996, 2001, and 2006. The 2006 permit (Regional Water Board Order No. R2-2006-0075) expired on January 12, 2012. There are 20 current Dischargers covered under this permit. In 2011, 18 Dischargers submitted Notice of Intent (NOI) applications to either continue discharging or initiate the discharge of treated groundwater to surface water under the Fuel General Permit after it expires.

In 1994, the Regional Water Board issued the VOC General Permit. This permit was reissued in 1999, 2004, and 2009. The current VOC General Permit (Regional Water Board Order No. R2-2009-0059) was adopted on August 12, 2009, became effective October 1, 2009, and expires September 30, 2014. There are 56 current Dischargers covered under this permit.

The Fuel General Permit needs to be reissued because 18 Dischargers have submitted NOI applications to either continue discharging or initiate the discharge of treated groundwater to surface water. In addition, within the next five years, it is anticipated that a number of fuel-contaminated sites will be conducting cleanup by extracting contaminated groundwater, treating, and discharging

treated groundwater. Some Publicly Owned Treatment Works (POTWs) do not accept new discharges from groundwater clean-up, and, therefore, a number of sites conducting groundwater cleanup will require waste discharge requirements from the Regional Water Board for discharge to surface water. The number of cleanups anticipated exceeds the capacity of available Regional Water Board staff to develop and bring individual waste discharge requirements to the Regional Water Board for adoption. These circumstances create the need for an expedited system to process the anticipated requests. The reissuance of the Fuel General Permit will expedite the processing of requirements, enable the Regional Water Board to better utilize limited staff resources, and permit cleanups to begin promptly.

What is New in this Permit Reissuance - Because the nature and treatment of pollutants present in fuel-contaminated groundwater and VOC-contaminated groundwater is similar, the Regional Water Board expects to cover both types of discharges under this General Permit. It is also anticipated that the total number of VOC and fuel-contaminated sites that will be conducting cleanup by extracting contaminated groundwater, and treating and discharging treated groundwater to surface water will decline. This decline is the result of several factors:

(i) Fewer open cases as the Regional Water Board closes cases but finds not as many new cases to take their place,
(ii) Significant shift in groundwater cleanup technology away from "pump and treat" and towards in-situ methods, due to the latter's greater effectiveness, and
(iii) Wider use of the Regional Water Board low-threat closure tool for both fuel and VOC cleanup sites.

For the above reasons, two separate general NPDES permits will not be needed when the VOC General Permit expires in 2014. Those requiring continued permit coverage and new dischargers are expected to submit NOI applications for coverage under this Order.

The following VOC and fuel clean-up discharges are normally not eligible for coverage: discharges from cleanups involving significant contamination by metals, pesticides, or other conservative pollutants and discharges from sites with other NPDES discharges (e.g., process waste). Dischargers that combine extracted groundwater with stormwater before treatment are normally not eligible for coverage under this Order because the amount of rainwater varies and may exceed the treatment system capacity.

The following table (Table F-1) is a standard template primarily useful for individual permits. For this General Permit, it provides cross-references to the specific sections of the Notice of Intent (NOI) Form, in Attachment B, that each Discharger enrolled under this Order must initially complete and submit as part of the NOI.

Table F-1. Facility Information

California Integrated Water Quality System (CIWQS) Regulatory measure and Place ID	A CIWQS Place ID and Regulatory measure identification number will be assigned to a facility when the Executive Officer issues the Authorization to Initiate Discharge
Discharger	NOI Form in Attachment B
Name of Facility	
Facility Address	
Facility Contact, Title, Phone, and email address	
Consultant Name, Phone, and email address	
Authorized Person to Sign and Submit Reports	
Mailing Address and Contact Person Name, Phone, and email address	
Billing Address and Contact Person Name, Phone, and email address	
Type of Project	
Major or Minor Facility	Minor
Pretreatment Program	Not Applicable
Reclamation Requirements	Producer (See NOI in Attachment B)
Facility Permitted Flow	NOI Form in Attachment B
Facility Design Flow	
Watershed	
Receiving Water Type	

A. Site Owners or Operators who apply for an authorization to discharge under this Order and who are granted such authorization are hereinafter called Discharger(s). The groundwater treatment facility is considered the facility regulated under this Order (hereinafter Facility). For the purposes of this Order, references to the "Discharger(s)" or "permittee(s)" in applicable federal and State laws, regulations, plans, or policy are held to be equivalent to references to the Discharger(s) herein.

B. The Facilities regulated under the previously issued Fuel and VOC General NPDES permits discharge wastewater to multiple receiving waters of the State and/or the United States, mainly in Santa Clara County. The Fuel General Permit was adopted on November 13, 2006, became effective on January 12, 2007, and expired on January 12, 2012. The terms and conditions of Order No. R2-2006-0075 were automatically continued in effect until new Waste Discharge Requirements and NPDES permit are adopted pursuant to this Order. During the term of Order No. R2-2006-0075, 78 facilities were authorized to discharge treated groundwater to the receiving water documented in the NOI submitted for each discharge. Out of 78 facilities, 60 completed groundwater cleanup or changed to different cleanup methods that obviate the need to discharge any treated groundwater.

C. As of November 2011, 18 Dischargers had filed a report of waste discharge by submitting an NOI to continue their discharge authorization under this NPDES General Permit. In the process of reviewing and approving NOIs, supplemental information may be requested from a subset of these facilities. It may also be necessary to visit facilities for which an NOI has been submitted, to observe operations and collect additional data to determine the eligibility of authorizing those discharges

under this Order. This Order requires Dischargers to submit monitoring data according to the requirements contained in the Monitoring and Reporting Program (Attachment E). If monitoring data indicate significant contamination by metals, pesticides, or other conservative pollutants, Dischargers authorized under this Order may be required to apply for an individual NPDES permit.

II. FACILITY DESCRIPTION

The facilities that may be covered under this Order are groundwater treatment facilities located at active or closed sites with solvent and/or fuel leaks. These groundwater treatment facilities are in operation to extract and treat groundwater polluted mainly by VOC and/or fuel components. This Order covers discharges from these facilities to all surface waters such as creeks, streams, rivers including flood control channels, lakes, or San Francisco Bay. Such discharges may occur directly to surface waters or through constructed storm drain systems.

A. Description of Wastewater Treatment

Dischargers authorized under this Order typically use aeration and/or granular activated carbon (GAC) systems to treat their groundwater prior to discharge. Facilities that use other types of treatment systems that are effective at removal of VOC pollutants may be covered by this Order subject to the approval of the Executive Officer. The most common VOC pollutants contained in the influent of these treatment systems are tetrachloroethylene and trichloroethylene. The most common pollutants contained in groundwater influent that has been contaminated by fuel leaks are benzene, ethylbenzene, toluene, total xylenes, methyl tertiary butyl ether (MTBE), and other petroleum hydrocarbons collectively called total petroleum hydrocarbons (TPHs). Other volatile or semi-volatile organic compounds may also be present in the influent of a subset of facilities regulated under this permit. Less commonly, inorganic pollutants, such as metals, are present in the influent and effluent and may be naturally occurring.

Except for some inorganic compounds and some other organic compounds such as 1,4 dioxane, the concentrations of organic pollutants in the effluents of the discharges are usually below detectable levels. The Fuel and VOC Dischargers reported design flow rates ranging from 5 gpm to 840 gpm, and discharge flow rates ranging from 2.5 gpm to 605 gpm.

The reported detection limit for benzene, ethylbenzene, toluene, total xylenes, and most VOC is 0.5 microgram per liter (ug/L); for MTBE, the reported detection limit ranges from 0.5 to 5.0 ug/L; for TPH, the reported detection limit is mostly 50.0 ug/L; and the reported detection limits for semi volatile organic compounds are mostly 5.0 or 10.0 ug/L.

B. Discharge Points and Receiving Waters

The NOI Form (Attachment B) requires every Discharger to provide the discharge location and a map highlighting the discharge path to surface waters.

C. Summary of Existing Requirements

The effluent limitation contained in the previously issued Fuel (Order No. R2-2006-0075) and VOC (Order No. R2-2009-0059) General Permits is summarized in Table F-2. Except the residual chlorine effluent limit in the VOC General NPDES permit, the effluent limitations contained in the previously issued Fuel and VOC General Permits were the same.

Table F-2. Historic Effluent Limitations

No.	Compound	CAS Number	Column A: Discharge to Drinking Water Areas[2]		Column B: Discharge to Other Surface Water Areas	
			Average Monthly Effluent Limitation (µg/L)	Maximum Daily Effluent Limitation (µg/L)	Average Monthly Effluent Limitation (µg/L)	Maximum Daily Effluent Limitation (µg/L)
1	Benzene	71432		1		5
2	Carbon Tetrachloride	56235	0.25 [1]	0.50	4.4	5
3	Chloroform	67663		5		5
4	1,1-Dichloroethane	75343		5		5
5	1,2-Dichloroethane	107062	0.38 [1]	0.5		5
6	1,1-Dichloroethylene	75354	0.057 [1]	0.11[1]	3.2	5
7	Ethylbenzene	100414		5		5
8	Methylene Chloride (Dichloromethane)	75092	4.7	5		5
9	Tetrachloroethylene	127184	0.8	1.6		5
10	Toluene	108883		5		5
11	Cis 1,2-Dichloroethylene	156592		5		5
12	Trans 1,2-Dichloroethylene	156605		5		5
13	1,1,1-Trichloroethane	71556		5		5
14	1,1,2-Trichloroethane	79005	0.6	1.2		5
15	Trichloroethylene	79016	2.7	5		5
16	Vinyl Chloride	75014		0.5		1
17	Total Xylenes	1330207		5		5
18	Methyl Tertiary Butyl Ether (MTBE)	1634044		5		5
19	Total Petroleum Hydrocarbons (as Gasoline or as Diesel)			50		50
20	Ethylene Dibromide (1,2-Dibromoethane)	106934		0.05[1]		5
21	Trichloro-trifluoroethane	76131		5		5
22	Total Chlorine Residual	---	---	0.0[3]	---	0.0[3]

Notes for Table F-2:

[1] If reported detection level is greater than effluent limit, then a non-detect result using a 0.5 µg/L detection level will not be deemed to be out of compliance.

[2] Drinking water areas are defined as surface waters with the existing or potential beneficial uses of "municipal and domestic supply" and "groundwater recharge" (the latter includes recharge areas to maintain salt balance or to halt salt water intrusion into fresh water aquifers).

[3] There shall be no detectable levels of residual chlorine in the effluent (a non-detect result using a detection level equal or less than 0.08 milligram per liter (mg/L) will not be deemed to be out of compliance). This limit only applies to Dischargers that chlorinate their extracted groundwater.

D. Compliance Summary

Forty-four effluent limit and 17 late reporting violations (for a total of 61 violations) are reported in CIWQS during the term of the Fuel General Permit. On average, the Dischargers reported effluent limit compliance rates of about 99% for TPHd, TPHg, and on-time report submittal, and almost 100% for the remaining pollutants with effluent limits in Table F-2. Regional Water Board enforcement staff completed enforcement actions for 53 of these violations, and continues to review the remaining 8 violations. The VOC General Permit compliance summary is on page F-4 of Order No. R2-2009-0059.

E. Planned Changes

As required in Attachment D, a Discharger authorized under this Order shall submit a modified NOI before making any material change in the character, location, or volume of the discharge.

III. APPLICABLE PLANS, POLICIES, AND REGULATIONS

The requirements contained in the Order are based on the requirements and authorities described in this section.

A. Legal Authorities

This Order is issued pursuant to section 402 of the federal Clean Water Act (CWA) and implementing regulations adopted by the U.S. Environmental Protection Agency (USEPA) and chapter 5.5, division 7 of the California Water Code [(CWC), commencing with section 13370]. It shall serve as a NPDES permit for point source discharges from these facilities to surface waters. This Order also serves as General Waste Discharge Requirements (GWDRs) pursuant to CWC article 4, chapter 4, division 7 (commencing with section 13260). States may request authority to issue general NPDES permits pursuant to Code of Federal Regulations, Title 40, Chapter 1, Subchapter D, part 122.28 (40 CFR 122.28). 40 CFR 122.28 provides for the issuance of general permits to regulate discharges of waste which result from similar operations, are the same types of waste, require the same effluent limitations, require similar monitoring, and are more appropriately regulated under a general permit rather than individual permits. This general permit meets the requirements of 40 CFR 122.28 because the discharges and proposed discharges:

- result from similar operations (all involve extraction, treatment, and discharge of groundwater);
- are the same types of waste (all are groundwater containing VOC, fuel components, and other related wastes due to leaks and spills);
- require similar effluent limitations for the protection of the beneficial uses of surface waters in the San Francisco Bay Region (this general permit does not cover direct discharges to the Pacific Ocean);

- require similar monitoring; and
- are more appropriately regulated under a general permit rather than individual permits.

B. California Environmental Quality Act (CEQA)

Under CWC section 13389, this action to issue an NPDES permit is exempt from the provisions of CEQA.

C. State and Federal Regulations, Policies, and Plans

1. **Water Quality Control Plans.** *The Water Quality Control Plan for the San Francisco Bay Basin* (the Basin Plan) is the Regional Water Board's master water quality control planning document. It designates beneficial uses and water quality objectives (WQOs) for waters of the State, including surface and groundwater. It also includes implementation programs to achieve WQOs. The Basin Plan was duly adopted by the Regional Water Board and approved by the State Water Resources Control Board (State Water Board), the Office of Administrative Law, and USEPA. Requirements of this Order implement the Basin Plan.

   The Basin Plan designates beneficial uses, establishes water quality objectives, and contains implementation programs and policies to achieve those objectives for all waters addressed through the plan. The Basin Plan states that the beneficial uses of any specifically identified water body generally apply to its tributary streams. The Basin Plan may not specifically identify beneficial uses for every receiving water regulated under this permit, but identifies present and potential uses for the downstream water body, to which the receiving water, via an intermediate water body, is tributary. These potential and existing beneficial uses are: municipal and domestic supply, fish migration and fish spawning, industrial service supply, navigation, industrial process supply, marine habitat, agricultural supply, estuarine habitat, groundwater recharge, shellfish harvesting, water contact and non-contact recreation, ocean, commercial, and sport fishing, wildlife habitat, areas of special biological significance, cold freshwater and warm freshwater habitat, and preservation of rare and endangered species for surface waters and municipal and domestic supply, industrial service supply, industrial process supply, agricultural supply, and freshwater replenishment for groundwaters. In addition, the Basin Plan implements State Water Board Resolution No. 88-63, which established state policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply. Requirements of this Order implement the Basin Plan.

   On September 18, 1975, the State Water Board adopted the *Water Quality Control Plan for Control of Temperature in the Coastal Interstate Waters and Enclosed Bays and Estuaries of California* (hereinafter the Thermal Plan). The Thermal Plan contains objectives governing cooling water discharges, providing different and specific numeric and narrative water quality objectives for new and existing discharges.

   The State Water Board's *Water Quality Control Plan for Enclosed Bays and Estuaries—Part 1, Sediment Quality* became effective on August 25, 2009. This plan supersedes other narrative sediment quality objectives and establishes new sediment quality objectives and

related implementation provisions for specifically defined sediments in most bays and estuaries.

2. **National Toxics Rule (NTR) and California Toxics Rule (CTR).** USEPA adopted the NTR on December 22, 1992, and amended it on May 4, 1995, and November 9, 1999. About 40 criteria in the NTR and apply in California. On May 18, 2000, USEPA adopted the CTR. The CTR promulgated new toxics criteria for California and, in addition, incorporated the previously adopted NTR criteria that applied in the State. The CTR was amended on February 13, 2001. These rules contain water quality criteria (WQC) for priority toxic pollutants.

3. **State Implementation Policy.** On March 2, 2000, the State Water Board adopted the *Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California* (State Implementation Policy or SIP). The SIP became effective on April 28, 2000, with respect to the priority pollutant criteria promulgated through the NTR and to the WQOs established in the Basin Plan. The SIP became effective on May 18, 2000, with respect to the priority pollutant criteria promulgated through the CTR. The State Water Board adopted amendments to the SIP on February 24, 2005, which became effective on July 13, 2005. The SIP establishes implementation provisions for priority pollutant criteria and objectives and provisions for chronic toxicity control. Requirements of this Order implement the SIP.

4. **Alaska Rule.** On March 30, 2000, USEPA revised its regulation that specifies when new and revised state and tribal water quality standards (WQS) become effective for CWA purposes [65 Fed. Reg. 24641 (April 27, 2000), codified at 40 CFR 131.21]. Under the revised regulation (also known as the Alaska Rule), new and revised standards submitted to USEPA after May 30, 2000, must be approved by USEPA before being used for CWA purposes. The final rule also provides that standards already in effect and submitted to USEPA by May 30, 2000, may be used for CWA purposes, whether or not approved by USEPA.

5. **Antidegradation Policy.** 40 CFR 131.12 requires that state WQS include an antidegradation policy consistent with the federal policy. The State Water Board established California's antidegradation policy in State Water Board Resolution 68-16, which incorporates the federal antidegradation policy where the federal policy applies under federal law and requires that existing quality of waters be maintained unless degradation is justified based on specific findings. The Regional Water Board's Basin Plan implements, and incorporates by reference, both the State and federal antidegradation policies.

6. **Anti-Backsliding Requirements.** CWA Sections 402(o)(2) and 303(d)(4) and 40 CFR 122.44(l) prohibit backsliding in NPDES permits. These anti-backsliding provisions require that effluent limitations in a reissued permit must be as stringent as those in the previous permit, with some exceptions in which limitations may be relaxed. This Order retains effluent limitations no less stringent than those established by previous orders.

D. Impaired Water Bodies on CWA 303(d) List

In November 2006, USEPA approved a revised list of impaired water bodies prepared pursuant to CWA section 303(d), which requires identification of specific waterbodies where it is expected that water quality standards will not be met after implementation of technology-based effluent limitations on point sources. In November 2010, USEPA partially approved an updated 303(d) list. Where it has not already done so, the Regional Water Board plans to adopt Total Maximum Daily Loads (TMDLs) for pollutants on the 303(d) list. TMDLs establish wasteload allocations for point sources and load allocations for non-point source sand are established to achieve the water quality standards for the impaired waterbodies. The SIP requires final effluent limitations for all 303(d)-listed pollutants to be based on total maximum daily loads and associated waste load allocations.

IV. RATIONALE FOR EFFLUENT LIMITATIONS AND DISCHARGE SPECIFICATIONS

The CWA requires point source dischargers to control the amount of conventional, non-conventional, and toxic pollutants that are discharged into the waters of the United States. The control of pollutants discharged is established through effluent limitations and other requirements in NPDES permits. There are two principal bases for effluent limitations in 40CFR: Section 122.44(a) requires that permits include applicable technology-based limitations and standards; and Section 122.44(d) requires that permits include water quality-based effluent limitations to attain and maintain applicable numeric and narrative water quality criteria to protect the beneficial uses of the receiving water.

Several specific factors affecting the development of limitations and requirements in this Order are discussed as follows:

A. Discharge Prohibitions

1. **Prohibition III.A (Unauthorized discharges of extracted and treated groundwater are prohibited):** This discharge prohibition is retained from the previously issued Fuel and VOC General Permits and is based on CWC section 13260, which requires filing of a report of waste discharge (ROWD) before discharges can occur. Discharges which have not been described in a Discharger's NOI are prohibited.

2. **Prohibition III.B (Discharges of effluent other than extracted groundwater treated only with approved chemicals are prohibited):** This prohibition is retained from the previously issued Fuel and VOC General Permits and is based on the fact that the requirements in the Order were developed for discharges of treated groundwater from VOC or fuel-contaminated groundwater sites so only discharges associated with this type of activity can be permitted under this Order.

3. **Prohibition III.C (Discharges in excess of the authorized flow rate are prohibited):** This prohibition is retained from the previously issued Fuel and VOC General Permits. The basis for the prohibition is the same rationale documented for Prohibition III.A. Dischargers have submitted NOIs that included a description of treatment facility design and the maximum

design flow rate, certified by a professional engineer. Flows in excess of the design flow rate may result in lowering the reliability of achieving compliance with water quality requirements.

4. **Prohibition III.D (No scouring or erosion due to discharge of extracted and treated groundwater at the point where a storm drain discharges to a receiving water):** This prohibition is retained from the previously issued Fuel and VOC General Permits, with slight revisions for consistency with similar provisions of the Municipal Regional Stormwater NPDES Permit (Order No. R2-2009-0074), and is based on the sediment and erosion control goals of section 4.19 of the Basin Plan.

5. **Prohibition III.E (No pollution, contamination, or nuisance):** This prohibition is based on CWC section 13050, and has been retained from the previously issued Fuel and VOC General Permits.

6. **Prohibition III.F (No bypass or overflow of untreated or partially treated polluted groundwater**): This prohibition is retained from the previously issued Fuel and VOC General Permits and is based on 40 CFR 122.41(m).

B. Shallow Water Discharges and Basin Plan Discharge Prohibition 1

The Basin Plan (Chapter 4, Table 4-1, Discharge Prohibition 1) prohibits discharges not receiving a minimum 10:1 initial dilution or to dead end sloughs. In accordance with the Basin Plan, this Order continues to grant Dischargers an exception to the discharge prohibition for discharges to shallow waters. The exception is based on section 4.2 of the Basin Plan, which states that an exception to Prohibition 1 will be considered where:

- A discharge is approved as part of a reclamation project; or
- It can be demonstrated that net environmental benefits will be derived as a result of the discharge; or
- A discharge is approved as part of a groundwater cleanup project and, in accordance with Resolution No. 88-160 'Regional Board Position on the Disposal of Extracted Groundwater from Groundwater Clean-Up Projects', it has been demonstrated that neither reclamation nor discharge to a publicly owned treatment works is technically and economically feasible, and the discharger has provided certification of the adequacy and reliability of treatment facilities and a plan that describes procedures for proper operation and maintenance of all treatment facilities.

The Basin Plan further states:

> Significant factors to be considered by the Regional Water Board in reviewing requests for exceptions will be the reliability of the discharger's system in preventing inadequately treated wastewater from being discharged to the receiving water and the environmental consequences of such discharges.

To comply with the exception, this Order requires Dischargers to document in the NOI application that neither reclamation nor discharge to a POTW is technically and economically

feasible. In addition, to prevent inadequately treated wastewater from being discharged to receiving waters, Dischargers are required to document in the NOI that the discharge of inadequately treated waste will be reliably prevented.

C. Technology-Based Effluent Limitations

If any extracted and treated groundwater receives less than proper treatment, the pollutants listed in Table F-2 may be discharged at levels that have a reasonable potential to cause or contribute to an exceedance of any applicable criterion established by the USEPA pursuant to CWA section 303.

1. Scope and Authority

The CWA requires technology-based effluent limitations (TBELs) based on several levels of controls:

- Best practicable treatment control technology (BPT) represents the average of the best performance by plants within an industrial category or subcategory. BPT standards apply to toxic, conventional, and non-conventional pollutants.

- Best available technology economically achievable (BAT) represents the best existing performance of treatment technologies that are economically achievable within an industrial point source category. BAT standards apply to toxic and non-conventional pollutants.

- Best conventional pollutant control technology (BCT) represents the control from existing point sources of conventional pollutants including BOD, TSS, fecal coliform, pH, and oil and grease. The BCT standard is established after considering the "cost reasonableness" of the relationship between the cost of attaining a reduction in effluent discharge and the benefits that would result, and also the cost effectiveness of additional industrial treatment beyond BPT.

- New source performance standards (NSPS) represent the best available demonstrated control technology standards. The intent of NSPS guidelines is to set limitations that represent state-of-the-art treatment technology for new sources.

The CWA requires USEPA to develop effluent limitations, guidelines, and standards (ELGs) representing application of BPT, BAT, BCT, and NSPS. Section 402(a)(1) of the CWA and 40 CFR 125.3 authorize the use of Best Professional Judgment (BPJ) to derive TBELs on a case-by-case basis where ELGs are not available for certain industrial categories and/or pollutants of concern. Where BPJ is used, the permit writer must consider specific factors outlined in 40 CFR 125.3.

2. Applicable Technology-Based Effluent Limitations

Regional Water Board staff used BPJ in developing TBELs in this Order. BPJ is defined as the highest quality technical opinion developed by a permit writer after consideration of all reasonably available and pertinent data or information that forms the basis for the terms and conditions of a NPDES permit. The authority for BPJ is contained in CWA section 402(a)(1).

In the treatment systems regulated by this Order, organic compounds, including VOC and petroleum compounds, are removed from contaminated groundwater using such technologies as air stripping and activated carbon. Treated groundwater is then discharged to surface waters. When properly designed and operated, these treatment systems can lower the concentration of such pollutants to levels below analytical detection limits.

USEPA Region 9 issued a document titled *NPDES Permit Limitations for Discharge of Contaminated Groundwater: Guidance Document* (USEPA, 1986) in which USEPA concluded that the cost of reducing concentrations of most organic compounds commonly detected in contaminated groundwater to a non-detect concentration of 5 µg/L, and to a non-detect concentration for vinyl chloride of 1 µg/L, is considered economically achievable.

Based on an understanding that available treatment technologies can economically remove organic pollutants from contaminated groundwater, the Regional Water Board has established TBELs using BPJ at 5.0 µg/L for benzene, carbon tetrachloride, chloroform, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethylene, ethylbenzene, methylene chloride, tetrachloroethylene, Toluene, Cis 1,2-Dichloroethylene, Trans 1,2-Dichloroethylene, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, Trichloroethylene, and total xylenes, and at 1.0 µg/L for vinyl chloride.

Petroleum-based compounds and fuel additives are commonly found at sites with fuel or fuel VOC commingled plumes. This Order therefore retains TBELs for TPHs, ethylene dibromide, and MTBE from the previous Fuel General Permit. Limitations for TPH are 50 µg/L and for ethylene dibromide and MTBE are 5 µg/L, which reflect a level of treated wastewater quality that is economically achievable by the treatment technologies contemplated by this Order.

Because a number of facilities covered under the Fuel General Permit are former semiconductor manufacturing operations, which used trichlorotrifluoroethane (Freon 113) in a manufacturing process and have detected concentrations of this compound in contaminated groundwater, this Order retains the effluent limitation from the previous Fuel General Permit for Freon. The effluent limitation of 5 µg/L reflects a level of treated wastewater quality that is economically achievable by the treatment technologies contemplated by this Order.

Table F-3, below, summarizes the TBELs established by this Order.

Table F-3. Summary of Technology-Based Effluent Limitations

No.	Compound	Limitations Established by BPJ	
		USEPA	RWB
1	Benzene	5	---
2	Carbon Tetrachloride	5	---
3	Chloroform	5	---
4	1,1-Dichloroethane	5	---
5	1,2-Dichloroethane	5	---
6	1,1-Dichloroethylene	5	---
7	Ethylbenzene	5	---

No.	Compound	Limitations Established by BPJ	
		USEPA	RWB
8	Methylene Chloride	5	---
9	Tetrachloroethylene	5	---
10	Toluene	5	---
11	Cis-1,2-Dichloroethylene	5	---
12	Trans-1,2-Dichloroethylene	5	---
13	1,1,1-Trichloroethane	5	---
14	1,1,2-Trichloroethane	5	---
15	Trichloroethylene	5	---
16	Vinyl Chloride	1	---
17	Total Xylenes	5	---
18	Methyl Tertiary Butyl Ether (MTBE)	5	5
19	Total Petroleum Hydrocarbons (TPH)	---	50
20	Ethylene Dibromide (1,2-Dibromoethane)	---	5
21	Trichlorotrifluoroethane	---	5

D. Water Quality-Based Effluent Limitations (WQBELs)

WQBELs have been derived to implement WQOs that protect beneficial uses. Both the beneficial uses and the WQOs have been approved pursuant to federal law. The procedures for calculating individual WQBELs are based on the SIP and the Basin Plan. Most Basin Plan beneficial uses and WQOs were approved under State law and submitted to and approved by USEPA prior to May 30, 2000. Any WQOs and beneficial uses submitted to USEPA prior to May 30, 2000, but not approved by USEPA before that date, are nonetheless "applicable water quality standards for purposes of the [Clean Water] Act" pursuant to 40 CFR 131.21(c)(1). Collectively, this Order's restrictions on individual pollutants are no more stringent than those required by CWA water quality standards.

1. Scope and Authority

a. 40 CFR 122.44(d)(1)(i) mandates that permits include effluent limitations for all pollutants that are or may be discharged at levels that have reasonable potential to cause or contribute to an excursion of a water quality standard, including numeric and narrative objectives within a standard. As specified in 40 CFR 122.44(d)(1)(i), permits are required to include WQBELs for all pollutants "which the Director determines are or may be discharged at a level which will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard."

The process for determining "reasonable potential" and calculating WQBELs when necessary is intended to protect the designated beneficial uses of the receiving water as

specified in the Basin Plan, and achieve applicable WQOs contained in other state plans and policies, and applicable WQC contained in the CTR and NTR.

b. NPDES regulations and the SIP provide the basis to establish Maximum Daily Effluent Limitations (MDELs).

(1) NPDES regulations at 40 CFR 122.45(d) state, "For continuous discharges all permit effluent limitations, standards, and prohibitions, including those necessary to achieve water quality standards, shall *unless impracticable* be stated as maximum daily and average monthly discharge limitations for all discharges other than publicly owned treatment works."

(2) SIP section 1.4 requires WQBELs to be expressed as MDELs and average monthly effluent limitations (AMELs).

c. MDELs are used in this Order to protect against acute water quality effects. MDELs are necessary for preventing fish kills or mortality to aquatic organisms.

2. Applicable Beneficial Uses and Water Quality Criteria and Objectives

The WQOs applicable to the receiving waters for these discharges are from the Basin Plan; the CTR, established by USEPA at 40 CFR 131.38; and the NTR, established by USEPA at 40 CFR 131.36. Some pollutants have WQOs established by more than one of these three sources.

a. Basin Plan. The Basin Plan specifies numeric WQOs for 10 priority toxic pollutants, as well as narrative WQOs for toxicity and bioaccumulation in order to protect beneficial uses. The pollutants for which the Basin Plan specifies numeric objectives are arsenic, cadmium, chromium (VI), copper in fresh and marine water, lead, mercury, nickel, silver, zinc, and cyanide. The narrative toxicity objective states, "All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms." The bioaccumulation objective states, "Controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered." Effluent limitations and provisions contained in this Order are designed to implement these objectives, based on available information.

The Basin Plan also contains a narrative objective for surface waters designated for use as a domestic or municipal supply (MUN) which states that these surface waters shall not contain concentrations of constituents in excess of the maximum contaminant levels (MCLs) or secondary MCLs specified in Title 22 of the California Code of Regulations. Effluent limitations and provisions contained in this Order are designed to implement these objectives, based on available information.

b. CTR. The CTR specifies numeric aquatic life criteria for 23 priority toxic pollutants and numeric human health criteria for 57 priority toxic pollutants. These criteria apply to all

inland surface waters and enclosed bays and estuaries of the San Francisco Bay Region, although Tables 3-3 and 3-4 of the Basin Plan include numeric objectives for certain of these priority toxic pollutants, which supersede criteria of the CTR (except in the South Bay south of the Dumbarton Bridge).

Human health criteria are further identified as "water and organisms" and "organisms only." The CTR criteria applicable to "water and organisms" are applied in the Reasonable Potential Analysis (RPA) for discharges to receiving waters with a MUN designation, and criteria applicable to "organisms only" were used in the RPA for discharges to receiving waters that are not MUN-designated.

c. NTR. The NTR establishes numeric aquatic life criteria for selenium and numeric "organisms only" human health criteria for 33 toxic pollutants for waters of San Francisco Bay upstream to, and including Suisun Bay and the San Joaquin-Sacramento River Delta.

d. Sediment Quality Objectives. The *Water Quality Control Plan for Enclosed Bays and Estuaries – Part 1, Sediment Quality* contains a narrative WQO, "Pollutants in sediments shall not be present in quantities that, alone or in combination, are toxic to benthic communities in bays and estuaries of California." This WQO is to be implemented by integrating three lines of evidence: sediment toxicity, benthic community condition, and sediment chemistry. The policy requires that is the Regional Water Board determines that a discharge has reasonable potential to cause or contribute to an exceedance of this WQO, it is to impose the WQO as a receiving water limit.

e. Basin Plan Receiving Water Salinity Policy. The Basin Plan (like the CTR and the NTR) states that the salinity characteristics (i.e., freshwater vs. saltwater) of the receiving water are to be considered in determining the applicable WQOs. Freshwater criteria apply to discharges to waters with salinities equal to or less than one part per thousand (ppt) at least 95 percent of the time. Saltwater criteria apply to discharges to waters with salinities equal to or greater than 10 ppt at least 95 percent of the time in a normal water year. For discharges to water with salinities between these two categories, or tidally influenced freshwaters that support estuarine beneficial uses, the WQOs are the lower of the salt or freshwater WQOs (the latter calculated based on ambient hardness) for each substance.

Receiving waters considered by for this permit are the San Francisco Bay and other estuarine and tidally influences waters, and inland freshwaters. The Basin Plan implements State Water Board Resolution No. 88-63, which establishes State policy that all waters, with certain exceptions, should be considered suitable or potentially suitable for municipal or domestic supply (MUN). Because of marine influence on all reaches of San Francisco Bay and other tidally influenced waters, total dissolved solids levels exceed 3,000 mg/L and thereby meet an exception to State Water Board Resolution No. 88-63. The RPA therefore separately considered criteria that were applicable to receiving waters with a MUN designation and to receiving waters that are not MUN-designated.

Aquatic life criteria were based on the most stringent of the fresh and salt water criteria, to be fully protective of all receiving waters.

f. **Receiving Water Hardness.** Ambient hardness values are used to calculate freshwater WQOs that are hardness dependent. In determining the WQOs for this Order, Regional Water Board staff used a hardness value of 100 mg/L as $CaCO_3$, which is a conservative value and generally protective of aquatic life in all circumstances contemplated by the General Permit.

g. **Site-Specific Translators (SSTs).** NPDES regulations at 40 CFR 122.45(c) require that effluent limitations for metals be expressed as total recoverable metal. Since applicable WQOs for metals are typically expressed as dissolved metal, translators must be used to convert metals concentrations from dissolved to total recoverable and vice versa. The CTR includes default translators; however, site-specific conditions, such as water temperature, pH, suspended solids, and organic carbon greatly affect the form of metal (dissolved, non-filterable, or otherwise) present in the water and therefore available to cause toxicity. In general, the dissolved form of the metal is more available and more toxic to aquatic life than non-filterable forms. Site-specific translators can be developed to account for site-specific conditions, thereby preventing exceedingly stringent or under protective WQOs.

Receiving waters for discharges from the facilities covered under the General Permit are varied, and, therefore, site specific conditions are varied. In determining the need for and calculating WQBELs for all metals except for copper and nickel, the Regional Water Board has used default translators established by the USEPA in the CTR at 40 CFR 131.38 (b) (2), Table 2 to be protective in all circumstances. Most discharges are anticipated to eventually enter San Francisco Bay, and, therefore, the site specific translators were applied in determining criteria for copper and nickel. For copper, the Regional Water Board applied the SSTs adopted by Regional Water Board Resolution No. R2-2007-0042 for North and Central San Francisco Bay, and the SST contained in the Basin Plan Table 7.2.1-1 for South San Francisco Bay. For nickel, the Regional Water Board applied the translators for North and Central San Francisco Bay based on the recommendation of the Clean Estuary Partnership's *North of Dumbarton Bridge Copper and Nickel Development and Selection of Final Translators* (2005), and applied the translators contained in Table 7.2.1-1 of the Basin Plan for South San Francisco Bay. These translators for copper and nickel are summarized below.

Table F-4. SSTs for Copper and Nickel for San Francisco Bay

	Copper		**Nickel**	
San Francisco Bay Segment	**AMEL Translator**	**MDEL Translator**	**AMEL Translator**	**MDEL Translator**
North	0.38	0.66	0.27	0.57
Central	0.73	0.87	0.65	0.85
South	0.53	0.53	0.44	0.44

3. Determining the Need for WQBELs

Assessing whether a pollutant has Reasonable Potential is the fundamental step in determining whether or not a WQBEL is required.

a. Reasonable Potential Methodology

For priority pollutants and most other toxic pollutants, the RPA identifies the observed maximum effluent concentration (MEC) for each pollutant based on effluent concentration data. There are three triggers in determining Reasonable Potential according to SIP Section 1.3.

(1) The first trigger (Trigger 1) is activated if the MEC is greater than or equal to the lowest applicable WQO (MEC $\geq$ WQO), which has been adjusted, if appropriate, for pH, hardness, and translator data. If the MEC is greater than or equal to the adjusted WQO, then that pollutant has Reasonable Potential, and a WQBEL is required.

(2) The second trigger (Trigger 2) is activated if the observed maximum ambient background concentration (B) is greater than the adjusted WQO (B > WQO), and the pollutant is detected in any of the effluent samples (MEC > ND).

(3) The third trigger (Trigger 3) is activated if a review of other information determines that a WQBEL is required to protect beneficial uses, even though both MEC and B are less than the WQO/WQC.

b. Effluent Data

Each Discharger currently covered under the Fuel General Permit was required to conduct effluent monitoring pursuant to the Self-Monitoring Program for Order No. R2-2006-0075. The Regional Water Board analyzed the Dischargers' priority pollutant data and the nature of the discharges to determine if discharges have Reasonable Potential. Effluent data used to conduct this RPA consisted of data submitted as part of each Fuel General Permit facility's NOI which was combined with data submitted by facilities as part of the NOI application for coverage under the VOC General Permit. The Regional Water Board analyzed effluent quality data collected from 2004 to 2011 for a total of 55 facilities (43 from the VOC General Permit and 12 from the Fuel General Permit) in the San Francisco Bay Region. Effluent monitoring data from three NOIs received after the July 15, 2011, due date were not included in this RPA.

From this analysis, it was concluded that the data for metals would be excluded for use in RPA pursuant to SIP 1.2. The reason is that the metals were detected only occasionally and at low levels likely from natural background in the groundwater.

c. Ambient Background Data

The SIP states that, for calculating WQBELs, ambient background concentrations are either the observed maximum ambient water column concentrations or, for objectives

intended to protect human health from carcinogenic effects, the arithmetic mean of observed ambient water concentrations. Ambient background concentrations are the observed maximum detected water column concentrations for aquatic life protection.

Because the receiving waters for discharges from the facilities covered under this Order are varied, receiving water background concentrations were not considered for this RPA.

d. Reasonable Potential Determination for Priority Pollutants

The MECs and the most stringent applicable WQC used in the RPA are presented in the following table, along with the RPA results (yes or no) for each pollutant. Reasonable Potential was not determined for all pollutants because there are not applicable WQC for all pollutants, or monitoring data are not available for others. Based on a review of the effluent data, the pollutants that demonstrate reasonable potential by Trigger 1 are benzene, bromoform, chlorodibromomethane, 1,2-dichloroethane, 1,1-dichloroethylene, methylene chloride, trichloroethylene, vinyl chloride, and bis(2-ethylhexyl)phthalate.

The Regional Water Board has also determined that Reasonable Potential exists to exceed water quality objectives, by Trigger 3, for the organic pollutants that have been identified as pollutants that are commonly present in VOC and fuel-contaminated groundwater (i.e., those pollutants for which TBELs have been established.) As these TBELs limitations are achievable dependent on the proper design and operation of treatment systems, there is Reasonable Potential for excursions above applicable water quality criteria for these pollutants if the system is not designed or operated correctly.

Total residual chlorine is also identified as a pollutant with Reasonable Potential to exceed the Basin Plan narrative toxicity objective, as determined by Trigger 3. The Regional Water Board has identified that chlorine may be used in conjunction with air stripping and/or activated carbon treatment systems to control biological growth, and therefore Reasonable Potential exists for total residual chlorine for those facilities that use it.

Table F-5. Summary of RPA Results

CTR #	Priority Pollutants	MEC or Minimum DL [1][2] (µg/L)	Governing Applicable Criteria (µg/L)				RPA Results [3]
			Aquatic Life	Human Health			
			(Most stringent of salt and fresh water)	CTR Water + Organisms	Basin Plan Title 22 MCLs	CTR Organisms Only	
1	Antimony	**21**	---	14	6	4300	Ud
2	Arsenic	**140**	36	---	10	---	Ud
3	Beryllium	0.00053	---	---	4	---	Ud
4	Cadmium	0.36	1.1	---	5	---	Ud
5a	Chromium (III)	NA	207	---	50	---	Ud
5b	Chromium (VI)	**14**	11	---	---	---	Ud
6	Copper	**24**	4.7[4]	---	1000	---	Ud

CTR #	Priority Pollutants	MEC or Minimum DL [1][2] (µg/L)	Governing Applicable Criteria (µg/L)				RPA Results [3]
			Aquatic Life	Human Health			
			(Most stringent of salt and fresh water)	CTR Water + Organisms	Basin Plan Title 22 MCLs	CTR Organisms Only	
	Copper	**24**	3.4[5]	---	1000	---	Ud
	Copper	**24**	5.9[6]	---	1000	---	Ud
7	Lead	0.048	3.2	---	---	---	Ud
8	Mercury (303d listed)	0.00082	0.025	0.050	2	0.051	Ud
9	Nickel	**49**	19[7]	610	100	4600	Ud
	Nickel	**49**	13[8]	610	100	4600	Ud
	Nickel	**49**	30[9]	610	100	4600	Ud
10	Selenium (303d listed)	**25**	5.0	---	---	---	Ud
11	Silver	<0.25	2.2	---	---	---	Ud
12	Thallium	**7.3**	---	1.7	2.0	6.3	Ud
13	Zinc	**150**	86	---	5000	---	Ud
14	Cyanide	**30**	2.9[10]	700	150	220,000	Ud
19	**Benzene**	**1.2**	---	1.2	1	71	**Yes**
20	**Bromoform**	**5.2**		4.3	---	360	**Yes**
23	**Chlorodibromomethane**	**2.8**	---	0.401	---	34	**Yes**
26	**Chloroform**	**7.1**	---	No Criteria			**Yes**
28	**1,1-Dichloroethane**	**4.1**	---	---	5	---	**Yes**
29	**1,2-Dichloroethane**	**0.6**	---	0.38	0.5	99	**Yes**
30	**1,1-Dichloroethylene**	**5.7**	---	0.057	6	3.2	**Yes**
33	**Ethylbenzene**	**<0.5**	---	3100	300	29,000	**Yes**
36	**Methylene Chloride**	**23**	---	4.7	5	1600	**Yes**
38	**Tetrachloroethylene**	**25**	---	0.8	5	8.85	**Yes**
39	**Toluene**	**3.07**	---	6800	150	200,000	**Yes**
---	**1,2-Cis-Dichloroethylene**	**20**	---	---	6	---	**Yes**
40	**1,2-Trans-Dichloroethylene**	**4.2**	---	700	10	140,000	**Yes**
41	**1,1,1-Trichloroethane**	**15**	---	---	200	---	**Yes**
42	**1,1,2-Trichloroethane**	**0.5**	---	0.60	5	42	**Yes**
43	**Trichloroethylene**	**460**	---	2.7	5	81	**Yes**
44	**Vinyl Chloride**	**2.1**	---	2	0.5	525	**Yes**
68	**Bis-2(ethylhexyl)phthalate**	100		1.8	4	5.9	**Yes**
70	Butylbenzyl Phthalate	22	---	3000	---	5200	No
---	**Total Xylenes**	**3**	---	---	1750	---	**Yes**
---	**Methyl Tertiary Butyl Ether (MTBE)**	**2.7**	---	---	13	---	**Yes**
---	Total Petroleum Hydrocarbons (TPH)	1600	No Criteria				Ud
---	**Ethylene Dibromide**	**<0.05**	---	---	0.05	---	**Yes**
---	**Trichlorotrifluoroethane**	**5.4**	---	---	1200	---	**Yes**
---	**Total Residual Chlorine[11]**	**NA**	---	---	---	---	**Yes**

Notes for Table F-5:

[1] The Maximum Effluent Concentration (MEC) and maximum background concentration are the actual detected concentrations unless preceded by a "<" sign, in which case the value shown is the minimum detection level (DL).

[2] The MEC or maximum background concentration is "Not Available" (NA) when there are no monitoring data for the constituent.

[3] RPA Results = Yes, if MEC > WQO/WQC, B > WQO/WQC and MEC is detected, or Trigger 3;
= No, if MEC and B are < WQO/WQC or all effluent data are undetected;
= Undetermined (Ud), if no criteria have been promulgated or there are insufficient data. For metals and cyanide, Ud was determined because as noted previously the reported discharge data were excluded for use in RPA pursuant to SIP 1.2. Though the detected levels are high as shown in the MECs above, these were in just a few samples. Metals and cyanide were detected only occasionally and generally at low levels likely from

natural background in the groundwater extracted for cleanup. Because this Order would exclude coverage for sites where there is persistent metals contamination, and the relative small load of background metals to the Bay from all the discharges, a finding of undetermined is appropriate.

[4] Criterion based on the Basin Plan marine SSO for copper, and the site-specific translators (0.53 acute and chronic) for the Lower and South Bay.

[5] Criterion based on the Basin Plan marine SSO for copper, and the site-specific translators (0.87 acute, 0.73 chronic) for the Central Bay.

[6] Criterion based on the Basin Plan marine SSO for copper, and the site-specific translators (0.66 acute, 0.38 chronic) for Suisun and San Pablo Bay.

[7] Criterion based on the Basin Plan marine SSO for nickel and the site-specific translators (0.44 acute and chronic) for the Lower and South Bay.

[8] Criterion based on the Basin Plan marine WQO for nickel, and the site-specific translators (0.85 acute, 0.65 chronic) for the Central Bay.

[9] Criterion based on the Basin Plan marine WQO for nickel, and the site-specific translators (0.57 acute, 0.27 chronic) for Suisun and San Pablo Bay.

[10] Criterion based on the Basin Plan marine SSO for cyanide.

[11] Total Residual Chlorine: The water quality objective applicable to total residual chlorine is the Basin Plan narrative objective for toxicity which states "[a]ll waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms."

e. Constituents with limited data

In some cases, Reasonable Potential cannot be determined because effluent data are limited, or ambient background concentrations are unavailable. When additional data become available, further RPA will be conducted to determine whether numeric effluent limitations are necessary.

f. Pollutants with No Reasonable Potential

WQBELs are not included in this Order for constituents that do not demonstrate Reasonable Potential; however, monitoring for those pollutants is still required. If concentrations of these constituents are found to have increased significantly, the Discharger will be required to investigate the sources of the increases. Remedial measures are required if the increases pose a threat to receiving water quality.

g. RPA Determination for Sediment Quality Objectives

To date there is no evidence directly linking compromised sediment conditions to the discharges subject to this Order; therefore the Regional Water Board cannot draw a conclusion about Reasonable Potential for the discharges to cause or contribute to exceedances of the sediment quality objectives. However, due to the relatively small discharge volumes and the type and level of treatment, it is unlikely that the discharges would contribute to exceedance of sediment objectives.

4. WQBEL Calculations

a. Pollutants with Reasonable Potential. WQBELs were developed for the toxic and priority pollutants that were determined to have Reasonable Potential to cause or contribute to exceedances of the WQOs or WQC. The WQBELs were calculated based on WQOs and the appropriate procedures specified in Section 1.4 of the SIP. The WQOs used for each pollutant with Reasonable Potential are discussed below.

b. Shallow/Deep Water Discharge. The Basin Plan defines a deep water discharge as a discharge through an outfall equipped with a diffuser that achieves a minimum initial dilution of 10:1. Because the General Permit authorizes discharges to many types of receiving waters, Dischargers covered under the General Permit are classified by the

Regional Water Board as shallow water discharges, so that the General Permit is protective under all circumstances.

c. **Dilution Credit.** The General Permit assumes minimal dilution is available for discharges that it authorizes, and therefore no dilution credit is granted in calculating WQBELs. No dilution credit is granted because almost all discharges of treated groundwater regulated under this Order are to storm drain systems that discharge to rivers, creeks, and streams. Many of these creeks and streams are dry during the summer months. Therefore, for a few months of the year, these discharges may represent all or nearly all of the flow in some portions of the receiving creeks or streams. These discharges therefore also have the potential to recharge groundwaterss protected as drinking waters.

d. **Development of WQBELs for Specific Pollutants.** To develop WQBELs for pollutants that demonstrate reasonable potential based on CTR human health criteria (benzene, bromoform, chlorodibromomethane, 1,2-dichloroethane, and bis(2-ethylhexyl)phthalate) , the average monthly effluent limitation (AMEL) is established as the most stringent WQC because the WQC are based on applicable human health criteria. To calculate the maximum daily effluent limitation (MDEL), the AMEL is multiplied by a MDEL/AMEL multiplier of 2.01, which assumes a coefficient of variation (CV) of effluent data of 0.60, because not enough data were available to calculate a CV.

For pollutants with criteria based on Title 22 MCLs (benzene, vinyl chloride), where the MUN designation is applicable to the receiving water, MDELs are set equal to the MCL, because the MCLs are levels that shall not be exceeded in the receiving water, and no credit for dilution is granted.

WQBELs for total residual chlorine are based in Table 4-2 of the Basin Plan.

For the CTR metals and cyanide, WQBELs are not being established at this time. Instead, trigger values will be set for these inorganic pollutants as a backstop to ensuring that sites with metals or cyanide contamination are appropriately identified and addressed. Exceedance of these trigger values in the discharge would trigger actions specified Provision VI.C.6, which if warranted may also lead to termination of discharge authorization under this Order.

Table F-6. Summary of WQBELs

No.	Compound	Discharge to Receiving Waters used as Drinking Water Source[1]		Discharge to Other Receiving Waters	
		AMEL (µg/L)	MDEL (µg/L)	AMEL (µg/L)	MDEL (µg/L)
1	Benzene	---	1	71	142
2	Carbon Tetrachloride	0.25	0.5	4.4	8.8
3	Chloroform	---	---	---	---
4	1,1-Dichloroethane	---	5	---	---

No.	Compound	Discharge to Receiving Waters used as Drinking Water Source[1]		Discharge to Other Receiving Waters	
		AMEL (µg/L)	MDEL (µg/L)	AMEL (µg/L)	MDEL (µg/L)
5	1,2-Dichloroethane	0.38	0.5	99	199
6	1,1-Dichloroethylene	0.057	0.11	3.2	6.4
7	Ethylbenzene	---	300	29,000	58,000
8	Methylene Chloride	4.7	9.4	1600	3200
9	Tetrachloroethylene	0.8	1.6	8.85	17.8
10	Toluene	---	150	200,000	400,000
11	Cis-1,2-Dichloroethylene	---	6	---	---
12	Trans-1,2-Dichloroethylene	---	10	140,000	280,000
13	1,1,1-Trichloroethane	---	200	---	---
14	1,1,2-Trichloroethane	0.60	1.2	42	84
15	Trichloroethylene	2.7	5.4	81	160
16	Vinyl Chloride	---	0.5	525	1060
17	Total Xylenes	---	1750	---	---
18	Methyl Tertiary Butyl Ether (MTBE)	---	13	---	---
19	Total Petroleum Hydrocarbons (TPH)	---	---	---	---
20	Ethylene Dibromide (1,2-Dibromoethane)	---	0.05	---	---
21	Trichlorotrifluoroethane	---	1200	---	---
22	Total Residual Chlorine[2]	---	0.0	---	0.0

Notes for Table F-6:

[1] Receiving waters which are sources of drinking water are surface waters with the existing or potential beneficial use of Municipal and Domestic Supply, and/or Groundwater Recharge.

[2] The total residual chlorine requirement is defined as below the limit of detection in standard test methods defined in the latest USEPA approved edition of *Standard Methods for the Examination of Waste and Wastewater*.

5. Whole Effluent Toxicity (WET)

The Basin Plan requires dischargers to either conduct flow-through effluent toxicity tests or perform static renewal bioassays (Chapter 4, Acute Toxicity) to measure the toxicity of wastewaters and to assess negative impacts upon water quality and beneficial uses caused by the aggregate toxic effect of the discharge of pollutants. This Order retains the effluent limitation for whole effluent acute toxicity. Compliance evaluation with these limitations is based on 96-hour static-renewal bioassays. All bioassays shall be performed according to the USEPA-approved method in 40 CFR Part 136, currently *"Methods for Measuring the Acute Toxicity of Effluents and Receiving Water, 5th Edition."*

6. Final Effluent Limitations

The following table presents a summary of final effluent limitations for toxic pollutants established by this Order. The most stringent of the TBELs and WQBELs are established by the Order as final effluent limitations. For pollutants where the WQBEL is more stringent than the

TBEL, average monthly and maximum daily effluent limitations have been established, which is consistent with the SIP. When the TBEL is limiting, only an MDEL is established. For pollutants where the analytical detection limit is higher than the effluent limitation, the Regional Water Board shall deem a discharge out of compliance if the sample result is greater than the detection limit.

In summary, the effluent limitations contained in the previously issued Fuel and VOC General Permits (Regional Water Board Order Nos. R2-2006-0075 and R2-2009-0059) were the same except the residual chlorine effluent limit in the VOC General NPDES permit, which has been continued into this Order as summarized in Table F-7.

Table F-7. Summary of Final Effluent Limitations

No.	Compound	Discharge to Receiving Waters used as Drinking Water Source[1]		Discharge to Other Receiving Waters	
		AMEL (µg/L)	MDEL (µg/L)	AMEL (µg/L)	MDEL (µg/L)
1	Benzene	---	1	---	5
2	Carbon Tetrachloride	0.25	0.5	4.4	5
3	Chloroform	---	5	---	5
4	1,1-Dichloroethane	---	5	---	5
5	1,2-Dichloroethane	0.38	0.5	---	5
6	1,1-Dichloroethylene	0.057	0.11	3.2	5
7	Ethylbenzene	---	5	---	5
8	Methylene Chloride	4.7	5	---	5
9	Tetrachloroethylene	0.8	1.6	---	5
10	Toluene	---	5	---	5
11	Cis-1,2-Dichloroethylene	---	5	---	5
12	Trans-1,2-Dichloroethylene	---	5	---	5
13	1,1,1-Trichloroethane	---	5	---	5
14	1,1,2-Trichloroethane	0.60	1.2	---	5
15	Trichloroethylene	2.7	5	---	5
16	Vinyl Chloride	---	0.5	---	1
17	Total Xylenes	---	5	---	5
18	Methyl Tertiary Butyl Ether (MTBE)	---	5	---	5
19	Total Petroleum Hydrocarbons (TPH)	---	50	---	50
20	Ethylene Dibromide (1,2-Dibromoethane)	---	0.05	---	5
21	Trichlorotrifluoroethane	---	5	---	5
22	Total Residual Chlorine[2]	---	0.0	---	0.0

Notes:
[1] Receiving waters which are sources of drinking water are surface waters with the existing or potential beneficial use of Municipal and Domestic Supply, and/or Groundwater Recharge.
[2] Limitation defined as below the limit of detection using standard test methods defined in the latest USEPA approved edition of *Standard Methods for the Examination of Waste and Wastewater*

7. Anti-backsliding and Antidegradation

Effluent limitations in this Order comply with anti-backsliding and antidegradation requirements because all effluent limitations are as least as stringent as the limitations contained in the previously issued Fuel and VOC General Permits.

E. Reclamation Specifications

Reclamation or Reuse Specifications are retained from the previously issued Fuel and VOC General Permits. Reclamation specifications are required because reuse of treated groundwater is a preferred method of disposal. The basis for these requirements is Resolution No. 88-160.

V. RATIONALE FOR RECEIVING WATER LIMITATIONS

A. Surface Water Limitations

Receiving water limitations V.A.1 and V.A.2 are based on narrative and numeric WQOs in Basin Plan Chapter 3.

Receiving water limitation V.A.3 is a more general requirement intended to protect receiving water quality based on water quality standards not expressly addressed in this Order and Fact Sheet. It is retained from the previously issued Fuel and VOC permits and requires compliance with all federal and State water quality standards established pursuant to the CWA.

B. Groundwater Limitations

Groundwater limitations are in section 3.4 of the Basin Plan.

VI. RATIONALE FOR MONITORING AND REPORTING REQUIREMENTS

NPDES regulations at 40 CFR 122.48 require that all NPDES permits specify monitoring and reporting requirements. California Water Code (CWC) sections 13267 and 13383 also authorize the Regional Water Board to require technical and monitoring reports. This Monitoring and Reporting Program establishes monitoring and reporting requirements that implement federal and State regulations.

The principal purposes of a monitoring program are to:

- Document compliance with waste discharge requirements and prohibitions established by the Regional Water Board,
- Facilitate self-policing by the Discharger in the prevention and abatement of pollution arising from waste discharge,
- Develop or assist in the development of limitations, discharge prohibitions, national standards of performance, pretreatment and toxicity standards, and other standards, and

- Prepare water and wastewater quality inventories.

The Monitoring and Reporting Program is a standard requirement in almost all NPDES permits issued by the Regional Water Board, including this Order. It contains definitions of terms and sets out requirements for reporting of routine monitoring data in accordance with NPDES regulations, the CWC, and State and Regional Water Board policies. The Monitoring and Reporting Program also defines the sampling stations and frequency, the pollutants to be monitored, and additional reporting requirements. Pollutants to be monitored include all parameters for which effluent limitations are specified. Monitoring for additional constituents, for which no effluent limitations are established, is also required to provide data for future completion of RPAs.

The following provides the rationale for the monitoring and reporting requirements contained in the Monitoring and Reporting Program for this facility.

A. Influent Monitoring

The purpose of influent monitoring is to provide documentation that pollutant loadings are below the level that the treatment system was designed for and to provide a warning if one or more new pollutants are being extracted that the as-built treatment system was not designed to remove. All influent monitoring requirements are retained from the previous Fuel General Permit and the VOC General Permit. If there is a discrepancy in monitoring frequency between the two General Permits, the more frequent requirement was retained.

B. Effluent Monitoring

The purpose of effluent monitoring is to provide documentation that the treatment system adequately removed all pollutants of concern in compliance with the limitations contained in the Order. Effluent monitoring data can also indicate if one or more pollutants are detected at levels less than effluent limits, but greater than trigger levels, which may indicate poor maintenance or other unexpected problems. All effluent monitoring requirements are retained from the previous Fuel General Permit and the VOC General Permit. If there is a discrepancy in monitoring frequency between the two General Permits, the more frequent requirement was retained.

C. Whole Effluent Toxicity Testing Requirements

The selected test species and frequency of testing are the same as previously issued Fuel and VOC General Permits and appropriately cost effective for the Dischargers covered under this Order.

D. Receiving Water Monitoring

The purpose of receiving water monitoring is to provide documentation about the condition of the receiving water should any effluent limit violations occur that may harm the life in the receiving water. The receiving water monitoring frequency is the same as previously issued Fuel and VOC General Permits.

E. Other Monitoring Requirements

The purpose of additional monitoring requirements is to investigate complaints, identify the discharges that should be regulated by individual NPDES permits, coordinate stormwater monitoring with municipalities, and quantify potential impacts of extracted and treated groundwater discharge on the receiving water and the ambient conditions of the receiving waters.

F. Reporting Requirements

Reporting requirements are included in the Monitoring and Reporting Program. The reporting requirements establish requirements for report submittal format.

VII. RATIONALE FOR PROVISIONS

A. Standard Provisions (Provision VI.A)

Standard Provisions, which in accordance with 40 CFR 122.41and 122.42 apply to all NPDES discharges and must be included in every NPDES permit, are provided in Attachments D of this Order. 40 CFR 122.41(a)(1) and (b) through (n) establish conditions that apply to all state-issued NPDES permits. These conditions must be incorporated into the permits either expressly or by reference. 40 CFR 123.25(a)(12) allows the state to omit or modify conditions to impose more stringent requirements. In accordance with 40 CFR 123.25, this Order omits federal conditions that address enforcement authority specified in 40 CFR 122.41(j)(5) and (k)(2) because the CWC enforcement authority is more stringent. In lieu of these conditions, this Order incorporates by reference CWC section 13387(e).

B. Monitoring and Reporting Program Requirements (Provision VI.B)

The Discharger is required to monitor the permitted discharge in order to evaluate compliance with permit conditions. Monitoring requirements are contained in the Monitoring and Reporting Program (Attachment E), and Standard Provisions (Attachment D). This provision requires compliance with these documents and is authorized by 40 CFR 122.41(h) and (j), and CWC sections 13267 and 13383.

C. Special Provisions (Provision VI.C)

1. **Reopener Provisions.** These reopener provisions are based on 40 CFR 122.63 and allow modification of this Order and its effluent limitations as necessary in response to updated WQOs, regulations, or other new relevant information that may be established in the future and other circumstances allowed by law.

2. **Notice of Intent (NOI) Application.** Provision VI.C.2, Notice of Intent (NOI) Application, is based on 40 CFR 122.28(b).

3. **NOI Review.** Provision VI.C.3, NOI Review, is based on 40 CFR 122.28(b).

4. **Discharge Authorization.** Provision VI.C.4, Discharge Authorization, is based on 40 CFR 122.28(b).

5. **Non-Compliance is a Violation.** Provision VI.C.5, Non-Compliance is a Violation, is based on 40 CFR 122.41(a).

6. **Triggers.** Dischargers authorized under this Order are expected to use BAT and treat their fuel or VOC pollutants to non-detectable levels. Some compounds other than pollutants with

effluent limitations may be detected in the effluent of some of the treatment systems, however. These pollutants include both organic and inorganic compounds. The purpose of these provisions is to require Dischargers to do additional activities should any pollutants exceed the triggers in Table F-8. These triggers are not effluent limitations, and must not be construed as such. Instead, they are levels at which additional investigation is warranted to determine whether a numeric limit for a particular constituent is necessary. Unless explained in a note, the concentration-based triggers in Table F-8 are set at the minimum applicable criterion, as determined from State MCLs, federal MCLs, CTR criteria, or Basin Plan WQOs. The reason for this approach is explained in section IV of this Fact Sheet, and further explained below.

a. **Triggers for Inorganic Compounds.** Antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, and zinc (hereinafter called inorganic compounds) are present in fuel- or VOC-cleanup discharges, primarily due to background concentrations in the shallow groundwater being remediated. The discharge volume and concentrations of inorganic compounds concentrations in the effluent are relatively low. The Regional Water Board has concluded that Bay-wide inorganic compounds loading from fuel- or VOC-cleanup discharges represent a very small portion of total inorganic compounds loadings from sources within the Region (including municipal and industrial point source discharges and stormwater discharges), and, therefore, shall cause no impairment of beneficial uses or potential exceedances of inorganic compounds objectives in receiving waters.

   Facilities where inorganic compounds have adversely impacted groundwater are not eligible for coverage under this Order. Each Discharger shall submit, as part of the NOI application for proposed discharge, analytical results including inorganic compounds concentrations in the influent and effluent, if available, or maximum concentrations in any individual extraction wells, if not operating yet. Based on these data, the Discharger may receive a discharge authorization letter. In some cases after starting up an extraction and treatment system, the effluent concentration of some inorganic compounds may exceed the triggers listed in Table F-8. In this case, the Discharger shall take three additional samples and have them analyzed for the inorganic compound of concern and comply with the Provisions VI.C.7, VI.C.8, or VI.C.9.

   Triggers for copper and nickel have been updated in the General Permit from the previous Fuel General Permit to reflect the recently adopted SSOs and SSTs for copper throughout San Francisco Bay, and the SSOs and SSTs for nickel in the South Bay.

b. **Triggers for Organic Compounds.** Dischargers authorized under this Order are expected to use BAT and treat their VOC pollutants to non-detectable levels. Sites where pesticides or other conservative pollutants have adversely impacted groundwater are not eligible for coverage under this Order. Each Discharger shall submit, as part of the NOI application for proposed discharge, analytical results including volatile and semi-volatile organic compounds concentrations in the influent and effluent if available or maximum concentrations in any individual extraction wells, if not operating yet. In addition, each Discharger shall submit a report, to the satisfaction of Executive Officer, certifying the

adequacy of the proposed treatment system in removal of all organic pollutants of concern. Based on these data and information, the Discharger may receive a discharge authorization letter. However, some organic compounds, other than pollutants with effluent limitations, may be detected in the effluent of some of the treatment systems. This could be due to the movement of the contaminated groundwater from a neighboring site into the capture zone of the treatment facility authorized under this permit. Table F-8 contains concentration-based triggers for conducting additional activities for a list of pollutants reported by Dischargers or listed in the CTR. This provision would allow Dischargers to continue groundwater cleanup while investigating the ability to treat any detected volatile or semi-volatile organic compounds, in excess of Table F-8 triggers.

Table F-8. Basis for Table 3 Trigger Compounds

Pollutant	CAS Number	Minimum State/Federal MCL (µg/L)	Minimum Basin Plan Criteria[1] (µg/L)	Minimum CTR Criteria[1] (µg/L)	Trigger[1][7] (µg/L)
Antimony	7440360	6	---	14	6
Arsenic	7440382	10	36	36	10
Beryllium	7440417	4	---	---	4
Cadmium	7440439	5	1.1	2.5	1.1
Chromium (VI)	18540299	---	11	11	11[2]
Copper[3]	7440508	1000	5.9	---	5.9
Copper[4]	7440508	1000	3.4	---	3.4
Copper[5]	7440508	1000	4.7	---	4.7
Lead	7439921	15	3.2	3.2	3.2
Mercury	7439976	2	0.025	0.050	0.025
Nickel[3]	7440020	100	30	30	30
Nickel[4]	7440020	100	13	13	13
Nickel[5]	7440020	100	19	19	19
Selenium	7782492	50	---	5	5
Silver	7440224	100	2.2	2.2	2.2
Thallium	7440280	2	---	1.7	1.7
Zinc	7440666	5000	86	86	86
Cyanide	57125	150	2.9	5.2	2.9
2,3,7,8-TCDD	1746016	0.00003	---	1.3E-08	1.3E-08
Acrylonitrile	107131	---	---	0.059	0.059
Bromoform	75252	80	---	4.3	4.3
Chlorodibromomethane	124481	80	---	0.401	0.401
Dichlorobromomethane	75274	80	---	0.56	0.56
1,2-Dichloropropane	78875	5	---	0.52	0.52
1,3-Dichloropropylene	542756	0.5	---	10	0.5
1,1,2,2-Tetrachloroethane	79345	1	---	0.17	0.17
Pentachlorophenol	87865	1	---	0.28	0.28
2,4,6-Trichlorophenol	88062	---	---	2.1	2.1
Benzidine	92875	---	---	0.00012	0.00012
Benzo(a)anthracene	56553	---	---	0.0044	0.0044
Benzo(a)pyrene	50328	0.2	---	0.0044	0.0044
Benzo(b)fluoranthene	205992	---	---	0.0044	0.0044
Benzo(k)fluoranthene	207089	---	---	0.0044	0.0044
Bis(2-chloroethyl)ether	111444	---	---	0.031	0.031
Bis(2-ethylhexyl)phthalate	117817	---	---	1.8	1.8
Chrysene	218019	---	---	0.0044	0.044

Pollutant	CAS Number	Minimum State/Federal MCL (µg/L)	Minimum Basin Plan Criteria[1] (µg/L)	Minimum CTR Criteria[1] (µg/L)	Trigger[1][7] (µg/L)
Dibenzo(a,h)anthracene	53703	---	---	0.0044	0.0044
3,3'-Dichlorobenzidine	91941	---	---	0.04	0.04
2,4-Dinitrotoluene	121142	---	---	0.11	0.11
1,2-Diphenylhydrazine	122667	---	---	0.040	0.040
Hexachlorobenzene	118741	1	---	0.00075	0.00075
Hexachlorobutadiene	87683	---	---	0.44	0.44
Hexachloroethane	67721	---	---	1.9	1.9
Indeno(1,2,3-c,d)pyrene	193395	---	---	0.0044	0.0044
N-nitrosodimethylamine	62759	---	---	0.00069	0.00069
N-nitrosodi-n-propylamine	621647	---	---	0.005	0.005
Aldrin	309002	---	---	0.00013	0.00013
alpha-BHC	319846	---	---	0.0039	0.0039
beta-BHC	319857	---	---	0.014	0.014
gamma-BHC	58899	0.2	---	0.019	0.019
Chlordane	57749	0.1	---	0.00057	0.00057
4,4-DDT	50393	---	---	0.00059	0.00059
4,4-DDE	72559	---	---	0.00059	0.00059
4,4-DDD	72548	---	---	0.00083	0.00083
Dieldrin	60571	---	---	0.00014	0.00014
alpha-Endosulfan	959988	---	---	0.0087	0.0087
beta-Endosulfan	33213659	---	---	0.0087	0.0087
Endrin	72208	2	---	0.0023	0.0023
Endrin aldehyde	7421934	---	---	0.76	0.76
Heptachlor	76448	0.01	---	0.00021	0.00021
Heptachlor epoxide	1024573	0.01	---	0.00010	0.00010
PCBs, sum	1336363	0.5	---	0.00017	0.00017
Toxaphene	8001352	3	---	0.0002	0.0002
1,4-dioxane	123911	3	---	---	3
Turbidity (NTU)	---	5	---	---	5
Odor-Threshold (Units)	---	3	---	---	3
TPHs (other than gasoline and diesel)	---	---	---	---	50[6]
Sulfate	---	250,000	---	---	250,000
Foaming agents	---	500	---	---	500
Color (units)	---	15	---	---	15

Notes for Table F-8:
[1] Unit is µg/L unless noted otherwise right after the name of pollutant
[2] If total chromium concentration exceeds 11 µg/L, then analysis for chromium(VI) shall also be conducted
[3] Applicable to Suisun Bay and San Pablo Bay segments of San Francisco Bay.
[4] Applicable to Central Bay and Lower Bay segments of San Francisco Bay.
[5] Applicable to South San Francisco Bay, south of Hayward Shoals.
[6] Trigger value based on Regional Water Board staff BPJ. If a discharger is reporting monitoring data with a detection level higher than 50 µg/L, the reason for the higher detection level shall be fully explained within the monitoring report.
[7] If a discharger is reporting non-detect monitoring data with a reporting level higher than the trigger, the reason for the higher detection level shall be consistent with the SIP Appendix 4 required minimum levels (please refer to our web site for the latest version of SIP) and must be explained within the monitoring report.

8. **Individual NPDES Permit May Be Required.** Provision VI.C.11 is retained from the previously issued Fuel and VOC General Permits and is based on 40 CFR 122.28(b)(3).

9. **Treatment Reliability Requirement.** Provision VI.C.12, Treatment Reliability, is mostly based on 40 CFR 122.41. The basis for the requirement for a certified engineer to oversee the treatment and operation of the treatment system is to ensure that qualified professionals perform this work. Service stations operators are generally not qualified for this technical level of oversight.

VIII. PUBLIC PARTICIPATION

The Regional Water Board is considering the reissuance of general waste discharge requirements (GWDRs) that will serve as a General NPDES Permit. As a step in the GWDRs adoption process, the Regional Water Board has developed tentative GWDRs. The Regional Water Board encourages public participation in the GWDR adoption process.

A. Notification of Interested Parties

The Regional Water Board has notified the Dischargers and interested agencies and persons of its intent to prescribe GWDRs for the discharge and has provided them with an opportunity to submit their written comments and recommendations. Notification was provided through the Recorder on December 12, 2011.

B. Written Comments

Staff determinations are tentative. Interested persons are invited to submit written comments concerning this Order. Comments should be submitted either in person or by mail to the Executive Officer at the Regional Water Board at the address above on the cover page of this Order.

To be fully responded to by staff and considered by the Regional Water Board, written comments should be received at the Regional Water Board offices by 5:00 p.m. on January 12, 2012**.**

C. Public Hearing

The Regional Water Board will hold a public hearing on the tentative WDRs during its regular Board meeting on the following date and time and at the following location:

Date:	February 8, 2012
Time:	9:00 a.m.
Location:	Elihu Harris State Building (1st Floor auditorium) 1515 Clay Street (Walking distance from City Center 12th Street BART station) Oakland, CA 94612

Interested persons are invited to attend. At the public hearing, the Regional Water Board will hear testimony, if any, pertinent to the discharge, GWDRs, and permit. Oral testimony will be heard; however, for accuracy of the record, important testimony should be in writing.

Please be aware that dates and venues may change. Our web address is http://www.waterboards.ca.gov/sanfranciscobay where you can access the current agenda for changes in dates and locations.

D. Waste Discharge Requirements Petitions

Any aggrieved person may petition the State Water Resources Control Board to review the decision of the Regional Water Board regarding the final GWDRs. The petition must be submitted within 30 days of the Regional Water Board's action to the following address:

State Water Resources Control Board
Office of Chief Counsel
P.O. Box 100, 1001 I Street
Sacramento, CA 95812-0100

E. Information and Copying

Report of Waste Discharges, related documents, tentative effluent limitations and special provisions, comments received, and other information are on file and may be inspected at the address above during regular office hours, which are generally weekdays from 8:00 a.m. to 5:00 p.m., excluding 12:00 p.m. to 1:00 p.m. lunch hours and holidays. Copying of documents may be arranged through the Regional Water Board by calling (510) 622-2300.

F. Register of Interested Persons

Any person interested in being placed on the mailing list for information regarding the GWDRs and NPDES permit should contact the Regional Water Board, reference this facility, and provide a name, address, and phone number.

G. Additional Information

Requests for additional information or questions regarding this order should be directed to **Farhad Azimzadeh at (510) 622-2310 or by e-mail at fazimzadeh@waterboards.ca.gov.**

Appendix D Water Quality Objectives from Water Quality Control Plan (Basin Plan) for San Francisco Bay Region

CHAPTER 3: WATER QUALITY OBJECTIVES

The overall goals of water quality regulation are to protect and maintain thriving aquatic ecosystems and the resources those systems provide to society and to accomplish these in an economically and socially sound manner. California's regulatory framework uses water quality objectives both to define appropriate levels of environmental quality and to control activities that can adversely affect aquatic systems.

3.1 WATER QUALITY OBJECTIVES

There are two types of objectives: narrative and numerical. Narrative objectives present general descriptions of water quality that must be attained through pollutant control measures and watershed management. They also serve as the basis for the development of detailed numerical objectives.

Historically, numerical objectives were developed primarily to limit the adverse effect of pollutants in the water column. Two decades of regulatory experience and extensive research in environmental science have demonstrated that beneficial uses are not fully protected unless pollutant levels in all parts of the aquatic system are also monitored and controlled. The Regional Board is actively working towards an integrated set of objectives, including numerical sediment objectives, that will ensure the protection of all current and potential beneficial uses.

Numerical objectives typically describe pollutant concentrations, physical/chemical conditions of the water itself, and the toxicity of the water to aquatic organisms. These objectives are designed to represent the maximum amount of pollutants that can remain in the water column without causing any adverse effect on organisms using the aquatic system as habitat, on people consuming those organisms or water, and on other current or potential beneficial uses (as described in Chapter 2).

The technical bases of the region's water quality objectives include extensive biological, chemical, and physical partitioning information reported in the scientific literature, national water quality criteria, studies conducted by other agencies, and information gained from local environmental and discharge monitoring (as described in Chapter 6). The Regional Board recognizes that limited information exists in some cases, making it difficult to establish definitive numerical objectives, but the Regional Board believes its conservative approach to setting objectives has been proper. In addition to the technical review, the overall feasibility of reaching objectives in terms of technological, institutional, economic, and administrative factors is considered at many different stages of objective derivation and implementation of the water quality control plan.

Together, the narrative and numerical objectives define the level of water quality that shall be maintained within the region. In instances where water quality is better than that prescribed by the objectives, the state Antidegradation Policy applies (State Board Resolution 68-16: Statement of Policy With Respect to Maintaining High Quality of Waters in California). This policy is aimed at protecting relatively uncontaminated aquatic systems where they exist and preventing further degradation. The state's Antidegradation Policy is consistent with the federal Antidegradation Policy, as interpreted by the State Water Resources Control Board in State Board Order No. 86-17.

When uncontrollable water quality factors result in the degradation of water quality beyond the levels or limits established herein as water quality objectives, the Regional Board will conduct a case-by-case analysis of the benefits and costs of preventing further degradation. In cases where this analysis indicates that beneficial uses will be adversely impacted by allowing further degradation, then the Regional Board will not allow controllable water quality factors to cause any further degradation of water quality. Controllable water quality factors are those actions, conditions, or circumstances resulting from human activities that may influence the quality of the waters of the state and that may be reasonably controlled.

The Regional Board establishes and enforces waste discharge requirements for point and nonpoint source of pollutants at levels necessary to meet numerical and narrative water quality objectives. In setting waste discharge requirements, the Regional Board will consider, among other things, the potential impact on beneficial uses within the area of influence of the discharge, the existing quality of receiving waters, and the appropriate water quality objectives.

In general, the objectives are intended to govern the concentration of pollutant constituents in the main water mass. The same objectives cannot be applied at or immediately adjacent to submerged effluent discharge structures. Zones of initial dilution within which higher concentrations can be tolerated will be allowed for such discharges.

For a submerged buoyant discharge, characteristic of most municipal and industrial wastes that are released from submerged outfalls, the momentum of the discharge and its initial buoyancy act together to produce turbulent mixing. Initial dilution in this case is completed when the diluting wastewater ceases to rise in the water column and first begins to spread horizontally.

For shallow water submerged discharges, surface discharges, and nonbuoyant discharges, characteristic of cooling water wastes and some individual discharges, turbulent mixing results primarily from the momentum of discharge. Initial dilution, in these cases, is considered to be completed when the momentum-induced velocity of the discharge ceases to produce significant mixing of the waste, or the diluting plume reaches a fixed distance from the discharge to be specified by the Regional Board, whichever results in the lower estimate for initial dilution.

Compliance with water quality objectives may be prohibitively expensive or technically impossible in some cases. The Regional Board will consider modification of specific water quality objectives as long as the discharger can demonstrate that the alternate objective will protect existing beneficial uses, is scientifically defensible, and is consistent with the state Antidegradation Policy. This exception clause properly indicates that the Regional Board will conservatively compare benefits and costs in these cases because of the difficulty in quantifying beneficial uses.

These water quality objectives are considered necessary to protect the present and potential beneficial uses described in Chapter 2 of this Plan and to protect existing high quality waters of the state. These objectives will be achieved primarily through establishing and enforcing waste discharge requirements and by implementing this water quality control plan.

3.2 OBJECTIVES FOR OCEAN WATERS

The provisions of the State Board's "Water Quality Control Plan for Ocean Waters of California" (Ocean Plan) and "Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California" (Thermal Plan) and any revision to them will apply to ocean waters. These plans describe objectives and effluent limitations for ocean waters.

3.3 OBJECTIVES FOR SURFACE WATERS

The following objectives apply to all surface waters within the region, except the Pacific Ocean.

3.3.1 BACTERIA

Table 3-1 provides a summary of the bacterial water quality objectives and identifies the sources of those objectives. Table 3-2 summarizes U.S. EPA's water quality criteria for water contact recreation based on the frequency of use a particular area receives. These criteria will be used to differentiate between pollution sources or to supplement objectives for water contact recreation.

3.3.2 BIOACCUMULATION

Many pollutants can accumulate on particles, in sediment, or bioaccumulate in fish and other aquatic organisms. Controllable water quality factors shall not cause a detrimental increase in concentrations of toxic substances found in bottom sediments or aquatic life. Effects on aquatic organisms, wildlife, and human health will be considered.

3.3.3 BIOSTIMULATORY SUBSTANCES

Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses. Changes in chlorophyll a and associated phytoplankton communities follow complex dynamics that are sometimes associated with a discharge of biostimulatory substances. Irregular and extreme levels of chlorophyll a or phytoplankton blooms may indicate exceedance of this objective and require investigation.

3.3.4 COLOR

Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses.

3.3.5 DISSOLVED OXYGEN

For all tidal waters, the following objectives shall apply:

In the Bay:

Downstream of Carquinez Bridge	5.0 mg/l minimum
Upstream of Carquinez Bridge	7.0 mg/l minimum

For nontidal waters, the following objectives shall apply:

Waters designated as:

Cold water habitat	7.0 mg/l minimum
Warm water habitat	5.0 mg/l minimum

The median dissolved oxygen concentration for any three consecutive months shall not be less than 80 percent of the dissolved oxygen content at saturation.

Dissolved oxygen is a general index of the state of the health of receiving waters. Although minimum concentrations of 5 mg/l and 7 mg/l are frequently used as objectives to protect fish life, higher concentrations are generally desirable to protect sensitive aquatic forms. In areas unaffected by waste discharges, a level of about 85 percent of oxygen saturation exists. A three-month median objective of 80 percent of oxygen saturation allows for some degradation from this level, but still requires a consistently high oxygen content in the receiving water.

3.3.6 FLOATING MATERIAL

Waters shall not contain floating material, including solids, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses.

3.3.7 OIL AND GREASE

Waters shall not contain oils, greases, waxes, or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water, that cause nuisance, or that otherwise adversely affect beneficial uses.

3.3.8 POPULATION AND COMMUNITY ECOLOGY

All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce significant alterations in population or community ecology or receiving water biota. In addition, the health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ significantly from those for the same waters in areas unaffected by controllable water quality factors.

3.3.9 pH

The pH shall not be depressed below 6.5 nor raised above 8.5. This encompasses the pH range usually found in waters within the basin. Controllable water quality factors shall not cause changes greater than 0.5 units in normal ambient pH levels.

3.3.10 RADIOACTIVITY

Radionuclides shall not be present in concentrations that result in the accumulation of radionuclides in the food web to an extent that presents a hazard to human, plant, animal, or aquatic life. Waters designated for use as domestic or municipal supply shall not contain concentrations of radionuclides in excess of the limits specified in Table 4 of Section 64443 (Radioactivity) of Title 22 of the California Code of Regulations (CCR), which is incorporated by reference into this Plan. This incorporation is prospective, including future changes to the incorporated provisions as the changes take effect (see Table 3-5).

3.3.11 SALINITY

Controllable water quality factors shall not increase the total dissolved solids or salinity of waters of the state so as to adversely affect beneficial uses, particularly fish migration and estuarine habitat.

3.3.12 SEDIMENT

The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

Controllable water quality factors shall not cause a detrimental increase in the concentrations of toxic pollutants in sediments or aquatic life.

3.3.13 SETTLEABLE MATERIAL

Waters shall not contain substances in concentrations that result in the deposition of material that cause nuisance or adversely affect beneficial uses.

3.3.14 SUSPENDED MATERIAL

Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.

3.3.15 SULFIDE

All water shall be free from dissolved sulfide concentrations above natural background levels. Sulfide occurs in Bay muds as a result of bacterial action on organic matter in an anaerobic environment.

Concentrations of only a few hundredths of a milligram per liter can cause a noticeable odor or be toxic to aquatic life. Violation of the sulfide objective will reflect violation of dissolved oxygen objectives as sulfides cannot exist to a significant degree in an oxygenated environment.

3.3.16 TASTES AND ODORS

Waters shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin, that cause nuisance, or that adversely affect beneficial uses.

3.3.17 TEMPERATURE

Temperature objectives for enclosed bays and estuaries are as specified in the "Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California," including any revisions to the plan.

In addition, the following temperature objectives apply to surface waters:

- The natural receiving water temperature of inland surface waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses.
- The temperature of any cold or warm freshwater habitat shall not be increased by more than 5°F (2.8°C) above natural receiving water temperature

3.3.18 TOXICITY

All waters shall be maintained free of toxic substances in concentrations that are lethal to or that produce other detrimental responses in aquatic organisms. Detrimental responses include, but are not limited to, decreased growth rate and decreased reproductive success of resident or indicator species. There shall be no acute toxicity in ambient waters. Acute toxicity is defined as a median of less than 90 percent survival, or less than 70 percent survival, 10 percent of the time, of test organisms in a 96-hour static or continuous flow test.

There shall be no chronic toxicity in ambient waters. Chronic toxicity is a detrimental biological effect on growth rate, reproduction, fertilization success, larval development, population abundance, community composition, or any other relevant measure of the health of an organism, population, or community.

Attainment of this objective will be determined by analyses of indicator organisms, species diversity, population density, growth anomalies, or toxicity tests (including those described in Chapter 4), or other methods selected by the Water Board. The Water Board will also consider other relevant information and numeric criteria and guidelines for toxic substances developed by other agencies as appropriate.

The health and life history characteristics of aquatic organisms in waters affected by controllable water quality factors shall not differ significantly from those for the same waters in areas unaffected by controllable water quality factors.

3.3.19 TURBIDITY

Waters shall be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. Increases from normal background light penetration or turbidity relatable to waste discharge shall not be greater than 10 percent in areas where natural turbidity is greater than 50 NTU.

3.3.20 UN-IONIZED AMMONIA

The discharge of wastes shall not cause receiving waters to contain concentrations of un-ionized ammonia in excess of the following limits (in mg/l as N):

Annual Median	0.025
Maximum, Central Bay (as depicted in Figure 2-5) and upstream	0.16
Maximum, Lower Bay (as depicted in Figures 2-6 and 2-7):	0.4

The intent of this objective is to protect against the chronic toxic effects of ammonia in the receiving waters. An ammonia objective is needed for the following reasons:

- Ammonia (specifically un-ionized ammonia) is a demonstrated toxicant. Ammonia is generally accepted as one of the principle toxicants in municipal waste discharges. Some industries also discharge significant quantities of ammonia.
- Exceptions to the effluent toxicity limitations in Chapter 4 of the Plan allow for the discharge of ammonia in toxic amounts. In most instances, ammonia will be diluted or degraded to a nontoxic state fairly rapidly. However, this does not occur in all cases, the South Bay being a notable example. The ammonia limit is recommended in order to preclude any build up of ammonia in the receiving water.
- A more stringent maximum objective is desirable for the northern reach of the Bay for the protection of the migratory corridor running through Central Bay, San Pablo Bay, and upstream reaches.

3.3.21 OBJECTIVES FOR SPECIFIC CHEMICAL CONSTITUENTS

Surface waters shall not contain concentrations of chemical constituents in amounts that adversely affect any designated beneficial use. Water quality objectives for selected toxic pollutants for surface waters are given in Tables 3-3, 3-3A, 3-3B, 3-3C, 3-4 and 3-4A.

The Water Board intends to work towards the derivation of site-specific objectives for the Bay-Delta estuarine system. Site-specific objectives to be considered by the Water Board shall be developed in accordance with the provisions of the federal Clean Water Act, the State Water Code, State Board water quality control plans, and this Plan. These site-specific objectives will take into consideration factors such as all available scientific information and monitoring data and the latest U.S. EPA guidance, and local environmental conditions and impacts caused by bioaccumulation. The objectives in Tables 3-3 and 3-4 apply throughout the region except as otherwise indicated in the tables or when site-specific objectives for the pollutant parameter have been adopted. Site-specific objectives have been adopted for copper in segments of San Francisco Bay (see Figure 7.2-1-01), for nickel in South San Francisco Bay (Table 3-3A), and for cyanide in all

San Francisco Bay segments (Table 3-3C). Objectives for mercury that apply to San Francisco Bay are listed in Table 3-3B. Objectives for mercury that apply to Walker Creek, Soulajule Reservoir, and their tributaries, and to waters of the Guadalupe River watershed are listed in Table 3-4A.

South San Francisco Bay south of the Dumbarton Bridge is a unique, water-quality-limited, hydrodynamic and biological environment that merits continued special attention by the Water Board. Controlling urban and upland runoff sources is critical to the success of maintaining water quality in this portion of the Bay. Site-specific water quality objectives have been adopted for dissolved copper and nickel in this Bay segment. Site-specific objectives may be appropriate for other pollutants of concern, but this determination will be made on a case-by-case basis, and after it has been demonstrated that all other reasonable treatment, source control and pollution prevention measures have been exhausted. The Water Board will determine whether revised water quality objectives and/or effluent limitations are appropriate based on sound technical information and scientific studies, stakeholder input, and the need for flexibility to address priority problems in the watershed.

3.3.22 CONSTITUENTS OF CONCERN FOR MUNICIPAL AND AGRICULTURAL WATER SUPPLIES

At a minimum, surface waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of constituents in excess of the maximum (MCLs) or secondary maximum contaminant levels (SMCLs) specified in the following provisions of Title 22, which are incorporated by reference into this plan: Table 64431-A (Inorganic Chemicals) of Section 64431, and Table 64433.2-A (Fluoride) of Section 64433.2, Table 64444-A (Organic Chemicals) of Section 64444, and Table 64449-A (SMCLs-Consumer Acceptance Limits) and 64449-B (SMCLs-Ranges) of Section 64449. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect. Table 3-5 contains water quality objectives for municipal supply, including the MCLs contained in various sections of Title 22 as of the adoption of this plan.

At a minimum, surface waters designated for use as agricultural supply (AGR) shall not contain concentrations of constituents in excess of the levels specified in Table 3-6.

3.4 OBJECTIVES FOR GROUNDWATER

Groundwater objectives consist primarily of narrative objectives combined with a limited number of numerical objectives. Additionally, the Water Board will establish basin- and/or site-specific numerical groundwater objectives as necessary. For example, the Water Board has groundwater basin-specific objectives for the Alameda Creek watershed above Niles to include the Livermore-Amador Valley as shown in Table 3-7.

The maintenance of existing high quality of groundwater (i.e., "background") is the primary groundwater objective.

In addition, at a minimum, groundwater shall not contain concentrations of bacteria, chemical constituents, radioactivity, or substances producing taste and odor in excess of the objectives described below unless naturally occurring background concentrations are greater. Under existing law, the Water Board regulates waste discharges to land that could affect water quality,

including both groundwater and surface water quality. Waste discharges that reach groundwater are regulated to protect both groundwater and any surface water in continuity with groundwater. Waste discharges that affect groundwater that is in continuity with surface water cannot cause violations of any applicable surface water standards.

3.4.1 BACTERIA

In groundwater with a beneficial use of municipal and domestic supply, the median of the most probable number of coliform organisms over any seven-day period shall be less than 1.1 most probable number per 100 milliliters (MPN/100 mL) (based on multiple tube fermentation technique; equivalent test results based on other analytical techniques as specified in the National Primary Drinking Water Regulation, 40 CFR, Part 141.21 (f), revised June 10, 1992, are acceptable).

3.4.2 ORGANIC AND INORGANIC CHEMICAL CONSTITUENTS

All groundwater shall be maintained free of organic and inorganic chemical constituents in concentrations that adversely affect beneficial uses. To evaluate compliance with water quality objectives, the Water Board will consider all relevant and scientifically valid evidence, including relevant and scientifically valid numerical criteria and guidelines developed and/or published by other agencies and organizations (e.g., U.S. Environmental Protection Agency (U.S. EPA), the State Water Board, California Department of Health Services (DHS), U.S. Food and Drug Administration, National Academy of Sciences, California Environmental Protection Agency's (Cal/EPA) Office of Environmental Health Hazard Assessment (OEHHA), U.S. Agency for Toxic Substances and Disease Registry, Cal/EPA Department of Toxic Substances Control (DTSC), and other appropriate organizations.)

At a minimum, groundwater designated for use as domestic or municipal supply (MUN) shall not contain concentrations of constituents in excess of the maximum (MCLs) or secondary maximum contaminant levels (SMCLs) specified in the following provisions of Title 22, which are incorporated by reference into this plan: Tables 64431-A (Inorganic Chemicals) of Section 64431, Table 64433.2-A (Fluoride) of Section 64433.2, and Table 64444-A (Organic Chemicals) of Section 64444. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect. (See Table 3-5.)

Groundwater with a beneficial use of agricultural supply shall not contain concentrations of chemical constituents in amounts that adversely affect such beneficial use. In determining compliance with this objective, the Water Board will consider as evidence relevant and scientifically valid water quality goals from sources such as the Food and Agricultural Organizations of the United Nations; University of California Cooperative Extension, Committee of Experts; and McKee and Wolf's "Water Quality Criteria," as well as other relevant and scientifically valid evidence. At a minimum, groundwater designated for use as agricultural supply (AGR) shall not contain concentrations of constituents in excess of the levels specified in Table 3-6.

Groundwater with a beneficial use of freshwater replenishment shall not contain concentrations of chemicals in amounts that will adversely affect the beneficial use of the receiving surface water.

Groundwater with a beneficial use of industrial service supply or industrial process supply shall not contain pollutant levels that impair current or potential industrial uses.

3.4.3 RADIOACTIVITY

At a minimum, groundwater designated for use as domestic or municipal supply (MUN) shall not contain concentrations of radionuclides in excess of the MCLs specified in Table 4 (Radioactivity) of Section 64443 of Title 22, which is incorporated by reference into this plan. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect. (See Table 3-5.)

3.4.4 TASTE AND ODOR

Groundwater designated for use as domestic or municipal supply (MUN) shall not contain taste- or odor-producing substances in concentrations that cause a nuisance or adversely affect beneficial uses. At a minimum, groundwater designated for use as domestic or municipal supply shall not contain concentrations in excess of the SMCLs specified in Tables 64449-A (Secondary MCLs-Consumer Acceptance Limits) and 64449-B (Secondary MCLs-Ranges) of Section 64449 of Title 22, which is incorporated by reference into this plan. This incorporation-by-reference is prospective, including future changes to the incorporated provisions as the changes take effect. (See Table 3-5.)

3.5 OBJECTIVES FOR THE DELTA

The objectives contained in the State Water Board's 1995 "Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary" and any revisions thereto shall apply to the waters of the Sacramento-San Joaquin Delta and adjacent waters as specified in that plan.

3.6 OBJECTIVES FOR ALAMEDA CREEK WATERSHED

The water quality objectives contained in Table 3-7 apply to the surface and groundwaters of the Alameda Creek watershed above Niles.

Wastewater discharges that cause the surface water limits in Table 3-7 to be exceeded may be allowed if they are part of an overall wastewater resource operational program developed by those agencies affected and approved by the Water Board.

TABLES

Table 3-1: Water Quality Objectives for Bacteria

Table 3-2: U.S. EPA Bacteriological Criteria for Water Contact Recreation

Table 3-3: Marine Water Quality Objectives for Toxic Pollutants for Surface Waters

Table 3-3A: Water Quality Objectives for Copper and Nickel in San Francisco Bay Segments

Table 3-3B: Marine Water Quality Objectives for Mercury in San Francisco Bay

Table 3-3C: Marine Water Quality Objectives for Cyanide in San Francisco Bay

Table 3-4: Freshwater Water Quality Objectives for Toxic Pollutants for Surface Waters

Table 3-4A: Freshwater Water Quality Objectives for Mercury in Walker Creek, Soulajule Reservoir, and All Tributary Waters

Table 3-5: Water Quality Objectives for Municipal Supply

Table 3-6: Water Quality Objectives for Agricultural Supply

Table 3-7: Water Quality Objectives for the Alameda Creek Watershed above Niles

Table 3-1: Water Quality Objectives for Bacteria[a]

Beneficial Use	Fecal Coliform (MPN/100ml)	Total Coliform (MPN/100ml)	Enterococcus (MPN/100ml)[g]
Water Contact Recreation	geometric mean < 200 90th percentile < 400	median < 240 no sample > 10,000	geometric mean < 35 no sample > 104
Shellfish Harvesting[b]	median < 14 90th percentile < 43	median < 70 90th percentile < 230[c]	
Non-contact Water Recreation[d]	mean < 2000 90th percentile < 4000		
Municipal Supply: - Surface Water[e] - Groundwater	geometric mean < 20	geometric mean < 100 < 1.1[f]	

Notes:

a. Based on a minimum of five consecutive samples equally spaced over a 30-day period.

b. Source: National Shellfish Sanitation Program.

c. Based on a five-tube decimal dilution test or 300 MPN/100 ml when a three-tube decimal dilution test is used.

d. Source: Report of the Committee on Water Quality Criteria, National Technical Advisory Committee, 1968.

e. Source: California Department of Public Health recommendation.

f. Based on multiple tube fermentation technique; equivalent test results based on other analytical techniques, as specified in the National Primary Drinking Water Regulation, 40 CFR, Part 141.21(f), revised June 10, 1992, are acceptable.

g. Applicable to marine and estuarine waters only. Numeric values are based on Section 7958 of Title 17 of the California Code of Regulations, 69FR 67217 et seq., and 40 CFR Part 131.41 (effective date December 16, 2004).

Table 3-2: U.S. EPA Bacteriological Criteria for Water Contact Recreation[1,2]
(in colonies per 100 ML)

	Fresh Water		Salt Water
	Enterococci	**E. Coli**	**Enterococci**
Steady State (all areas)	33	126	35
Maximum at:			
- designated beach	61	235	104
- moderately used area	89	298	124
- lightly used area	108	406	276
- infrequently used area	151	576	500

NOTES:

1. The criteria were published in the Federal Register, Vol. 51, No. 45 / Friday, March 7, 1986 / 8012-8016. The Criteria are based on:
(a) Cabelli, V.J. 1983. Health Effects Criteria for Marine Recreational Waters. U.S. EPA, EPA 600/1-80-031, Cincinnati, Ohio, and
(b) Dufour, A.P. 1984. Health Effects Criteria for Fresh Recreational Waters. U.S. EPA, EPA 600/1-84-004, Cincinnati Ohio.

2. The U.S. EPA criteria apply to water contact recreation only. The criteria provide for a level of production based on the frequency of usage of a given water contact recreation area. The criteria may be employed in special studies within this region to differentiate between pollution sources or to supplement the current coliform objectives for water contact recreation.

Table 3-3: Marine[a] Water Quality Objectives for Toxic Pollutants for Surface Waters (all values in ug/l)

Compound	4-day Average	1-hr Average	24-hr Average
Arsenic[b, c, d]	36	69	
Cadmium[b, c, d]	9.3	42	
Chromium VI[b, c, d, e]	50	1100	
Copper[c, d, f]			
Cyanide[g]			
Lead[b, c, d]	8.1	210	
Mercury[h]	0.025	2.1	
Nickel[b, c, d]	8.2	74	
Selenium[i]			
Silver[b, c, d]		1.9	
Tributyltin[j]			
Zinc[b, c, d]	81	90	
PAHs[k]			15

NOTES:

a. Marine waters are those in which the salinity is equal to or greater than 10 parts per thousand 95% of the time, as set forth in Chapter 4 of the Basin Plan. Unless a site-specific objective has been adopted, these objectives shall apply to all marine waters except for the South Bay south of Dumbarton Bridge (where the California Toxics Rule (CTR) applies) or as specified in note h (below). For waters in which the salinity is between 1 and 10 parts per thousand, the applicable objectives are the more stringent of the freshwater (Table 3-4) or marine objectives.

b. Source: 40 CFR Part 131.38 (California Toxics Rule or CTR), May 18, 2000.

c. These objectives for metals are expressed in terms of the dissolved fraction of the metal in the water column.

d. According to the CTR, these objectives are expressed as a function of the water-effect ratio (WER), which is a measure of the toxicity of a pollutant in site water divided by the same measure of the toxicity of the same pollutant in laboratory dilution water. The 1-hr. and 4-day objectives = table value X WER. The table values assume a WER equal to one.

e. This objective may be met as total chromium.

f. Water quality objectives for copper were promulgated by the CTR and may be updated by U.S. EPA without amending the Basin Plan. Note: at the time of writing, the values are 3.1 ug/l (4-day average) and 4.8 ug/l (1-hr. average). The most recent version of the CTR should be consulted before applying these values.

g. Cyanide criteria were promulgated in the National Toxics Rule (NTR) (Note: at the time of writing, the values are 1.0 µg/l (4-day average) and 1.0 µg/l (1-hr. average)) and apply, except that site-specific

marine water quality objectives for cyanide have been adopted for San Francisco Bay as set forth in Table 3-3C.

h. Source: U.S. EPA Ambient Water Quality Criteria for Mercury (1984). The 4-day average value for mercury does not apply to San Francisco Bay; instead, the water quality objectives specified in Table 3-3B apply. The 1-hour average value continues to apply to San Francisco Bay.

i. Selenium criteria were promulgated for all San Francisco Bay/Delta waters in the National Toxics Rule (NTR). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and Sacramento-San Joaquin Delta. Note: at the time of writing, the values are 5.0 ug/l (4-day average) and 20 ug/l (1-hr. average).

j. Tributyltin is a compound used as an antifouling ingredient in marine paints and toxic to aquatic life in low concentrations. U.S. EPA has published draft criteria for protection of aquatic life (Federal Register: December 27, 2002, Vol. 67, No. 249, Page 79090-79091). These criteria are cited for advisory purposes. The draft criteria may be revised.

k. The 24-hour average aquatic life protection objective for total PAHs is retained from the 1995 Basin Plan. Source: U.S. EPA 1980.

Table 3-3A: Water Quality Objectives for Copper and Nickel in San Francisco Bay Segments (ug/L)

Compound	4-day Average (CCC)[1]	1-hr Average (CMC)[2]	Extent of Applicability
Copper	6.9	10.8	The portion of Lower San Francisco Bay south of the line representing the Hayward Shoals shown on Figure 7.1. and South San Francisco Bay
Copper	6.0	9.4	The portion of the delta located in the San Francisco Bay Region, Suisun Bay, Carquinez Strait, San Pablo Bay, Central San Francisco Bay, and the portion of Lower San Francisco Bay north of the line representing the Hayward Shoals on Figure 7.1.
Nickel	11.9	62.4*	South San Francisco Bay

[1]Criteria Continuous Concentration

[2]Criteria Maximum Concentration

*Handbook of Water Quality Standards, 2nd ed. 1994 in Section 3.7.6 states that the CMC = Final AcuteValue/2; 62.4 is the Final Acute Value (resident species database)/2; so the site-specific CMC is lower than the California Toxics Rule value because we are using the resident species database instead of the National Species Database.

Table 3-3B: Marine[a] Water Quality Objectives for Mercury in San Francisco Bay[b]		
Protection of Human Health	0.2 mg mercury per kg fish tissue	Average wet weight concentration measured in the edible portion of trophic level 3 and trophic level 4 fish[c]
Protection of Aquatic Organisms and Wildlife	0.03 mg mercury per kg fish	Average wet weight concentration measured in whole fish 3–5 cm in length

Notes:

a. Marine waters are those in which the salinity is equal to or greater than 10 parts per thousand 95% of the time, as set forth in Chapter 4 of the Basin Plan. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable objectives are the more stringent of the freshwater or marine objectives.

b. Objectives apply to all segments of San Francisco Bay, including Sacramento/San Joaquin River Delta (within San Francisco Bay region), Suisun Bay, Carquinez Strait, San Pablo Bay, Richardson Bay, Central San Francisco Bay, Lower San Francisco Bay, and South San Francisco Bay (including the Lower South Bay)~~.~~

c. Compliance shall be determined by analysis of fish tissue as described in Chapter 6, Surveillance and Monitoring.

Table 3-3C: Marine [a] Water Quality Objectives for Cyanide in San Francisco Bay [b] (values in ug/l)		
Cyanide	Chronic Objective (4-day Average)	2.9
Cyanide	Acute Objective (1-hour Average)	9.4

Notes:

a. Marine waters are those in which the salinity is equal to or greater than 10 parts per thousand 95% of the time, as set forth in Chapter 4 of the Basin Plan. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable objectives are the more stringent of the freshwater or marine objectives.

b. Objectives apply to all segments of San Francisco Bay, including Sacramento/San Joaquin River Delta (within San Francisco Bay region), Suisun Bay, Carquinez Strait, San Pablo Bay, Central San Francisco Bay, Lower San Francisco Bay, and South San Francisco Bay.

Table 3–4: Freshwater[a] Water Quality Objectives for Toxic Pollutants for Surface Waters (all values in ug/l)

Compound	4-day Average	1-hr Average
Arsenic[b, c, d]	150	340
Cadmium[b, d]	e	e
Chromium III[f]		
Chromium VI[b, c, d, g]	11	16
Copper[b, c, d]	9.0[h]	13[h]
Cyanide[i]		
Lead[b, c, d]	2.5[j]	65[j]
Mercury[k]	0.025	2.4
Nickel[b, c, d]	52[l]	470[l]
Selenium[m]		
Silver[b, c, d]		3.4[n]
Tributyltin[o]		
Zinc[b, c, d]	120[p]	120[p]

Notes:

a. Freshwaters are those in which the salinity is equal to or less than 1 part per thousand 95% of the time, as set forth in Chapter 4 of the Basin Plan. Unless a site-specific objective has been adopted, these objectives shall apply to all freshwaters except for the South Bay south of Dumbarton Bridge, where the California Toxics Rule (CTR) applies. For waters in which the salinity is between 1 and 10 parts per thousand, the applicable objectives are the more stringent of the marine (Table 3-3) and freshwater objectives.

b. Source: 40 CFR Part 131.38 (California Toxics Rule or CTR), May 18, 2000.

c. These objectives for metals are expressed in terms of the dissolved fraction of the metal in the water column.

d. These objectives are expressed as a function of the water-effect ratio (WER), which is a measure of the toxicity of a pollutant in site water divided by the same measure of the toxicity of the same pollutant in laboratory dilution water. The 1-hr. and 4-day objectives = table value X WER. The table values assume a WER equal to one.

e. The objectives for cadmium and other noted metals are expressed by formulas where H = ln (hardness) as $CaCO_3$ in mg/l: The four-day average objective for cadmium is $e^{(0.7852\ H\ -\ 3.490)}$. This is 1.1 µg/l at a hardness of 100 mg/l as $CaCO_3$. The one-hour average objective for cadmium is $e^{(1.128\ H\ -\ 3.828)}$. This is 3.9 µg/l at a hardness of 100 mg/l as $CaCO_3$.

f. Chromium III criteria were promulgated in the National Toxics Rule (NTR). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and Sacramento-San Joaquin Delta. Note: at the time of writing, the values are 180 ug/l (4-day average) and 550 ug/l (1-hr. average). The objectives for chromium III are based on hardness. The values in this footnote assume a hardness of 100 mg/l $CaCO_3$. At other hardnesses, the objectives must be calculated using the following formulas where H = ln (hardness): The 4-day average objective for chromium III is $e^{(0.8190H+1.561)}$. The 1-hour average for chromium III is $e^{(0.8190\ H+3.688)}$.

g. This objective may be met as total chromium.

h. The objectives for copper are based on hardness. The table values assume a hardness of 100 mg/l $CaCO_3$. At other hardnesses, the objectives must be calculated using the following formulas where H = ln (hardness): The 4-day average objective for copper is $e^{(0.8545H-1.702)}$. The 1-hour average for copper is $e^{(0.9422H-1.700)}$.

i. Cyanide criteria were promulgated in the National Toxics Rule (NTR). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and Sacramento-San Joaquin Delta. Note: at the time of writing, the values are 5.2 ug/l (4-day average) and 22 ug/l (1-hr. average).

j. The objectives for lead are based on hardness. The table values assume a hardness of 100 mg/l $CaCO_3$. At other hardnesses, the objectives must be calculated using the following formulas where H = ln (hardness): The 4-day average objective is $e^{(1.273H - 4.705)}$. The 1-hour average for lead is $e^{(1.273H-1.460)}$.

k. Source: U.S. EPA Quality Criteria for Water 1986 (EPA 440/5-86-001), which established a mercury criterion of 0.012 ug/l. The Basin Plan set the objective at 0.025 based on considerations of the level of detection attainable at that time. The 4-day average value for mercury does not apply to Walker Creek and Soulajule Reservoir and their tributaries nor to waters of the Guadalupe River watershed; instead, the water quality objectives specified in Table 3-4A apply. The 1-hour average value continues to apply to waters specified in Table 3-4A.

l. The objectives for nickel are based on hardness. The table values assume a hardness of 100 mg/l $CaCO_3$. At other hardnesses, the objectives must be calculated using the following formulas where H = ln (hardness): The 4-day average objective is $e^{(0.8460H + 0.0584)}$. The 1-hour average objective is $e^{(0.8460H + 2.255)}$.

m. Selenium criteria were promulgated for all San Francisco Bay/Delta waters in the National Toxics Rule (NTR). The NTR criteria specifically apply to San Francisco Bay upstream to and including Suisun Bay and Sacramento-San Joaquin Delta. Note: at the time of writing, the values are 5.0 ug/l (4-day average) and 20 ug/l (1-hr. average).

n. The objective for silver is based on hardness. The table value assumes a hardness of 100 mg/l $CaCO_3$. At other hardnesses, the objective must be calculated using the following formula where H = ln (hardness): The 1-hour average objective for silver is $e^{(1.72H - 6.52)}$. U.S. EPA has not developed a 4-day criterion.

o. Tributyltin is a compound used as an antifouling ingredient in marine paints and toxic to aquatic life in low concentrations. U.S. EPA has published draft criteria for protection of aquatic life (Federal Register: December 27, 2002, Vol. 67, No. 249, Page 79090-79091). These criteria are cited for advisory purposes. The draft criteria may be revised.

p. The objectives for zinc are based on hardness. The table values assume a hardness of 100 mg/l $CaCO_3$. At other hardnesses, the objectives must be calculated using the following formulas where H = ln (hardness): The 4-day average objective for zinc is $e^{(0.8473 H+0.884)}$. The 1-hour average for zinc is $e^{(0.8473 H+ 0.884)}$.

Table 3-4A: Freshwater Water Quality Objectives for Mercury in Walker Creek, Soulajule Reservoir, and Their Tributaries; and in Waters of the Guadalupe River Watershed, Except Los Gatos Creek and its Tributaries Upstream of Vasona Dam, Lake Elsman, Lexington Reservoir, and Vasona Lake

Protection of Aquatic Organisms and Wildlife[a]	0.05 mg methylmercury per kg fish	Average wet weight concentration measured in whole trophic level 3 fish 5–15 cm in length
	0.1 mg methylmercury per kg fish	Average wet weight concentration measured in whole trophic level 3 fish 15 – 35 cm in length

a. The freshwater water quality objectives for the protection of aquatic organisms and wildlife also protect humans who consume fish from the Walker Creek and Guadalupe River watersheds.

Table 3-5: Water Quality Objectives for Municipal Supply

Parameter	Objective (in MG/L)
Physical:	
Color (units)[a]	15.0
Odor (number)[a]	3.0
Turbidity (NTU)[a]	5.0
pH[b]	6.5 - 8.0
TDS[c]	500.0
EC (mmhos/cm)[c]	900
Corrosivity	non-corrosive
Inorganic Parameters:	
Aluminum[d]	1.0[d] / 0.2[a]
Antimony[d]	0.006
Arsenic[d]	0.05
Asbestos[d]	7 MFL[e]
Barium[d]	1.0
Beryllium[d]	0.004
Chloride[c]	250.0
Cadmium[d]	0.005
Chromium[d]	0.05
Copper[a]	1.0
Cyanide[d]	0.15
Fluoride[f]	0.6 - 1.7[g]
Iron[a]	0.3
Lead[b]	0.05
Manganese[a]	0.05
Mercury[d]	0.002
Nickel[d]	0.1
Nitrate (as NO_3)[d]	45.0
Nitrate + Nitrite (as N)[d]	10.0
Nitrite (as N)[d]	1.0
Selenium[d]	0.05
Silver[b]	0.1
Sulfate[c]	250.0
Thallium[d]	0.002
Zinc[a]	5.0
Organic Parameters:	
MBAS (Foaming agents)[a]	0.5
Oil and grease[b]	none
Phenols[b]	0.001
Trihalomethanes[b]	0.1
Chlorinated Hydrocarbons:	
Endrin[h]	0.002
Lindane[h]	0.0002
Methoxychlor[h]	0.03
Toxaphene[h]	0.003
2,3,7,8-TCDD (Dioxin)[h]	3×10^{-8}
2,4-D[h]	0.07
2,4,4-TP Silvex[h]	0.05
Synthetic Organic Chemicals:	
Alachor[h]	0.002
Atrazine[h]	0.001
Bentazon[h]	0.018
Benzo(a)pyrene[h]	0.0002
Dalapon[h]	0.2
Dinoseb[h]	0.007
Diquat[h]	0.02
Endothall[h]	0.1
Ethylene dibromide[h]	0.00005
Glyphosate[h]	0.7
Heptachlor[h]	0.00001
Heptachlor epoxide[h]	0.00001
Hexachlorecyclopentadiene[h]	0.001
Molinate[h]	0.02
Oxarnyl[h]	0.05
Pentachlorophenol[h]	0.001
Picloram[h]	0.5
Polychlorinated Biphenyls[h]	0.0005
Simazine[h]	0.004
Thiobencarb[h]	0.07 / 0.001
Volatile Organic Chemicals:	
Benzene[h]	0.001
Carbon Tetrachloride[h]	0.005
1,2-Dibromo-3-chloropropane[h]	0.0002
1,2-Dichlorobenzene[h]	0.6
1,4-Dichlorobenzene[h]	0.005
1,1-Dichloroethane[h]	0.005
1,2-Dichloroethane[h]	0.0005
cis-1,2-Dichloroethlyene[h]	0.006
trans-1,2-Dichloroethylene[h]	0.01
1,1-Dichloroethylene[h]	0.006
Dichloromethane[h]	0.005
1,2-Dichloropropane[h]	0.005
1,3-Dichloropropene[h]	0.0005
Ethylbenzene[h]	0.7
Methyl-tert-butyl ether[h]	0.13 / 0.005
Monochlorobenzene[h]	0.07
Styrene[h]	0.1
1,1,2,2-Tetrachloroethane[h]	0.001
Tetrachloroethylene[h]	0.005
1,2,4-Trichlorobenzene[h]	0.005
1,1,1-Trichloroethane	0.200
1,1,2-Trichloroethane[h]	0.005
Trichloroethylene[h]	0.005
Trichlorofluoromethane	0.15
Volatile Organic Chemicals (cont'd):	
1,1,2-Trichloro-1,2,2-trifluoromethane[h]	1.2
Toluene[h]	0.15
Vinyl Chloride[h]	0.0005
Xylenes (single or sum of isomers)[h]	1.750
Radioactivity:	
Combined Radium-226 and Radium-228[i]	5
Gross Alpha Particle Activity[i]	15i
Tritium[i]	20,000
Strontium-90[i]	8
Gross Beta Particle Activity[i]	50
Uranium[i]	20

NOTES:

a. Secondary Maximum Contaminant Levels as specified in Table 64449-A of Section 64449, Title 22 of the California Code of Regulations, as June 3, 2005.

b. Table III-2, 1986 Basin Plan

c. Secondary Maximum Contaminant Levels as specified in Table 64449-B of Section 64449, Title 22 of the California Code of Regulations, as of June 3, 2005. (Levels indicated are "recommended" levels. Table 64449-B contains a complete list of upper and short-term ranges.)

d. Maximum Contaminant Levels as specified in Table 64431-A (Inorganic Chemicals) of Section 64431, Title 22 of the California Code of Regulations, as of June 3, 2005.

e. MFL = million fibers per liter; MCL for fibers exceeding 10 um in length.

f. Flouride objectives depend on temperature.

g. A complete list of optimum and limiting concentrations is specified in Table 64433.2-A of Section 64433.2, Title 22 of the California Code of Regulations, as of June 3, 2005.

h. Maximum Contaminant Levels as specified in Table 64444-A (Organic Chemicals) of Section 64444, Title 22 of the California Code of Regulations, as of June 3, 2005.

i. Maximum Contaminant Levels as specified in Table 4 (Radioactivity) of Section 64443, Title 22 of the California Code of Regulations, as of June 3, 2005.

j. Included Radium-226 but excludes Radon and Uranium.

MG/L Milligrams per liter
pCi/L pico Curries per liter

Table 3-6: Water Quality Objectives for Agricultural Supply[a] (in mg/l)

Parameter	Threshold	Limit	Limit for Livestock Watering
Physical:			
pH	5.5-8.3	4.5-9.0	
TDS			10,000.0
EC (mmhos / cm)		0.2-3.0	
Inorganic Parameters:			
Aluminum	5.0	20.0	5.0
Arsenic	0.1	2.0	0.2
Beryllium	0.1	0.5	
Boron	0.5	2.0	5.0
Chloride	142.0	355.0	
Cadmium	0.01	0.5	0.05
Chromium	0.1	1.0	1.0
Cobalt	0.05	5.0	1.0
Copper	0.2	5.0	0.5
Flouride	1.0	15.0	2.0
Iron	5.0	20.0	
Lead	5.0	10.0	0.1
Lithium		2.5[b]	
Manganese	0.2	10.0	
Molybdenum	0.01	0.05	0.5
Nickel	0.2	2.0	
$NO_3 + NO_2$ (as N)	5.0	30[c]	100.0
Selenium		0.02	0.05
Sodium adsorption ratio (adjusted)[d]	3.0	9.0	
Vanadium	0.1	1.0	0.1
Zinc	2.0	10.0	25

NOTES:

a. For an extensive discussion of water quality for agricultural purposes, see "A Compilation of Water Quality Goals," Central Valley Regional Water Quality Control Board, May 1993.

b. For citrus irrigation, maximum 0.075 mg/l.

c. For sensitive crops. Values are actually for NO_3-N + NH_4-N.

d. Adjusted SAR = $\{ Na /[(Ca + Mg)+2]^{0.5} \}\{1 + [8.4 – pHc]\}$, where pHc is a calculated value based on total cations, Ca + Mg, and CO_3 + HCO_3, in me/l. Exact calculations of pHc can be found in "Guidelines for Interpretation of Water Quality for Agriculture" prepared by the Univ. of California Cooperative Extension.

Table 3-7: Water Quality Objectives for the Alameda Creek Watershed Above Niles

SURFACE WATER QUALITY OBJECTIVES (ALAMEDA CREEK AND TRIBUTARIES)

TDS:	250 mg/l (90 day-arithmetic mean)
	360 mg/l (90 day-90th percentile)
	500 mg/l (daily maximum)
Chlorides:	60 mg/l (90 day-arithmetic mean)
	100 mg/l (90 day-90th percentile)
	250 mg/l (daily maximum)

GROUNDWATER QUALITY OBJECTIVES

(Concentration not to be exceeded more than 10 percent of the time during one year.)

Central Basin

TDS:	Ambient or 500 mg/l, whichever is lower
Nitrate (NO_3):	45 mg/l

Fringe Subbasins

TDS:	Ambient or 1000 mg/l, whichever is lower
Nitrate (NO_3):	45 mg/l

Upland and Highland Areas

California domestic water quality standards set forth in California Code of Regulations, Title 22 and current county standards.

Ambient water quality conditions at a proposed project area will be determined by Zone 7 of the Alameda County Flood Control and Water Conservation District at the time the project is proposed, with the cost borne by the project proponents. Ambient conditions apply to the water-bearing zone with the highest quality water.

Waters designated for use as domestic or municipal water supply shall not contain concentrations of chemicals in excess of natural concentrations or the limits specified in California Code of Regulations, Title 22, Chapter 15, particularly Tables 64431-A and 64431-B of Section 64431, Table 64444-A of Section 64444, and Table 4 of Section 64443.

STATE OF CALIFORNIA EDMUND G. BROWN, JR., Governor

DEPARTMENT OF INDUSTRIAL RELATIONS
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT
2424 Arden Way, Suite 125
Sacramento, California 95825
doshM&Tsac@dir.ca.gov

Telephone (916) 574-2540
FAX (916) 574-2542

March 29, 2013

URS Corporation
100 W. San Fernando St. #200
San Jose, CA 95113

Attention: Scott Kelsey, Project Manager

Subject: Underground Classification C074-081-13T through C076-081-13T
Classification: Potentially Gassy With Special Conditions
Project: US 101 & Broadway Interchange Reconstruction Project

The information provided to this office relative to the above project has been reviewed. On the basis of this analysis, Underground Classifications of "Potentially Gassy With Special Conditions" have been assigned to the tunnels identified on your submittal. Please retain the original Classifications for your records and deliver a true and correct copy of each Classification to the tunnel contractor for posting at the job site.

When the contractor who will be performing the work is selected, please advise them to notify this office to schedule the mandated Pre-Job Conference with the Division prior to commencing any activity associated with boring of the tunnels.

Should you have another bore under construction that is not required to have an Underground Classification (i.e.: less than 30 inches in diameter), please contact the Mining and Tunneling Unit prior to any employee entry of such a space.

If you have any questions on this subject, please contact this office at your earliest convenience.

Sincerely,

Douglas Patterson
Senior Engineer

cc: R.Brockman

State of California

Department of Industrial Relations

DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT

Underground Classification

C076-081-13T

CALIF. DEPT. OF TRANSPORTATION
NAME OF TUNNEL OR MINE AND COMPANY NAME

of **111 GRAND AVE; OAKLAND, CA 94623**
MAILING ADDRESS

at **US 101 & BROADWAY INTERCHANGE RECONSTRUCTION PROJECT**
LOCATION

has been classified as ***** POTENTIALLY GASSY WITH SPECIAL CONDITIONS *****
CLASSIFICATION

as required by the California Labor Code § 7955.

The Division shall be notified if sufficient quantities of flammable gas or vapors have been encountered underground. Classifications are based on the California Labor Code Part 9, Tunnel Safety Orders and Mine Safety Orders.

*****SPECIAL CONDITIONS*****

1. **A Certified Gas Tester shall perform pre-entry and continuous monitoring of the underground environment to measure Oxygen and detect explosive, flammable, and toxic gasses whenever an employee is working in the underground environment.**
2. **Mechanical ventilation shall provide for continuous exhaust of fumes and air at any time an employee is working in the underground environment. The primary ventilation fans must be located outside of the underground environment and shall be reversible by a single switch near the fan location.**
3. **The Division shall be notified immediately if any Flammable Gas or Petroleum Vapor exceeds 5% of the Lower Explosive Limit.**
4. **All utilities that may be in conflict with the project shall be identified and physically located (potholed) prior to the start of project operations.**

**A 36-inch-diameter, 115-foot-long bore beneath Highway 101,
at the intersection of Rollins Road and Cadillac Way, Burlingame,
in San Mateo County.**

This classification shall be conspicuously posted at the place of employment.

Douglas Patterson, Senior Engineer

March 29, 2013

State of California

Department of Industrial Relations

DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT

Underground Classification

C075-081-13T

CALIF. DEPT. OF TRANSPORTATION
NAME OF TUNNEL OR MINE AND COMPANY NAME

of **111 GRAND AVE; OAKLAND, CA 94623**
MAILING ADDRESS

at **US 101 & BROADWAY INTERCHANGE RECONSTRUCTION PROJECT**
LOCATION

has been classified as ***** POTENTIALLY GASSY WITH SPECIAL CONDITIONS *****
CLASSIFICATION

as required by the California Labor Code § 7955.

The Division shall be notified if sufficient quantities of flammable gas or vapors have been encountered underground. Classifications are based on the California Labor Code Part 9, Tunnel Safety Orders and Mine Safety Orders.

*****SPECIAL CONDITIONS*****

1. **A Certified Gas Tester shall perform pre-entry and continuous monitoring of the underground environment to measure Oxygen and detect explosive, flammable, and toxic gasses whenever an employee is working in the underground environment.**
2. **Mechanical ventilation shall provide for continuous exhaust of fumes and air at any time an employee is working in the underground environment. The primary ventilation fans must be located outside of the underground environment and shall be reversible by a single switch near the fan location.**
3. **The Division shall be notified immediately if any Flammable Gas or Petroleum Vapor exceeds 5% of the Lower Explosive Limit.**
4. **All utilities that may be in conflict with the project shall be identified and physically located (potholed) prior to the start of project operations.**

**A 36-inch-diameter, 78-foot-long bore beneath Highway 101,
approximately 900 feet south of the Broadway undercrossing of Highway 101,
Burlingame, in San Mateo County.**

This classification shall be conspicuously posted at the place of employment.

Douglas Patterson, Senior Engineer

March 29, 2013

State of California

Department of Industrial Relations

DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT

Underground Classification

C074-081-13T

CALIF. DEPT. OF TRANSPORTATION
NAME OF TUNNEL OR MINE AND COMPANY NAME

of **111 GRAND AVE; OAKLAND, CA 94623**
MAILING ADDRESS

at **US 101 & BROADWAY INTERCHANGE RECONSTRUCTION PROJECT**
LOCATION

has been classified as ***** POTENTIALLY GASSY WITH SPECIAL CONDITIONS *****
CLASSIFICATION

as required by the California Labor Code § 7955.

The Division shall be notified if sufficient quantities of flammable gas or vapors have been encountered underground. Classifications are based on the California Labor Code Part 9, Tunnel Safety Orders and Mine Safety Orders.

*****SPECIAL CONDITIONS*****

1. **A Certified Gas Tester shall perform pre-entry and continuous monitoring of the underground environment to measure Oxygen and detect explosive, flammable, and toxic gasses whenever an employee is working in the underground environment.**
2. **Mechanical ventilation shall provide for continuous exhaust of fumes and air at any time an employee is working in the underground environment. The primary ventilation fans must be located outside of the underground environment and shall be reversible by a single switch near the fan location.**
3. **The Division shall be notified immediately if any Flammable Gas or Petroleum Vapor exceeds 5% of the Lower Explosive Limit.**
4. **All utilities that may be in conflict with the project shall be identified and physically located (potholed) prior to the start of project operations.**

A 36-inch-diameter, 121-foot-long bore beneath Highway 101, approximately 900 feet south of the Broadway undercrossing of Highway 101, Burlingame, in San Mateo County.

This classification shall be conspicuously posted at the place of employment.

Douglas Patterson, Senior Engineer

March 29, 2013

STATE OF CALIFORNIA EDMUND G. BROWN, JR., Governor

DEPARTMENT OF INDUSTRIAL RELATIONS
DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT
2424 Arden Way, Suite 125
Sacramento, California 95825
doshM&Tsac@dir.ca.gov

Telephone (916) 574-2540
FAX (916) 574-2542

December 19, 2013

Calif. Dept. of Transportation
c/o URS Corporation
100 W. San Fernando Street, Suite 200
San Jose, CA 95113

Attention: Scott Kelsey, Project Manager

Subject: Underground Classification No. C041-081-14T through C042-081-14T
Classification: Potentially Gassy With Special Conditions
Project: Route 101 Broadway Interchange Reconstruction Project

The information provided to this office relative to the above project has been reviewed. On the basis of this analysis, Underground Classifications of "Potentially Gassy With Special Conditions" have been assigned to the tunnels identified on your submittal. Please retain the original Classifications for your records and deliver a true and correct copy of each Classification to the tunnel contractor for posting at the job site.

When the contractor who will be performing the work is selected, please advise them to notify this office to schedule the mandated Pre-Job Conference with the Division prior to commencing any activity associated with boring of the tunnels. A Pre-Job Request Form is enclosed.

Should you have another bore under construction that is not required to have an Underground Classification (i.e.: less than 30 inches in diameter), please contact the Mining and Tunneling Unit prior to any employee entry of such a space.

If you have any questions on this subject, please contact this office at your earliest convenience.

Sincerely,

Douglas Patterson
Senior Engineer

enc: Classifications
Pre-Job Request Form

cc: sang.kim@urs.com
rbrockman@dir.ca.gov

State of California

Department of Industrial Relations

DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT

Underground Classification

C041-081-14T **DEPARTMENT OF TRANSPORTATION**

of **111 GRAND AVENUE, OAKLAND, CA 94612**

at **ROUTE 101 BROADWAY INTERCHANGE RECONSTRUCTION PROJECT**

has been classified as ***** POTENTIALLY GASSY WITH SPECIAL CONDITIONS *****

as required by the California Labor Code § 7955.

The Division shall be notified if sufficient quantities of flammable gas or vapors have been encountered underground. Classifications are based on the California Labor Code Part 9, Tunnel Safety Orders and Mine Safety Orders.

*****SPECIAL CONDITIONS*****

1. **A Certified Gas Tester shall perform pre-entry and continuous monitoring of the underground environment to measure Oxygen and detect explosive, flammable, and toxic gasses whenever an employee is working in the underground environment.**
2. **Mechanical ventilation shall provide for continuous exhaust of fumes and air at any time an employee is working in the underground environment. The primary ventilation fans must be located outside of the underground environment and shall be reversible by a single switch near the fan location.**
3. **The Division shall be notified immediately if any Flammable Gas or Petroleum Vapor exceeds 5% of the Lower Explosive Limit.**
4. **All utilities that may be in conflict with the project shall be identified and physically located (potholed) prior to the start of project operations.**

The 36-inch diameter 255-foot long bore alongside Rollins Road located 100 feet west of the intersection of Rollins Road and Cadillac Way, Burlingame, San Mateo County

This classification shall be conspicuously posted at the place of employment.

Douglas Patterson, Senior Engineer

December 18, 2013

State of California

Department of Industrial Relations

DIVISION OF OCCUPATIONAL SAFETY AND HEALTH
MINING AND TUNNELING UNIT

Underground Classification

C042-081-14T **DEPARTMENT OF TRANSPORTATION**

of **111 GRAND AVENUE, OAKLAND, CA 94612**

at **ROUTE 101 BROADWAY INTERCHANGE RECONSTRUCTION PROJECT**

has been classified as ***** POTENTIALLY GASSY WITH SPECIAL CONDITIONS *****

as required by the California Labor Code § 7955.

The Division shall be notified if sufficient quantities of flammable gas or vapors have been encountered underground. Classifications are based on the California Labor Code Part 9, Tunnel Safety Orders and Mine Safety Orders.

*****SPECIAL CONDITIONS*****

1. **A Certified Gas Tester shall perform pre-entry and continuous monitoring of the underground environment to measure Oxygen and detect explosive, flammable, and toxic gasses whenever an employee is working in the underground environment.**
2. **Mechanical ventilation shall provide for continuous exhaust of fumes and air at any time an employee is working in the underground environment. The primary ventilation fans must be located outside of the underground environment and shall be reversible by a single switch near the fan location.**
3. **The Division shall be notified immediately if any Flammable Gas or Petroleum Vapor exceeds 5% of the Lower Explosive Limit.**
4. **All utilities that may be in conflict with the project shall be identified and physically located (potholed) prior to the start of project operations.**

The 60-inch diameter 35-foot deep shaft located on the south side of Route 101 approximately 1,000 feet north of the intersection of Route 101 and Broadway, Burlingame, San Mateo County

This classification shall be conspicuously posted at the place of employment.

Douglas Patterson, Senior Engineer

December 19, 2013

State of California
Department of Industrial Relations
Division of Occupational Safety & Health

REQUEST FOR PRE-JOB (TUNNEL)

ATTACH COPY OF CLASSIFICATION AND DIESEL PERMIT

Company Name: _____

Phone _____ FAX: _____

DATE FAXED: _____

PLEASE NOTE: THE BORING CONTRACTOR SHOULD SCHEDULE THE PREJOB AS FAR IN ADVANCE AS POSSIBLE - AT LEAST 3-4 DAYS IN ADVANCE. THE DIVISION REQUIRES THE JOB TO BE SET UP WHEN THE FIELD ENGINEER ARRIVES FOR THE PREJOB. THIS MEANS THAT THE BORE PIT HAS BEEN DUG AND PROPERLY GUARDED, THE CRANE IS IN PLACE AND READY TO LIFT, THE BORING MACHINE IS IN THE PIT AND READY TO GO, AND THE CREW IS READY TO BEGIN BORING THE TUNNEL. IF THERE IS A DELAY IN SETTING UP THE JOB, THE BORING CONTRACTOR SHOULD CONTACT THE DIVISION IMMEDIATELY.

PRE-JOB REQUEST DATE & TIME: _____

ON-SITE SUPERVISOR & CELL NO.: _____

CLASSIFICATION #: _____ **DIESEL PERMIT #:** _____

BORE DIAMETER AND LENGTH: _____ _____
(Diameter) (Length)

IS BORE ENTRY ANTICIPATED? YES NO
(Circle One)

You MUST contact the Division if entry is planned, REGARDLESS of the bore diameter.

MANNER OF EXCAVATION: _____

_____

JOB-SITE LOCATION AND DIRECTIONS: _____

_____

_____

GENERAL CONTRACTOR: _____

SUBMITTED BY: _____

REVIEWED BY: _____ **DATE:** _____

☐ *Mining & Tunneling Unit, District 1*
2424 Arden Way, Suite 125
Sacramento, California 95825-2400
(916) 574-2540; ***FAX: (916) 574-2542***

☐ *Mining & Tunneling Unit, District 2*
6150 Van Nuys Blvd., Suite 310
Van Nuys, California 91401-3333
(818) 901-5420; ***FAX: (818) 901-5579***

☐ *Mining & Tunneling Unit, District 3*
464 West Fourth Street, Suite 354
San Bernardino, California 92401-1442
(909) 383-6782; ***FAX: (909) 388-7132***