FOR CONTRACT NO.: 11-259801
EFIS No. 1100000200

INFORMATION HANDOUT

MATERIALS INFORMATION

WATER SOURCE INFORMATION
NORDAHL ROAD GEOTECH REPORT_FINAL_DATED, July 28, 2010
SUPPLEMENTAL FOUNDATION EXPLORATION NORDAHL ROAD, Dated Feb 11, 2011
STRUCTURAL SECTION RECOMMENDATIONS - AMENDED, Dated Nov 8, 2010

ROUTE: 11-SD-78-15.3/15.7 (PM)

VALLECITOS WATER DISTRICT
A PUBLIC AGENCY
201 Vallecitos de Oro • San Marcos, California • 92069-1453 Telephone (760)744-0460

September 14, 2010

Mr. Andrew Sanford
Simon Wong Engineering
9968 Hilbert Street 2nd Floor
San Diego, CA 92131

Subject: Nordahl Road Bridge Replacement, 11-SD-78, PM 15.3/15.7, 11-2594804

Dear Mr. Sanford:

This letter will confirm water availability for the above-referenced project. The project is located within the Vallecitos Water District water service area. District water facilities are available in the vicinity for this project's use.

At this time, the District is able to provide potable water for this construction project through existing fire hydrants in the area. Exact fire hydrant locations have not been field verified for the issuance of this letter. At a later date, the District will provide a map indicating approximate locations of fire hydrants along the project work site.

Construction water connections are to use construction meters installed by the District on District fire hydrants. All connections are governed by District ordinances and regulations concerning connections, deposits and commodity charges. For more information, please contact Vallecitos Water District Engineering Department at (760-744-0460.

The District adopted Ordinance No. 162 on May 6, 2009, which identifies a Level 2 Drought Alert and requires 10% mandatory conservation. Ordinance No. 162 also identifies various water conservation measures including the curtailment of availability letters and limiting new service connections as it relates to current and future drought conditions.

The Vallecitos Water District relies one hundred percent on imported water supplies, water may not be available at the time the project is built. Commitments to provide service are made by the District Board of Directors and are subject to compliance with District fees, charges, rules and regulations.

Sincerely,

Kristie Little

Kristie Little
Engineering Technician III

Cc: Cheryl Brandstrom, Development Services Supervisor
Elias Gallegos, City of San Marcos

Riverside County

38655 Sky Canyon Drive, Suite A
Murrieta, California 92563
951-600-9271

PETRA

past + present + future
it's in our science

Engineers, Geologists
Environmental Scientists

July 28, 2010
J.N. 329-03

Mr. Andrew Sanford
SIMON WONG ENGINEERING, INC.
9968 Hibert Street, Suite 202
San Diego, California 92131

Subject: Foundation Report, Nordahl Road Overcrossing Replacement, Escondido, San Diego County, California – E.A. 11-259801, Bridge No. 57-1220, 11-SD-78-PM 15.4/15.5

Dear Mr. Sanford:

Petra Geotechnical, Inc. (Petra) is pleased to submit our report for the Nordahl Road overcrossing replacement in Escondido, California. Our services were conducted in accordance with our Proposal Number 1552-02 and as authorized by you on August 22, 2003 and subsequent contract addendums through June 2010. This final report presents the results of our updated evaluation of the physical characteristics of the soils and bedrock at the site. Included are our recommendations for design and construction of foundations for the replacement bridge, as well as modifications to the appurtenant onramps and offramps, associated site work, and work on Nordahl road and adjacent streets. The results of all phases of geotechnical field explorations performed by Petra, laboratory tests, and our geologic and seismic evaluations are presented herein. Please note that this report was prepared in the Caltrans format for Bridge Foundation Reports, however it also includes the information for roadway work in order to maintain continuity with the project and previously prepared reports.

It has been a pleasure working with you on this project. Please call if you have questions regarding this report or if we can be of further service to you on future projects.

Respectfully submitted,

PETRA GEOTECHNICAL, INC.

Grayson R. Walker, GE
Principal Engineer

Distribution: (8) Addressee

TABLE OF CONTENTS

Section **Page**

INTRODUCTION 1
SCOPE OF SERVICES 1
EXCEPTIONS TO POLICY 3
PROJECT DESCRIPTION AND PROPOSED CONSTRUCTION 3
FIELD EXPLORATION and testing program 4
Petra Borings 4
Previous Caltrans Borings 5
Sampling 5
Geophysics 6
Pavement Coring 7
LABORATORY TESTING PROGRAM 9
SITE GEOLOGY AND SUBSURFACE CONDITIONS 9
Regional Geologic Setting 9
Local Geology and Subsurface Soil Conditions 10
Depth to Bedrock 10
Groundwater 11
SCOUR EVALUATION 11
CORROSION EVALUATION 11
SEISMIC-DESIGN CRITERIA 12
Seismicity 12
Caltrans Acceleration Response Spectra 12
Liquefaction Potential 14
Other Seismic Hazards 15
AS-BUILT FOUNDATION CONDITIONS 15
RECOMMENDATIONS 16
FOUNDATIONS 17
Shallow foundations 17
DEEP FOUNDATIONS 20
CIDH Piles 20
Lateral Capacity 22
Group Factors 24
Pile Installation 24
ABUTMENTS AND WINGWALLS 25
RETAINING WALLS 26
Active, Seismic and Surcharge Earth Pressures 27
Drainage and Waterproofing 28
Wall Backfill 28
Retaining Wall Foundations 29
EARTHWORK AND GRADING 31
Earthwork 31
Approach Embankments 31

TABLE OF CONTENTS

Site Preparation 31
Excavation 32
Subgrade Preparation and Moisture Conditioning 33
Fill Placement and Compaction 34
Embankment Slopes 34
Material For Fill 36
Surface and Subsurface Drainage 37
PAVEMENT STRUCTURAL SECTION DESIGN 37
Description 37
Recommendations 38
Pavement Overlays 42
Driveways 43
Subgrade Preparation and Moisture Conditioning 43
NOTES TO DESIGNER 44
CONSTRUCTION CONSIDERATIONS 44
Geotechnical Observation 45
BASIS FOR RECOMMENDATIONS 46

References
Figure 1 – Site Location Map
Figure 2 – Abutment Pressure Diagram
Plate 1 – Boring Locations Map
Plate 2 – Boring Locations Map

Appendices
Appendix A – Exploration Logs
As Built Log of Test Borings
Log of Test Borings – Explanation Sheets 1 through 3
– LOTB Sheets 1 through 5
Hand Auger Boring Logs
Appendix B – Laboratory Test Criteria/Laboratory Test Data
Appendix C – Geophysicists Report
Appendix D – Seismic Analysis
Appendix E – Slope Stability Calculations
Appendix F – Pile Calculations
Appendix G – Footings Calculations

FOUNDATION REPORT
NORDAHL ROAD OVERCROSSING REPLACEMENT, ESCONDIDO, SAN DIEGO COUNTY, CALIFORNIA – E.A. 11-259801, BRIDGE NO. 57-1220, 11-SD-78-PM 15.4/15.5

INTRODUCTION

This report presents the results of Petra Geotechnical Inc.'s (Petra's) foundation investigation for the proposed replacement of the Nordahl Road overcrossing and associated modifications to the appurtenant onramps and offramps, associated site work, and work on Nordahl road and adjacent streets. The location of the subject project is presented on the Site Vicinity Map (Figure 1). The purpose of our foundation investigation was to identify the geotechnical conditions and potential geologic hazards at the site and to provide recommendations for the design and construction of foundations for the Nordahl Road bridge replacement and recommendations for pavement-structure sections for the eastbound and westbound onramps and offramps, as well as portions of Nordahl Road adjacent to the bridge. This report was prepared where possible in general accordance with the Foundation Report Preparation for Bridge Foundation guide, and the applicable guidelines for Geotechnical Design Reports (Caltrans, 2009) of the California Department of Transportation, hereinafter referred to as Caltrans, except as modified herein.

This Foundation Report supercedes all previous reports for this project, specifically to include the preliminary report titled *"Foundation Report, State Route 78 and Nordahl Road Overcrossing Replacement, and Widening of Eastbound and Westbound on and Offramps, Escondido, San Diego County, California, - 11-E.A. 259800"* Bridge dated October 29, 2009.

SCOPE OF SERVICES

Our scope of services for this study included the following.

- Project coordination, which included scheduling of our subsurface exploration, client liaison and conferences.
- Review of pertinent geologic and geotechnical literature, including readily available geologic maps and literature, seismic data, stereoscopic-aerial photographs and the Caltrans as-built plans.

- Coordination with Simon Wong Engineering, Inc., Dokken Engineering, Caltrans, the City of San Marcos, the County of San Diego and the City of Escondido (City) to obtain encroachment and excavation permits for our exploratory borings.

- Perform subsurface exploration for the bridge replacement, including excavation, logging and sampling of fifteen hollow-stem auger borings to depths of approximately 4 to 35 feet.

- Coring of the Number 1 and Number 3 lanes, eastbound and westbound, of the existing State Route 78 (SR 78) pavement.

- Perform subsurface exploration for the widening of the eastbound and westbound offramps, including pavement coring, drilling and sampling of hollow-stem auger borings, and excavating and sampling hand-auger borings at locations of the proposed retaining walls along the south side onramps and offramps.

- Coring of the existing pavement for the reconstruction of Nordahl Road immediately north and south of the overcrossing.

- Laboratory testing of selected soil and formational samples.

- Data compilation and engineering analysis of the information obtained from the background review, subsurface exploration and laboratory testing. Our engineering analyses included seismic design criteria, design earth pressures, corrosion potential and design criteria for the replacement bridge foundations, as well as pavement-structure design criteria for onramp and offramp modifications and Nordahl Road bridge approaches.

- Preparation of a report, including reference maps, logs of test borings and graphics presenting our geotechnical findings, conclusions and recommendations. Recommendations presented in the report are in general accordance with Caltrans guidelines (Caltrans, 2009).

- Geotechnical consultation and meetings with City and design team representatives.

Studies to assess environmental hazards that may affect the site were beyond our scope of work. Our recommendations are based on the results of our field reconnaissance and explorations, laboratory tests, geologic studies and engineering analyses.

Our professional services have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has been prepared for Simon Wong Engineering, Inc. and its design consultants to be used solely in the design of the subject project. The report has not been prepared for use by other parties and may not contain sufficient information for purposes of other parties or their uses.

EXCEPTIONS TO POLICY

No exceptions to policy were noted.

PROJECT DESCRIPTION AND PROPOSED CONSTRUCTION

The Nordahl Bridge overcrossing is located at the intersection of Nordahl Road and SR 78 at the boundary of San Marcos and Escondido, California. The existing bridge is four lanes wide (two lanes each direction) with left-turn lanes. The diamond interchange has four on/offramps. The pavement surface of SR 78 and Nordahl Road consists of asphalt concrete.

The original overcrossing was constructed in 1957 and was two lanes wide. Foundations consisted of spread footings. The overcrossing was subsequently widened to four lanes.

The existing Nordahl Road overcrossing has four spans. The southerly span (Abutment 1 to Bent 2) is 27.5 feet long. The two center spans are 58.0 feet long. The northerly span (Bent 4 to Abutment 5) is 43.3 feet long for a total bridge length of 188.6 feet. Site elevations range from approximately 689 feet above mean sea level (msl) to approximately 714 feet msl. The existing bridge is constructed with reinforced concrete box-girders.

It is proposed to widen the overcrossing 14 feet by replacing the existing bridge. The bridge profile grade will also be raised several feet above current elevations. Also included will be widening of approximately 100 feet of the west side of Nordahl Road south toward Mission Road, widening of the eastbound and westbound onramps and offramps, and Nordahl Road north to Montiel Road. As part of this, the Number 1 lane of SR-78 will be removed and replaced.

FIELD EXPLORATION AND TESTING PROGRAM

Petra Borings

A subsurface exploration program was performed by Petra and consisted of the excavation of fifteen borings ranging in depths from about 4 to 35 feet below the existing ground surface. Borings B-2, B-7 and B-8 were drilled along the eastern side of the existing overcrossing at Bent 3 and Abutment 1 and Abutment 5, including the westbound offramp and Nordahl Road to the north. These borings were drilled to depths ranging from approximately 10.5 to 21.6 feet. Borings B-1, B-9 and B-10 were drilled along the western side of the existing overcrossing at Bent 3 and Abutments 5 and 1, respectively. These borings were drilled to depths ranging from approximately 20 to 25.5 feet.

Three borings drilled in March 2010 to supplement the previous boring data were drilled at the proposed new abutment locations. These borings (B-11, B-12 and B13), were drilled to depths ranging from approximately 19 to 33 feet.

Three borings (B-4, B-5 and B-6) were drilled at the shoulder of the eastbound offramp. These borings were drilled to depths ranging from approximately 4 to 7 feet. One boring (B-3) was drilled at the left-turn lane to Mission Avenue on Nordahl Road, south of the overcrossing. This boring was drilled to a depth of approximately 10 feet. Data from this boring were used to provide a recommended pavement-structure section for this portion of Nordahl Road, outside of the Caltrans right-of-way.

Additionally three (3) hand-auger borings and two (2) hollow-stem auger borings were excavated along the south side of the on and off ramps at proposed retaining wall locations. These borings are labeled HA -1 to HA-3, and B14 and B15, and they were excavated to a depth of up to 7.0 feet.

The exploratory borings were excavated to determine the subsurface geotechnical conditions at the site. With the exception of the hand-auger borings, borings were excavated using a truck-mounted drill rig equipped with 8-inch diameter hollow-stem augers. A Petra geologist logged all borings. Earth materials encountered in the exploratory borings were classified and logged in accordance with the visual-manual procedure of the Unified Soil Classification System and Caltrans standards (Caltrans, 2010). The boring logs and approximate locations of the exploratory borings are shown on the Log of Test Borings (Sheets 1 through 5). Prior to drilling, existing pavement was cored. The drilled borings were backfilled using rapid-set sand/cement slurry and the pavement was patched with 3 feet of concrete. The hand-auger borings were excavated in open space and the borings backfilled with bentonite chips.

Previous Caltrans Borings

During design and construction of the existing bridge, Caltrans drilled a total of 9 borings at the bridge site. Three (3) of the borings were drilled in the 1950's and the remaining six (6) were drilled in the 1980's. The borings were a mix of hollow stem auger and dynamic penetration borings. For continuity of subsurface information the Log of Test Borings from the as-built plans for the existing bridge are also included with our report. All exploration logs are located in Appendix A. Plate 1 shows our interpretation of the locations of the original Caltrans borings, along with the location of our recent borings.

Sampling

Bulk samples, relatively undisturbed samples and standard penetration test samples of earth materials were obtained from the borings for laboratory testing. Bulk samples consisted of

selected soil materials obtained at various depth intervals from the exploratory borings. Undisturbed samples were obtained from the borings using a 3-inch outside diameter, modified California split-spoon soil sampler lined with 1-inch long brass rings with inside diameter of approximately 2.4-inch. The soil sampler was driven mechanically with successive 30-inch drops of a 140 lb hammer. The central portions of the driven samples were placed in sealed containers and transported to our laboratory for testing. The number of blows required to drive the split-spoon sampler 1 foot was recorded on the Log of Test Borings.

Standard penetration tests were also performed in accordance with the American Society for Testing Material Standard Procedure (ASTM) D1586. This method consisted of driving an unlined standard split-barrel sampler 18 inches into the soil with successive 30-inch drops of a 140 lb hammer. Blow counts were recorded for each 6-inch driving increment; however, the number of blows required to drive the standard split-barrel sampler for the last 12 inches of the 18 inches was identified as the standard penetration resistance, or N-count, and recorded on the Log of Test Borings. Soil samples from the unlined standard split-barrel sampler were placed in plastic bags and transported to our laboratory for subsequent testing.

Concurrent with the drilling operations, surveyors were onsite to measure bridge geometrics and locate borings. The borings in SR 78 were drilled at night. Borings along Nordahl Road and the eastbound offramp were drilled during approved daylight hours. Traffic control was provided to divert traffic during field operations.

Geophysics

Geophysical exploration was conducted at the Abutment 1 (South Abutment) utilizing seismic shear wave surveys. This was performed to obtain shear wave parameters for seismic design, as well as to better understand bedrock contact elevations, and expected fill and bedrock conditions. The Geophysics was performed by Terra Geosciences during the time of drilling for borings B-11 to B-13. The report is attached as Appendix C.

Pavement Coring

As part of the scope of services, existing pavement in the Number 1 and 3 lanes, eastbound and westbound, was cored. The purpose of the coring was to obtain measurements of the existing pavement section. We also performed coring at the on and off ramps, and at the intersection of Montiel and Nordahl roads north of the bridge. Results of the coring are presented in Table 1. Table I lists the cores, their locations and thickness of pavement components. These results will be utilized by the designer to help evaluate pavement section removals.

Table 1
Pavement Core Results

Core Number	Location	Diameter (in)	AC Thickness (in)	AB Thickness (in)	ASB Thickness (in)	Subgrade
1 (Boring B-1)	SR78, WB #1 lane	12	5.7 – 5.9	13.75	5.5	Granitic Bedrock
2 (Boring B-2)	SR78, EB #1 lane	12	6.0 – 6.5	11.5 – 12.0	5.5 – 6.0	Granitic Bedrock
3	SR78, WB # 3 lane	12	11.5	2.0	18.0	Granitic Bedrock
4	SR78, EB # 3 lane	12	12.5 – 13.0	6.0	16.0	Granitic Bedrock
5	EB Off Ramp	10	6.0	0.0	0.0	Decomposed Granitics
6	WB Off Ramp	10	7.5	3.0	0.0	Decomposed Granitics
7	WB On Ramp	10	5.25	4.75	0.0	Decomposed Granitics
8	Nordahl Road	10	5.25	10.75	0.0	Decomposed Granitics
9	Montiel Road	10	8.5	0.0	0.0	Decomposed Granitics

AC = asphalt concrete
AB = aggregate base
ASB = aggregate subbase

PETRA

LABORATORY TESTING PROGRAM

Laboratory tests were performed on selected samples obtained from the borings to aid in the classification of the soils and to evaluate the pertinent engineering properties of the foundation soils. The laboratory test results are included in Appendix B and on the Log of Test Borings. A summary of laboratory testing performed including test type, California Test Method (CTM) and ASTM designation and number of tests is presented in Table 2.

Table 2
Laboratory Tests

Test Method	Name	Number of Tests
CTM 226	Moisture Content	17
ASTM D2937	Moisture/Density	33
ASTM 2435	Collapse	2
CTM 417	Sulfate Content	6
CTM 422	Chloride Content	6
CTM 643	pH and Resistivity	6
CTM 301	R-Value	6
CTM 202	# 200 Wash	1
CTM 202 and 203	Sieve Analysis	2
CTM 222	Direct Shear	10

SITE GEOLOGY AND SUBSURFACE CONDITIONS

Regional Geologic Setting

Geologically, the site lies within the Peninsular Ranges Geomorphic Province. The Peninsular Range Region encompasses Orange, and San Diego Counties and portions of Los Angeles, San Bernardino and Riverside Counties. The Peninsular Range Region is underlain primarily by

plutonic rocks of the Southern California Batholith (bathos = "deep", lithos = "rock"). These rocks formed from the cooling of molten magma deep within the earth's crust. Intense heat associated with these plutonic magma metamorphosed the ancient sedimentary rocks into which the plutons intruded. The site and adjacent hills are underlain by the pre-Cenozoic crystalline plutonic basement rock that is a part of the Peninsular Range Geomorphic Province.

Local Geology and Subsurface Soil Conditions

Earth materials exposed in the exploratory borings and cores included artificial fill, alluvium and granitic bedrock. A general description of each of these earth units is provided below.

- Fill – Artificial fills consisted of fine to coarse sand, silty sand, clayey sand and sandy clay which were brown, dark yellowish brown, dark reddish brown, greyish brown, brownish grey, grey, dark grey and black. These materials were slightly moist to very moist and loose to very dense/soft to very stiff.

- Alluvium – Alluvial deposits were observed within Boring B-10, B-14. This material consisted of fine sandy clay which was dark grey and black, saturated and soft to firm.

- Older Alluvium – Older Alluvial deposits were observed within the bottom of boring B-11 and B-12. This material consisted of clayey sand to sandy clay which was dark redish brown, saturated and dense.

- Granitic Bedrock – Granodiorite – Cretaceous fine- to coarse-grained crystalline granitic rock was observed at depth and was dark yellowish brown, reddish brown, grey and white. This material was also slightly moist to very moist, hard to very hard and slightly to moderately weathered.

- Granitic Bedrock – Gabbro – This material was yellow brown, reddish brown and grey, slightly moist to moist, moderately hard to hard and slightly to highly weathered.

Depth to Bedrock

Depth to first contact with bedrock within our exploratory borings varied greatly among the borings, from just below the surface to about 31 feet below ground surface. Please review the Log of Test Borings, for contact information and location. **The majority of previous exploratory borings by Caltrans were penetration borings, thus contact with bedrock**

within these dynamic cone penetration borings should not be interpreted from the penetration data.

Groundwater

Groundwater was encountered in six of our borings as follows:

- Boring B-4 at approximately 6.9 feet, (El 698, 3/10/04)
- Boring B-10 at approximately 25.6 feet, (El 684, 3/29/04)
- Boring B-11 at about 30 feet during drilling which rose to 24.0 feet after drilling (El. 689, 3/15/10)
- Boring B-12 at about 31.0 feet, (El. 682, 3/15/10)
- Seepage in Hand Auger HA-2 at about 2.5 feet, (El, 696, 3/11/10)
- Hand Auger HA-3 at about 7 feet, (El, 691, 3/11/10)

Groundwater levels may vary with seasonal and other changes.

SCOUR EVALUATION

This bridge does not cross water; therefore a scour analysis was not part of this project.

CORROSION EVALUATION

The corrosion potential of the onsite materials was evaluated for its effect on steel and concrete. The corrosion potential was evaluated using the results of laboratory tests on six representative samples obtained during our field exploration. Laboratory testing was performed to evaluate pH, minimum resistivity and chloride and soluble sulfate content. The pH and minimum resistivity tests were performed in accordance with CTM 643 and 422, respectively. Results are summarized in Table 3 below.

According to Caltrans Memo to Designers 3-1 (Caltrans, 2000f), the site soils are considered to be non-corrosive to ferrous metals.

Table 3

SOIL CORROSION TEST SUMMARY

Boring/Depth (ft)	Sulfate[1] (ppm	Chloride[2] (ppm)	pH[3]	Resistivity[4] (ohm-cm)
B-1 @ 3 - 5	120	140	8.2	7,000
B-1 @ 10 - 15	80	145	8.5	7,200
B-8 @ 2 - 5	120	170	8.3	8,500
B-8 @ 6 - 8	80	200	7.1	8,600
B-9 @ 2 - 5	80	185	7.8	8,800
B-10 @ 10 - 13	160	150	8.0	3,400

Note: Caltrans currently considers a site to be corrosive to foundation elements if one or more of the following conditions exist: Chloride concentration is greater than or equal to 500 ppm, sulfate concentration is greater than or equal to 2000 ppm, or the pH is 5.5 or less.

For concrete structures in contact with soil, however, we recommend that Type II modified cement be used.

SEISMIC-DESIGN CRITERIA

Seismicity

The seismic analysis for the proposed overcrossing may be performed using an Acceleration Response Spectra (ARS) in accordance with current Caltrans seismic-design criteria. Recommendations for Caltrans ARS spectra follow.

Caltrans Acceleration Response Spectra

We have prepared the response spectrum analysis in accordance with the recently released version of the Caltrans Seismic Design Criteria Appendix B, dated August 12, 2009 (Caltrans

2009), and the corresponding 2009 Seismic Procedures QA/QC Checklist. According to the Caltrans ARS online 2007 Fault Database (Caltrans 2009), the site is located closest to the seismically active Newport Ingelwood - Rose Canyon Fault Zone, which is approximately 22.8 km southwest of the site. The estimated maximum credible earthquake (MCE) magnitude of the fault zone is 7.5. The horizontal peak bedrock acceleration from ARS online is 0.24 g (where "g" represents the acceleration due to gravity).

Based on a review of the local soil and geologic conditions and the geophysists report, we utilized an input shear wave velocity for bedrock of 1,220 meters per second (4,000 ft/s), average shear wave velocity in the upper 100 feet, to derive the response spectra for the site utilizing the Caltrans ARS Online toolkits. The site classification is Type B for this shear wave velocity and corresponding geologic conditions. The ARS curve and response spectra output are included in Appendix D.

According to the chart titled Soil Profile Description on page B-17 of the revised (8/12/09) Appendix B of the SDC, soil profile type B is for rock sites with a shear wave velocity from 2,500 to 5,000 feet per second (760 to 1,500 meters per second). In accordance with the "Selection of V_s30 for Site Amplification" section of page B-5 the shear wave velocity that is to be utilized is the average small strain shear wave velocity in the upper 100 feet. The bridge foundation will be placed in competent granitic bedrock, either by spread footings or the CIDH piles. Our field exploration program showed that the granitic bedrock at the site quickly refused the drilling equipment utilized.

A study conducted by the United States Geological Survey in which shear wave velocities of near-surface geologic materials were mapped is presented in U.S. GEOLOGICAL SURVEY PROFESSIONAL PAPER 1360. Table 21 (attached) within this report shows shear-wave velocities for Pre-Tertiary crystalline rocks which would include rock of the Southern California Batholith. The shear-wave velocities ranged from 1,150 m/s (meters per second) for Pre-Tertiary

crystalline rocks with closely spaced fractures to 1,760 m/s for Pre-Tertiary crystalline rocks with widely spaced fractures. These shear wave values correspond well with the shear wave velocity observed by the Geophysicist.

The types of bedrock encountered in our borings were identified as medium to coarse-grained granodiorite and gabbro. These rocks which were formed during the Cretaceous period (63 and 140 million years b.p.) are part of the Southern California Batholith and possess shear wave velocities in excess of 760m/s.

In conclusion it is Petra's opinion that the soil profile for this site should be S_B. This conclusion is based on the following.

1.) Boring log data exceeds the N>50 blows/ft criteria. Furthermore it is our opinion that the bedrock below the depths explored will exceed the criteria in the 2007 CBC to a depth of greater than 100 feet.

2.) Review of published literature regarding shear wave velocities of Pre-Tertiary crystalline rock which would include the Southern California Batholith (USGS Professional Paper 1360)

3.) Geophysical exploration indicating bedrock shear wave velocities greater than 5,600 feet per second.

Liquefaction Potential

Groundwater water was detected at the site at the locations and depths outlined above. As shown on the Log of Test Borings the groundwater was detected at depths located within the granitic bedrock. Granitic bedrock is not considered to be liquefiable material. Alluvial materials that were sampled above the granitic bedrock contact were either fine grained soils (clay) or if they

were granular materials the blow counts N were greater than 50, and therefore they are not considered to be liquefiable either, in the event of a rise in the groundwater profile, please refer to SP117A for information on liquefiable soils (CGS 2009).

Other Seismic Hazards

There are no known Active faults trending though or toward the site. Seismically induced flooding which might be considered a potential hazard to a site normally includes flooding due to a tsunami (seismic sea wave), a seiche (i.e., a wave-like oscillation of the surface of water in an enclosed basin that may be initiated by a strong earthquake) or failure of a major reservoir or retention structure upstream of the site. The site is located many miles from the Pacific Ocean at an elevation of more than 50 feet above sea level, no reservoirs, or water retention structures exist directly upstream of the site. Therefore the probability of flooding from a tsunami, seiche or dam-break is considered very low.

AS-BUILT FOUNDATION CONDITIONS

Our review of the as-built plans for the existing bridge indicates that the bridge was originally founded on conventional spread footings. During widening in the mid 1980's the widened portion of the bridge abutment at the south end of the bridge was founded on 16-inch diameter Cast In Drilled Hole (CIDH) piles. The surveyors informed us that the vertical datum utilized during the time frame of the previous construction was lower by 2.1 feet than the current datum, (NGVD 29 + 2.10' = NAVD 88), therefore elevations given on the as-built plans should be adjusted for comparison with current exploration conditions.

For the widened portion of the bridge the pile tip elevations were noted as 677.0'msl, revised with the datum correction to 679.1. The base elevations of the spread footings at abutments 2, 3, and 4 were noted as 684.0, 687.0, 687.0, respectively. The spread footing at abutment 5 was

noted as 702.0, stepping up to 706.0. Utilizing the revised datum, the elevations would be amended to 686.1, 689.1, 689.1, 704.1, and 708.1, respectively.

The as-built plans prepared in 1960 for the original portion of the bridge indicate the footings were constructed at the following elevations starting from the south abutment to the north, abutments 1 to 5: 681.0, 687.0, 687.0, 687.0 and 706.0, respectively. The new datum would amend the elevations to 683.1, 689.1, 689.1, 689.1, and 708.1.

According to the contours shown on the plan sheet "Foundation Plan" Drawing No. C-6264-2, the footing at Abutment 5 (North Abutment) was founded on up to approximately 4 feet of fill above the original ground towards the west end of the original bridge. The abutment was approximately 40 feet in length and utilized a strip footing about 4 feet wide by 40 feet long. The allowable bearing pressure for this footing was given as 2.0 tsf (4,000 psf). For the majority of the other footings, they appear to have been founded on bedrock or very close to the contact with bedrock. The allowable bearing pressure for the other footings was given as 6.0 tsf (12,000 psf).

RECOMMENDATIONS

Based on the results of our subsurface exploration and our understanding of the proposed construction, we present the following recommendations relative to the design and construction of the proposed overcrossing replacement and pavements. Grading for the overcrossing will consist of excavation of a portion of the existing approach embankments and embankment and abutment backfill. The new fill for the widening will be up to approximately 15 feet high. Grading for the eastbound and westbound offramps will consist of excavation of the existing shoulder and embankment and construction of additional embankment to accommodate the widening.

FOUNDATIONS

We have evaluated several foundation systems for support of the bridge, including spread foundations, driven steel H-piles, prestressed concrete piles and cast-in-drilled-hole (CIDH) piles. Based on our subsurface exploration, laboratory testing, existing construction and site access considerations and discussions with Simon Wong Engineering, Inc., we recommend that Abutment 1, including wingwalls, be supported on CIDH piles and that Abutment 3, including wingwalls, and Bent 2, be supported on spread footings founded on competent bedrock.

Shallow foundations

Spread foundations should be designed in accordance with structural considerations, Caltrans specifications and the recommendations provided below. The footing dimensions should be evaluated by the structural engineer.

Strength parameters for analysis of spread footings were obtained from laboratory test results and our professional experience. The value of unconfined compression strength was derived from the shear wave velocity. The material properties of the embankment fill and subgrade materials used in the analysis are presented in Table 4.

Table 4
Material Properties

Material Type	Total Unit Weight (lbs/ft^3)	Cohesion (psf)	Angle of Internal Friction (degrees)	Uniaxial Compression Strength
Structure backfill	120	0	32	-
Embankment fill	127	50	34	-
Weathered Granitic bedrock	145	100	34	-
Granitic Rock at Bent 2 (B-2 @ 3')	165	160	40	-
Granitic Rock Less Weathered	165	-	-	2,700

Estimates of the bearing capacities for the abutment foundations were made using the methods presented in the Bridge Design Specifications (Caltrans, 2008). These values assume footings embedded 3 feet or more into undisturbed granitic bedrock. The gross allowable bearing capacity may be derived by dividing the ultimate bearing capacity by using the safety factors presented below (for Service Load Design), or the strength reduction factor (phi) (for Strength Load Design).

Table 5
Factors of Safety

Load Type	Strength Reduction Factor (phi) LRFD (Strength Load Design)	Factor of Safety (FS) ASD (Service Load Design)
Dead plus Live Group Loads I-VI	0.5	3.0
Transient (wind and seismic) Group Loads VII	1.0	1.5

Footings founded in granitic bedrock may be designed using the values presented in Table 6. The allowable bearing capacity for various loading conditions may be derived by dividing the ultimate bearing capacity by the appropriate factor of safety. Based on our analyses, settlement of the footings is estimated to be less than ½ inch under total design loads.

As shown in Table 5, for Strength Load Design the ultimate capacity given in Table 6 should be multiplied by the strength factor phi of 0.5 for Group Loads I-VI, and 1.0 for Group Loads VII. For Strength Load Design the Nominal or Ultimate Bearing Capacity multiplied by the strength factor should be equal to or greater than the imposed loads multiplied by the respective partial safety factors.

Table 6
Bridge Spread Footing Data Table

Support Location	Footing Dimensions (B x L) (feet)	Proposed Bottom of Footing Elevation (feet, msl)	Minimum Footing Embedment Depth (ft)	Working Stress Design (WSD) (LRFD Service –I Limit State Load Combination		Load and Resistance Factor Design (LRFD)		
						Service	Strength Phi b = 0.5	Extreme Event Phi b = 1.0
				Permissible Gross Contact Stress (psf)	Allowable Gross Bearing Capacity (psf)	Permissible Net Contact Stress (psf)	Factored Gross Nominal Bearing Resistance (psf)	Factored Gross Nominal Bearing Resistance (psf)
Abutment 3	12 x 120	702.0	3	10,500	10,500	10,500	21,000	31,500
Bent 2	8 x 8	688.85	3	15,000	15,000	15,000	30,000	45,000

Footings placed in granitic bedrock may be designed using a coefficient of friction of 0.4 (total frictional resistance equals coefficient of friction times the dead load). Nominal passive resistance is equal to 500 psf, using a factor of safety of 1.5, an allowable passive resistance value of 333 psf per ft of depth may be used. The allowable lateral resistance can be calculated using 50 percent of the base resistance plus 50 percent of the passive resistance behind the footing or 100 percent of the base resistance only or 100 percent of the passive resistance only. The passive resistance may be increased by one-third when considering loads of short duration, such as wind or seismic forces.

Temporary support footings at the new bent 2 should be founded at the same specified depth given for the permanent footings given in Table 6, and if founded at that depth may utilize the same bearing capacities. Temporary support footings proposed at any other depth by the construction contractor should have their bearing capacity reviewed by the engineer prior to their construction.

DEEP FOUNDATIONS

CIDH Piles

Based on discussions with Simon Wong Engineering, Inc., we recommend that Abutment 1, including wing-walls, be supported on CIDH piles. CIDH piles should have a diameter of 36 inches or more and extend 5 feet or more into granitic bedrock. The allowable vertical load for CIDH piles may be derived using end bearing. Strength parameters for our analyses were obtained from the field and laboratory test results.

Recent further exploration indicates a relative similar depth of bedrock contact at abutment 1. Depth to first noted contact from current elevations was approximately 31 feet at B-11, and 30 feet at B-12. Geophysical exploration also indicated a similar depth to rock contact. The pile

lengths should be expected to vary from one side to the other. The material properties used in our analyses are summarized in Table 7.

Table 7
Material Properties

Material Type	Total Unit Weight (lbs/ft^3)	Cohesion (psf)	Angle of Internal Friction (degrees)	Uniaxial Compression[1] (psi)
Granitic Rock Less Weathered	165	-	-	2,700

Notes:

1. Uniaxial compression strength derived from shear wave velocity correlation using $G = \rho V_s^2$ and substituting into the transformation $E = 2G(1+v)$, and using 0.2 for Poison's Ration, and taking the strength value at a limit strain of 0.001. The full calculation is provided in the appendix.

The allowable vertical load for CIDH piles may be derived using the methods described in the Caltrans Bridge Design Specifications (Caltrans, 2006d). Capacities for CIDH piles at Abutment 1 are presented in Table 8.

Table 8
CIDH Pile Capacities

Location	Pile Type	Length (feet)	Nominal Resistance Compression (kips)	Nominal Resistance Tension (kips)	Design Tip Elevation[1] (feet, msl)	Specified Tip Elevation[2] (feet, msl)
Abutment No. 1	36 inch diameter CIDH	27	570	0	677	677

Notes:

1. Design tip for both lateral design and compression
2. Pile-tip elevation based on 5 feet or more of penetration into granitic bedrock
3. Design load based on FS=2 for service load

Due to the type of abutment design anticipated uplift loading will not occur on the CIDH piles, therefore we have not included values for uplift. Anticipated settlement for abutments founded on CIDH piles will be less than ½ inch.

Lateral Capacity

Simon Wong Engineering intends to carry out the structural deign of the CIDH piles for lateral capacity. The following soil parameters should be utilized as inputs to the lateral capacity calculation computer program LPILE (Ensoft, 2003) and are given in Table 9 below. We have developed one composite soil profile to account for the minor variation in subsurface conditions from one side to the other of the abutment. The pile diameter utilized is for a 36 inch CIDH pile. The bottom layer should extend 10 pile diameters (360 inches) below the bottom of the pile.

Table 9
LPILE Parameters

Soil Profile No. 1 (Abutment 1)

Pile Length = 27 Feet (324 Inches)

Pile Diameter = 36 Inches (3 feet)

Pile Area = 1,018 Square Inches

Pile Moment of Inertia = 82,400 In^4

Pile Modulus of Elasticity = 3,000,000 psi

Pile Cutoff Elevation = 704.0 Feet

Pile Tip Elevation = 677.0 Feet

Soil Type	Depth (inches) From Pile Cutoff of 704	Effective Unit Weight (lbs/in^3)	Subgrade Modulus k (lbs/in3)	Cohesion C (psi)	Friction Angle φ (deg)	Strain Limit ε_{50}	Uniaxial Comp. Strength (psi)	Notes
1) Sand	0-132	0.072	210	0	37	-	-	Overburden soils (API RP-2a)
2) Sand	132-180	0.077	140	0	31	-	-	Overburden soils (API RP-2a)
3) Clay w/ Free Water	180-264	0.031	1200	7.78	0	0.0037	-	Older Alluvium
4) Silt	264-300	0.06	1200	1.31	42.6	0.0001	-	Weathered Bedrock
5) Strong Rock	300-684	0.06	-	-	-	-	2,700	Hard rock near pile tip

Group Factors

Pile groups with spacing less than 8 diameters will result in a reduction of lateral capacity. The lateral load-reduction factors to be applied for various pile spacings for in-line loading are presented in Table 10. A linear interpolation may be utilized to estimate the reduction factor with different pile spacing. Piles grouped in more than 1 row, or in a complex layout should be evaluated by the Geotechnical Engineer for appropriate group interaction reduction factors.

Table 10
Lateral-Load Reduction Factors

Center-to-Center Pile Spacing for In-Line Loading	Ratio of Load Resistance of Piles in Group to Single Pile
8B*	1.00
6B*	0.81
4B*	0.58
3B*	0.44

* B = Pile Diameter

Passive resistance of the soil adjacent to pile caps may be determined using an allowable (FS=1.5) resistance of 250 psf per foot of depth.

Pile Installation

CIDH piles should be constructed in accordance with Section 49 of the Standard Specifications (Caltrans, 2006i) and the following recommendations. Due to the cohesionless nature of the majority of site soils and possibility of groundwater, caving and sloughing of the sidewalls should be anticipated. Casing and/or slurry should be considered for installation. A drilling contractor experienced with such methods should be used. Gamma-Gamma or other testing should be considered to evaluate the integrity of the pile after placement of concrete.

Pile holes should be cleaned, dewatered if necessary and concrete placed immediately after drilling and steel placement using a tremie. A 5-foot or more head of concrete should be maintained above the tremie to reduce the likelihood of contamination with soil should sloughing occur. The casing, if used, should be withdrawn as concrete is placed.

Piles should be checked for alignment and plumbness. The amount of acceptable horizontal misalignment of a CIDH pile is approximately 2 to 3 inches from the exact location and it is usually acceptable for the pile to be out of plumb 1 percent of the depth of the pile. Piles should be reinforced in accordance with the recommendations of the structural engineer. Piles in groups should be spaced three times the diameter of the pile, on-centers but not less than 3 feet. If the piles are so placed, no reduction in the vertical capacities of the piles need be considered due to group action.

ABUTMENTS AND WINGWALLS

Abutments and wingwalls may be designed in accordance with the pressure diagrams shown on Figure 2. This diagram includes static, dynamic and surcharge loading conditions. For longitudinal loading toward the approach embankments, a passive soil pressure of 260 psf per foot of depth may be used at the abutments. No seismic approach slab is planned.

For walls a dynamic force in addition to the static force, based on Monobe-Okabe seismic coefficient analysis, of 23H psf, where H equals the height of the wall, may be used assuming a triangular pressure distribution as recently shown by Al Atik and Sitar (Al Atik and Sitar 2007). They also found that for seismic acceleration values up to approximately 0.3g walls have performed adequately without separate seismic design loads. The expected site ground motions accelerations for Nordahl Bridge are expected to be close to this threshold (.24g) and therefore to be conservative we do recommend that the dynamic forces should be included in the design.

Figure 2 is based on backfill meeting the specifications for structure backfill presented in Section 19 of the Caltrans Standard Specifications (Caltrans, 2006i) and on free-draining conditions. Measures should be taken to reduce moisture build-up behind abutment walls. Abutment walls should include free-draining backfill materials and perforated drains as designed by the project civil engineer and should be constructed in accordance with Bridge Detail 3-5 on Plan BO-3 of the Standard Plans (Caltrans, 2006h).

Wingwalls are to be integrated with the abutment structure and cantilevered off of them. Therefore they will not have separate foundations and foundation support will come from the pile cap or spread footing for the abutment diaphragm wall at each location.

RETAINING WALLS

Two retaining walls are planned at the bridge site. One is desired along the eastbound offramp along the south side of the embankment fill retaining the offramp fill. The second is planned at the southeast corner of the intersection with the eastbound onramp to highway 78 also supporting the sidewalk. The walls are to be constructed of cast-in-place concrete designed in accordance with Caltrans standard plans such as Type I as shown on Plans B3-1 to B3-4. Masonry walls are also being considered. The length and approximate height of the walls as supplied by Dokken Engineering the Civil Designer is as follows:

RW1: ~300' long, 4-16' high, CT type 1
RW2: ~70' long, 6-12' high, CT type 1

Active, Seismic and Surcharge Earth Pressures

The proposed retaining wall on the site should be backfilled with onsite soils or imported granular materials that have an expansion index of 20 or less and a sand equivalent of 30 or more.

Onsite soils, or imported clean sand, exhibiting a sand equivalent value of 30 or greater or pea gravel or crushed rock may be used for wall backfill provided these granular backfill materials extend behind the walls to a minimum horizontal distance equal to one-half the wall height. In addition, the sand, pea gravel or rock backfill materials should extend behind the walls to a minimum horizontal distance of 2 feet at the base of the wall or to a horizontal distance equal to the heel width of the footing, whichever is greater. For the above conditions, cantilevered walls retaining a level backfill and ascending 2:1 (H:V) backfill may be designed to resist active earth pressures equivalent to fluids having densities of 36 and 53.5 pounds per cubic foot, respectively.

During an earthquake, an additional seismic earth pressure load of 23 psf per feet of wall height may be developed, for walls that retain a horizontal backfill. For seismic loading conditions, this additional seismic earth pressure should be added to the static active earth pressure. Note that the active and seismic earth pressures have a triangular distribution with the largest load occurring at the bottom of the wall (Al Atik and Sitar 2007), For the seismic earth pressure calculations, the Mononabe-Okabe relationship was used (Seed and Whitman, 1970).

To account for the lateral active earth pressures resulting from surcharge loading, a design value of 72 psf is recommended.

These values are also for retaining walls supplied with a proper subdrain system that can drain easily and, therefore, do not include hydrostatic pressures.

All structural calculations and details should be provided to the project geotechnical consultant for verification purposes prior to grading and construction phases.

Drainage and Waterproofing

Perforated pipe and gravel subdrains should be installed behind all retaining walls to prevent entrapment of water in the backfill (B3-8, B0-3 of the Standard Plans). Perforated pipe should consist of 4-inch-minimum diameter PVC Schedule 40, or ABS SDR-35, with the perforations laid down. The pipe should be encased in a 1-foot-wide column of 3/4-inch to 1-1/2-inch open-graded gravel. If onsite soils are used as backfill, the open-graded gravel should extend above the wall footings to a minimum height equal to one-half the wall height or to a minimum height of 1.5 feet above the footing, whichever is greater. If imported sand, pea gravel or crushed rocks are used as backfill, the open-graded gravel should extend above the wall footing to a minimum height of 1 foot above the footing. The open-graded gravel should be completely wrapped in filter fabric consisting of Mirafi 140N or equivalent. Solid outlet pipes should be connected to the subdrains and then routed to a suitable area for discharge of accumulated water. The backfilled side of retaining walls should be coated with an approved waterproofing compound or covered with a similar material to inhibit migration of moisture through the walls.

Wall Backfill

Where imported sand are used for backfill, they should be placed in approximately 6- to 8-inch thick maximum lifts, watered as necessary to achieve optimum or slightly above optimum moisture conditions and then mechanically compacted in-place to a minimum relative compaction of 90 percent. Flooding or jetting of the backfill materials should be avoided. A representative of the project geotechnical consultant should observe the backfill procedures and test the wall backfill to document that adequate compaction has been achieved.

If imported pea gravel or rock is used for backfill, the gravel should be placed in approximately 2- to 3-foot thick lifts, thoroughly wetted but not flooded and then mechanically tamped or vibrated into place. A representative of the project geotechnical consultant should observe the

backfill procedures and probe the backfill to determine that an adequate degree of compaction is achieved.

To mitigate the potential for the direct infiltration of surface water into the backfill, imported sand, gravel or rock backfill should be capped with at least 12 inches of onsite soil. Filter fabric such as Mirafi 140N, or equivalent, should be placed between the soil and the imported gravel or rock to prevent fines from penetrating into the backfill.

Retaining Wall Foundations

The retaining wall may be supported on either CIDH piles designed in accordance with the parameters utilized for the bridge Abutment 1, or spread footings founded on granitic bedrock, competent alluvial materials, or properly prepared fill soils. Our exploration revealed that generally the upper 2 to 6 feet of soil was not competent for retaining wall footings, and thus should be removed. Review of preliminary retaining wall plans indicated that the depth of the footings for the retaining walls below the existing grade would vary from about 2 to 6 feet in depth. Exploration along the retaining wall locations indicates the part of the footing for RW-1 would be likely to be founded in the granitic bedrock, and the remainder of the wall would likely have contact with bedrock several feet below the planned wall footing elevation. The bedrock follows a likely undulating contact. The elevation of contact with bedrock noted at B-14 was approximately elevation 692. Interpretation of the boring information indicates the general transition point for a footing founded at about elevation 693.5 would be about a little before station 11+50. Similarly the unsuitable materials near RW-2 should also be readily removable to competent materials about 2 to 3 feet below the planned footing levels of about 698.

Therefore we recommend that unsuitable soils should be removed and replaced with structural backfill that is recompacted to at least 95 percent of maximum, if the footings are to be set above the granitic bedrock or competent older alluvium. The removals should extend laterally at least 3 feet beyond the footings, deeper removals in some portions of the wall area should be expected.

Seepage from nearby landscaping may occur in some areas such as near HA-2. The removal depth should be reviewed in the field by the project geologist.

Where the footings are to be cast on native ground, the excavated soils surface should be scarified to a depth of 6 inches, moisture conditioned to within 2 percent of optimum moisture condition, then recompacted to 95 percent of maximum compaction. Maximum compaction should be evaluated by California Test Method (CTM) 216.

For spread footings founded on competent older alluvial materials or properly compacted fill soils, an allowable bearing capacity of 2,000 psf may be utilized for strip footings 2 feet in width, founded 2 feet below adjacent grade. The bearing value may be increased by 10 percent per foot of width or depth increase up to a maximum of 4,000 psf. A foundation elevation of approximately 698 to 700 feet msl was assumed for RW1 and RW2. The above bearing values are preliminary based on the soil sample taken during exploration. Bearing capacity should be confirmed in the field during construction by the field geologist observing the excavated soil conditions.

Footings placed in competent alluvium or properly compacted fill soils, may be designed using a coefficient of friction of 0.3 (total frictional resistance equals coefficient of friction times the vertical dead load). Nominal passive resistance is equal to 375 psf, using a factor of safety of 1.5, an allowable passive resistance value of 250 psf per foot of depth may be used. The allowable lateral resistance can be calculated using 50 percent of the base resistance plus 50 percent of the passive resistance behind the footing or 100 percent of the base resistance only or 100 percent of the passive resistance only. The passive resistance may be increased by one-third when considering loads of short duration, such as wind or seismic forces.

EARTHWORK AND GRADING

Earthwork

Earthwork will include excavation of existing abutment fills, subgrade preparation for the overcrossing widening, excavation of abutment footings and placement of bridge-abutment backfill and approach embankment and embankment for the eastbound and westbound offramps widening.

Approach Embankments

Existing approach embankments at the overcrossing will be excavated to accommodate construction. Backfill will be placed to widen the existing approach embankment and against the new abutment walls. The existing shoulders and embankment for the offramps will be excavated and additional fills will be placed. The approach embankment and offramps are anticipated to be underlain by granitic bedrock. Our analyses indicate that long-term settlement, as a result of placing embankment fill, will be approximately 1 inch for the approach embankments and offramp embankments. Approximately one-half of the settlement is likely to occur during grading. Based on our analyses and understanding of the proposed improvements, monitoring of embankment settlements is not warranted.

Our analyses were based on the assumption that existing fill will meet Caltrans specifications for structure backfill and embankment presented in Section 19 of the Caltrans Standard Specifications (Caltrans, 2006i).

Site Preparation

Prior to placement of fill associated with the construction of the proposed improvements, the surface area within the embankment footprints and extending laterally 5 feet beyond the footprints should be cleared of surface obstructions and stripped of brush and vegetation. The clearing and grubbing activities should be performed in accordance with Section 16 of the Caltrans Standard Specifications (Caltrans, 2006i). Vegetation and debris from the clearing

operations should be removed from the site and disposed of at a legal dump site. Obstructions, which extend below finish grade, if present, should be removed and the resulting hole filled with compacted soil. Existing pavement sections can be broken up and used in embankment areas or the base layers may be reused, provided they meet current Caltrans specifications as presented in Section 25 for aggregate sub-bases and Section 26 for aggregate bases of the Standard Specifications (Caltrans, 2006i).

Subsequent to clearing and grubbing, we recommend that, in areas to receive fill, the upper 8 inches of exposed material be scarified and compacted to 95 or more percent of the maximum density as evaluated by California Test Method (CTM) 216. Materials with a sand equivalent of less than 10 should not be placed in the upper 2.5 feet of the embankment.

Based on our review of the project plans, portions of the roadway embankment will be constructed on fill or formational material. We recommend that keys be excavated at the toes of proposed embankments. The keys should be one equipment-width or more wide and should be excavated 1 foot or more into competent granitic bedrock, as evaluated by the geotechnical consultant. Proposed embankments should also be cut into existing embankments in accordance with Section 19-6.01 of the Caltrans Standard Specifications (Caltrans, 2006i).

Excavation

Excavation will consist of removal of existing pavement and sidewalks, excavation of subgrade for the new footings and offramp widenings and drilling of CIDH piles. The existing fill soils are not expected to pose unusual excavation difficulties and conventional heavy-duty earthmoving equipment may be used. It is anticipated that weathered formational materials will be able to be excavated. However, it is possible that hard, unweathered materials may be encountered which will be difficult to excavate. The contractor may anticipate some ripping would likely be required during excavation for footings. During seasonal rains, handling of

saturated soils may pose problems with equipment access and cleanup and we suggest the materials be allowed to dry out, if possible, prior to excavation.

Temporary, unsurcharged excavation walls may be sloped back at an inclination of 1:1 or flatter. Some sloughing of surface soils should be anticipated. Where space for sloped embankments is not available, shoring will be necessary. Shoring should be designed in accordance with the Caltrans Excavation and Shoring manual. The geotechnical engineer should observe the excavations so that necessary modifications based on variations in the soil conditions encountered could be made.

Where sloped excavations are used, the tops of the slopes should be barricaded so that vehicles and storage loads are not within 10 feet of the tops of excavated slopes. If the temporary construction slopes are to be maintained during the rainy season, berms are recommended along the tops of the slopes to reduce the likelihood of runoff water from entering the excavation and eroding the slope faces. The applicable requirements of the California Construction and General Industry Safety Orders, the Occupational Safety and Health Act of 1970 and the Construction Safety Act should be met.

Subgrade Preparation and Moisture Conditioning

Prior to placing fill soils for the embankments, the exposed materials should be observed for debris, organic material or other undesirable materials. The exposed subgrade should then be observed and proof-rolled to disclose areas of soft and yielding material. After removal of undesirable materials, the exposed soils should be scarified to a depth of 6 inches, moisture-conditioned to within 2 percent of optimum moisture content and compacted to 95 percent or more of the maximum density as evaluated by CTM 216. The subgrade should be moisture conditioned and compacted just prior to placing fill.

Fill Placement and Compaction

Based on our review of the project plans, proposed improvements will include the construction of approach and roadway embankment. The height of the approach embankments will be up to approximately 15 feet. It is our understanding that fill material for the construction of these embankments will be derived partly from excavations within the project improvements and from material imported from offsite. With the exception of the areas described below, embankment fill should be compacted to 90 or more percent of the maximum laboratory density, as determined by CTM 216.

Fill associated with the proposed improvements should be placed and compacted in accordance with Section 19 of the Caltrans Standard Specifications (Caltrans, 2006i). Approach embankments should be constructed in accordance with the recommendations presented in Section 19-5.03 of the Standard Specifications (Caltrans, 2006i). Embankment fill within 150 feet of abutments should be compacted to 95 or more percent relative compaction in accordance with CTM 216. Backfill against temporary slopes should be cut into existing embankment in accordance with Section 19.6.01 of the Caltrans Standard Specifications (Caltrans, 2006i).

Material within the upper 2.5 feet of finish grade should have a sand equivalent of 10 or more. Fill within the width of the traveled way plus 3 feet, as defined by the outside edge of the shoulders and within 2.5 feet of the grading plane, should be compacted to 95 or more percent of the maximum density, as evaluated by CTM 216. In addition, soils within 2.5 feet of finish grade for the width of the traveled way plus 5 feet on either side should be compacted to 95 or more percent of the maximum density.

Embankment Slopes

Our review of the project plans indicates that the proposed roadway embankments will be up to about 20 feet high at a slope ratio no steeper than 1.5:1 (horizontal:vertical [H:V]). Slope-stability analyses, performed on the embankment fill slopes, indicate a factor of safety greater

than 1.5 for static conditions if three layers of geogrid reinforcing are placed near the slope toe as the slope is constructed, and greater than 1.1 for seismic conditions. The slope chosen for computer simulation was the slope configuration with the deeper bedrock contact like that expected at abutment 1. Piles and an abutment wall were simulated. Shear strength parameters utilized were taken from the laboratory test results, and ultimate strength conditions were utilized for the static case, and peak strength parameters were utilized for the seismic case. The computer software program GSTABL7 with STEDwin (Gregory, 2003) was utilized to perform the stability analyses. Several hundred trial failure surfaces of circular shape were generated by the program and the factor of safety for each trial surface was calculated by the modified Bishop method. Slope Stability Calculations are presented in Appendix C. Geogrid such as Tensar BX 1200 should be placed in a configuration as shown on the slope calculation cross section shown in appendix C.

We understand that the surficial stability of the embankment slopes will be protected by the installation of "Slope Paving Rock Cobble". For portions of the slope not paved, and that are at a slope ratio of 2:1 or flatter, our analyses indicate that the embankment slopes have calculated factors of safety of more than 1.5 for surficial stability. However, slopes may require periodic maintenance. To achieve compaction of embankment slope faces, the embankment slopes may be overbuilt, compacted and cut back to finish grade or compacted at the slope face by mechanical means. The construction and grading activities associated with the proposed slope should be performed in accordance with Section 19 of Caltrans Standard Specifications (Caltrans, 2006i). Embankment slopes should be planted with drought-tolerant vegetation as soon as practical after construction and irrigation should be kept to a minimum necessary to maintain plant vigor. Embankment slopes should be protected from erosion in accordance with Section 20 of the Caltrans Standard Specifications.

Material For Fill

Embankment and backfill for the new abutments should meet the specifications presented in Section 19 of the current Caltrans Standard Specifications (Caltrans, 2006i). Structure backfill should have a sand equivalent of 20 or more and meet the gradation presented in Table 3.

Expansive soils should be avoided. If expansive soil is used, it should be placed and compacted at a moisture content of 2 or more percent above optimum, as evaluated by CTM 216. Expansive fill should be mixed with sandier material and placed in the lower portion of embankments and not near slope faces. The geotechnical consultant should evaluate the expansiveness of the onsite soils during grading, utilizing either visual and field methods or laboratory testing, as warranted. Laboratory tests, including Atterberg limits and gradation (sieve analysis), should be performed on suspected expansive soils so that the degree of expansion of the soils may be evaluated. Imported material should be evaluated by the geotechnical consultant prior to arrival at the site.

Table 3
Structure Backfill

Sieve Size	Percent Passing by Weight (%)
3 in	100
0.187 in (No. 4)	35 to 100
0.023 in (No. 30)	20 to 100

Import materials for embankment fill should be non-expansive, granular soils with a plasticity index less than 15, less than 35 percent passing the # 200 sieve and a maximum particle size of 3/4 inch.

Surface and Subsurface Drainage

Surface drainage should be directed away from the tops of slopes and should not be allowed to pond at the toes of slopes. Positive drainage should be established at the toes of slopes and surface water should be directed offsite by means of appropriate erosion-reducing devices. Runoff should not be allowed to flow over the tops of slopes. Drainage for the proposed improvements should be in accordance with Chapter 800 of the Caltrans Highway Design Manual (Caltrans, 2009).

Due to irregular subsurface geometry of the bedrock the need may arise to install backdrains to facilitate subsurface drainage where fill materials are placed in contact with the bedrock. Unless keyway bottoms and sidewalls are found to expose free-draining, granular materials, internal backdrains will be required in the keyways to prevent entrapment of irrigation and precipitation water in the key bottoms. During grading each keyway should be observed by the project engineering geologist to determine whether a backdrain should be installed. Determination of subsurface drainage locations should be made in the field by a geologist because of the variables of subsurface conditions.

PAVEMENT STRUCTURAL SECTION DESIGN

The following paragraphs present the recommended pavement design sections for SR 78 eastbound and westbound on and offramps and a portion of Nordahl Road based on the Traffic Indexes (TI's) provided to Petra.

Description

Pavement sections associated with the proposed construction will include construction of new on and offramp lanes and a portion of Nordahl Road. The pavement structural sections presented in the following sections were designed in accordance with Chapter 600 of the Caltrans Highway Design Manual (Caltrans, 2009).

Recommendations

Six samples of soil from the proposed areas of excavation within this portion of SR 78 and Nordahl Road were tested and found to have the resistance values (R-values) indicated in Table 11.

Table 11
R-Value Results

Boring No./Depth (ft)	Location	R-Value
B-1 @ 3 - 5	WB SR78	67
B-3 @ 1 - 5	Nordahl Road	73
B-6 @ 2 - 5	EB offramp	67
B-8 @ 2 - 5	WB offramp	75
C-5 @ 1	EB offramp	73
C-9 @ 1	Montiel Road	68

The design R-values selected are as indicated in Table 12.

Table 12
Design R-value

Material	Design R-Value
Aggregate Base (Class 2)	78
Aggregate Sub-Base (Class 4)	40
SR 78, #1 Lane	40
EB and WB ramps	40
Montiel and Nordahl Roads	40

The traffic indices used for design of the pavement structural sections are presented in Table 13.

Table 13
Design Traffic Indices

Location	Traffic Index (TI)
SR 78, #1 Lane	10.0
EB and WB on and offramp lanes	10.0
EB and WB on and offramp shoulders	6.5
Nordahl Road	10.0

The recommended pavement sections are presented in the following Table 14.

Table 14
Pavement Structural Section

Location	Design R-Value	Traffic Index	AC Surface (ft)	AC Base (ft)	Class 2 AB (ft)	Class 4 AS (ft)	Total Thickness (ft)
SR 78, # 1 Lane							
Alternate 1	40	10	0.2	0.3	0.95	--	1.45
Alternate 2	40	10	0.2	0.3	0.56	0.41	1.47
SR 78 Inside Shoulder	40	--	0.2	--	0.5	--	0.7
EB On and Offramps							
Alternate 1	40	10	0.2	0.3	0.95	--	1.45
Alternate 2	40	10	0.2	0.3	0.56	0.41	1.47
EB On and Offramps Outside Shoulder							
Alternate 1	40	6.5	0.3	--	0.56	--	0.86
Alternate 2	40	6.5	0.3	--	0.36	0.36	1.02
WB On and Offramps							
Alternate 1	40	10	0.2	0.3	0.95	--	1.45
Alternate 2	40	10	0.2	0.3	0.56	0.41	1.47
WB On and Offramps Outside Shoulder							
Alternate 1	40	6.5	0.3	--	0.56	--	0.86
Alternate 2	40	6.5	0.3	--	0.36	0.36	1.02
Nordahl Road North/South							
Alternate 1	40	10	0.2	0.3	0.95	--	1.45
Alternate 2	40	10	0.2	0.3	0.56	0.41	1.47

Legend:
AC = Asphalt concrete
AB = Aggregate base (Class 2), R = 78
AS = Aggregate sub-base (Class 4), R = 40

PETRA

Pavement Overlays

The project plans call for pavement overlays at several locations to transition the roadway surface from the existing pavements to the new structural sections. A short section on Nordahl road around Station 27 just before mission and a significant section of Nordahl at the intersection of Montiel road from approximately Station 38 to 41+ along Nordahl and about 100 feet into Montiel on each side of the intersection is planned for pavement overlay. Also indicated is a section more than 100 feet long at the beginning of each offramp. The purpose of the overlays is to improve the esthetics of the project.

At boring B-3 in Nordahl Road and also near coring C-8 the structural section was noted at a total thickness of about 1.5 feet. This is approximately equal to the structural section recommended above in Table 14. Therefore we would recommend that the existing pavement should be milled and overlayed with an equivalent thickness of asphalt concrete. To better control any reflective cracking we recommend that the mill depth should be about ½ the depth of the existing AC section or about 0.2 feet as recommended in the Caltrans Highway Design Manual (HDM) Chapter 635 (Caltrans 2009). Further this recommendation will maintain the minimum 0.15 foot thickness of the remainder section to prevent tearing up of the underlying base by the milling machine as recommended in the Caltrans HDM. Our recent supplemental exploration has shown that some of the existing ramp structural sections do not equal the structural section recommended in Table 14. Therefore we would also recommend that the same amount of milling occur but that the overlay should be built up to gradually increase to the structural section shown in table 14 on the ramp locations that are less than recommended. Alternatively the overlay approach can be abandoned and the pavement removal limits expanded and full structural sections can be placed the entire length of the ramps to the freeway pavement connection.

After milling the exposed surface should be evaluated and cracks and defects should be repaired as outlined in the HDM, the Standard Specifications and the Special Provisions such as SSP 37-

400 for crack repair. Any potholes should be excavated out and patched prior to placement of the overlay course. Any other areas of obvious structural failure such as closely spaced cracking or depressions should be repaired by removal to the subgrade, repair of the subgrade and replacement with a new AC patch. After repair of all defects, the surface should be swept of any remaining debris or loose material. A tack coat should be applied just prior to paving with the new AC overlay.

Driveways

There are a total of 7 driveways off of Nordahl Road that are affected by this project. Several of the driveways are to gas stations, several businesses and a strip mall. Delivery truck traffic is common at the gas stations. Driveway entrances should be constructed in accordance with either the City of San Marcos, or the City of Escondido standard details. For ease of continuity during the project we would recommend a similar structural section for all the driveways. The City of Escondido calls for a minimum structural section of 3 inches AC over 6 inches of Class II aggregate base (AB) course for AC driveways and alleyways. For the areas with expected heavier truck traffic we would recommend they be constructed from Portland Cement Concrete (PCC) pavement such as is shown on drawing G-5-E of the Escondido standard drawings which calls for 7 inches PCC over 8 inches base.

Base course material should conform to Caltrans standards and should be compacted to 95 percent or more of maximum density.

Subgrade Preparation and Moisture Conditioning

Prior to placing base material for driveways the exposed subgrade materials should be observed for debris, organic material or other undesirable materials. The exposed subgrade should then be observed and proof-rolled to disclose areas of soft and yielding material. After removal of undesirable materials, the exposed soils should be scarified to a depth of 6 inches, moisture-conditioned to within 2 percent of optimum moisture content and compacted to 95 percent or

more of the maximum density as evaluated by California Test Method (CTM) 216. The subgrade should be moisture conditioned and compacted just prior to placing fill.

NOTES TO DESIGNER

The designers should show on the grading plans the requirement to include geogrid reinforcing at the slope at the south abutment as explained above under slope stability.

CONSTRUCTION CONSIDERATIONS

Construction will include widening of the existing structure and construction of new abutments and compaction of new abutment structure, approach embankment and offramp embankment backfill, drilling and construction of CIDH piles, spread footings, wingwalls, widening of the eastbound and westbound offramps and paving of Nordahl Road. Excavations should be laid back or shored and measures taken to avoid surcharging the temporary backslope and prevent water from flowing over slopes. Workmen should be protected in accordance with OSHA regulations. Groundwater, if encountered in excavations, should be removed by pumping, as necessary.

Existing utilities in the street and adjacent areas, including an existing powerline which parallels the right-of-way, should be located and their effect on the construction evaluated. Overhead clearance for the drill rig should be evaluated including clearance necessary to place steel cages, staging areas and equipment storage should also be evaluated.

Unusual excavation conditions are generally not anticipated. However, large hard-rock boulders could be encountered resulting in difficult excavation.

During staged construction shoring of the excavation or fill may be required to support portions of the roadway where traffic is re-routed. The contractor should be aware that on the north side of the bridge the footing is to founded in bedrock, and thus any excavation to the bedrock would necessarily also cause any H piles to shore the adjacent roadway portion to have to penetrate into the bedrock as well. This may be difficult and the contractor should evaluate other shoring options in this area.

Geotechnical Observation

It is our understanding that the construction phase of this project may be administered by Caltrans. The installation of the foundations and compaction of fill and backfill should be observed and tested during placement by a representative of the geotechnical consultant familiar with Caltrans requirements and procedures. This representative should perform the following duties.

- Observe the excavation of the bridge foundation subgrade and excavation of existing abutment backfill.
- Observe and document CIDH pile installation.
- Test and observe placement of foundation concrete.
- Observe the clearing and grubbing operations for proper removal of unsuitable materials along the alignment.
- Observe the exposed subgrade in areas to receive fill and in areas where excavation has resulted in the desired finished subgrade. The representative should also observe proof-rolling and delineation of areas to be overexcavated.
- Evaluate the suitability of onsite and import soils for fill placement and collect and submit soil samples for required or recommended laboratory testing, where necessary.
- Observe the fill and backfill for uniformity during placement.
- Test backfill for field density and compaction to evaluate the percentage of compaction achieved during backfill placement.

- Test and observe placement of pavement.

The governmental agencies having jurisdiction over the project should be notified prior to commencement of grading so that the necessary grading permits can be obtained and arrangements can be made for required inspection(s). The contractor should be familiar with the inspection requirements of the reviewing agencies.

BASIS FOR RECOMMENDATIONS

The recommendations provided in this report are based on our understanding of the described project information and on our interpretation of the data collected during the subsurface exploration. We have made our recommendations based on experience with similar subsurface conditions under similar loading conditions. The recommendations apply to the specific project discussed in this report; therefore, changes in loads and/or walls or site grades should be provided to us so we may review our conclusions and recommendations and make necessary modification.

The recommendations provided in this report are also based on the assumption that representatives of Petra will perform the necessary geotechnical observations and testing during construction. The field observation services are considered a continuation of the geotechnical exploration to evaluate that the actual soil and bedrock conditions are as anticipated. This also provides for the procedure whereby Simon Wong Engineering, Inc. and the City are provided with an independent professional opinion regarding the geotechnical-related construction procedures. If another firm or agency were retained for the geotechnical observation services, our professional responsibility and liability would be limited to the extent that we would not be the geotechnical engineer of record.

We appreciate this opportunity to be of service. If you have questions, please contact this office.

Respectfully submitted,

PETRA GEOTECHNICAL, INC.

J. Montgomery Schultz, PE
Senior Project Engineer
C61144
7/28/10

REGISTERED PROFESSIONAL ENGINEER
JOHN MONTGOMERY SCHULTZ
C 61144
EXP. 12/31/10
CIVIL
STATE OF CALIFORNIA

James S. Olbinski, CEG
Senior Associate Geologist
CEG 1462
7-28-10

PROFESSIONAL GEOLOGIST
JAMES S. OLBINSKI
NO. 1462
CERTIFIED
ENGINEERING
GEOLOGIST
11-30-11
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Grayson R. Walker, GE
Principal Engineer
GE 871

REGISTERED PROFESSIONAL ENGINEER
GRAYSON R. WALKER
No. 871
EXP. 3-31-2011
GEOTECHNICAL
STATE OF CALIFORNIA

JMS/JSO/GRW/kms/emw

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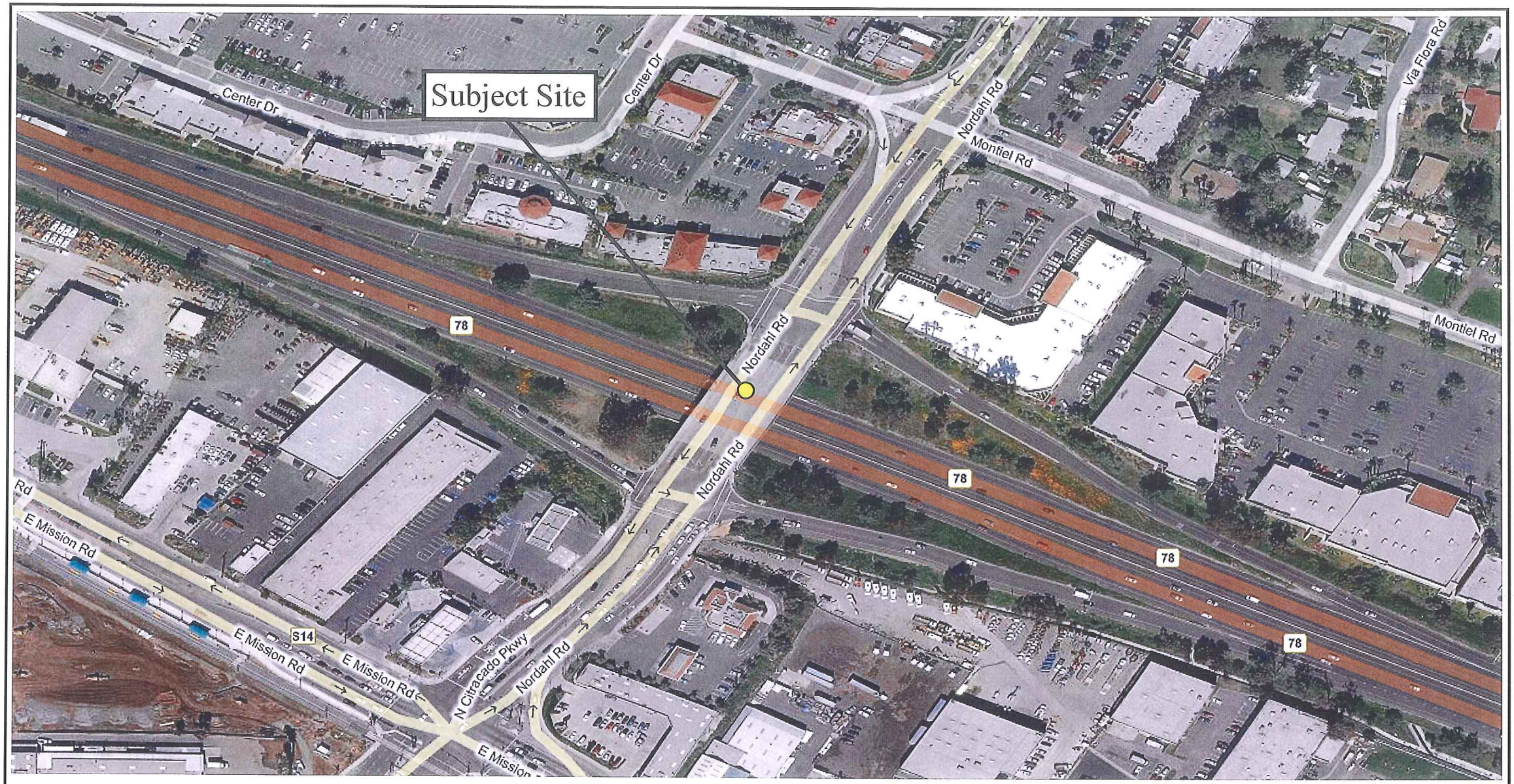
Aerial Photos Reviewed

Date	Photo Number
04/16/72	107 – 3-4-5
08/02/78	210 – 29-30
12/18/79	FCSD-43 -- 13-14
04/08/80	FCSD-9 --12-13
01/14/88	SD – 5-12-13
10/21/93	C97-8 – 210-211
07/09/98	C120-8 – 17-18



N
W E
S

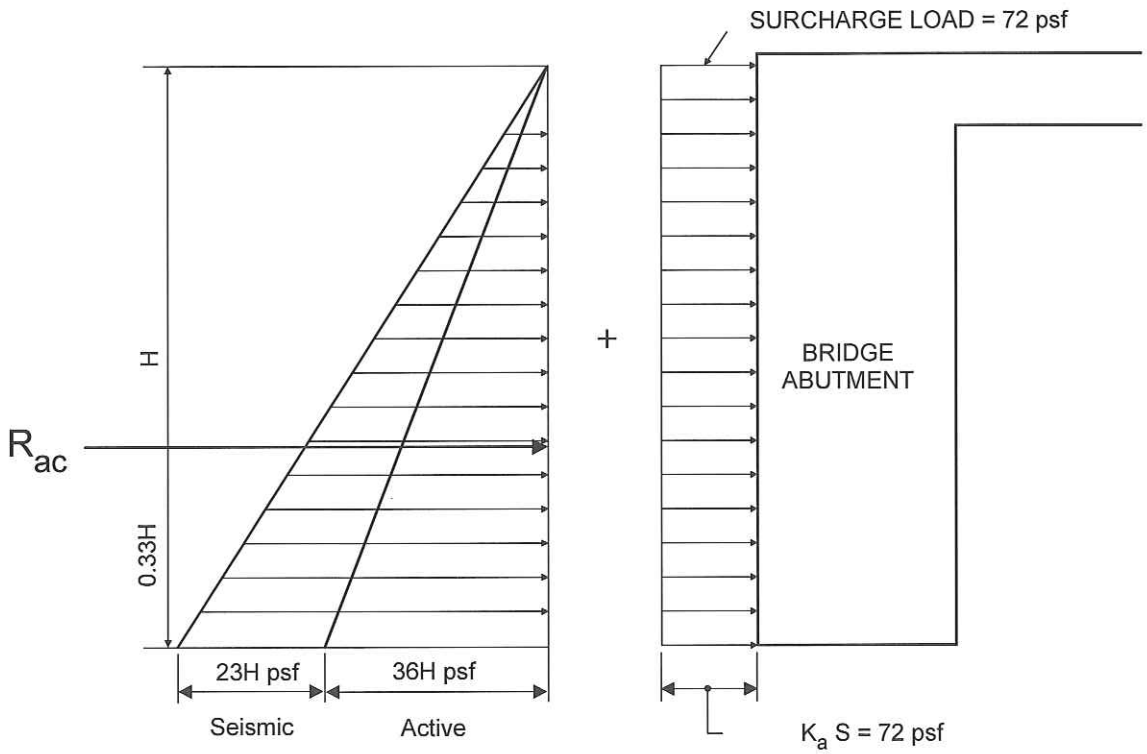
Reference: Bing Maps

PETRA GEOTECHNICAL, INC.
38655 SKY CANYON DRIVE, SUITE A
MURRIETA, CALIFORNIA 92563
PHONE: (951) 600-9271
COSTA MESA MURRIETA PALM DESERT SAN DIEGO SANTA CLARITA

SITE LOCATION MAP

Nordahl Road Bridge Project
State Route 78
City of Escondido, California

DATE: July 2010	J.N.: 329-03	**Figure 1**
DWG BY: JC	SCALE: N/A	



RESULTANT $R_H = (23H + 36H)\left(\frac{H}{2}\right) + 72H$

ASSUMED CONDITIONS

1. Abutment movement unrestrained
2. $K_a = 0.3$
3. No groundwater
4. H = Abutment height
5. S = Surcharge = 2 feet (240 psf)
6. $\gamma_t = 120$ lbs/ft^3

CANTILEVERED ABUTMENT PRESSURE DIAGRAM

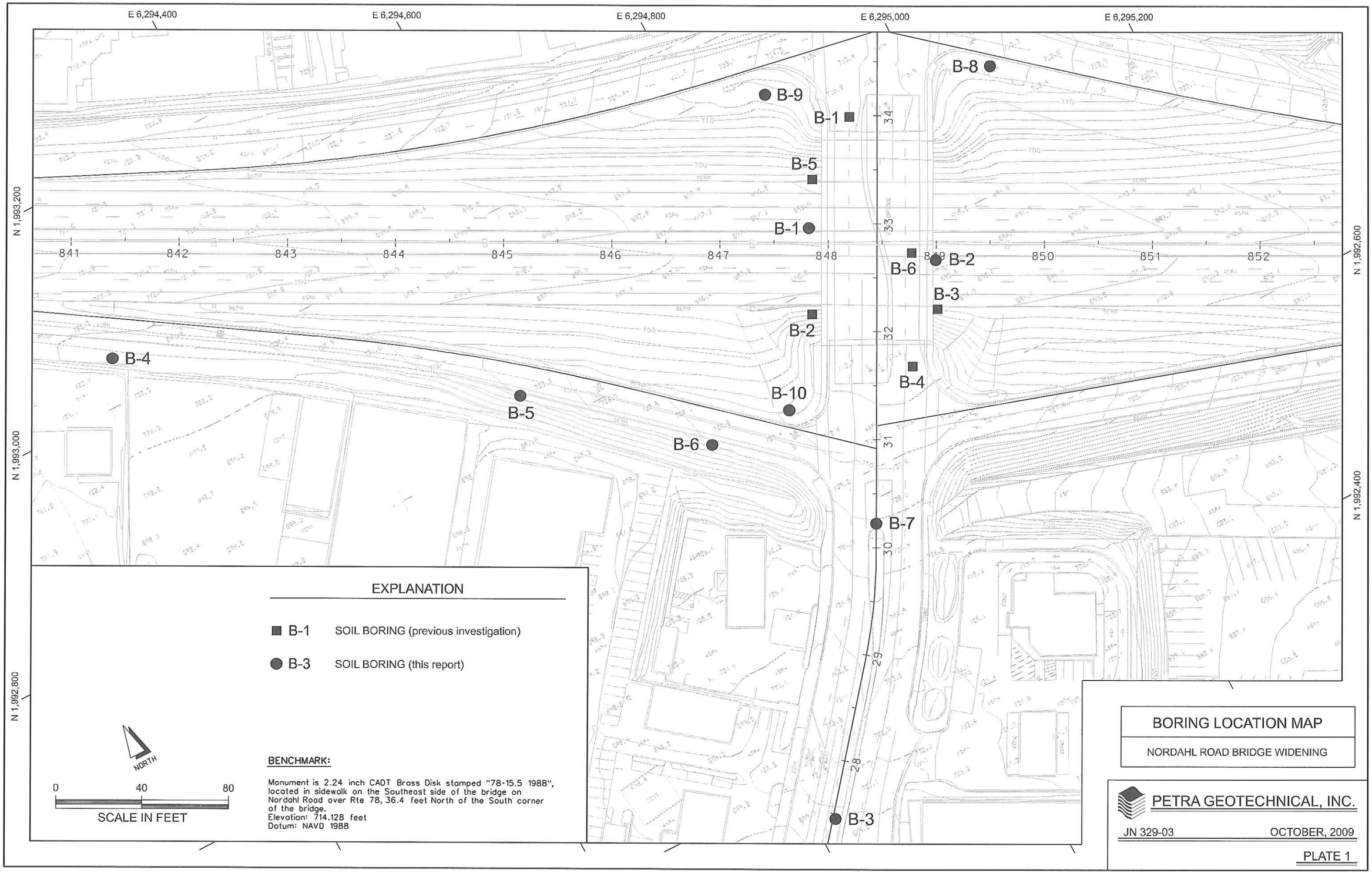
NOT TO SCALE

PETRA GEOTECHNICAL, INC.

JN 329-03 JULY 2010

FIGURE 2

re abut pres dia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E 6,294,600
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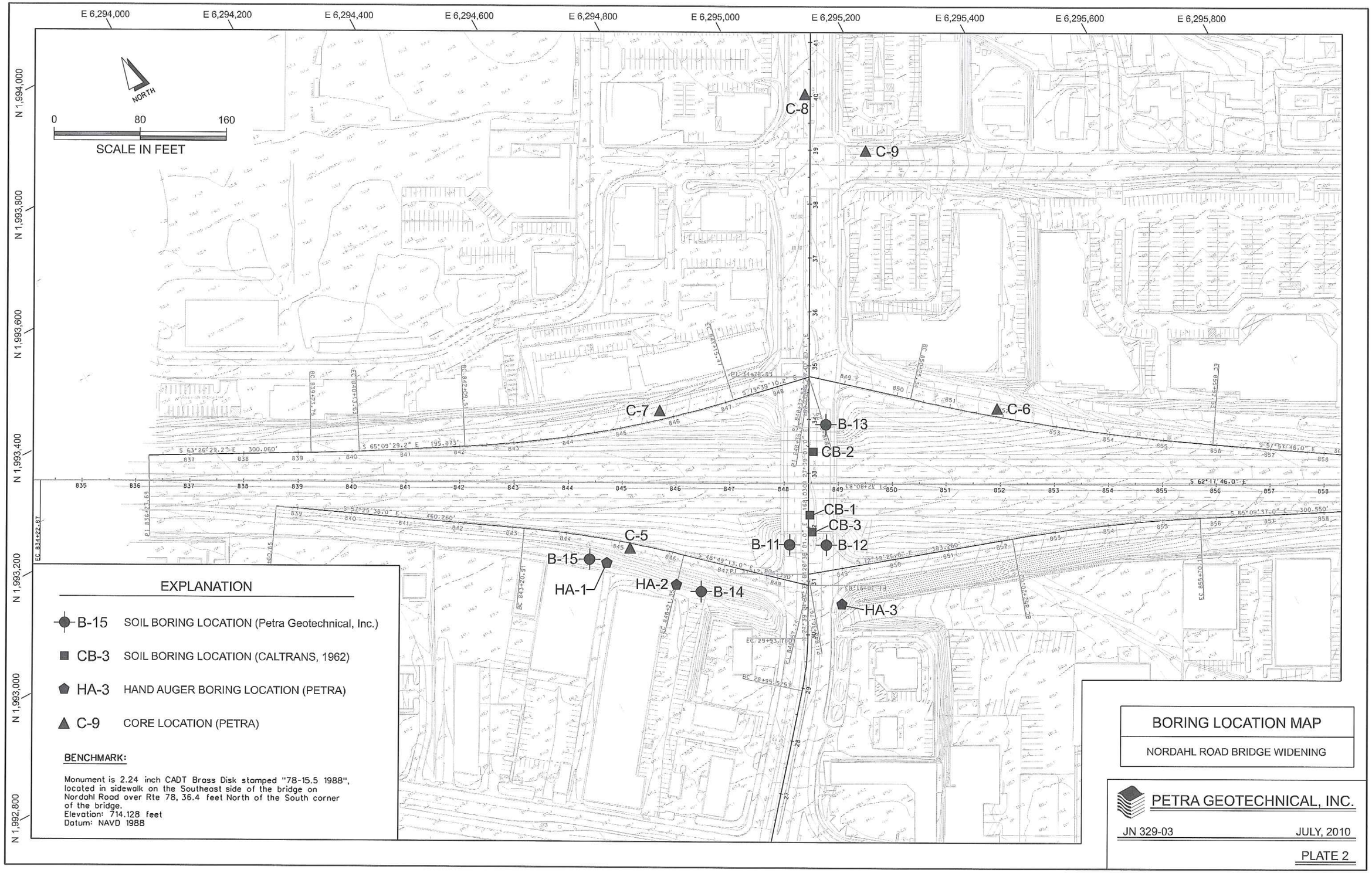
N 1,992,600
N 1,992,400
841
842
843
844
845
846
847
848
849
850
851
852
34
33
32
31
30
29
28
B-1
B-2
B-3
B-4
B-5
B-6
B-7
B-8
B-9
B-10
EXPLANATION
B-1 SOIL BORING (previous investigation)
B-3 SOIL BORING (this report)
NORTH
0
40
80
SCALE IN FEET
BENCHMARK:
Monument is 2.24 inch CADT Brass Disk stamped "78-15.5 1988", located in sidewalk on the Southeast side of the bridge on Nordahl Road over Rte 78, 36.4 feet North of the South corner of the bridge.
Elevation: 714.128 feet
Datum: NAVD 1988
BORING LOCATION MAP
NORDAHL ROAD BRIDGE WIDENING
PETRA GEOTECHNICAL, INC.
JN 329-03
OCTOBER, 2009
PLATE 1


E 6,294,000
E 6,294,200
E 6,294,400
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E 6,295,600
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N 1,993,600
N 1,993,400
N 1,993,200
N 1,993,000
N 1,992,800
NORTH
0
80
160
SCALE IN FEET
C-8
C-9
C-7
C-6
B-13
CB-2
CB-1
CB-3
B-11
B-12
C-5
B-15
HA-1
HA-2
B-14
HA-3
EXPLANATION
B-15 SOIL BORING LOCATION (Petra Geotechnical, Inc.)
CB-3 SOIL BORING LOCATION (CALTRANS, 1962)
HA-3 HAND AUGER BORING LOCATION (PETRA)
C-9 CORE LOCATION (PETRA)
BENCHMARK:
Monument is 2.24 inch CADT Brass Disk stamped "78-15.5 1988", located in sidewalk on the Southeast side of the bridge on Nordahl Road over Rte 78, 36.4 feet North of the South corner of the bridge.
Elevation: 714.128 feet
Datum: NAVD 1988
BORING LOCATION MAP
NORDAHL ROAD BRIDGE WIDENING
PETRA GEOTECHNICAL, INC.
JN 329-03
JULY, 2010
PLATE 2

APPENDIX A

EXPLORATION LOGS
LOG OF TEST BORINGS-SHEETS 1 THROUGH 8
HAND AUGER BORING LOGS

PETRA

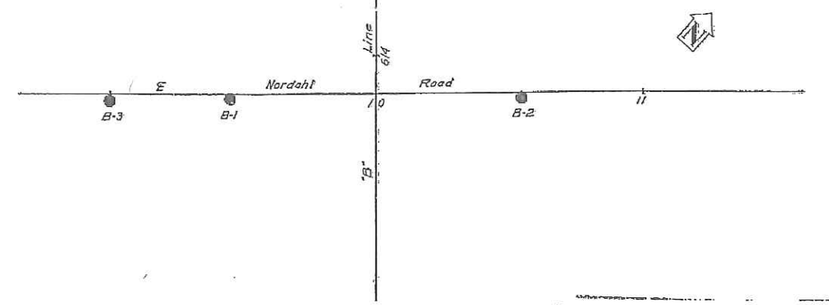
F-0106-1(1)

FED. ROAD DIST. NO.	STATE	FISCAL No.	FISCAL YEAR	SHEET No.	TOTAL SHEETS
7	CAL.			128	128

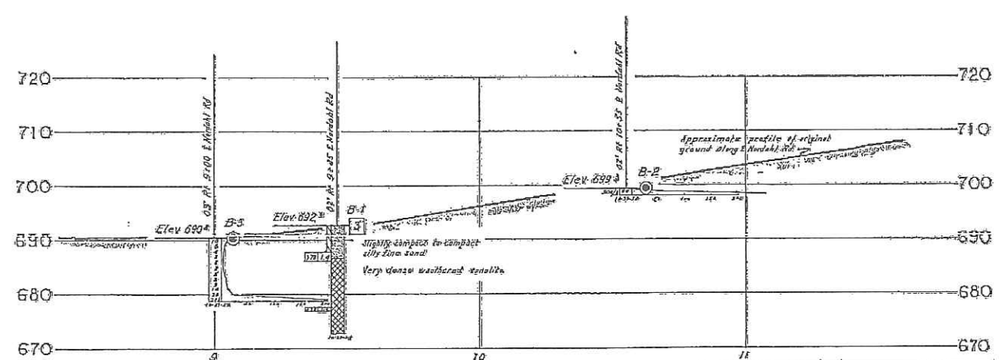
DIST.	COUNTY	ROUTE	SUFFIX	PROJECT No.	TASK ORDER
XI	SD	196	B	K-1	7

SIGNED BY DISTRICT ENGINEER

DATE APPROVED July 5, 1960



AS BUILT PLANS
Contract No. 11-11V13C.7
Date Completed
Document No. A0000331



THIS SET OF PLANS HAS BEEN CHANGED TO CORRESPOND TO THE "AS BUILT" PRINTS DATED 9-22-62, AS SUBMITTED BY RESIDENT ENGINEER M.W. Dorfer
FOUNDATIONS CONSOLIDATED BY [illegible] DATED 7-23-62

BRIDGE DEPARTMENT

128

FIELD STUDY	1-7-60	[illegible]
DRAWN	1-7-60	[illegible]
CHECKED	1-7-60	[illegible]
Layout Approved by		[illegible]

Classification of Material Based on Standard Grade Size Limits

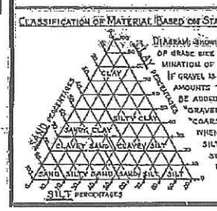


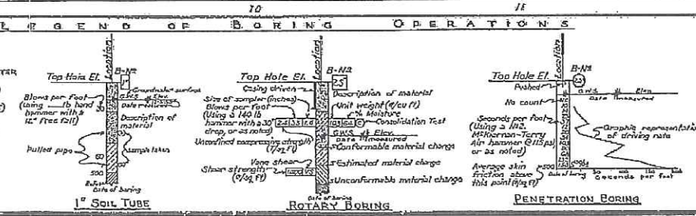
DIAGRAM SHOWING THE BASIS FOR ESTIMATES OF GRADE SIZE DISTRIBUTION USED IN DETERMINATION OF CLASS NAMES.
IF GRAVEL IS PRESENT IN APPRECIABLE AMOUNTS THE TERM "GRAVELLY" MAY BE ADDED TO THE CLASS NAME, VIZ. "GRAVELLY SAND". THE TERMS "COARSE", "MEDIUM" AND "FINE" WHEN USED TO DESCRIBE SAND, SILT AND GRAVEL REFER TO STANDARD GRADE SIZE LIMITS.

Legend of Earth Materials

- Gravel
- Sand
- Silt
- Clay
- Sandy Clay or Clayey Sand
- Sandy Silt or Silty Sand
- Silty Clay or Clayey Silt
- Peat and/or Organic Matter
- Fill Material
- Igneous Rock
- Sedimentary Rock
- Metamorphic Rock

Legend of Boring Operations

- Plan of Auger Boring
- Penetrometer
- 2½" Cone Penetrometer
- Sampler Boring (Dry)
- Rotary Boring (Wet)
- Auger Boring (Dry)
- Jet Boring
- Core Boring
- Test Pit



Notes

The contractor's attention is directed to Section 2-1.03 of the Standard Specifications and to the Special Provisions accompanying this set of plans.
Classification of earth material as shown on this sheet is based upon field inspection and is not to be construed to imply mechanical analysis.

STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

NORDAHL ROAD OVERCROSSING

LOG OF TEST BORINGS

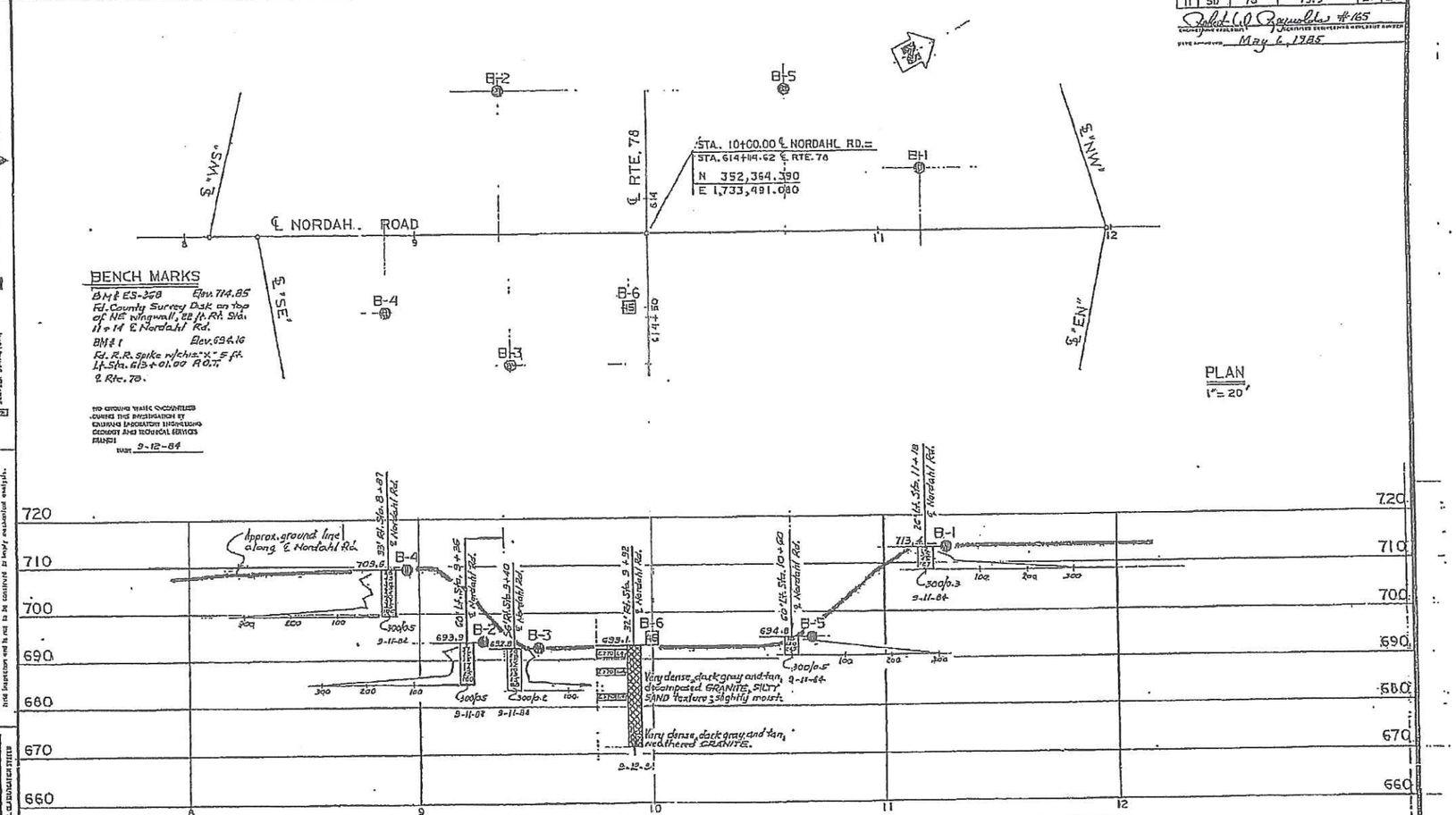
SCALE		BRIDGE	FILE	DRAWING
HORIZ. 1"=20'	VERT. 1"=10'	57-390		C-6264-7

PREL. DRAWING NO. P-6264 17 of 23

ClibPDF - www.fastio.com

DIST.	COUNTY	ROUTE	POST MILE	EA	
11	SD	78	15.5	26	2L

Robert L. Q. Reynolds #165
ENGINEER IN RESPONSIBLE CHARGE — REGISTERED ENGINEER OR PROJECT SURVEYOR
DATE SURVEYED May 6, 1985



ENGINEERING GEOLOGY BRANCH
FIELD STUDY Joseph Gau 9-12-84
DRAWN Victor Sestokas 9-12-84
CHECKED

State of CALIFORNIA DEPARTMENT OF TRANSPORTATION

STRUCTURES - DESIGN
BRIDGE NO. 57-390
POST MILE 15.5

NORDAHL ROAD OVERCROSSING (WIDEN)
LOG OF TEST BORINGS

CU 11206
WO 133491

ORIGINAL SCALE IS INCHES FOR REDUCED PLANS

SHEET 10 OF 10

26

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 8-16-86 SUPERVISOR OF HIGHWAYS

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
11	S. D.	SR 78	24.93		

REGISTERED CIVIL ENGINEER DATE

PLANSAPPROVALDATE

PETRA GEOTECHNICAL, INC.
3185-A AIRWAY AVENUE, COSTA MESA, CA 92626
PHONE: (714) 549-8921; FAX: (714) 549-1438

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CEMENTATION

Description	Criteria
Weak	Crumbles or breaks with handling or little finger pressure.
Moderate	Crumbles or breaks with considerable finger pressure.
Strong	Will not crumble or break with finger pressure.

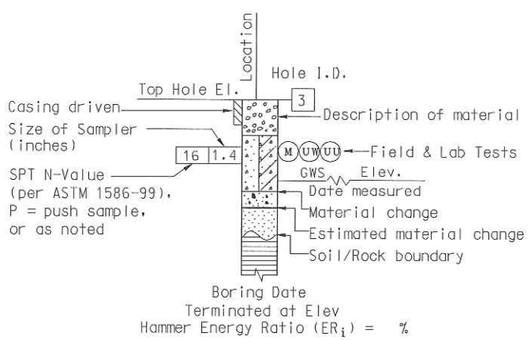
BOREHOLE IDENTIFICATION

Symbol	Hole Type	Description
Size	A	Auger Boring (hollow or solid stem bucket)
Size	R RW RC P	Rotary drilled boring (conventional) Rotary drilled with self-casing wire-line Rotary core with continuously-sampled, self-casing wire-line Rotary percussion boring (air)
Size	R	Rotary drilled diamond core
Size	HD HA	Hand driven (1-inch soil tube) Hand Auger
	D	Dynamic Cone Penetration Boring
	CPT	Cone Penetration Test (ASTM D 5778)
	O	Other (note on LOTB)

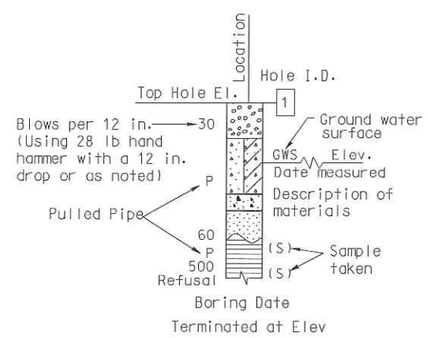
Note: Size in inches.

CONSISTENCY OF COHESIVE SOILS

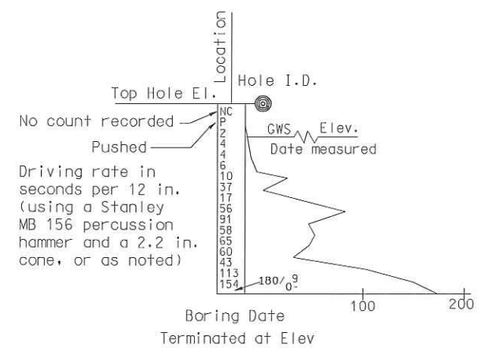
Description	Shear Strength (tsf)	Pocket Penetrometer Measurement, PP, (tsf)	Torvane Measurement, TV, (tsf)	Vane Shear Measurement, VS, (tsf)
Very Soft	Less than 0.12	Less than 0.25	Less than 0.12	Less than 0.12
Soft	0.12 - 0.25	0.25 - 0.5	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.5	0.5 - 1	0.25 - 0.5	0.25 - 0.5
Stiff	0.5 - 1	1 - 2	0.5 - 1	0.5 - 1
Very Stiff	1 - 2	2 - 4	1 - 2	1 - 2
Hard	Greater than 2	Greater than 4	Greater than 2	Greater than 2



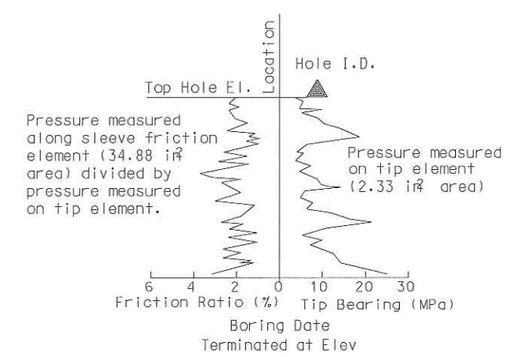
ROTARY BORING



HAND BORING



DYNAMIC CONE PENETRATION BORING



CONE PENETRATION TEST (CPT) BORING

ENGINEERING SERVICES		GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO. 57-1220	NORDAHL ROAD BRIDGE WIDENING
FUNCTIONAL SUPERVISOR:	DRAWN BY: N. Varadi	FIELD INVESTIGATION BY: Jon Cain, Senior Project Geologist		DESIGN BRANCH	POST MILE 15.5	LOG OF TEST BORINGS (1 OF 3)
	CHECKED BY: Monty Schultz					

GS LOTB SOIL LEGEND

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 11-273
EA 11-259801

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 28 OF 30

FILE -) $REQUEST

USERNAME -)$USER DATE PLOTTED -)$DATE TIME PLOTTED -) $TIME

REFERENCE: CALTRANS SOIL & ROCK LOGGING, CLASSIFICATION, AND PRESENTATION MANUAL (2010)

GROUP SYMBOLS AND NAMES

Graphic/Symbol	Group Names
GW	Well-graded GRAVEL Well-graded GRAVEL with SAND
GP	Poorly-graded GRAVEL Poorly-graded GRAVEL with SAND
GW-GM	Well-graded GRAVEL with SILT Well-graded GRAVEL with SILT and SAND
GW-GC	Well-graded GRAVEL with CLAY (or SILTY CLAY) Well-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GP-GM	Poorly-graded GRAVEL with SILT Poorly-graded GRAVEL with SILT and SAND
GP-GC	Poorly-graded GRAVEL with CLAY (or SILTY CLAY) Poorly-graded GRAVEL with CLAY and SAND (or SILTY CLAY and SAND)
GM	SILTY GRAVEL SILTY GRAVEL with SAND
GC	CLAYEY GRAVEL CLAYEY GRAVEL with SAND
GC-GM	SILTY, CLAYEY GRAVEL SILTY, CLAYEY GRAVEL with SAND
SW	Well-graded SAND Well-graded SAND with GRAVEL
SP	Poorly-graded SAND Poorly-graded SAND with GRAVEL
SW-SM	Well-graded SAND with SILT Well-graded SAND with SILT and GRAVEL
SW-SC	Well-graded SAND with CLAY (or SILTY CLAY) Well-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SP-SM	Poorly-graded SAND with SILT Poorly-graded SAND with SILT and GRAVEL
SP-SC	Poorly-graded SAND with CLAY (or SILTY CLAY) Poorly-graded SAND with CLAY and GRAVEL (or SILTY CLAY and GRAVEL)
SM	SILTY SAND SILTY SAND with GRAVEL
SC	CLAYEY SAND CLAYEY SAND with GRAVEL
SC-SM	SILTY, CLAYEY SAND SILTY, CLAYEY SAND with GRAVEL
PT	PEAT
	COBBLES COBBLES and BOULDERS BOULDERS

Graphic/Symbol	Group Names
CL	Lean CLAY Lean CLAY with SAND Lean CLAY with GRAVEL SANDY lean CLAY SANDY lean CLAY with GRAVEL GRAVELLY lean CLAY GRAVELLY lean CLAY with SAND
CL-ML	SILTY CLAY SILTY CLAY with SAND SILTY CLAY with GRAVEL SANDY SILTY CLAY SANDY SILTY CLAY with GRAVEL GRAVELLY SILTY CLAY GRAVELLY SILTY CLAY with SAND
ML	SILT SILT with SAND SILT with GRAVEL SANDY SILT SANDY SILT with GRAVEL GRAVELLY SILT GRAVELLY SILT with SAND
OL	ORGANIC lean CLAY ORGANIC lean CLAY with SAND ORGANIC lean CLAY with GRAVEL SANDY ORGANIC lean CLAY SANDY ORGANIC lean CLAY with GRAVEL GRAVELLY ORGANIC lean CLAY GRAVELLY ORGANIC lean CLAY with SAND
OL	ORGANIC SILT ORGANIC SILT with SAND ORGANIC SILT with GRAVEL SANDY ORGANIC SILT SANDY ORGANIC SILT with GRAVEL GRAVELLY ORGANIC SILT GRAVELLY ORGANIC SILT with SAND
CH	Fat CLAY Fat CLAY with SAND Fat CLAY with GRAVEL SANDY fat CLAY SANDY fat CLAY with GRAVEL GRAVELLY fat CLAY GRAVELLY fat CLAY with SAND
MH	Elastic SILT Elastic SILT with SAND Elastic SILT with GRAVEL SANDY elastic SILT SANDY elastic SILT with GRAVEL GRAVELLY elastic SILT GRAVELLY elastic SILT with SAND
OH	ORGANIC fat CLAY ORGANIC fat CLAY with SAND ORGANIC fat CLAY with GRAVEL SANDY ORGANIC fat CLAY SANDY ORGANIC fat CLAY with GRAVEL GRAVELLY ORGANIC fat CLAY GRAVELLY ORGANIC fat CLAY with SAND
OH	ORGANIC elastic SILT ORGANIC elastic SILT with SAND ORGANIC elastic SILT with GRAVEL SANDY ORGANIC elastic SILT SANDY ORGANIC elastic SILT with GRAVEL GRAVELLY ORGANIC elastic SILT GRAVELLY ORGANIC elastic SILT with SAND
OL/OH	ORGANIC SOIL ORGANIC SOIL with SAND ORGANIC SOIL with GRAVEL SANDY ORGANIC SOIL SANDY ORGANIC SOIL with GRAVEL GRAVELLY ORGANIC SOIL GRAVELLY ORGANIC SOIL with SAND

FIELD AND LABORATORY TESTING

- (C) Consolidation (ASTM D 2435)
- (CL) Collapse Potential (ASTM D 5333)
- (CP) Compaction Curve (CTM 216)
- (CR) Corrosivity Testing (CTM 643, CTM 422, CTM 417)
- (CU) Consolidated Undrained Triaxial (ASTM D 4767)
- (DS) Direct Shear (ASTM D 3080)
- (EI) Expansion Index (ASTM D 4829)
- (M) Moisture Content (ASTM D 2216)
- (OC) Organic Content-% (ASTM D 2974)
- (P) Permeability (CTM 220)
- (PA) Particle Size Analysis (ASTM D 422)
- (PI) Plasticity Index (AASHTO T 90) Liquid Limit (AASHTO T 89)
- (PL) Point Load Index (ASTM D 5731)
- (PM) Pressure Meter
- (R) R-Value (CTM 301)
- (SE) Sand Equivalent (CTM 217)
- (SG) Specific Gravity (AASHTO T 100)
- (SL) Shrinkage Limit (ASTM D 427)
- (SW) Swell Potential (ASTM D 4546)
- (UC) Unconfined Compression-Soil (ASTM D 2166) Unconfined Compression-Rock (ASTM D 2938)
- (UU) Unconsolidated Undrained Triaxial (ASTM D 2850)
- (UW) Unit Weight (ASTM D 4767)

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
11	S. D.	SR 78	24.93		

REGISTERED CIVIL ENGINEER DATE

PLANSAPPROVALDATE

PETRA GEOTECHNICAL, INC.
3185-A AIRWAY AVENUE, COSTA MESA, CA 92626
PHONE: (714) 549-8921; FAX: (714) 549-1438

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APPARENT DENSITY OF COHESIONLESS SOILS

Description	SPT N_{60} (Blows / 12 in.)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	Greater than 50

MOISTURE

Description	Criteria
Dry	No discernable moisture
Moist	Moisture present, but no free water
Wet	Visible free water

PERCENT OR PROPORTION OF SOILS

Description	Criteria
Trace	Particles are present but estimated to be less than 5%
Few	5% - 10%
Little	15% - 25%
Some	30% - 45%
Mostly	50% - 100%

PARTICLE SIZE

Description		Size (in.)
Boulder		Greater than 12
Cobble		3 - 12
Gravel	Coarse	3/4 - 3
	Fine	1/5 - 3/4
Sand	Coarse	1/16 - 1/5
	Medium	1/64 - 1/16
	Fine	1/300 - 1/64
Silt and Clay		Less than 1/300

ENGINEERING SERVICES
FUNCTIONAL SUPERVISOR:
DRAWN BY: N. Varadi
CHECKED BY: Monty Schultz

GEOTECHNICAL SERVICES
FIELD INVESTIGATION BY: Jon Cain, Senior Project Geologist

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

DIVISION OF ENGINEERING SERVICES
STRUCTURE DESIGN
DESIGN BRANCH

BRIDGE NO. 57-1220
POST MILE 15.5

NORDAHL ROAD BRIDGE WIDENING
LOG OF TEST BORINGS (2 OF 3)

GS LOTB SOIL LEGEND

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 11-273
EA 11-259801

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

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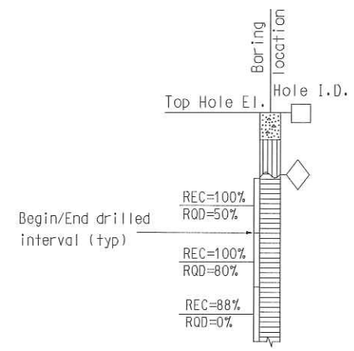
PERCENT CORE RECOVERY (REC) & ROCK QUALITY DESIGNATION (RQD)

$$REC = \frac{\sum \text{Length of the recovered core pieces (in.)}}{\text{Total length of core run (in.)}} \times 100\%$$

$$RQD = \frac{\sum \text{Length of intact core pieces} \geq 4 \text{ in.}}{\text{Total length of core run (in.)}} \times 100\%$$

RQD* Indicates soundness criteria not met.



BEDDING SPACING

Description	Thickness / Spacing
Massive	Greater than 10 ft
Very Thickly Bedded	3 ft - 10 ft
Thickly Bedded	1 ft - 3 ft
Moderately Bedded	4 in. - 1 ft
Thinly Bedded	1 in. - 4 in.
Very Thinly Bedded	1/4 in. - 1 in.
Laminated	Less than 1/4 in.

LEGEND OF ROCK MATERIALS

- IGNEOUS ROCK
- SEDIMENTARY ROCK
- METAMORPHIC ROCK

ROCK HARDNESS

Description	Criteria
Extremely Hard	Cannot be scratched with a pocketknife or sharp pick. Can only be chipped with repeated heavy hammer blows.
Very Hard	Cannot be scratched with a pocketknife or sharp pick. Breaks with repeated heavy hammer blows.
Hard	Can be scratched with a pocketknife or sharp pick with difficulty (heavy pressure). Breaks with heavy hammer blows.
Moderately Hard	Can be scratched with pocketknife or sharp pick with light or moderate pressure. Breaks with moderate hammer blows.
Moderately Soft	Can be grooved 1/16 in. deep with a pocketknife or sharp pick with moderate or heavy pressure. Breaks with light hammer blow or heavy manual pressure.
Soft	Can be grooved or gouged easily by a pocketknife or sharp pick with light pressure, can be scratched with fingernail. Breaks with light to moderate manual pressure.
Very Soft	Can be readily indented, grooved or gouged with fingernail, or carved with a pocketknife. Breaks with light manual pressure.

FRACTURE DENSITY

Description	Observed Fracture Density
Unfractured	No fractures.
Very Slightly Fractured	Core lengths greater than 3 ft.
Slightly Fractured	Core lengths mostly from 1 to 3 ft.
Moderately Fractured	Core lengths mostly from 4 in. to 1 ft.
Intensely Fractured	Core lengths mostly from 1 to 4 in.
Very Intensely Fractured	Mostly chips and fragments.

WEATHERING DESCRIPTORS FOR INTACT ROCK

Description	Diagnostic Features					General Characteristics
	Chemical Weathering-Discoloration and/or Oxidation		Mechanical Weathering-Grain Boundary Conditions (Disaggregation) Primarily for Granitics and Some Coarse-Grained Sediments	Texture and Leaching		
	Body of Rock	Fracture Surfaces		Texture	Leaching	
Fresh	No discoloration, not oxidized.	No discoloration or oxidation.	No separation, intact (tight).	No change	No leaching	Hammer rings when crystalline rocks are struck.
Slightly Weathered	Discoloration or oxidation is limited to surface of, or short distance from, fractures; some feldspar crystals are dull.	Minor to complete discoloration or oxidation of most surfaces.	No visible separation, intact (tight).	Preserved	Minor leaching of some soluble minerals.	Hammer rings when crystalline rocks are struck. Body of rock not weakened.
Moderately Weathered	Discoloration or oxidation extends from fractures usually throughout; Fe-Mg minerals are "rusty," feldspar crystals are "cloudy."	All fracture surfaces are discolored or oxidized.	Partial separation of boundaries visible.	Generally preserved	Soluble minerals may be mostly leached.	Hammer does not ring when rock is struck. Body of rock is slightly weakened.
Intensely Weathered	Discoloration or oxidation throughout; all feldspars and Fe-Mg minerals are altered to clay to some extent; or chemical alteration produces in-situ disaggregation, see grain boundary conditions.	All fracture surfaces are discolored or oxidized, surfaces friable.	Partial separation, rock is friable; in semiarid conditions granitics are disaggregated.	Texture altered by chemical disintegration (hydration, argillation).	Leaching of soluble minerals may be complete.	Dull sound when struck with hammer, usually can be broken with moderate to heavy manual pressure or by light hammer blow without reference to planes of weakness such as incipient or hairline fractures, or veinlets. Rock is significantly weakened.
Decomposed	Discolored or oxidized throughout, but resistant minerals such as quartz may be unaltered; all feldspars and Fe-Mg minerals are completely altered to clay.		Complete separation of grain boundaries (disaggregated).	Resembles a soil, partial or complete remnant rock structure may be preserved; leaching of soluble minerals usually complete.		Can be granulated by hand. Resistant minerals such as quartz may be present as "stringers" or "dikes."

ENGINEERING SERVICES		GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN DESIGN BRANCH	BRIDGE NO. 57-1220 POST MILE 15.5	NORDAHL ROAD BRIDGE WIDENING
FUNCTIONAL SUPERVISOR:	DRAWN BY: N. Varadi	PREPARED BY: Jon Cain, Senior Project Geologist				LOG OF TEST BORINGS (3 OF 3)
	CHECKED BY: Monty Schultz					

GS LOTB ROCK LEGEND

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 11-273
EA 11-259801

FILE -) $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 30 OF 30

USERNAME -$USER DATE PLOTTED -) $DATE TIME PLOTTED -) $TIME

BENCHMARK:

Monument is 2.24 inch CADT Brass Disk stamped "78-15.5 1988", located in sidewalk on the Southeast side of the bridge on Nordahl Road over Rte 78, 36.4 feet North of the South corner of the bridge.
Elevation: 714.128 feet
Datum: NAVD 1988

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
11	S. D.	SR 78	24.93	1	3

CERTIFIED ENGINEERING GEOLOGIST

PLANS APPROVAL DATE

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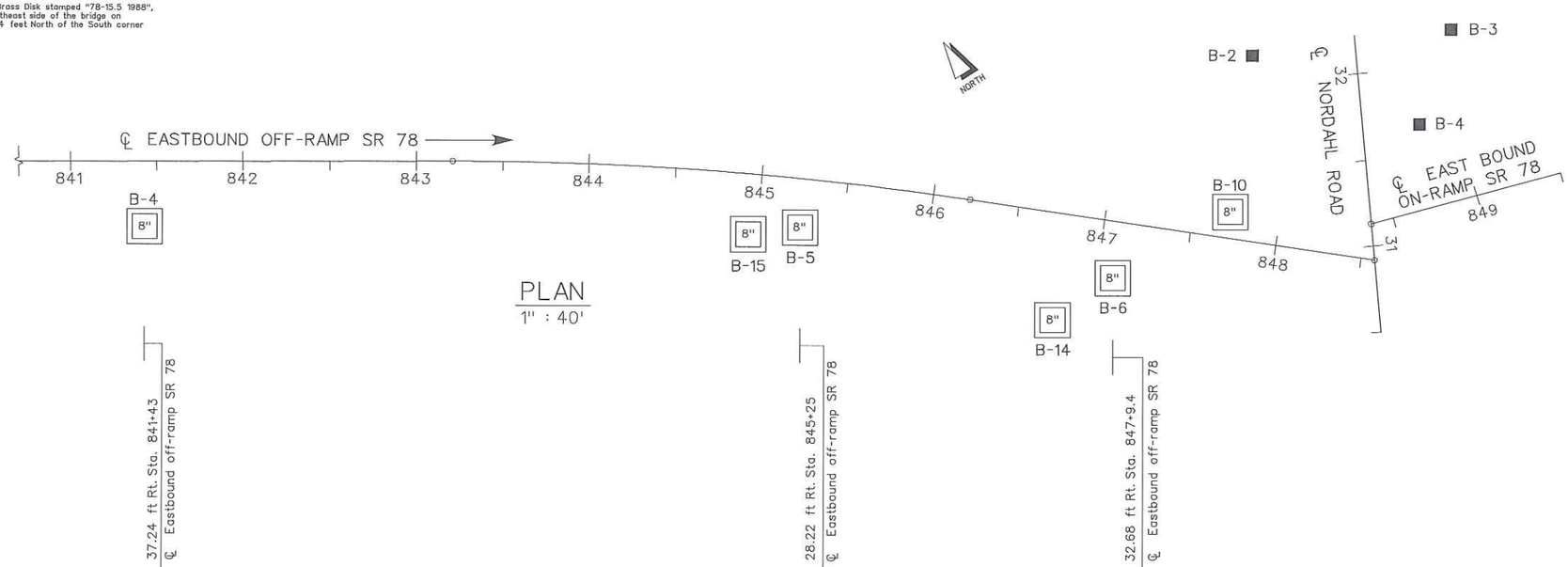
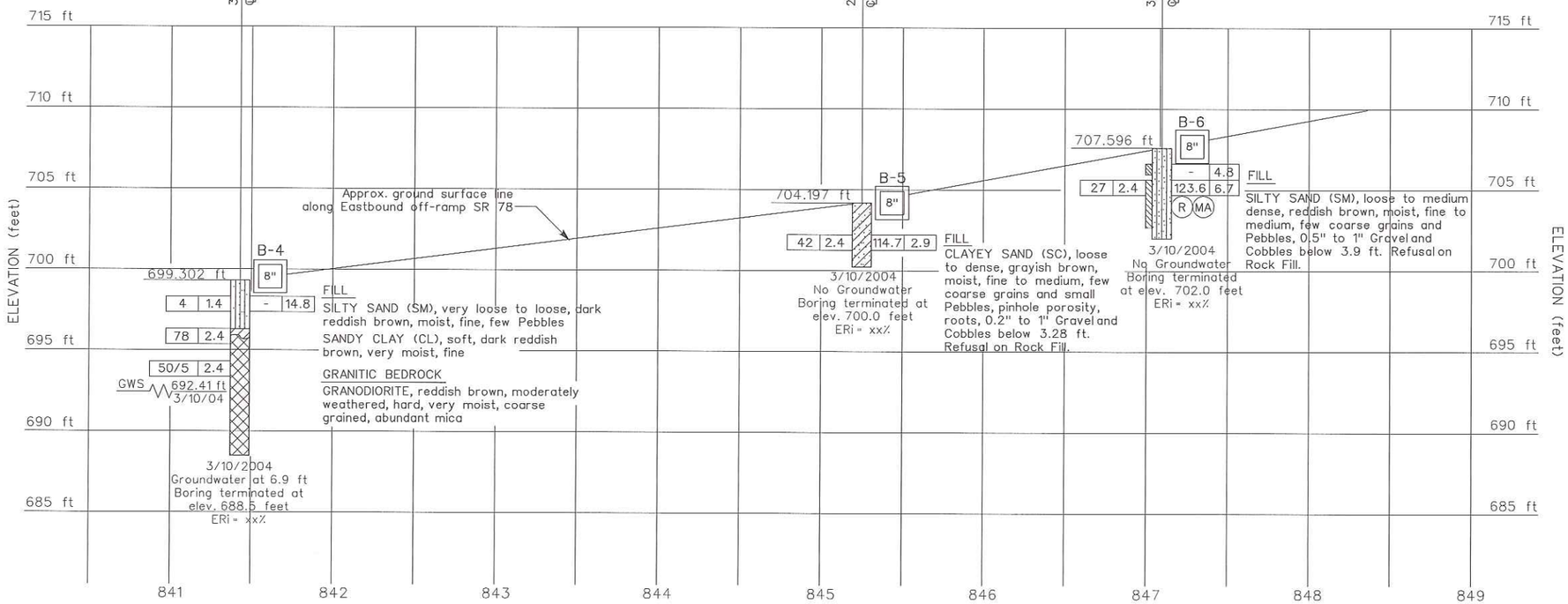


PLAN
1" : 40'



PROFILE
HOR. 1" : 40'
VER. 1" : 4'

NOTES:

1) TEST BORINGS B-1 THROUGH B-13 WERE DRILLED UTILIZING A CME-55 DRILL RIG EQUIPPED WITH HOLLOW-STEM AUGER.

2) TEST BORINGS B-14 AND B-15 WERE DRILLED UTILIZING A LIMITED ACCESS, MINIMOLE DRILL RIG EQUIPPED WITH CONTINUOUS FLIGHT AUGER.

3) THE APPROXIMATE BORING COORDINATES AND ELEVATIONS ARE BASED ON THE TOPOGRAPHIC MAP PROVIDED BY DOKKEN ENGINEERING.

4) 2.4-INCH SAMPLES WERE TAKEN USING A MODIFIED CALIFORNIA SPLIT-SPOON SAMPLER WITH AN INSIDE DIAMETER OF 2.4 INCHES AND OUTSIDE DIAMETER OF 3-INCHES.

5) A 140 LB. CME AUTOMATIC HAMMER FALLING 30 INCHES WAS USED TO DRIVE THE SAMPLER.

6) VISUAL CLASSIFICATION OF EARTH MATERIALS WAS BASED ON FIELD INSPECTION AND WAS CONFIRMED OR REVISED WITH LABORATORY TEST RESULTS.

7) THE BORING LOGS AND RELATED INFORMATION REPRESENT THE OPINION OF THE GEOLOGIST/ENGINEER AS TO THE CHARACTER OF THE MATERIAL AT THE LOCATIONS SHOWN. SOIL AND GROUNDWATER CONDITIONS BETWEEN ADJACENT TEST BORINGS AND AT OTHER LOCATIONS MAY DIFFER FROM THOSE SHOWN. GROUNDWATER CONDITIONS MAY CHANGE WITH TIME.

8) THIS LOTB WAS PREPARED IN ACCORDANCE WITH THE CALTRANS SOIL AND ROCK LOGGING, CLASSIFICATION AND PRESENTATION MANUAL (2010).

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NAME:	CHECKED BY: Monty Schultz					
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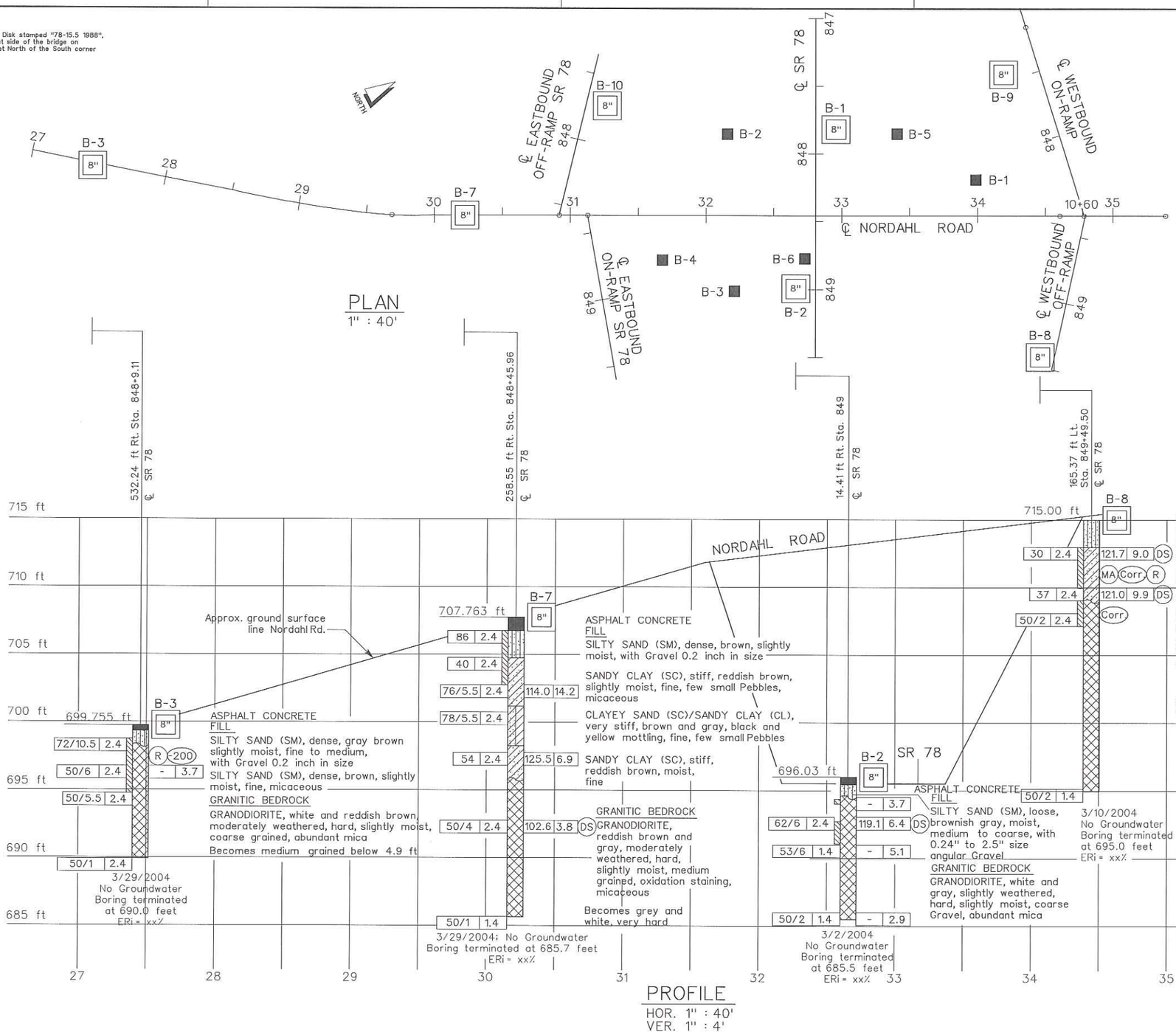

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FUNCTIONAL SUPERVISOR	DRAWN BY: N. Varadi	FIELD INVESTIGATION BY:		DESIGN BRANCH	POST MILES 15.5	LOG OF TEST BORINGS (2 OF 5)
NAME:	CHECKED BY: Monty Schultz	Jon Cain, Senior Project Geologist				

OGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 11-273
EA 11-259801

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REVISION DATES

SHEET 24 OF 30

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DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
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CERTIFIED ENGINEERING GEOLOGIST

PLANS APPROVAL DATE

PETRA GEOTECHNICAL, INC.
3185-A AIRWAY AVENUE, COSTA MESA, CA 92626
PHONE: (714) 549-8921; FAX: (714) 549-1438

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.

BENCHMARK:

Monument is 2.24 inch CADT Brass Disk stamped "78-15.5 1988", located in sidewalk on the Southeast side of the bridge on Nordahl Road over Rte 78, 38.4 feet North of the South corner of the bridge.
Elevation: 714.128 feet
Datum: NAVD 1988

NOTES:

1) TEST BORINGS B-1 THROUGH B-13 WERE DRILLED UTILIZING A CME-55 DRILL RIG EQUIPPED WITH HOLLOW-STEM AUGER.

2) TEST BORINGS B-14 AND B-15 WERE DRILLED UTILIZING A LIMITED ACCESS, MINI MOLE DRILL RIG EQUIPPED WITH CONTINUOUS FLIGHT AUGER.

3) THE APPROXIMATE BORING COORDINATES AND ELEVATIONS ARE BASED ON THE TOPOGRAPHIC MAP PROVIDED BY DOKKEN ENGINEERING.

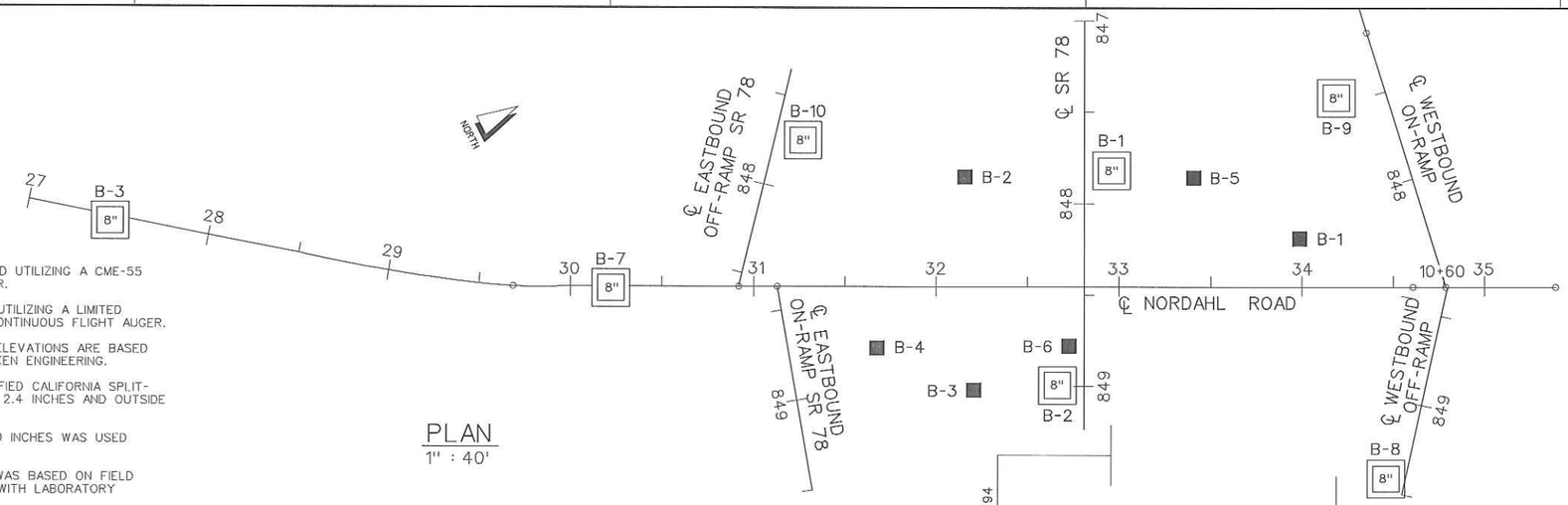
4) 2.4-INCH SAMPLES WERE TAKEN USING A MODIFIED CALIFORNIA SPLIT-SPOON SAMPLER WITH AN INSIDE DIAMETER OF 2.4 INCHES AND OUTSIDE DIAMETER OF 3-INCHES.

5) A 140 LB. CME AUTOMATIC HAMMER FALLING 30 INCHES WAS USED TO DRIVE THE SAMPLER.

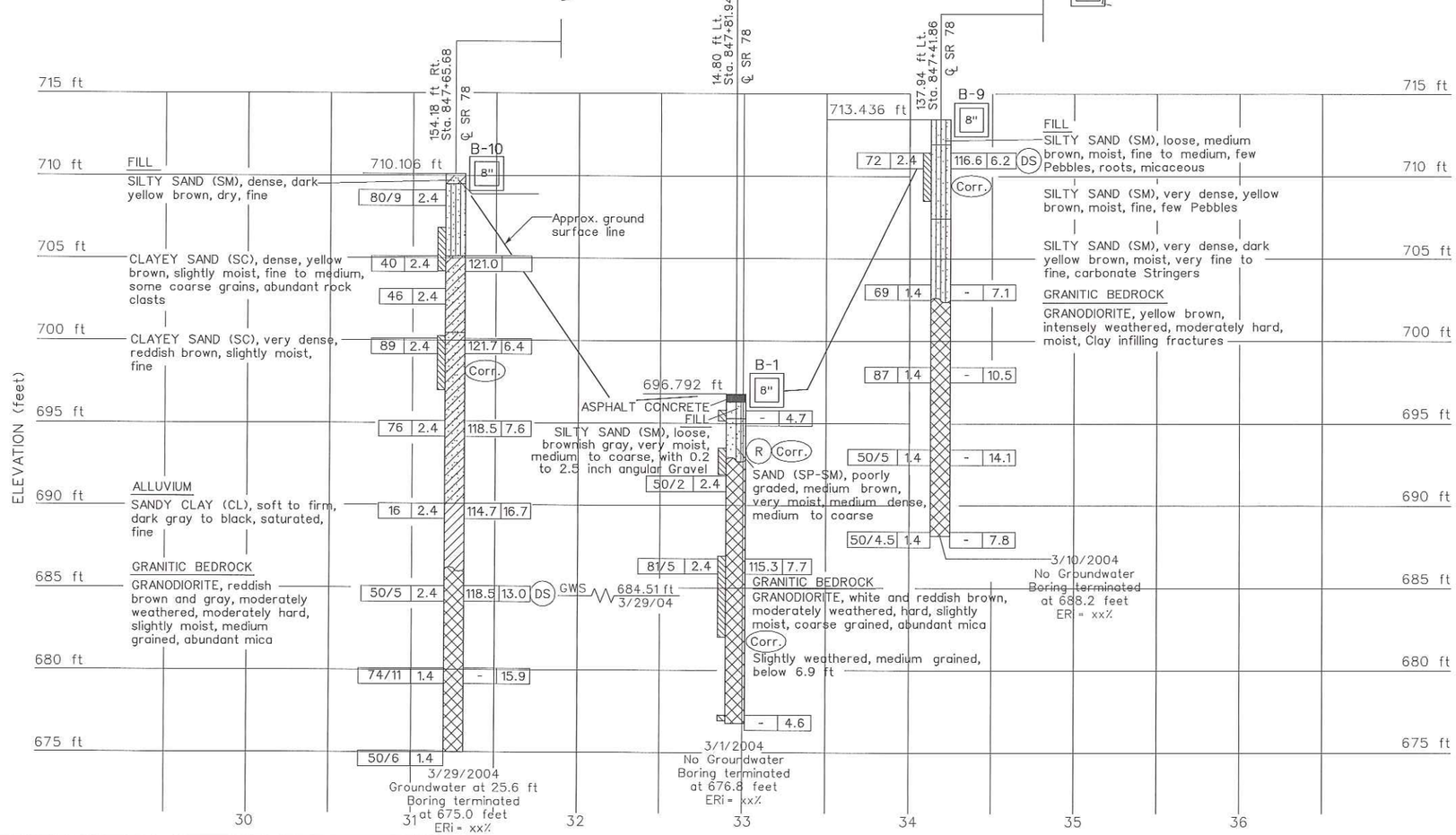
6) VISUAL CLASSIFICATION OF EARTH MATERIALS WAS BASED ON FIELD INSPECTION AND WAS CONFIRMED OR REVISED WITH LABORATORY TEST RESULTS.

7) THE BORING LOGS AND RELATED INFORMATION REPRESENT THE OPINION OF THE GEOLOGIST/ENGINEER AS TO THE CHARACTER OF THE MATERIAL AT THE LOCATIONS SHOWN. SOIL AND GROUNDWATER CONDITIONS BETWEEN ADJACENT TEST BORINGS AND AT OTHER LOCATIONS MAY DIFFER FROM THOSE SHOWN. GROUNDWATER CONDITIONS MAY CHANGE WITH TIME.

8) THIS LOTB WAS PREPARED IN ACCORDANCE WITH THE CALTRANS SOIL AND ROCK LOGGING, CLASSIFICATION AND PRESENTATION MANUAL (2010).



PLAN
1" : 40'



PROFILE
HOR. 1" : 40'
VER. 1" : 4'

ENGINEERING SERVICES	GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN	BRIDGE NO. 57-1220	NORDAHL ROAD BRIDGE WIDENING
FUNCTIONAL SUPERVISOR	DRAWN BY: N. Varadi	FIELD INVESTIGATION BY: Jon Cain, Senior Project Geologist	DESIGN BRANCH	POST MILES 15.5	LOG OF TEST BORINGS (3 OF 5)
NAME:	CHECKED BY: Monty Schultz				

OGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 11-273
EA 11-259801

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES: FEB. 08 2007; SEP. 16 2009

SHEET 25 OF 30

FILE -) $REQUEST

USERNAME -)$USER DATE PLOTTED -)$DATE TIME PLOTTED -) $TIME

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Elevation: 714.128 feet
Datum: NAVD 1988

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
11	S.D.	SR 78	24.93	1	3

CERTIFIED ENGINEERING GEOLOGIST

PLANS APPROVAL DATE

PETRA GEOTECHNICAL, INC.
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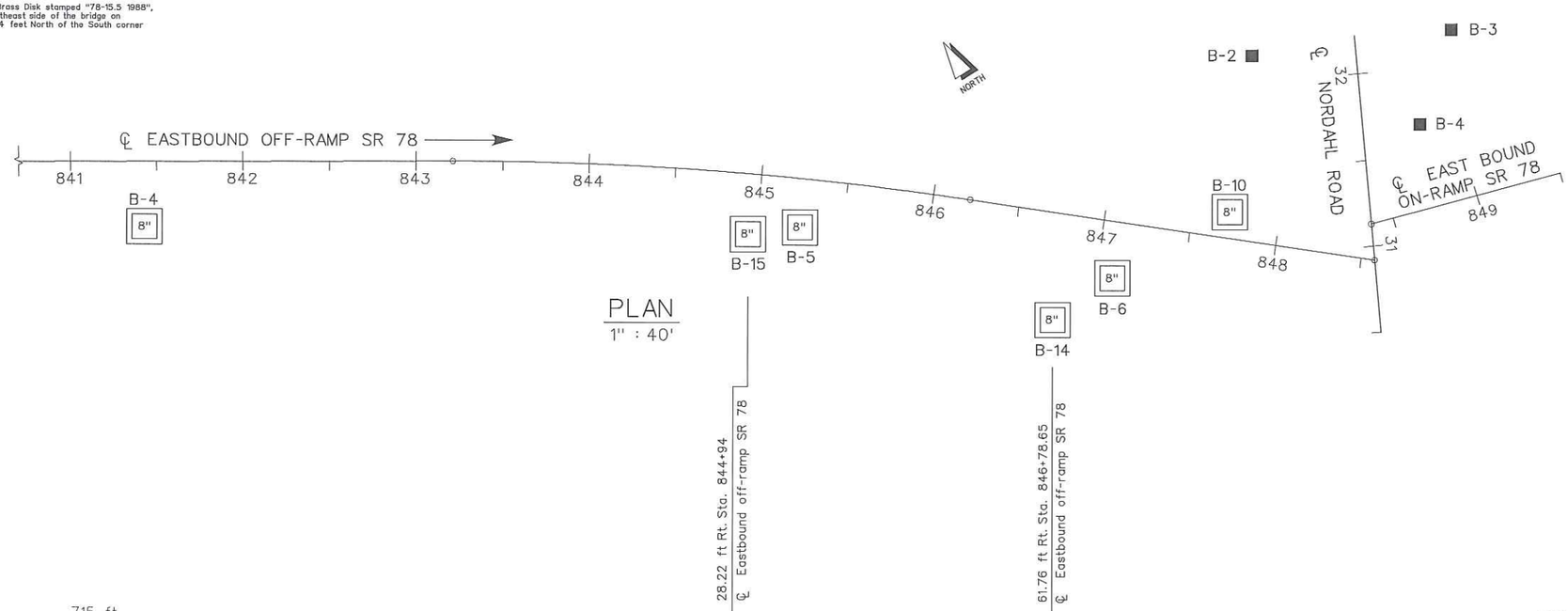
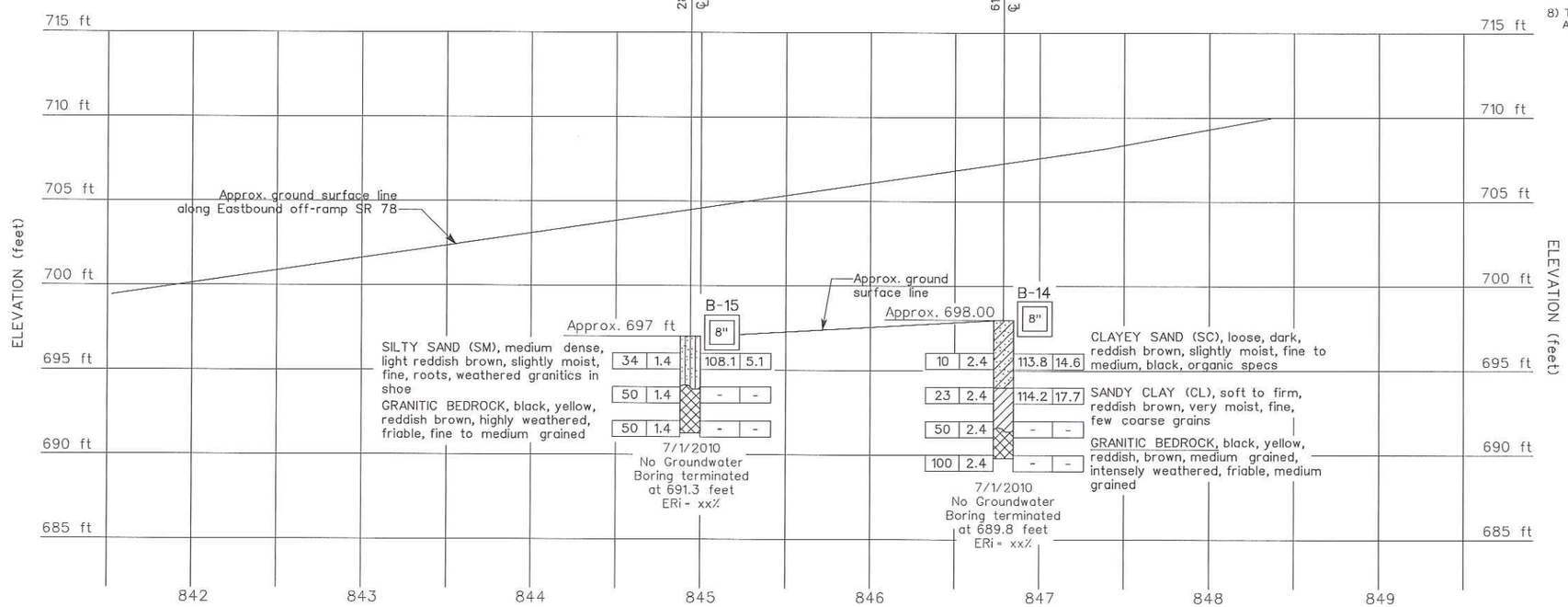


PLAN
1" : 40'



PROFILE
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VER. 1" : 4'

NOTES:

1) TEST BORINGS B-1 THROUGH B-13 WERE DRILLED UTILIZING A CME-55 DRILL RIG EQUIPPED WITH HOLLOW-STEM AUGER.

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ENGINEERING SERVICES		GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN DESIGN BRANCH	BRIDGE NO. 57-1220 POST MILES 15.5	NORDAHL ROAD BRIDGE WIDENING LOG OF TEST BORINGS (4 OF 5)
FUNCTIONAL SUPERVISOR	DRAWN BY: N. Varadi	FIELD INVESTIGATION BY: Jon Cain, Senior Project Geologist				
NAME:	CHECKED BY: Monty Schultz					

OGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 11-273
EA 11-259801

FILE => $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES → FEB. 08 2007 | SEP. 16 2009

REVISION DATES

SHEET 26 OF 30

USERNAME => $USER DATE PLOTTED => $DATE TIME PLOTTED => $TIME

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Datum: NAVD 1988

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET No	TOTAL SHEETS
11	S. D.	SR 78	24.93	1	1

CERTIFIED ENGINEERING GEOLOGIST

PLANS APPROVAL DATE

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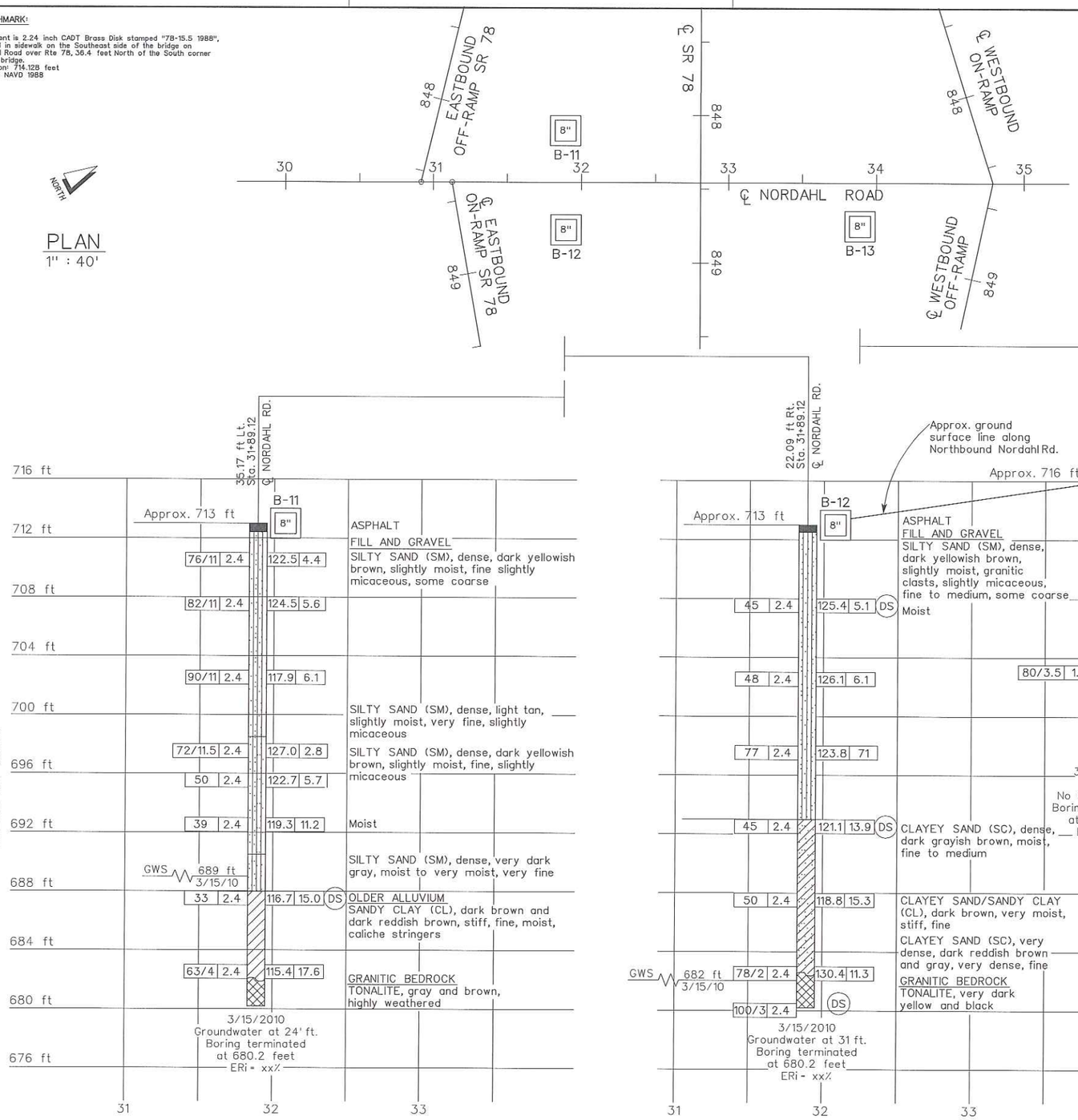

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PROFILE
HOR. 1" : 40'
VER. 1" : 4'

ENGINEERING SERVICES		GEOTECHNICAL SERVICES	STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	DIVISION OF ENGINEERING SERVICES STRUCTURE DESIGN DESIGN BRANCH	BRIDGE NO. 57-1220 POST MILES 15.5	NORDAHL ROAD BRIDGE WIDENING LOG OF TEST BORINGS (5 OF 5)
FUNCTIONAL SUPERVISOR	DRAWN BY: N. Varadi	FIELD INVESTIGATION BY: Jon Cain, Senior Project Geologist				
NAME:	CHECKED BY: Monty Schultz					

OGS CIVIL LOG OF TEST BORINGS SHEET

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

CU 11-273
EA 11-259801

FILE -) $REQUEST

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES

SHEET 27 OF 30

USERNAME -)$USER DATE PLOTTED -) $DATE TIME PLOTTED -) $TIME

EXPLORATION LOG

Project: **Nordahl Bridge Widening**		Boring No.: **HA-1**	
Location: **San Marcos, CA**		Elevation: **N/A**	
Job No.: **329-03**	Client: **Simon Wong Engineering**	Date: **3/11/10**	
Drill Method: **Hand Auger**	Driving Weight:	Logged By: **TM/LH**	

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		ALLUVIUM (Qal) Silty SAND (SM): reddish brown, moist, loose.							
1					■		13.5	109.8	
2									
3		**OLDER ALLUVIUM (Qoal)** SAND with Silt (SP-SM): olive brown, moist, very dense; poorly graded.			■				
4									
5					■				
		Total Depth 5.5 Feet No Groundwater encountered.							

PLATE A-1

EXPLORATION LOG

Project: **Nordahl Bridge Widening**		Boring No.: **HA-2**	
Location: **San Marcos, CA**		Elevation: **N/A**	
Job No.: **329-03**	Client: **Simon Wong Engineering**	Date: **3/11/10**	
Drill Method: **Hand Auger**	Driving Weight:	Logged By: **TM/LH**	

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		ALLUVIUM (Qal) Sandy SILT (ML): reddish brown, wet, soft.							
1					■				
2									
		OLDER ALLUVIUM (Qoal) Sandy CLAY (CL): reddish brown, saturated, very stiff.	▽						
3									
4		Silty SAND (SM): reddish brown, moist, very dense.			■		18.3	116.9	
5									
6		Sandy SILT(ML): brown, wet, stiff.			■				
		Total Depth 6.5 Feet Groundwater Encountered at 2.5 Feet.							

PLATE A-2

EXPLORATION LOG

Project: **Nordahl Bridge Widening**		Boring No.: **HA-3**	
Location: **San Marcos, CA**		Elevation: **N/A**	
Job No.: **329-03**	Client: **Simon Wong Engineering**	Date: **3/11/10**	
Drill Method: **Hand Auger**	Driving Weight:	Logged By: **TM/LH**	

Depth (Feet)	Lith-ology	Material Description	Water	Samples: Blows Per Foot	Samples: Core	Samples: Bulk	Laboratory Tests: Moisture Content (%)	Laboratory Tests: Dry Density (pcf)	Laboratory Tests: Other Lab Tests
		ALLUVIUM (Qal) Silty SAND (SM): yellow brown, moist, medium dense.							
1					■		8.5	115.3	
2									
3		**OLDER ALLUVIUM (Qoal)** Silty SAND (SM): yellowish brown,moist, very dense.			■		10.7	116.4	
4									
5		Medium dense.			■				
6									
7		Wet, very dense Groundwater Encountered.	▽		■				
		Total Depth 7.5 Feet Grounwater Encountered at 7 Feet.							

PLATE A-3

APPENDIX B

LABORATORY TEST CRITERIA/LABORATORY TEST DATA

PETRA

APPENDIX B

Laboratory Test Criteria

Soil Classification

Soils encountered within the exploration borings were initially classified in the field in general accordance with the visual-manual procedures of the Unified Soil Classification System (ASTM D2488). The samples were re-examined in the laboratory and the classifications reviewed and then revised where appropriate. The assigned group symbols are presented on the Log of Test Borings (Sheets 1 through 3).

In-Situ Moisture and Density

Moisture content and unit dry density of in-place soil and bedrock materials were determined in accordance with California Test Method (CTM) 226 and ASTM D2937. Test data are summarized on the Log of Test Borings (Sheets 1 through 3).

Corrosion Tests

Chemical analyses were performed on selected samples of onsite soil to determine concentrations of soluble sulfate and chloride, as well as pH and resistivity. These tests were performed in accordance with CTM 417 (sulfate), 422 (chloride) and 643 (pH and resistivity). Test results are included on Plate B-1.

R-Value

R-value tests were performed on selected samples of soil from the site. The purpose of this test was to provide data with respect to design of structural pavement sections. The R-value tests were performed in accordance with CTM 301. Test data are presented on Plate B-1.

Direct Shear

The Coulomb shear strength parameters, angle of internal friction and cohesion, were determined for undisturbed samples. These tests were performed in general accordance with CTM 222. Three specimens were prepared for each test. The test specimens were artificially saturated, and then sheared under varied normal loads at a maximum constant rate of strain of 0.05 inches per minute. Results are summarized on Plates B-2 through B-7.

Grain-Size Analysis

Grain-size analyses were performed on selected samples to verify visual classifications performed in the field. These tests were performed in accordance with CTM 202 and 203. Test results are presented on Plates B-8 and B-9.

SIMON WONG ENGINEERING, INC.
Nordahl Road Overcrossing Replacement

July 28, 2010
J.N. 329-03
E.A. 11-259801
Plate B-1

CORROSION TESTS

Boring/Depth (ft)	Sulfate[1] (ppm	Chloride[2] (ppm)	pH[3]	Resistivity[4] (ohm-cm)
B-1 @ 3 - 5	120	140	8.2	7,000
B-1 @ 10 - 15	80	145	8.5	7,200
B-8 @ 2 - 5	120	170	8.3	8,500
B-8 @ 6 - 8	80	200	7.1	8,600
B-9 @ 2 - 5	80	185	7.8	8,800
B-10 @ 10 - 13	160	150	8.0	3,400

R-VALUE TESTS

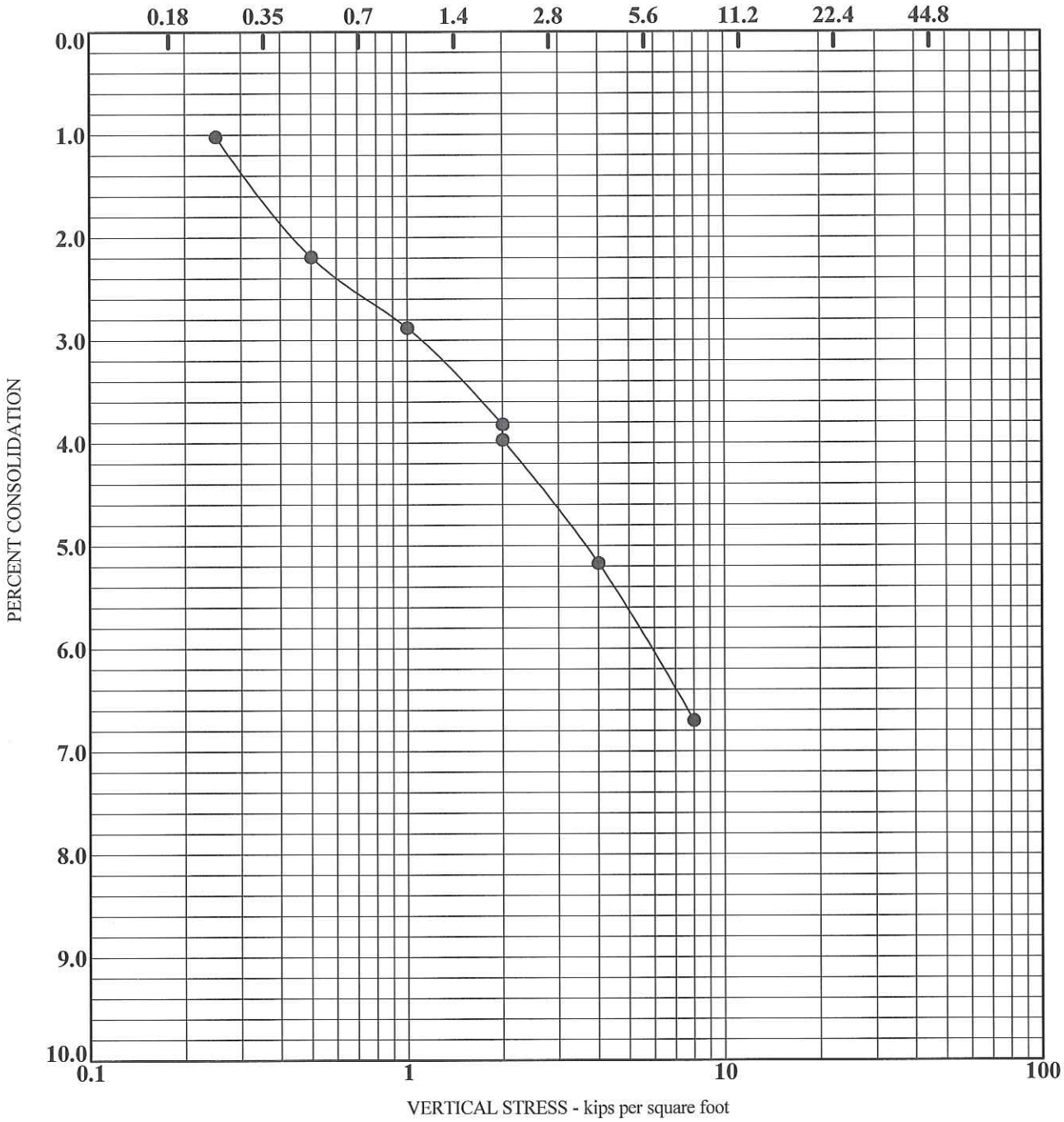
Boring/Depth (ft)	Soil Type	R-Value[5]
B-1 @ 3 - 5	Brown, medium to coarse SAND (SP)	67
B-3 @ 1 - 5	Brown Silty SAND (SM)	73
B-6 @ 2 - 5	Reddish brown, fine to medium Silty SAND (SM)	67
B-8 @ 2 - 5	Brown, Clayey fine SAND (SC)	75
C-5 @ 1	Redish brown, Silty Sand (DG)	73
C-9 @ 1	Redish brown, Silty Sand (DG)	68

WET SIEVE NO. 200 TEST[6]

Boring/Depth (ft)	Soil Type	Percent Passing No. 200 Sieve (%)
B-3 @ 1 - 5	Grey brown Silty SAND (SM)	16.8

(1) PER CTM 417
(2) PER CTM 422
(3) PER CTM 643
(4) PER CTM 643
(5) PER CTM 301
(6) PER CTM 202

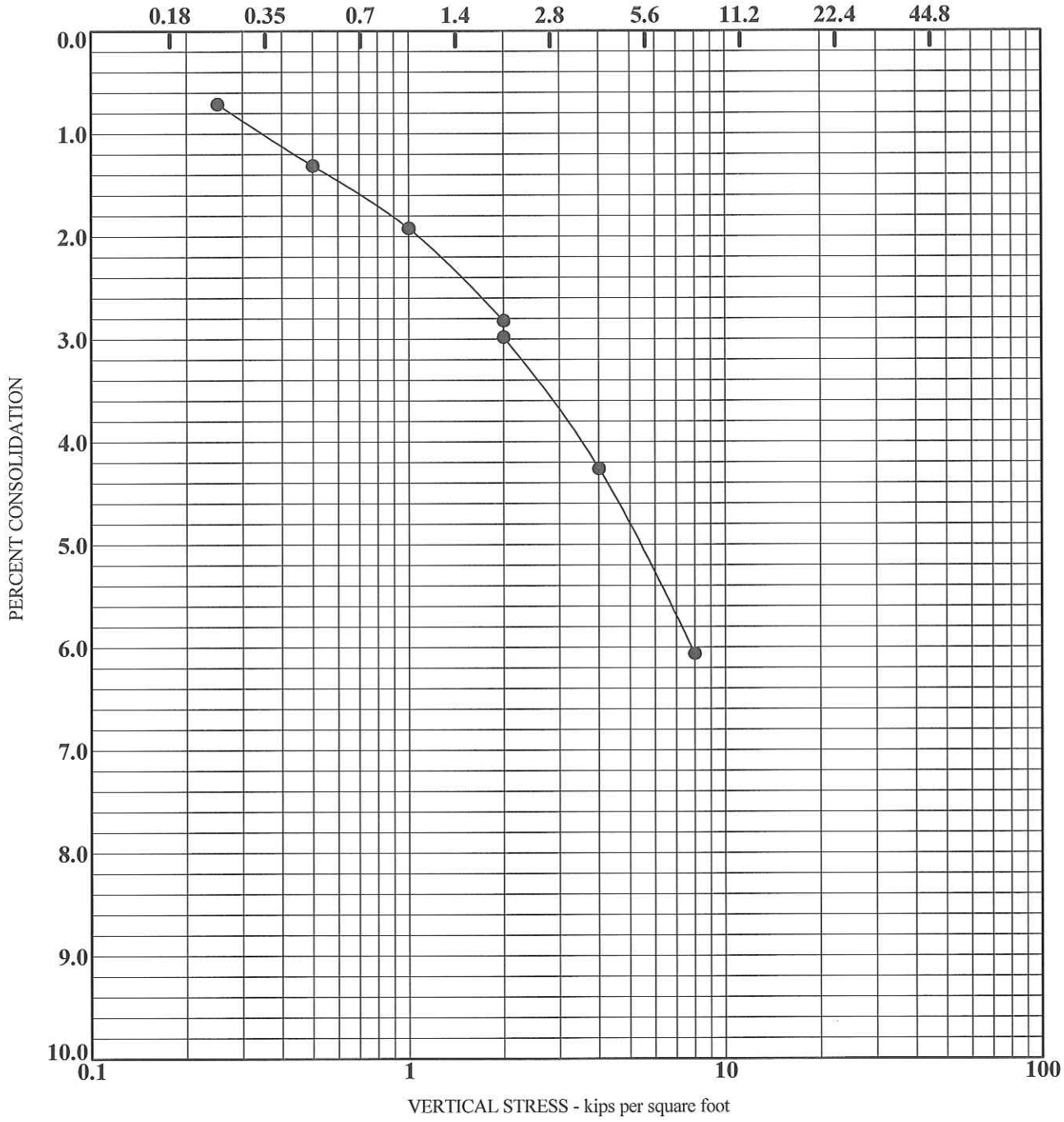
SAMPLE LOCATION	MATERIAL DESCRIPTION	INITIAL			INUNDATED
		DENSITY (pcf)	MOISTURE (%)	SATURATION (%)	LOAD (ksf)
● HA2 @ 1.0	Silty Sand (SM)	104.0	18.7	81	2.00



J.N. 329-03	CONSOLIDATION TEST RESULTS	July, 2010
PETRA GEOTECHNICAL, INC.		PLATE B-2

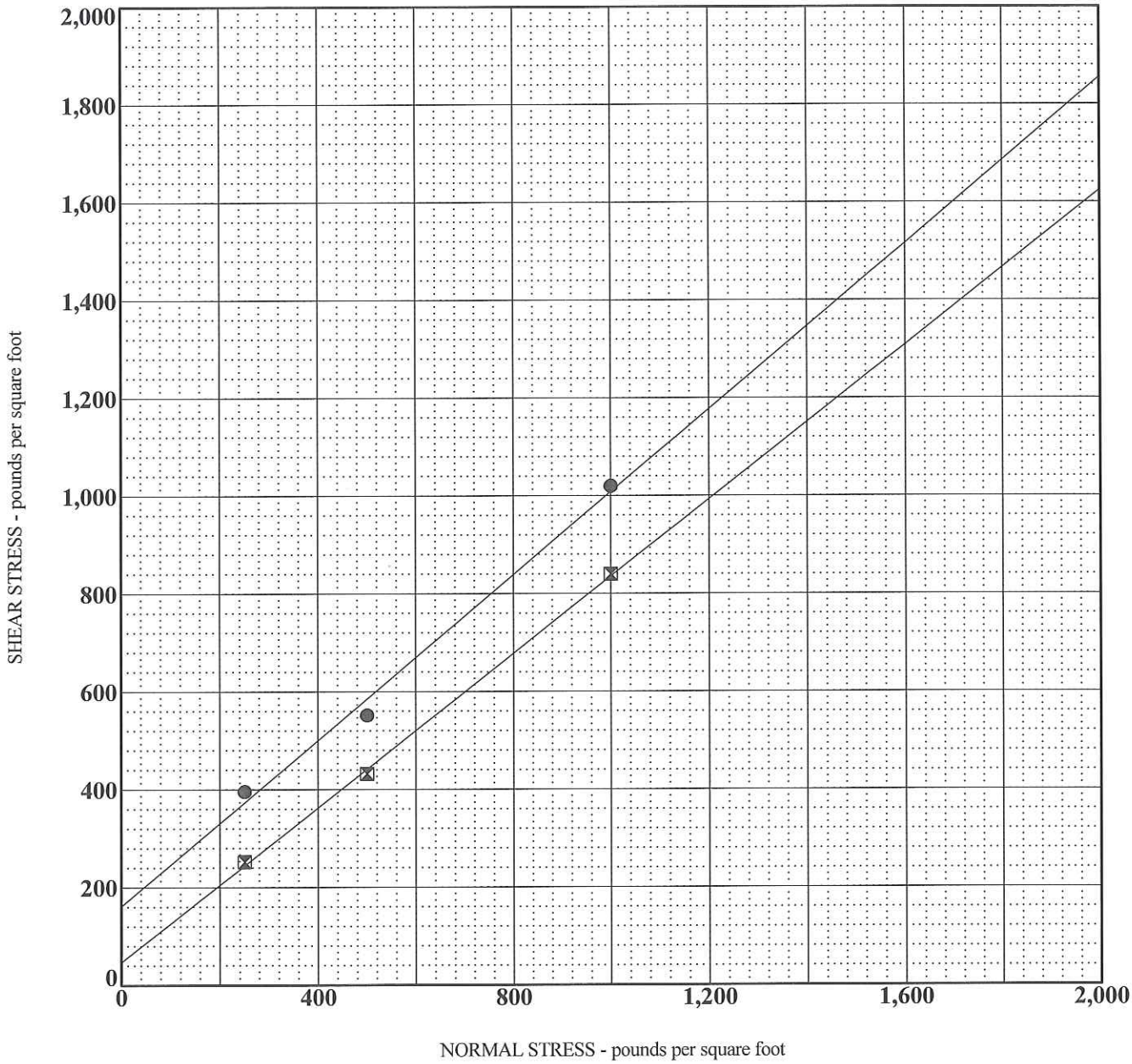
CONSOLIDATION - STRAIN 329-03.GPJ PETRA.GDT 7/20/10

SAMPLE LOCATION	MATERIAL DESCRIPTION	INITIAL			INUNDATED
		DENSITY (pcf)	MOISTURE (%)	SATURATION (%)	LOAD (ksf)
● HA3 @ 5.0	Silty Sand (SM)	108.4	17.2	84	2.00



J.N. 329-03	CONSOLIDATION TEST RESULTS	July, 2010
PETRA GEOTECHNICAL, INC.		PLATE B-3

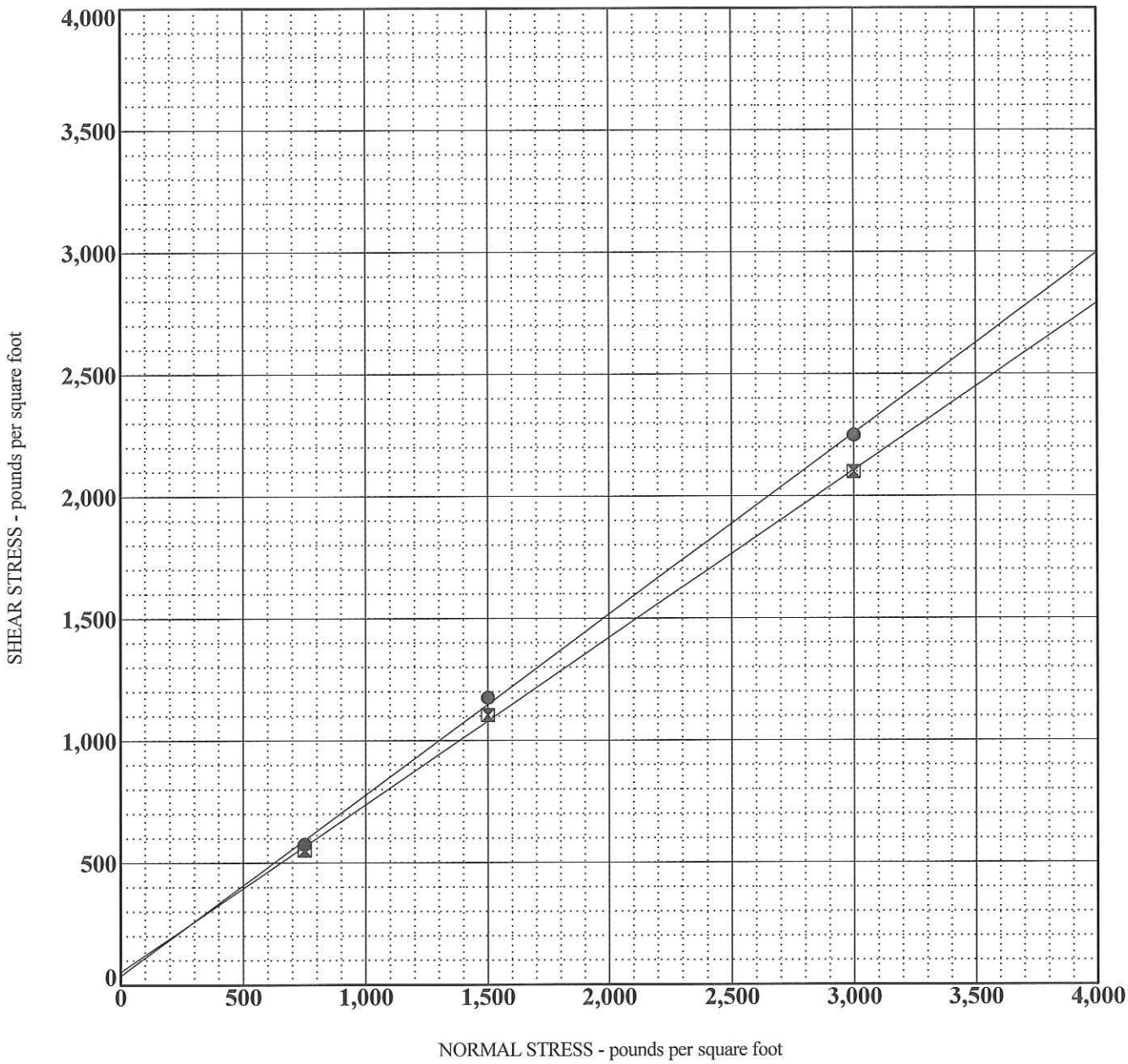
CONSOLIDATION - STRAIN 329-03.GPJ PETRA.GDT 7/20/10



SAMPLE LOCATION (feet)	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-2 @ 3.0	Peak - GRANITICS	40	160
⊠ B-2 @ 3.0	Ultimate - GRANITICS	38	50

NOTES:

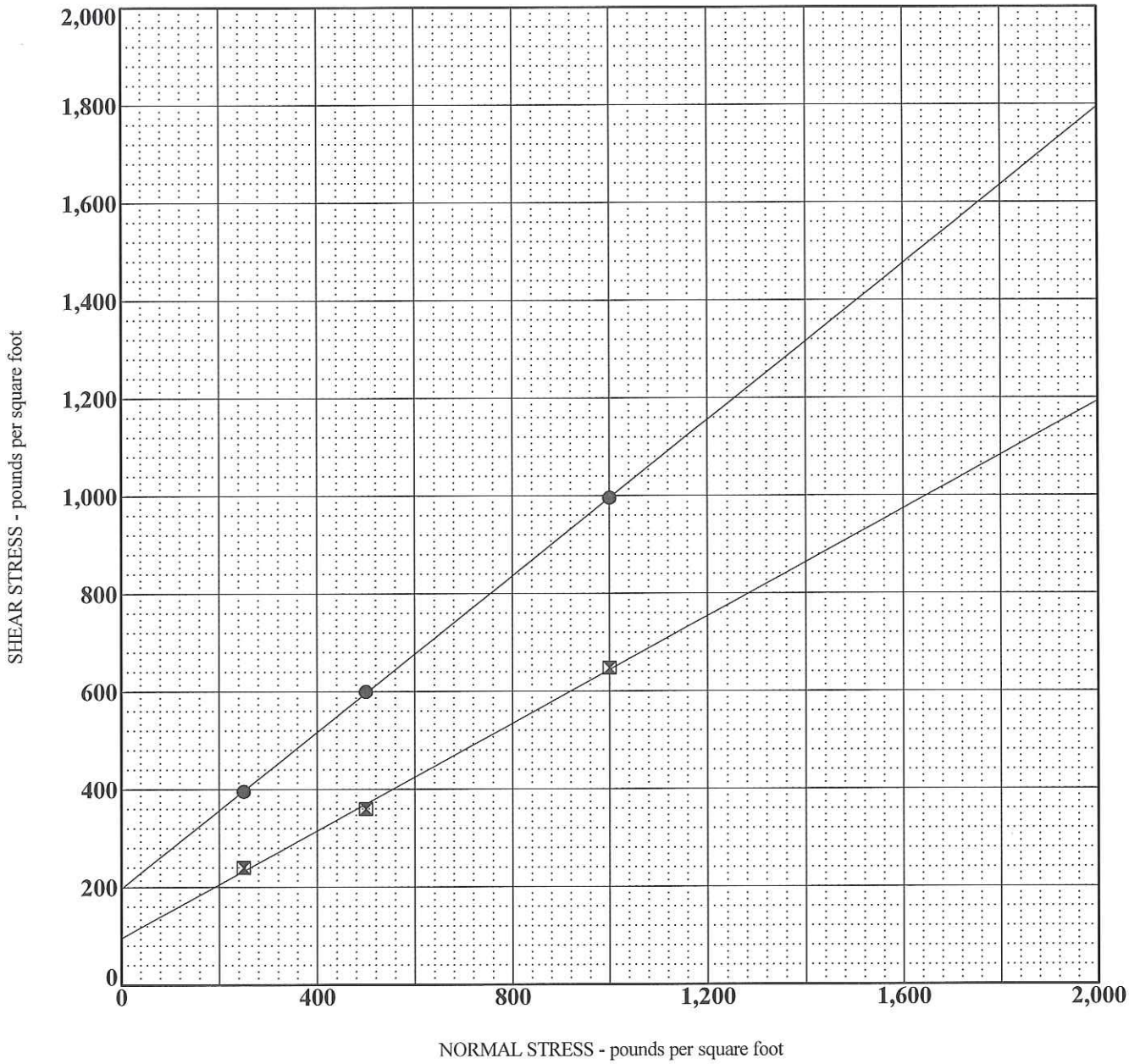
J.N. 329-03	DIRECT SHEAR TEST DATA	July, 2010
PETRA GEOTECHNICAL, INC.	UNDISTURBED TEST SAMPLES	PLATE B-4



SAMPLE LOCATION (feet)	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-7 @ 15.0	Peak - GRANITICS	37	40
⊠ B-7 @ 15.0	Ultimate - GRANITICS	34	55

NOTES:

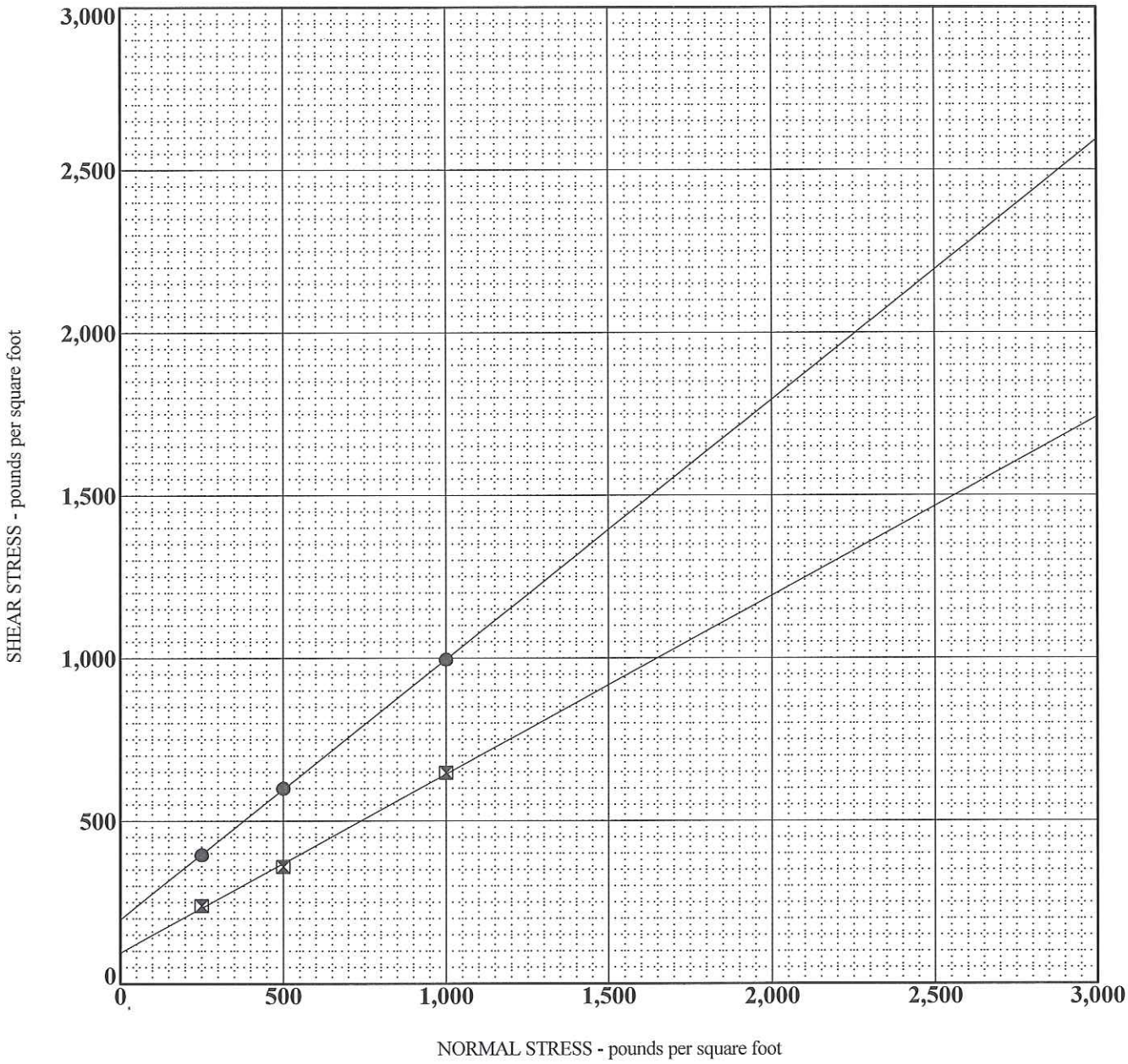
J.N. 329-03	DIRECT SHEAR TEST DATA	July, 2010
PETRA GEOTECHNICAL, INC.	UNDISTURBED TEST SAMPLES	PLATE B-5



SAMPLE LOCATION (feet)	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-8 @ 2.0	Peak - Silty SAND	39	200
⊠ B-8 @ 2.0	Ultimate - Silty SAND	29	95

NOTES:

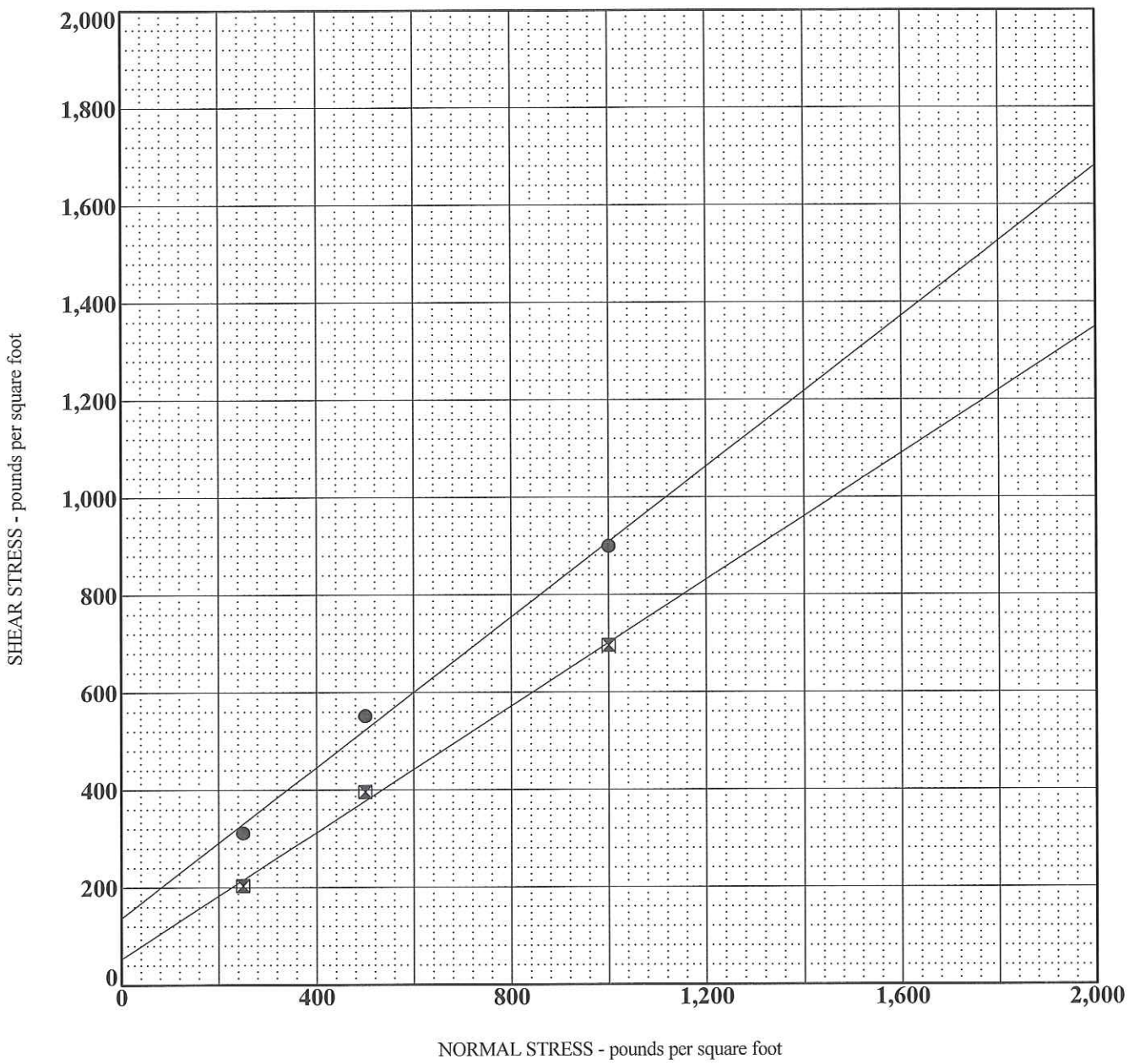
J.N. 329-03	DIRECT SHEAR TEST DATA	July, 2010
PETRA GEOTECHNICAL, INC.	UNDISTURBED TEST SAMPLES	PLATE B-6



SAMPLE LOCATION (feet)	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-8 @ 2.0	Peak - Silty SAND	39	200
⊠ B-8 @ 2.0	Ultimate - Silty SAND	29	95

NOTES:

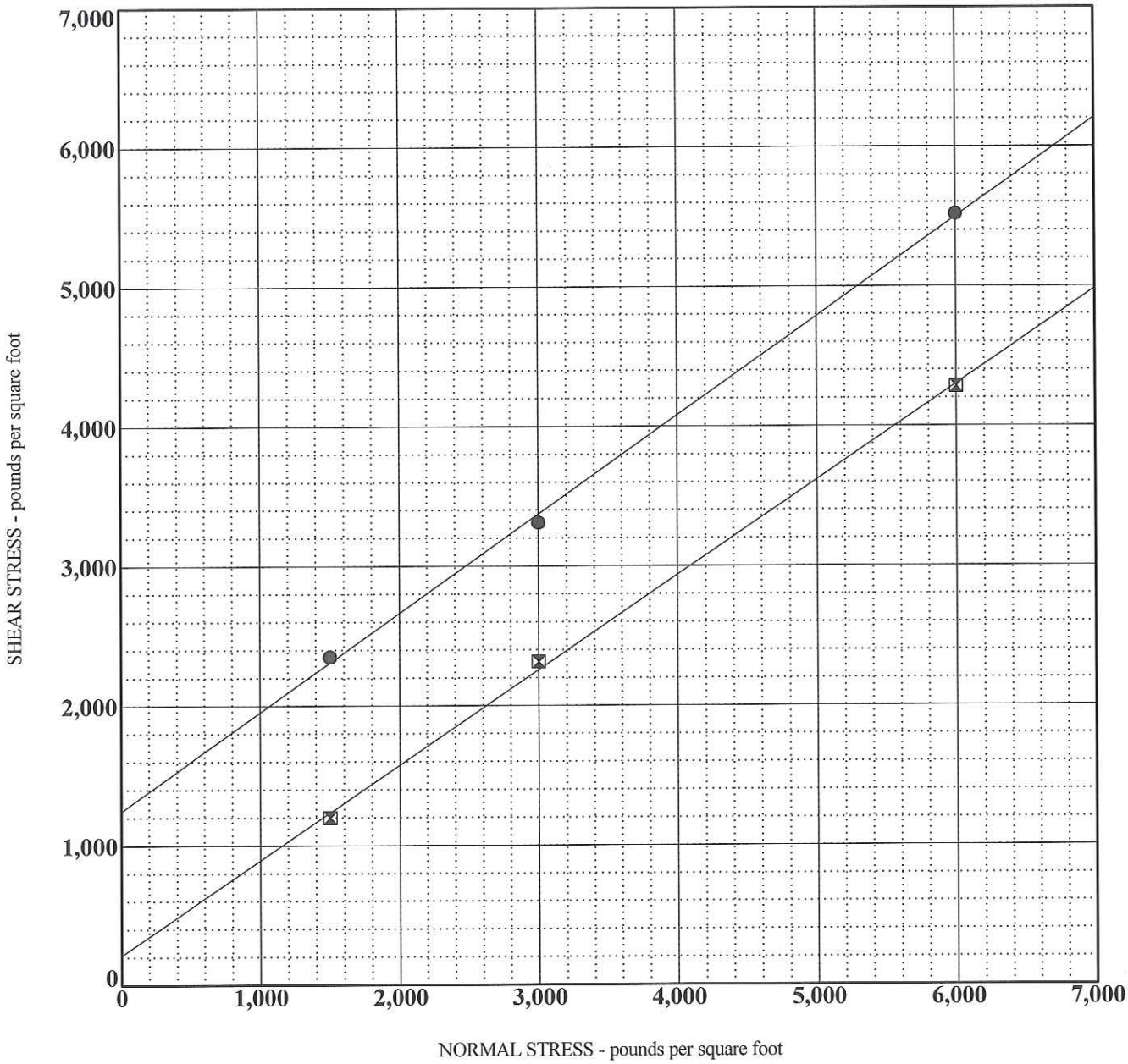
J.N. 329-03	DIRECT SHEAR TEST DATA	July, 2010
PETRA GEOTECHNICAL, INC.	UNDISTURBED TEST SAMPLES	PLATE B-7



SAMPLE LOCATION (feet)	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-9 @ 2.0	Peak - Silty SAND	38	140
⊠ B-9 @ 2.0	Ultimate - Silty SAND	33	55

NOTES:

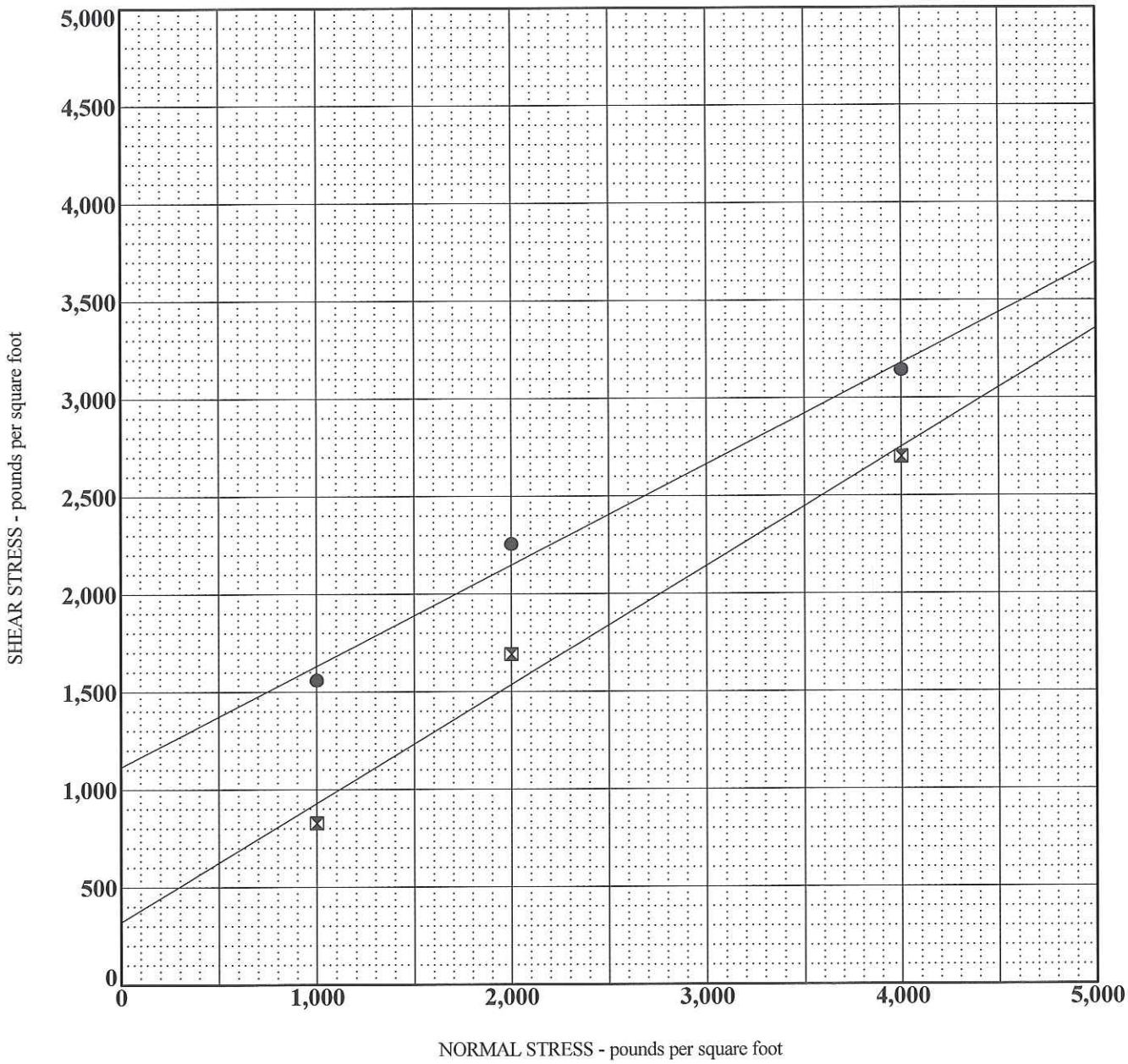
J.N. 329-03	DIRECT SHEAR TEST DATA	July, 2010
PETRA GEOTECHNICAL, INC.	UNDISTURBED TEST SAMPLES	PLATE B-8



SAMPLE LOCATION (feet)	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-10 @ 25.0	Peak - Silty SAND	35	1250
⊠ B-10 @ 25.0	Ultimate - Silty SAND	34	215

NOTES:

J.N. 329-03	DIRECT SHEAR TEST DATA	July, 2010
PETRA GEOTECHNICAL, INC.	UNDISTURBED TEST SAMPLES	PLATE B-9

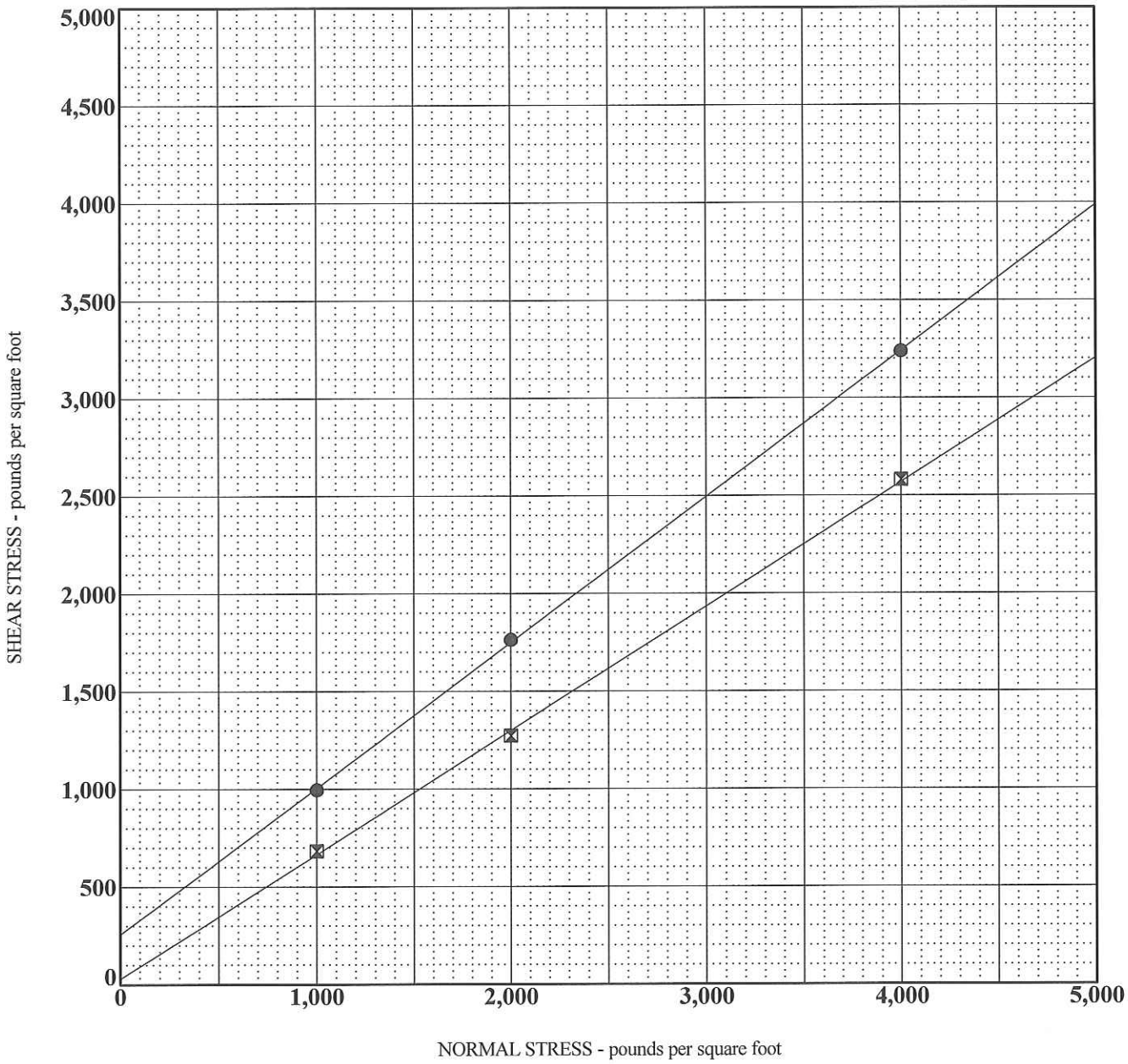


SAMPLE LOCATION (feet)	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-11 @ 25.0	Clayey Sand (SC) - Peak	27	1120
⊠ B-11 @ 25.0	Clayey Sand (SC) - Ultimate	31	320

NOTES:

Undisturbed Test Samples
All Samples Were Inundated Prior to Shearing

J.N. 329-03	DIRECT SHEAR TEST DATA	July, 2010
PETRA GEOTECHNICAL, INC.	UNDISTURBED TEST SAMPLES	PLATE B-10

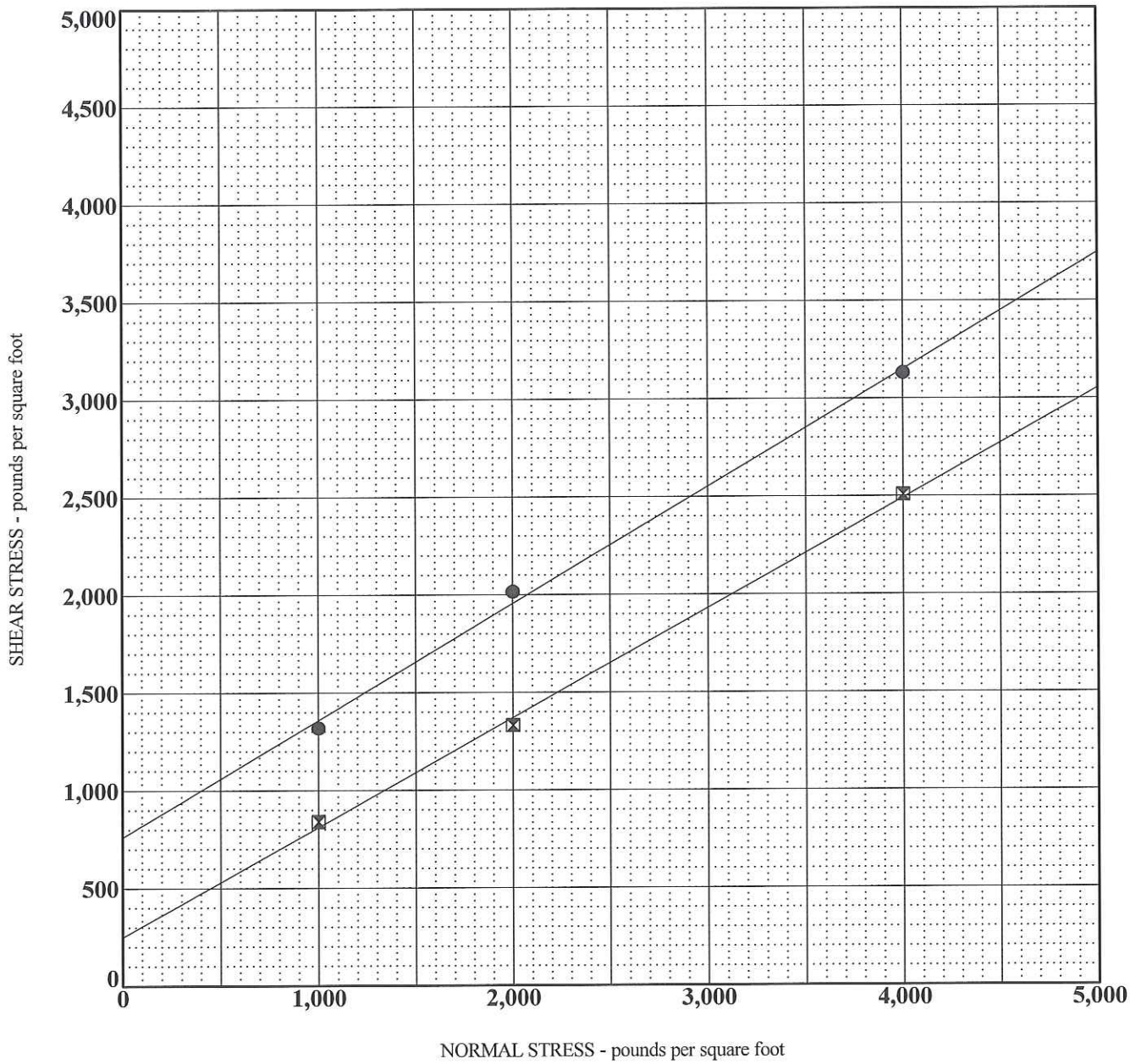


SAMPLE LOCATION (feet)	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-12 @ 5.0	Silty Sand (SM) - Peak	37	260
⊠ B-12 @ 5.0	Silty Sand (SM) - Ultimate	32	30

NOTES:

Undisturbed Test Samples
All Samples Were Inundated Prior to Shearing

J.N. 329-03	DIRECT SHEAR TEST DATA	July, 2010
PETRA GEOTECHNICAL, INC.	UNDISTURBED TEST SAMPLES	PLATE B-11

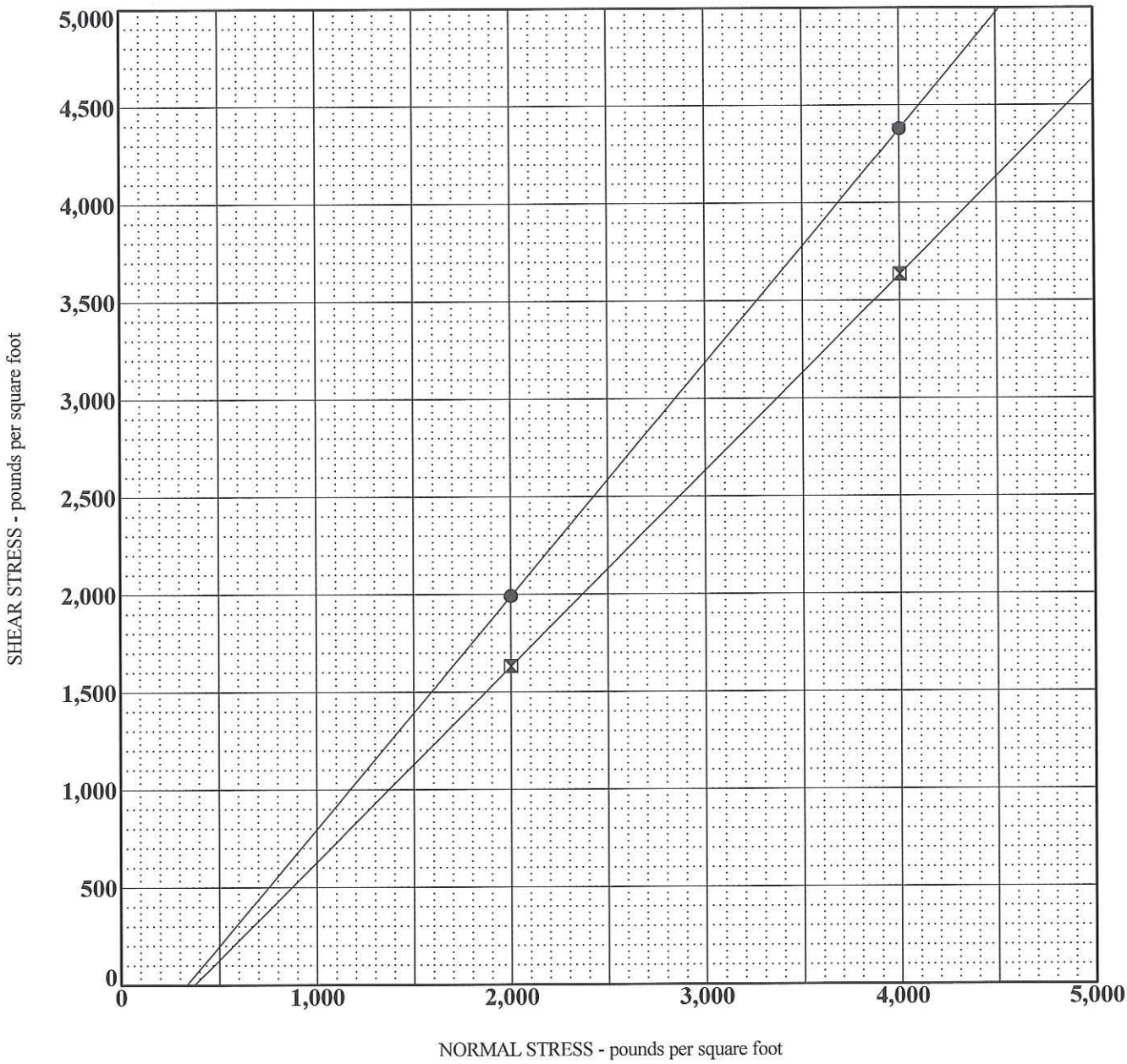


SAMPLE LOCATION (feet)	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-12 @ 20.0	Silty Sand (SM) - Peak	31	760
⊠ B-12 @ 20.0	Silty Sand (SM) - Ultimate	29	250

NOTES:

Undisturbed Test Samples
All Samples Were Inundated Prior to Shearing

J.N. 329-03	DIRECT SHEAR TEST DATA	July, 2010
PETRA GEOTECHNICAL, INC.	UNDISTURBED TEST SAMPLES	PLATE B-12

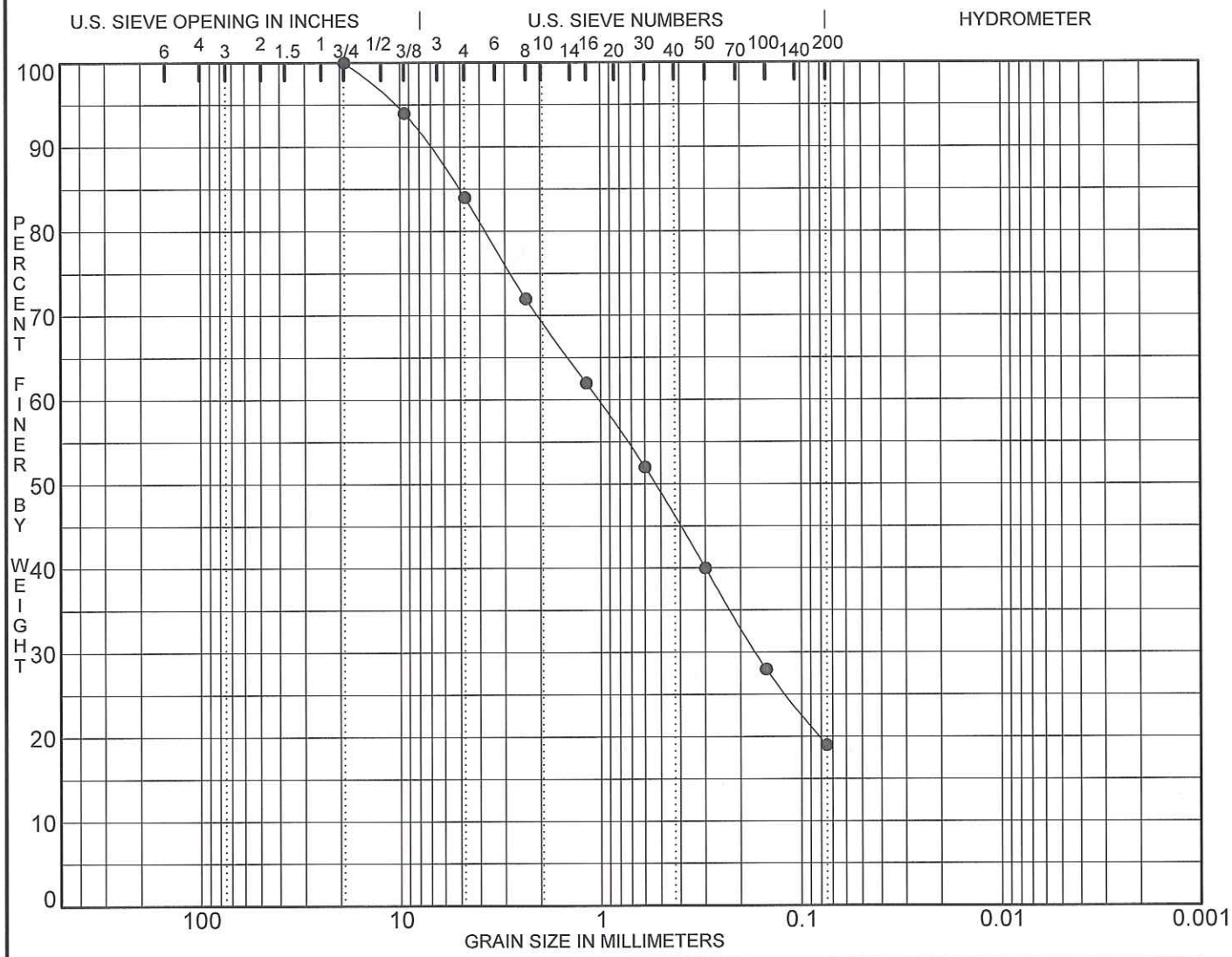


SAMPLE LOCATION (feet)	DESCRIPTION	FRICTION ANGLE (°)	COHESION (PSF)
● B-12 @ 32.5	Bedrock - Peak	50	400
⊠ B-12 @ 32.5	Bedrock - Ultimate	45	370

NOTES:

Undisturbed Test Samples
All Samples Were Inundated Prior to Shearing

J.N. 329-03	DIRECT SHEAR TEST DATA	July, 2010
PETRA GEOTECHNICAL, INC.	UNDISTURBED TEST SAMPLES	PLATE B-13



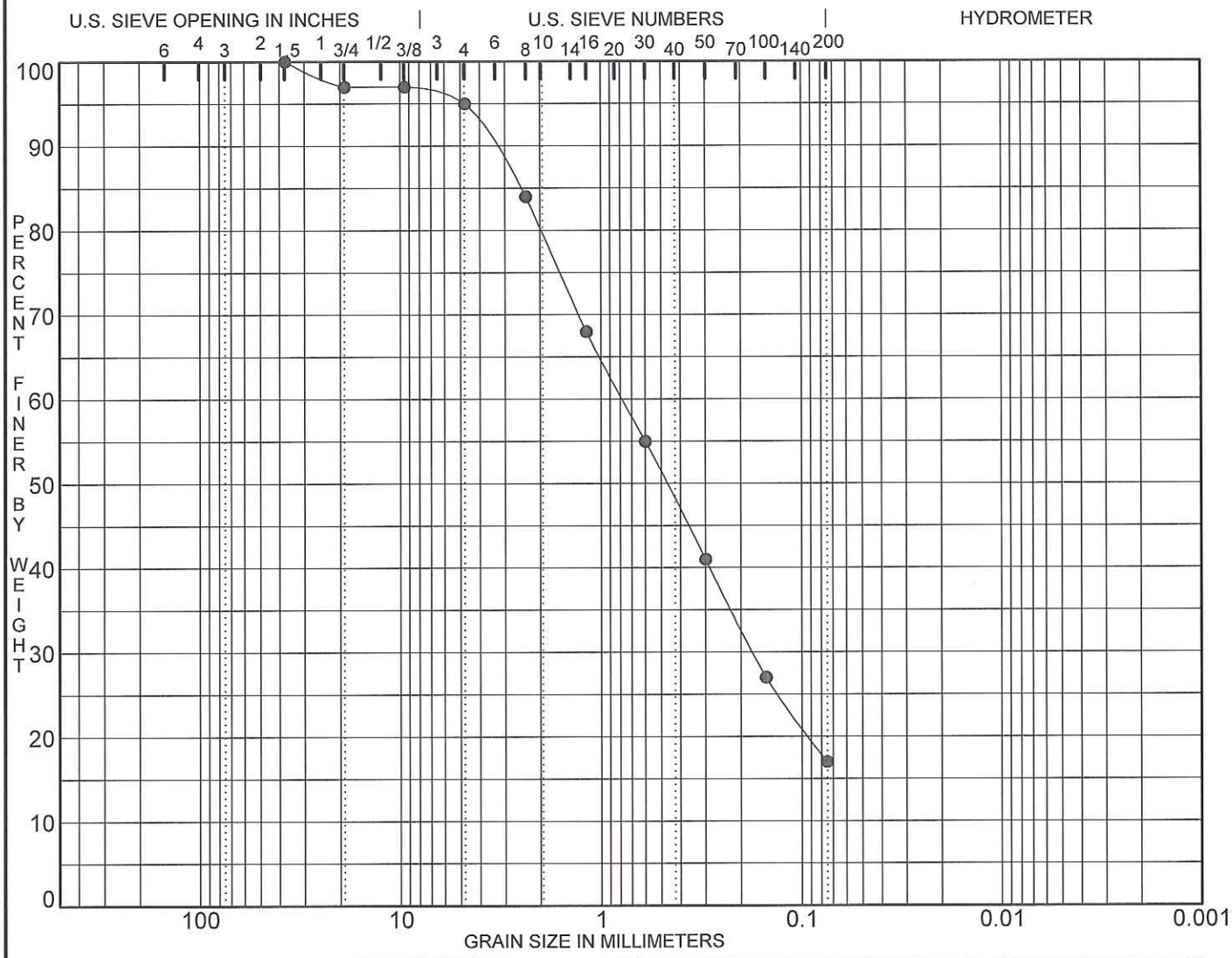
COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	B-6	3.0	Silty SAND (SM)						

	Specimen Identification		D100	D60	D30	D50	%Gravel	%Sand	%Silt	%Clay
●	B-6	3.0	19.00	1.03	0.168	0.5345	16.0	65.0	19.0	

GRAIN SIZE - V1 329-03.GPJ PETRA.GDT 7/20/10

J.N. 329-03	GRAIN SIZE ANALYSIS	July, 2010
PETRA GEOTECHNICAL, INC.		PLATE B-14



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	MC%	LL	PL	PI	Cc	Cu
●	B-8	3.0	Silty SAND (SM)						

	Specimen Identification		D100	D60	D30	D50	%Gravel	%Sand	%Silt	%Clay
●	B-8	3.0	37.50	0.78	0.174	0.4684	5.0	78.0	17.0	

GRAIN SIZE - V1 329-03.GPJ PETRA.GDT 7/20/10

J.N. 329-03	**GRAIN SIZE ANALYSIS**	July, 2010
PETRA GEOTECHNICAL, INC.		PLATE B-15

APPENDIX C

GEOPHYSICISTS REPORT

PETRA

TERRA GEOSCIENCES

SEISMIC SHEAR-WAVE SURVEY

NORDAHL ROAD BRIDGE PROJECT

CITY OF ESCONDIDO, CALIFORNIA

Project No. 102450-1

March 17, 2010

Prepared for:

Petra Geotechnical, Inc.
38655 Sky Canyon Drive
Suite A
Murrieta, CA 92563

Consulting Engineering Geology & Geophysics

P.O. Box 1099, Loma Linda, CA 92354 • 909-796-4667

Petra Geotechnical, Inc.
38655 Sky Canyon Drive, Suite A
Murrieta, CA 92563

Attention: Mr. Jon Cain

Regarding: Seismic Shear-Wave Survey
Nordahl Road Bridge Project
City of Escondido, California
Petra Job No. 329-03

INTRODUCTION

As requested, this firm has performed a seismic shear-wave survey using the microtremor refraction survey for the above-referenced site. The purpose of this survey was to assess the one-dimensional average shear-wave velocity structure to a minimum depth of at least 50 feet along the southern side of the proposed Nordahl Road Bridge Project. Geologic mapping of the surficial earth materials by Kennedy (1999) indicates the local area to be mantled by late Pleistocene age older colluvial deposits that are for the most part moderately well-consolidated and consist of poorly sorted slope wash and stream deposits. The bedrock materials that underlie the local area are shown to consist of both Cretaceous age granitic rocks and Cretaceous to Jurassic age undivided metavolcanic and metasedimentary rocks. Additionally, artificial fill materials may also be present within the vicinity of our survey associated with the existing bridge structure.

We understand that this report will be included as a technical appendix to your report, therefore, some descriptive sections such as site description, proposed development, location map, etc., have been purposely omitted as they will be included within your main report. The seismic traverses have been approximately located on a partial copy of the Nordahl Bridge map you provided us, for reference purposes. As authorized by you, the following services were performed during this study:

- **Review of available pertinent published and unpublished geologic and geophysical data in our files pertaining to the site.**
- **Performing a seismic refraction survey by a State of California Professional Geophysicist, to include two seismic traverses for shear-wave velocity analysis purposes.**
- **Preparation of this report, presenting the results of our findings with respect to the shear-wave velocities of the subsurface earth materials.**

Accompanying Map and Appendices

Figure 1 - Seismic Line Location Map
Appendix A - Microtremor Refraction Survey Results
Appendix B - References

SUMMARY OF SHEAR-WAVE SURVEY

Methodology

This study uses the SeisOpt® ReMi™ software developed by Optim, LLC (2006), based on the refraction microtremor method (Louie, 2001). This method economically and efficiently estimates one-dimensional subsurface shear-wave velocities up to 100-meters in depth, using data collected from standard primary-wave (P-wave) refraction surveys. This method does not require any artificial seismic source and uses ambient "noise" as the energy source for data collection. The refraction microtremor technique is based on two fundamental ideas. The first is that common seismic-refraction recording equipment, deployed the same as a typical shallow P-wave refraction survey, can efficiently record surface waves at frequencies as low as 2 Hz, and the second being that a simple, two-dimensional slowness-frequency transform of a microtremor record can separate Raliegh waves from other seismic arrivals and allow recognition of the true phase velocity against apparent velocities.

Field Procedures

Two seismic refraction survey traverses were performed that were each 115 feet in length and were conducted along the southern side of the Nordahl Road Bridge, as shown on Figure 1. These surveys used a linear geometry array that consisted of using a series of twenty-four 4.5-Hz geophones that were spaced at five-foot intervals. The field survey employed a twenty-four channel Geometrics StrataVisor™ NZXP model signal-enhancement refraction seismograph. No artificial seismic source is required for this passive shear-wave (S-wave) analysis. The primary ambient background noise source originated from the vehicular traffic vibrations from both Nordahl Road and the adjacent Highway 78 along the north. The ground vibrations were recorded using a thirty-two second record length at a two-millisecond sampling rate. Twenty separate seismic records were obtained along each survey line for quality control purposes. The seismic-wave "wiggle-trace" data that was displayed on the seismograph screen were used to assess the recorded seismic waves at each geophone station for quality control purposes in the field. The acceptable records were digitally recorded on the in-board seismograph computer and subsequently transferred to a flash drive so that they could be subsequently transferred to our office computer for analysis.

Data Reduction

The data on the paper record and/or display screen were used to analyze the arrival time of the seismic waves at each geophone station, in the form of a wiggle trace for quality control purposes in the field. All of the recorded data on the flash drive was subsequently transferred to our office computer. These files were then electronically transferred to Optim, Inc. (Seismology Lab, University of Reno, Nevada), for further processing and analysis using the refraction microtremor method developed by Louie (2001). Upon completion of their analysis, the results for the shear-wave survey line were then electronically transferred to our office and are presented within Appendix A, for presentation and reference purposes.

SUMMARY OF DATA ANALYSIS

Data acquisition went very smoothly, and the quality was considered to be very good. Analysis of the dispersion curves revealed that the average shear-wave velocity beneath the seismic survey traverses have overall two basic velocity layers which are interpreted to be artificial fill/alluvium (with some minor gradational velocity increases) overlying crystalline bedrock materials at depth. No velocity reversals were encountered locally. Presented within Appendix A are the detailed shear-wave models for both Seismic Line S-1 and S-2 which displays the calculated layer boundaries/depths and associated velocities (feet/second) for the upper 60 feet that was locally sampled in a graphical depiction. The associated Dispersion Curves are also included within this appendix for visual and reference purposes. These curves illustrate the data quality within the slowness-frequency plot (*p-f* image), which in turn show the dispersion picks and subsequently how they are fit to be calculated in the models.

Tabulated below are the individual calculated layer velocities and associated depth range for each of the seismic traverses.

SEISMIC LINE S-1

Depth Range (ft)	Shear-Wave Velocity (ft/s)
0 – 1.90	592.66
1.90 – 9.04	750.817
9.04 – 30.71	908.97
30.71 – 60.00 (depth limit)	5,608.42

Table 1- Average one-dimensional shear-wave velocities beneath Seismic Line S-1.

SEISMIC LINE S-2

Depth Range (ft)	Shear-Wave Velocity (ft/s)
0 – 0.95	253.76
0.95 – 8.09	908.97
8.09 – 31.18	999.45
31.18 – 60.00 (depth limit)	5,947.32

Table 2- Average one-dimensional shear-wave velocities beneath Seismic Line S-2.

CLOSURE

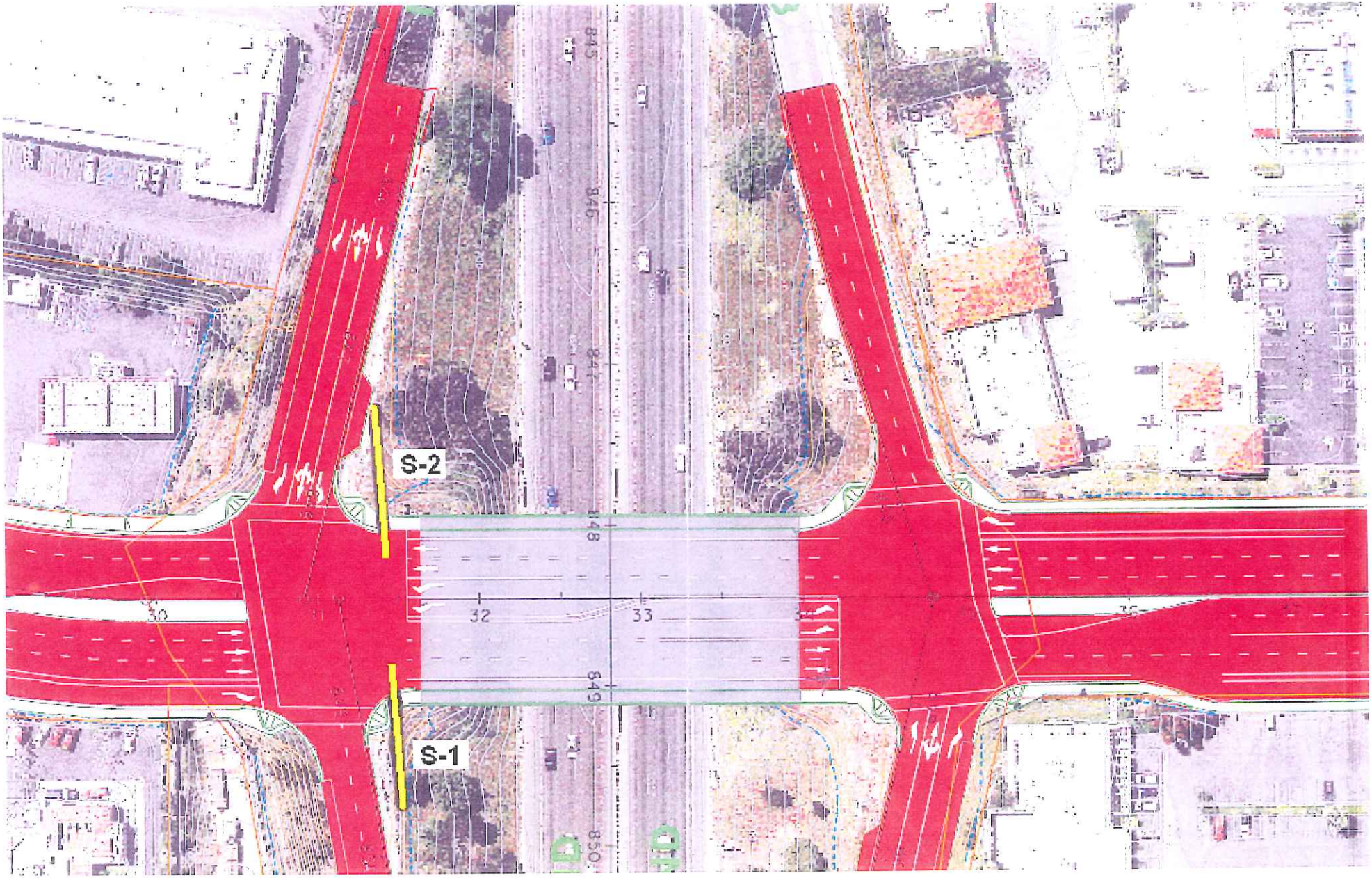
This survey was performed using "state of the art" geophysical equipment, techniques, and computer software. We make no warranty, either expressed or implied. It should be understood that when using these theoretical geophysical principles and techniques, sources of error are possible in both the data obtained and in the interpretation. Compared with traditional borehole shear-wave surveys of which use vertical body waves, the sources of error (if present) using horizontal surface waves for this project are not believed to be greater than 15 percent. If you should have any questions regarding this report or do not understand the limitations or interpretations of this survey, please do not hesitate to contact our office.

Respectfully submitted,
TERRA GEOSCIENCES

Donn C. Schwartzkopf
Principal Geophysicist
PGP 1002

PROFESSIONAL GEOPHYSICIST
DONN C. SCHWARTZKOPF
No. 1002
STATE OF CALIFORNIA

SEISMIC LINE LOCATION MAP



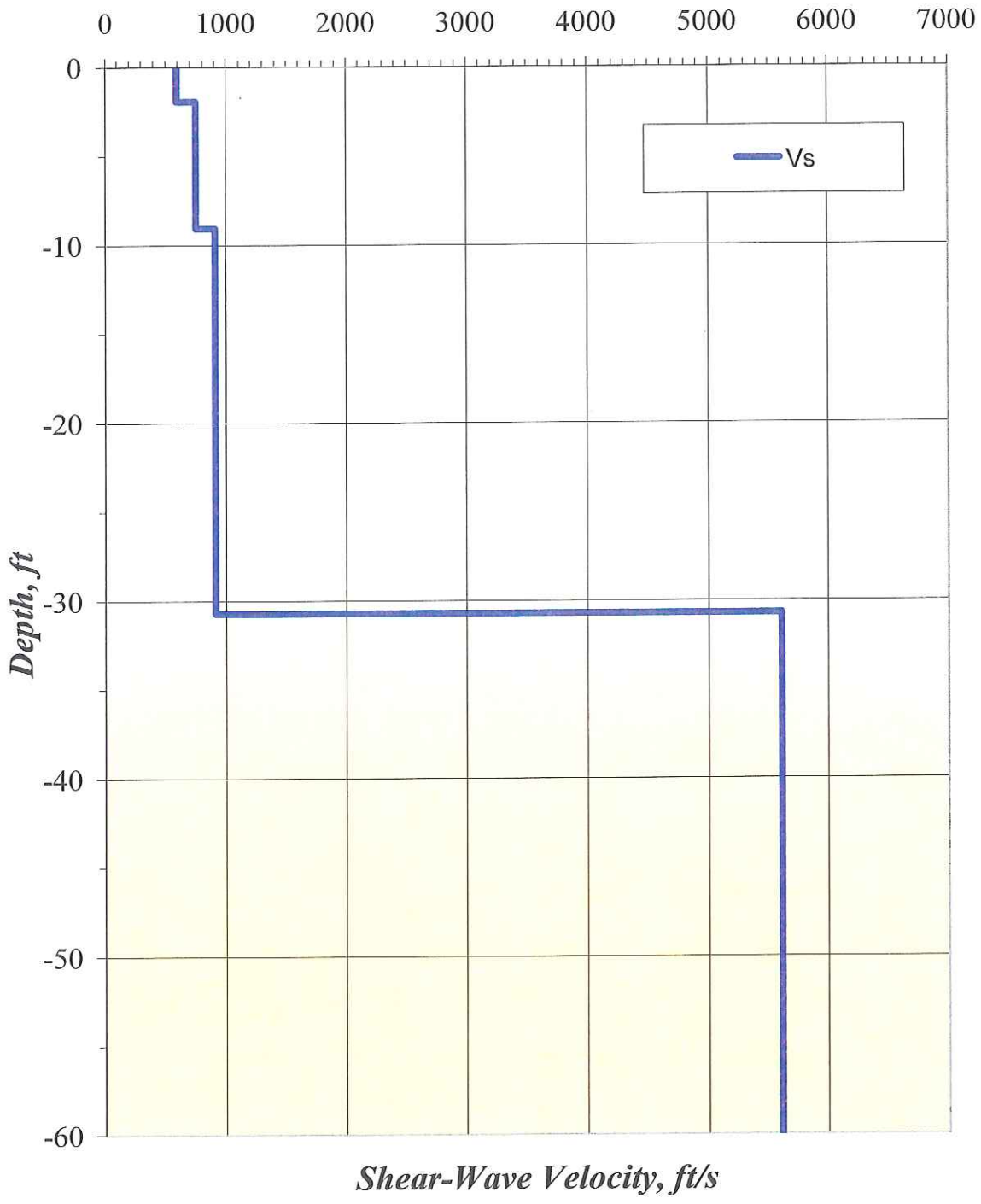
PROJECT NO. 102450-1

PLATE 1

APPENDIX A

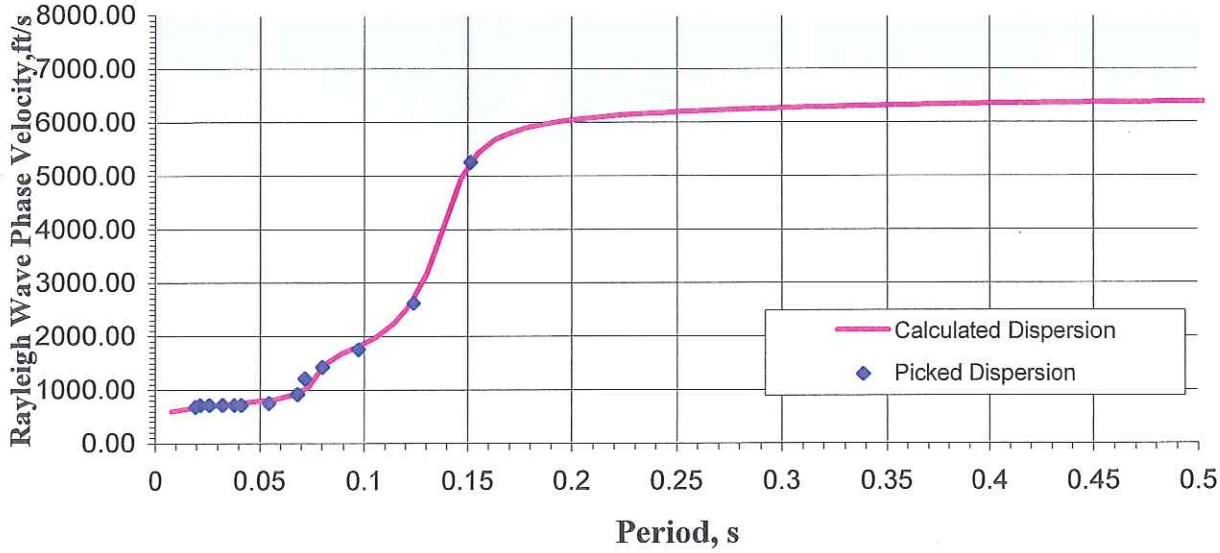
MICROTREMOR REFRACTION SURVEY RESULTS

SEISMIC LINE S-1

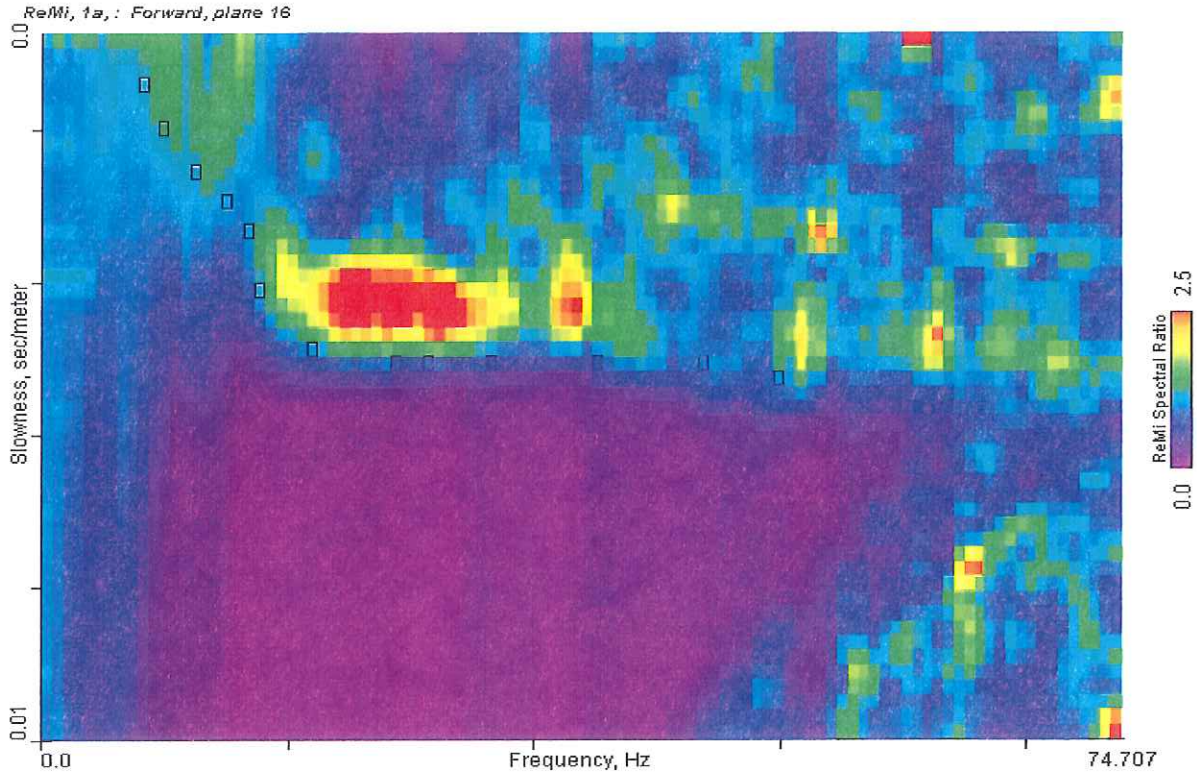


SEISMIC LINE S-1

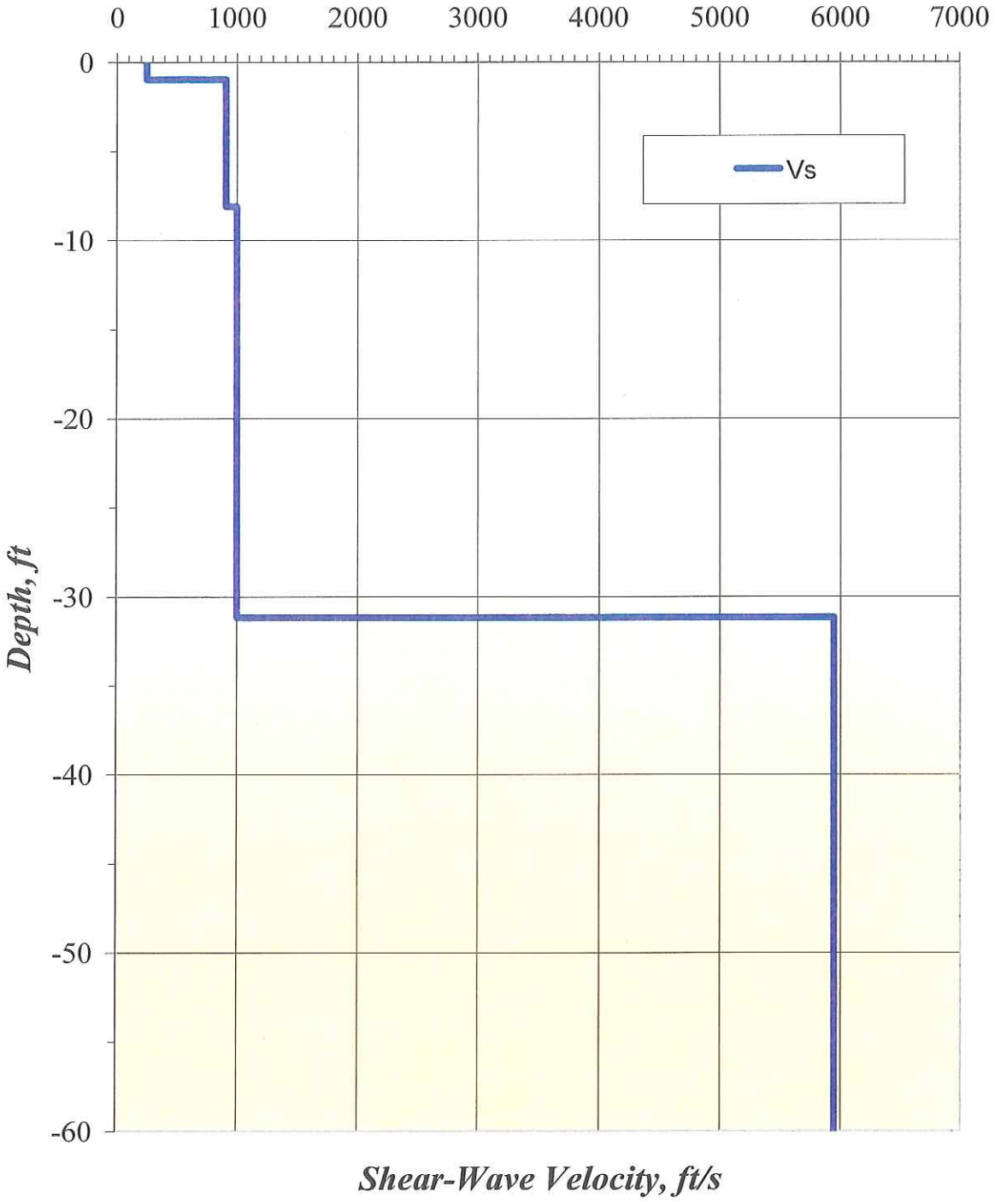
Dispersion Curve and Fits



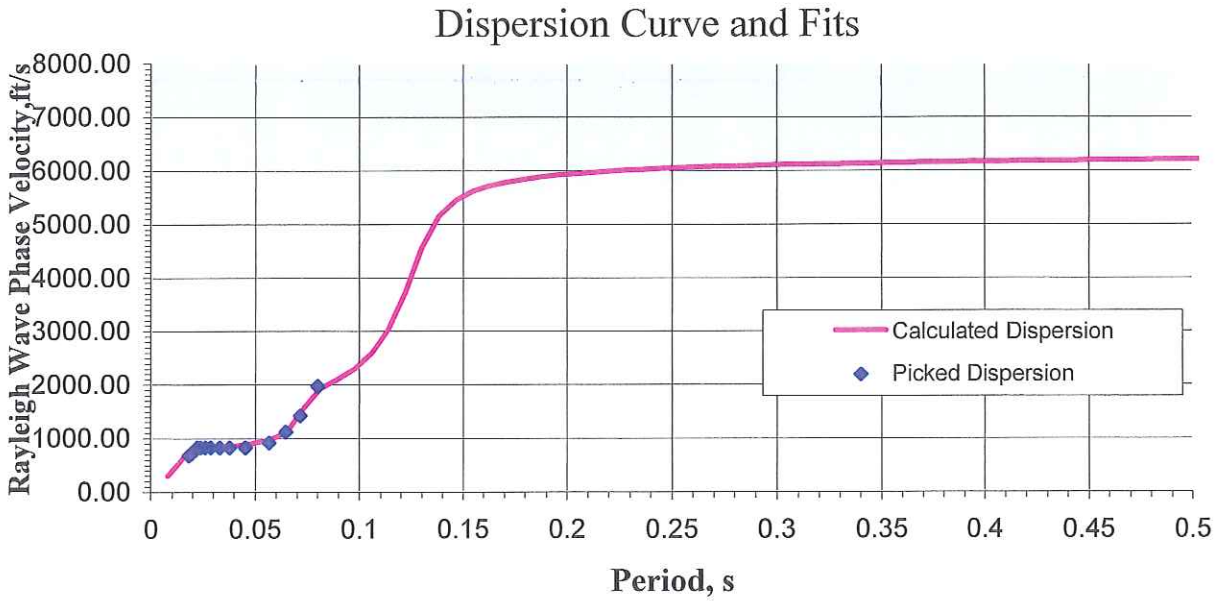
p-f Image with Dispersion Modeling Picks

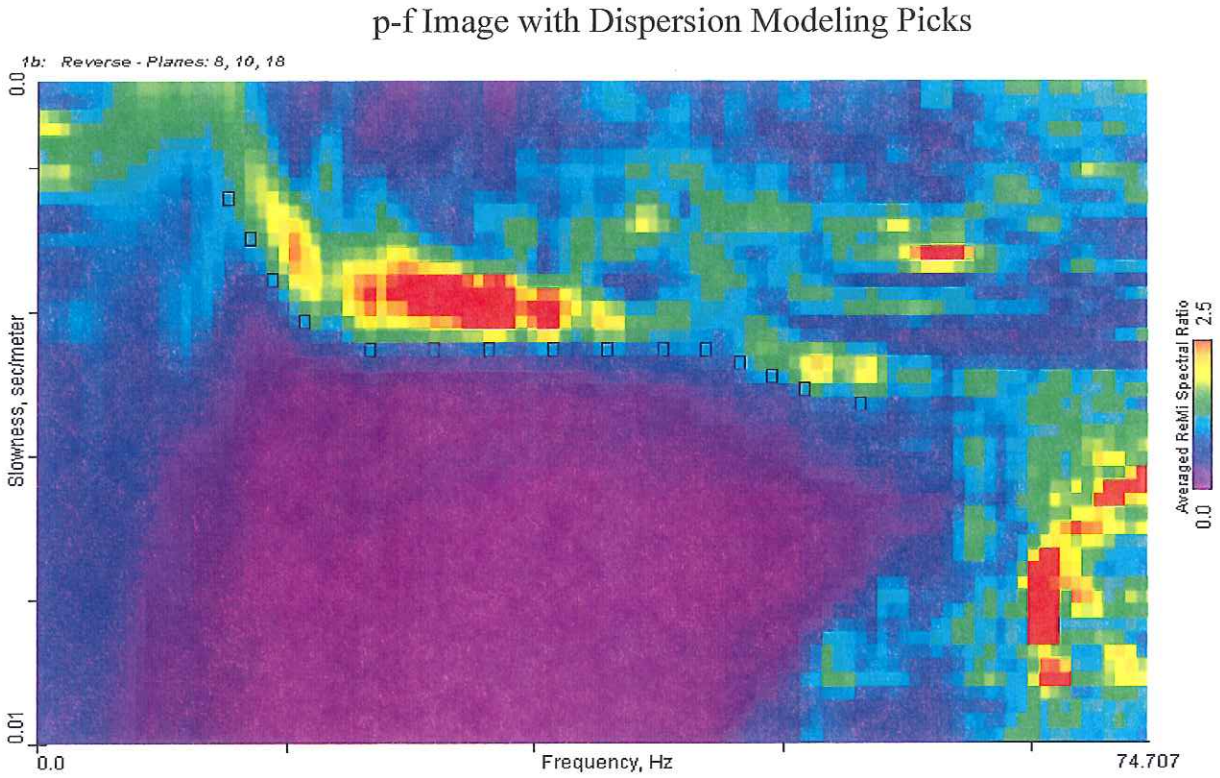


SEISMIC LINE S-2



SEISMIC LINE S-2





APPENDIX B

REFERENCES

REFERENCES

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APPENDIX D

SEISMIC ANALYSIS

PETRA

USGS Professional Paper 1360

TABLE 21.—Assigned shear-wave velocities of exposed geologic units in the upper Santa Ana River basin

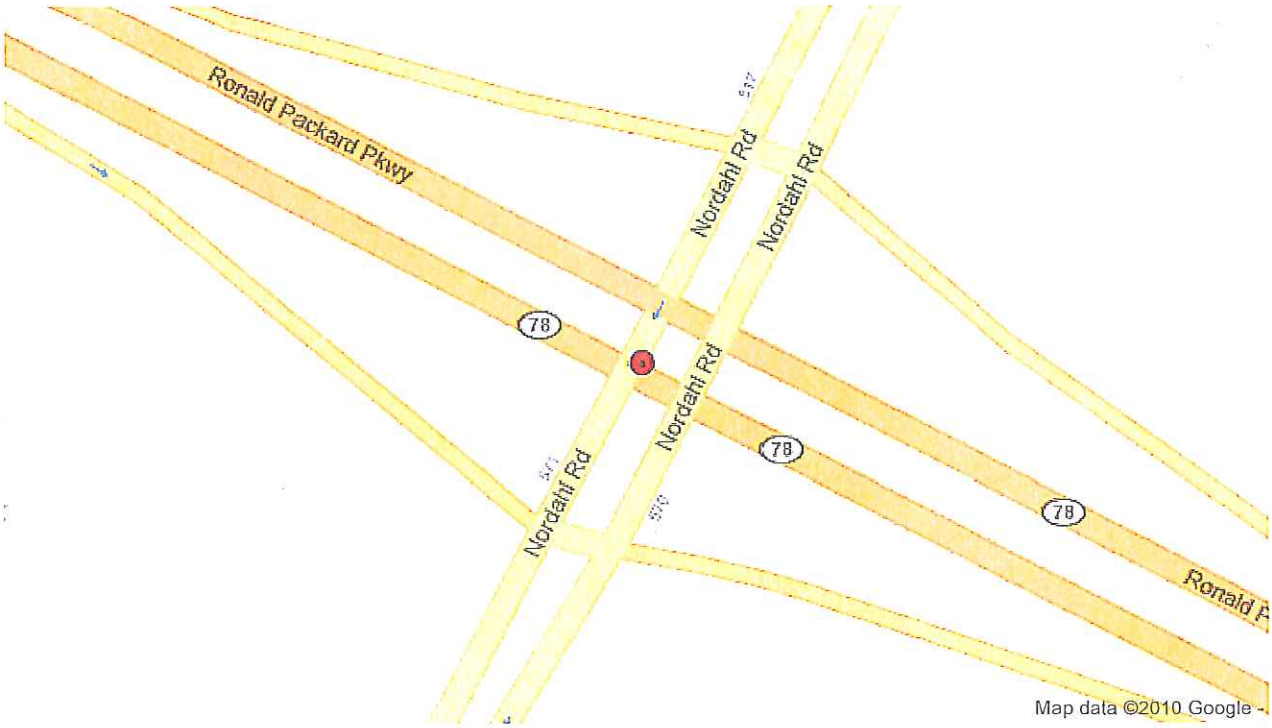
Geologic map unit[1]	Bedrock velocity unit[2]	Assigned mean shear-wave velocity, in m/s
Holocene sediments[3]		
Very coarse grained alluvium		365
Coarse-grained alluvium		320
Medium-grained alluvium		230
Fine-grained alluvium		210
Eolian sand		230
Late and middle Pleistocene sediments[4]		
Very coarse grained alluvium; Coarse-grained alluvium; Medium-grained alluvium; Fine-grained alluvium		435
Pliocene and Pleistocene nonmarine sediments		
San Timoteo Beds of Frick (1921)	I and II	420
Tertiary rocks		
Sedimentary rocks:		
Puente Formation	I and II	420
Potato Sandstone (Dibblee, 1964)	II	550
Volcanic rocks:		
Glendora Volcanics (largely andesite breccias in map area).	III	770
Pre-Tertiary crystalline rocks with widely spaced fractures		
Granitic rocks: Relatively unweathered[5]; Deeply weathered[6]	VII	1,760
Pre-Tertiary crystalline rocks with closely spaced fractures		
Granitic rock; Metamorphic rocks: Low grade; High grade	IV and VII	1,150

[1]From Cox and Morton (1978).
[2]From table 19.
[3]Equivalent to Holocene map units of the Los Angeles basin.
[4]Although these deposits show an apparent correlation between V_s and texture, age is probably more important for medium-grained to very coarse grained deposits. Since these deposits have not been subdivided according to age and since the texture in the subsurface is not well known, these deposits have been combined.
[5]Probably comparable to the three hardest granitic sites in the San Gabriel–San Bernardino Mountains.
[6]Thin (<5 m) layer of deeply weathered material over fresh rock.

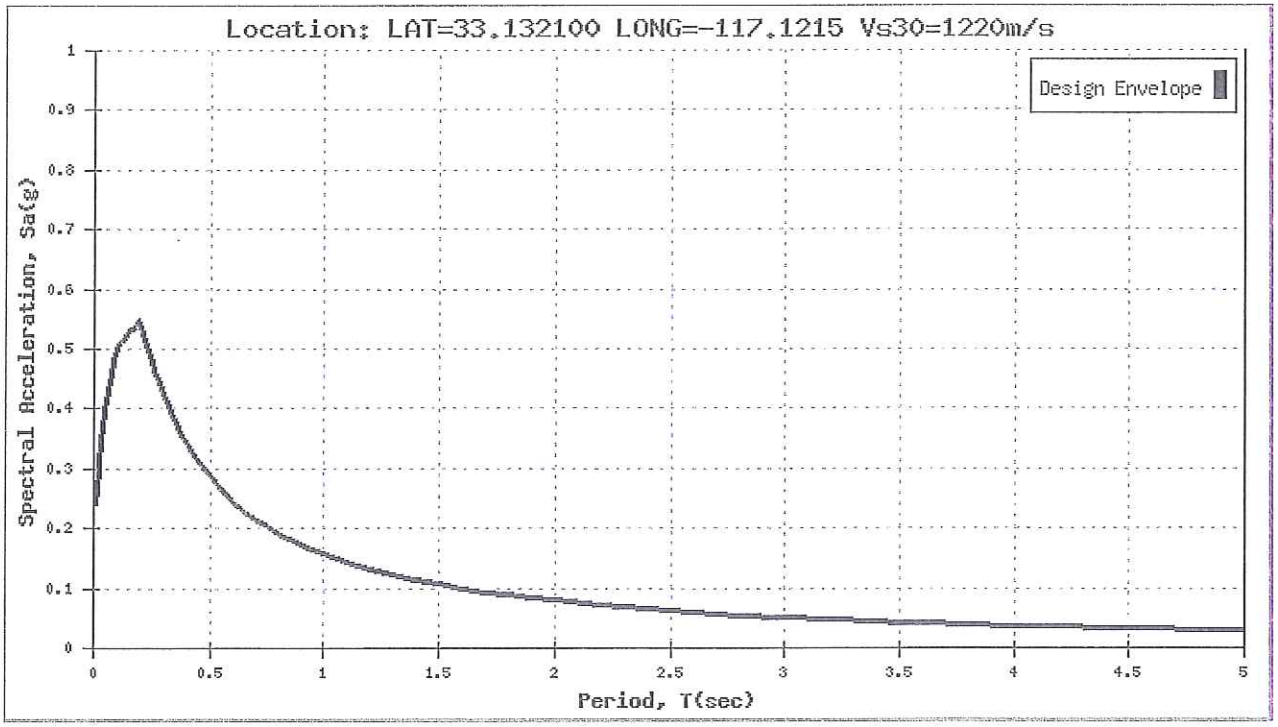
Angeles and San Francisco Bay regions having distinct shear-wave velocities.

Geologic maps incorporating data on physical properties are becoming available for the Los Angeles region. Tinsley and Fumal (this volume) describe a mapping scheme that divides Holocene and late and middle Pleistocene alluvium into four textural categories, each having distinct shear-wave velocity characteristics. Detailed studies in the Antelope Valley suggest that velocity increases with age in the late and middle Pleistocene alluvium. The distinct reddening of soils developed on deposits older than about 100,000 yr may be a useful criterion for estimating shear-wave velocity. Wentworth and others (1985) have provided detailed descriptions of hardness and fracture spacing for all mappable bedrock units in San Mateo County (near San

SELECT SITE LOCATION



CALCULATED SPECTRA



SITE DATA

Shear Wave Velocity, Vs_{30}:	1220 m/s
Latitude:	33.132100
Longitude:	-117.121500
Depth to Vs = 1.0 km/s:	4 m
Depth to Vs = 2.5 km/s:	2.00 km

DETERMINISTIC

Newport Inglewood-Rose Canyon fault zone (Oceanside section)

Fault ID:	223
Maximum Magnitude (MMax):	7.5
Fault Type:	RLSS
Fault Dip:	90 Deg
Dip Direction:	V
Bottom of Rupture Plane:	13.00 km
Top of Rupture Plane(Ztor):	0.00 km
Rrup	23.08 km
Rjb:	23.08 km
Rx:	23.07 km
Fnorm:	0
Frev:	0

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor (Applied)	SA(Final Spectrum)
0.01	0.140	1.000	1.000	0.140
0.02	0.143	1.000	1.000	0.143
0.022	0.145	1.000	1.000	0.145
0.025	0.148	1.000	1.000	0.148
0.029	0.153	1.000	1.000	0.153
0.03	0.154	1.000	1.000	0.154
0.032	0.157	1.000	1.000	0.157
0.035	0.163	1.000	1.000	0.163
0.036	0.165	1.000	1.000	0.165
0.04	0.172	1.000	1.000	0.172
0.042	0.176	1.000	1.000	0.176
0.044	0.180	1.000	1.000	0.180
0.045	0.182	1.000	1.000	0.182
0.046	0.184	1.000	1.000	0.184
0.048	0.187	1.000	1.000	0.187
0.05	0.191	1.000	1.000	0.191
0.055	0.203	1.000	1.000	0.203
0.06	0.214	1.000	1.000	0.214
0.065	0.225	1.000	1.000	0.225
0.067	0.230	1.000	1.000	0.230

0.07	0.236	1.000	1.000	0.236
0.075	0.246	1.000	1.000	0.246
0.08	0.255	1.000	1.000	0.255
0.085	0.264	1.000	1.000	0.264
0.09	0.271	1.000	1.000	0.271
0.095	0.279	1.000	1.000	0.279
0.1	0.286	1.000	1.000	0.286
0.11	0.296	1.000	1.000	0.296
0.12	0.305	1.000	1.000	0.305
0.13	0.311	1.000	1.000	0.311
0.133	0.313	1.000	1.000	0.313
0.14	0.316	1.000	1.000	0.316
0.15	0.319	1.000	1.000	0.319
0.16	0.317	1.000	1.000	0.317
0.17	0.314	1.000	1.000	0.314
0.18	0.311	1.000	1.000	0.311
0.19	0.307	1.000	1.000	0.307
0.2	0.303	1.000	1.000	0.303
0.22	0.287	1.000	1.000	0.287
0.24	0.273	1.000	1.000	0.273
0.25	0.266	1.000	1.000	0.266
0.26	0.259	1.000	1.000	0.259
0.28	0.247	1.000	1.000	0.247
0.29	0.242	1.000	1.000	0.242
0.3	0.236	1.000	1.000	0.236
0.32	0.226	1.000	1.000	0.226
0.34	0.217	1.000	1.000	0.217
0.35	0.213	1.000	1.000	0.213
0.36	0.209	1.000	1.000	0.209
0.38	0.201	1.000	1.000	0.201
0.4	0.193	1.000	1.000	0.193
0.42	0.187	1.000	1.000	0.187
0.44	0.180	1.000	1.000	0.180
0.45	0.177	1.000	1.000	0.177
0.46	0.174	1.000	1.000	0.174
0.48	0.169	1.000	1.000	0.169
0.5	0.163	1.000	1.000	0.163
0.55	0.150	1.000	1.004	0.151
0.6	0.139	1.000	1.008	0.140
0.65	0.129	1.000	1.012	0.131
0.667	0.126	1.000	1.013	0.128
0.7	0.121	1.000	1.015	0.123
0.75	0.114	1.000	1.019	0.116
0.8	0.108	1.000	1.023	0.111
0.85	0.103	1.000	1.027	0.106
0.9	0.098	1.000	1.031	0.101
0.95	0.094	1.000	1.035	0.097
1	0.090	1.000	1.038	0.093
1.1	0.082	1.000	1.038	0.085
1.2	0.075	1.000	1.038	0.078

1.3	0.070	1.000	1.038	0.072
1.4	0.065	1.000	1.038	0.067
1.5	0.060	1.000	1.038	0.063
1.6	0.056	1.000	1.038	0.058
1.7	0.053	1.000	1.038	0.055
1.8	0.050	1.000	1.038	0.051
1.9	0.047	1.000	1.038	0.048
2	0.044	1.000	1.038	0.046
2.2	0.039	1.000	1.038	0.041
2.4	0.036	1.000	1.038	0.037
2.5	0.034	1.000	1.038	0.035
2.6	0.033	1.000	1.038	0.034
2.8	0.030	1.000	1.038	0.031
3	0.028	1.000	1.038	0.029
3.2	0.026	1.000	1.038	0.027
3.4	0.024	1.000	1.038	0.025
3.5	0.023	1.000	1.038	0.024
3.6	0.022	1.000	1.038	0.023
3.8	0.021	1.000	1.038	0.022
4	0.020	1.000	1.038	0.021
4.2	0.019	1.000	1.038	0.020
4.4	0.018	1.000	1.038	0.019
4.6	0.017	1.000	1.038	0.018
4.8	0.016	1.000	1.038	0.017
5	0.016	1.000	1.038	0.016

Elsinore fault zone (Julian section)

Fault ID:	422
Maximum Magnitude (MMax):	7.6
Fault Type:	RLSS
Fault Dip:	85 Deg
Dip Direction:	NE
Bottom of Rupture Plane:	15.00 km
Top of Rupture Plane(Ztor):	0.00 km
Rrup	25.40 km
Rjb:	25.40 km
Rx:	25.40 km
Fnorm:	0
Frev:	0

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor (Applied)	SA(Final Spectrum)
0.01	0.135	1.000	1.000	0.135
0.02	0.137	1.000	1.000	0.137
0.022	0.139	1.000	1.000	0.139
0.025	0.143	1.000	1.000	0.143
0.029	0.147	1.000	1.000	0.147
0.03	0.148	1.000	1.000	0.148
0.032	0.151	1.000	1.000	0.151

0.035	0.156	1.000	1.000	0.156
0.036	0.158	1.000	1.000	0.158
0.04	0.165	1.000	1.000	0.165
0.042	0.168	1.000	1.000	0.168
0.044	0.172	1.000	1.000	0.172
0.045	0.174	1.000	1.000	0.174
0.046	0.176	1.000	1.000	0.176
0.048	0.179	1.000	1.000	0.179
0.05	0.183	1.000	1.000	0.183
0.055	0.194	1.000	1.000	0.194
0.06	0.205	1.000	1.000	0.205
0.065	0.215	1.000	1.000	0.215
0.067	0.219	1.000	1.000	0.219
0.07	0.225	1.000	1.000	0.225
0.075	0.234	1.000	1.000	0.234
0.08	0.243	1.000	1.000	0.243
0.085	0.251	1.000	1.000	0.251
0.09	0.258	1.000	1.000	0.258
0.095	0.266	1.000	1.000	0.266
0.1	0.272	1.000	1.000	0.272
0.11	0.282	1.000	1.000	0.282
0.12	0.290	1.000	1.000	0.290
0.13	0.296	1.000	1.000	0.296
0.133	0.298	1.000	1.000	0.298
0.14	0.301	1.000	1.000	0.301
0.15	0.304	1.000	1.000	0.304
0.16	0.302	1.000	1.000	0.302
0.17	0.300	1.000	1.000	0.300
0.18	0.297	1.000	1.000	0.297
0.19	0.293	1.000	1.000	0.293
0.2	0.290	1.000	1.000	0.290
0.22	0.275	1.000	1.000	0.275
0.24	0.262	1.000	1.000	0.262
0.25	0.255	1.000	1.000	0.255
0.26	0.249	1.000	1.000	0.249
0.28	0.238	1.000	1.000	0.238
0.29	0.232	1.000	1.000	0.232
0.3	0.227	1.000	1.000	0.227
0.32	0.218	1.000	1.000	0.218
0.34	0.209	1.000	1.000	0.209
0.35	0.205	1.000	1.000	0.205
0.36	0.201	1.000	1.000	0.201
0.38	0.194	1.000	1.000	0.194
0.4	0.187	1.000	1.000	0.187
0.42	0.180	1.000	1.000	0.180
0.44	0.174	1.000	1.000	0.174
0.45	0.172	1.000	1.000	0.172
0.46	0.169	1.000	1.000	0.169
0.48	0.164	1.000	1.000	0.164
0.5	0.159	1.000	1.000	0.159

0.55	0.146	1.000	1.000	0.146
0.6	0.136	1.000	1.000	0.136
0.65	0.127	1.000	1.000	0.127
0.667	0.124	1.000	1.000	0.124
0.7	0.119	1.000	1.000	0.119
0.75	0.112	1.000	1.000	0.112
0.8	0.107	1.000	1.000	0.107
0.85	0.101	1.000	1.000	0.101
0.9	0.097	1.000	1.000	0.097
0.95	0.093	1.000	1.000	0.093
1	0.089	1.000	1.000	0.089
1.1	0.081	1.000	1.000	0.081
1.2	0.075	1.000	1.000	0.075
1.3	0.070	1.000	1.000	0.070
1.4	0.065	1.000	1.000	0.065
1.5	0.060	1.000	1.000	0.060
1.6	0.056	1.000	1.000	0.056
1.7	0.053	1.000	1.000	0.053
1.8	0.050	1.000	1.000	0.050
1.9	0.047	1.000	1.000	0.047
2	0.044	1.000	1.000	0.044
2.2	0.040	1.000	1.000	0.040
2.4	0.036	1.000	1.000	0.036
2.5	0.034	1.000	1.000	0.034
2.6	0.033	1.000	1.000	0.033
2.8	0.030	1.000	1.000	0.030
3	0.028	1.000	1.000	0.028
3.2	0.026	1.000	1.000	0.026
3.4	0.024	1.000	1.000	0.024
3.5	0.024	1.000	1.000	0.024
3.6	0.023	1.000	1.000	0.023
3.8	0.022	1.000	1.000	0.022
4	0.020	1.000	1.000	0.020
4.2	0.019	1.000	1.000	0.019
4.4	0.018	1.000	1.000	0.018
4.6	0.018	1.000	1.000	0.018
4.8	0.017	1.000	1.000	0.017
5	0.016	1.000	1.000	0.016

PROBABILISTIC

Probabilistic Model
USGS Seismic Hazard Map(2008) 975 Year Return Period

Period	SA(Base Spectrum)	Basin Factor	Near Fault Factor (Applied)	SA(Final Spectrum)
0.01	0.238	1.000	1.000	0.238
0.02	0.298	1.000	1.000	0.298
0.022	0.307	1.000	1.000	0.307

0.025	0.320	1.000	1.000	0.320
0.029	0.335	1.000	1.000	0.335
0.03	0.339	1.000	1.000	0.339
0.032	0.346	1.000	1.000	0.346
0.035	0.356	1.000	1.000	0.356
0.036	0.360	1.000	1.000	0.360
0.04	0.372	1.000	1.000	0.372
0.042	0.378	1.000	1.000	0.378
0.044	0.384	1.000	1.000	0.384
0.045	0.386	1.000	1.000	0.386
0.046	0.389	1.000	1.000	0.389
0.048	0.394	1.000	1.000	0.394
0.05	0.400	1.000	1.000	0.400
0.055	0.412	1.000	1.000	0.412
0.06	0.424	1.000	1.000	0.424
0.065	0.435	1.000	1.000	0.435
0.067	0.439	1.000	1.000	0.439
0.07	0.445	1.000	1.000	0.445
0.075	0.455	1.000	1.000	0.455
0.08	0.465	1.000	1.000	0.465
0.085	0.474	1.000	1.000	0.474
0.09	0.483	1.000	1.000	0.483
0.095	0.491	1.000	1.000	0.491
0.1	0.499	1.000	1.000	0.499
0.11	0.505	1.000	1.000	0.505
0.12	0.511	1.000	1.000	0.511
0.13	0.516	1.000	1.000	0.516
0.133	0.518	1.000	1.000	0.518
0.14	0.521	1.000	1.000	0.521
0.15	0.525	1.000	1.000	0.525
0.16	0.530	1.000	1.000	0.530
0.17	0.534	1.000	1.000	0.534
0.18	0.538	1.000	1.000	0.538
0.19	0.541	1.000	1.000	0.541
0.2	0.545	1.000	1.000	0.545
0.22	0.514	1.000	1.000	0.514
0.24	0.488	1.000	1.000	0.488
0.25	0.476	1.000	1.000	0.476
0.26	0.465	1.000	1.000	0.465
0.28	0.444	1.000	1.000	0.444
0.29	0.435	1.000	1.000	0.435
0.3	0.426	1.000	1.000	0.426
0.32	0.405	1.000	1.000	0.405
0.34	0.386	1.000	1.000	0.386
0.35	0.378	1.000	1.000	0.378
0.36	0.370	1.000	1.000	0.370
0.38	0.354	1.000	1.000	0.354
0.4	0.340	1.000	1.000	0.340
0.42	0.328	1.000	1.000	0.328
0.44	0.316	1.000	1.000	0.316

0.45	0.310	1.000	1.000	0.310
0.46	0.305	1.000	1.000	0.305
0.48	0.295	1.000	1.000	0.295
0.5	0.286	1.000	1.000	0.286
0.55	0.262	1.000	1.020	0.268
0.6	0.243	1.000	1.040	0.252
0.65	0.226	1.000	1.060	0.239
0.667	0.220	1.000	1.067	0.235
0.7	0.211	1.000	1.080	0.228
0.75	0.198	1.000	1.100	0.218
0.8	0.187	1.000	1.120	0.210
0.85	0.177	1.000	1.140	0.202
0.9	0.169	1.000	1.160	0.196
0.95	0.161	1.000	1.180	0.189
1	0.153	1.000	1.200	0.184
1.1	0.140	1.000	1.200	0.167
1.2	0.128	1.000	1.200	0.154
1.3	0.118	1.000	1.200	0.142
1.4	0.110	1.000	1.200	0.132
1.5	0.103	1.000	1.200	0.123
1.6	0.096	1.000	1.200	0.115
1.7	0.091	1.000	1.200	0.109
1.8	0.086	1.000	1.200	0.103
1.9	0.081	1.000	1.200	0.097
2	0.077	1.000	1.200	0.092
2.2	0.069	1.000	1.200	0.083
2.4	0.063	1.000	1.200	0.075
2.5	0.060	1.000	1.200	0.072
2.6	0.057	1.000	1.200	0.069
2.8	0.053	1.000	1.200	0.063
3	0.049	1.000	1.200	0.059
3.2	0.045	1.000	1.200	0.054
3.4	0.042	1.000	1.200	0.050
3.5	0.041	1.000	1.200	0.049
3.6	0.039	1.000	1.200	0.047
3.8	0.037	1.000	1.200	0.044
4	0.035	1.000	1.200	0.041
4.2	0.033	1.000	1.200	0.040
4.4	0.032	1.000	1.200	0.038
4.6	0.031	1.000	1.200	0.037
4.8	0.030	1.000	1.200	0.036
5	0.029	1.000	1.200	0.034

MINIMUM DETERMINISTIC SPECTRUM

Period	SA
0.01	0.171

0.02	0.175
0.022	0.178
0.025	0.183
0.029	0.189
0.03	0.190
0.032	0.195
0.035	0.203
0.036	0.205
0.04	0.215
0.042	0.220
0.044	0.226
0.045	0.228
0.046	0.231
0.048	0.236
0.05	0.241
0.055	0.257
0.06	0.273
0.065	0.289
0.067	0.295
0.07	0.304
0.075	0.319
0.08	0.331
0.085	0.343
0.09	0.353
0.095	0.364
0.1	0.374
0.11	0.386
0.12	0.395
0.13	0.403
0.133	0.405
0.14	0.408
0.15	0.412
0.16	0.407
0.17	0.402
0.18	0.396
0.19	0.390
0.2	0.384
0.22	0.359
0.24	0.338
0.25	0.327
0.26	0.318
0.28	0.300
0.29	0.292
0.3	0.284
0.32	0.271
0.34	0.259
0.35	0.253
0.36	0.248
0.38	0.238
0.4	0.228

0.42	0.218
0.44	0.207
0.45	0.203
0.46	0.198
0.48	0.190
0.5	0.182
0.55	0.163
0.6	0.147
0.65	0.134
0.667	0.130
0.7	0.123
0.75	0.113
0.8	0.105
0.85	0.098
0.9	0.092
0.95	0.087
1	0.082
1.1	0.073
1.2	0.065
1.3	0.059
1.4	0.054
1.5	0.049
1.6	0.045
1.7	0.042
1.8	0.038
1.9	0.036
2	0.033
2.2	0.029
2.4	0.026
2.5	0.025
2.6	0.023
2.8	0.021
3	0.019
3.2	0.018
3.4	0.016
3.5	0.016
3.6	0.015
3.8	0.014
4	0.013
4.2	0.012
4.4	0.012
4.6	0.011
4.8	0.011
5	0.010

Envelope Data

Period	**SA**
0.01	0.238
0.02	0.298

0.022	0.307
0.025	0.320
0.029	0.335
0.03	0.339
0.032	0.346
0.035	0.356
0.036	0.360
0.04	0.372
0.042	0.378
0.044	0.384
0.045	0.386
0.046	0.389
0.048	0.394
0.05	0.400
0.055	0.412
0.06	0.424
0.065	0.435
0.067	0.439
0.07	0.445
0.075	0.455
0.08	0.465
0.085	0.474
0.09	0.483
0.095	0.491
0.1	0.499
0.11	0.505
0.12	0.511
0.13	0.516
0.133	0.518
0.14	0.521
0.15	0.525
0.16	0.530
0.17	0.534
0.18	0.538
0.19	0.541
0.2	0.545
0.22	0.514
0.24	0.488
0.25	0.476
0.26	0.465
0.28	0.444
0.29	0.435
0.3	0.426
0.32	0.405
0.34	0.386
0.35	0.378
0.36	0.370
0.38	0.354
0.4	0.340
0.42	0.328

0.44	0.316
0.45	0.310
0.46	0.305
0.48	0.295
0.5	0.286
0.55	0.268
0.6	0.252
0.65	0.239
0.667	0.235
0.7	0.228
0.75	0.218
0.8	0.210
0.85	0.202
0.9	0.196
0.95	0.189
1	0.184
1.1	0.167
1.2	0.154
1.3	0.142
1.4	0.132
1.5	0.123
1.6	0.115
1.7	0.109
1.8	0.103
1.9	0.097
2	0.092
2.2	0.083
2.4	0.075
2.5	0.072
2.6	0.069
2.8	0.063
3	0.059
3.2	0.054
3.4	0.050
3.5	0.049
3.6	0.047
3.8	0.044
4	0.041
4.2	0.040
4.4	0.038
4.6	0.037
4.8	0.036
5	0.034

APPENDIX E

SLOPE STABILITY CALCULATIONS

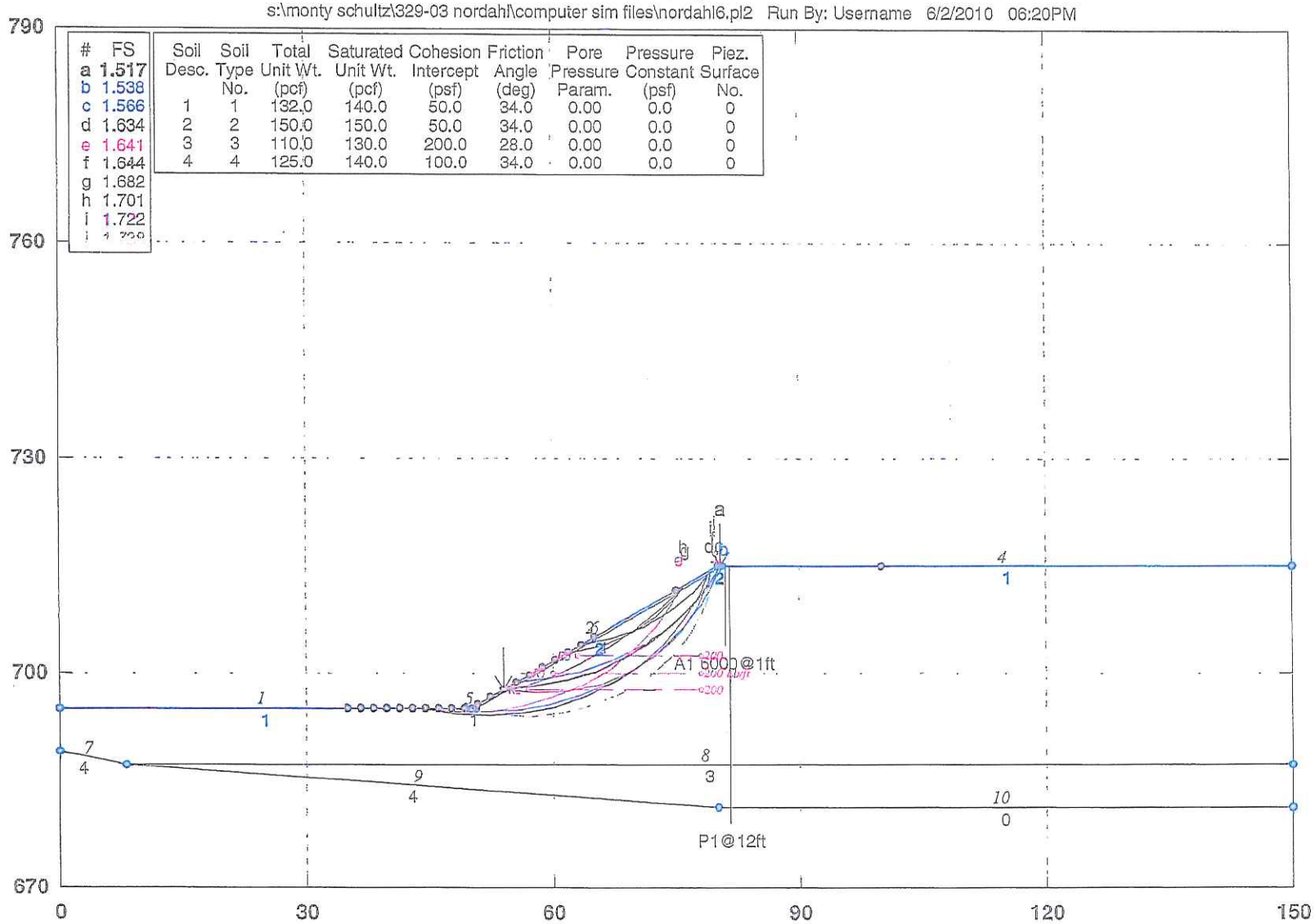
PETRA

Nordahl Bridge 329-03

s:\monty schultz\329-03 nordahl\computer sim files\nordahl6.pl2 Run By: Username 6/2/2010 06:20PM

#	FS
a	1.517
b	1.538
c	1.566
d	1.634
e	1.641
f	1.644
g	1.682
h	1.701
i	1.722
j	1.738

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	1	132.0	140.0	50.0	34.0	0.00	0.0	0
2	2	150.0	150.0	50.0	34.0	0.00	0.0	0
3	3	110.0	130.0	200.0	28.0	0.00	0.0	0
4	4	125.0	140.0	100.0	34.0	0.00	0.0	0



GSTABL7 v.2 FSmin=1.517

Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

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                    *** GSTABL7 ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
       Modified Bishop, Simplified Janbu, or GLE Method of Slices.
       (Includes Spencer & Morgenstern-Price Type Analysis)
       Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
       Nonlinear Undrained Shear Strength, Curved Phi Envelope,
       Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
       Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
    Analysis Run Date:        6/2/2010
    Time of Run:              06:20PM
    Run By:                   Username
    Input Data Filename:      S:\Monty Schultz\329-03 Nordahl\Computer Sim Files\nordahl6.
in
    Output Filename:          S:\Monty Schultz\329-03 Nordahl\Computer Sim Files\nordahl6.
OUT
    Unit System:              English
    Plotted Output Filename:  S:\Monty Schultz\329-03 Nordahl\Computer Sim Files\nordahl6.
PLT
    PROBLEM DESCRIPTION:  Nordahl Bridge
                          329-03
```

BOUNDARY COORDINATES
4 Top Boundaries
10 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	695.00	50.00	695.00	1
2	50.00	695.00	80.00	715.00	2
3	80.00	715.00	80.60	715.00	2
4	80.60	715.00	150.00	715.00	1
5	50.00	695.00	50.60	695.00	1
6	50.60	695.00	80.60	715.00	1
7	0.00	689.00	8.00	687.00	4
8	8.00	687.00	150.00	687.00	3
9	8.00	687.00	80.00	681.00	4
10	80.00	681.00	150.00	681.00	0

User Specified Y-Origin = 670.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
4 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	132.0	140.0	50.0	34.0	0.00	0.0	0
2	150.0	150.0	50.0	34.0	0.00	0.0	0
3	110.0	130.0	200.0	28.0	0.00	0.0	0
4	125.0	140.0	100.0	34.0	0.00	0.0	0

APPLIED FORCE(S)
1 Applied Force(s) Specified
APPLIED FORCE(S) DESCRIPTION:
Abutment Wall Reistance

Aforce No.	X-Pos (ft)	Y-Pos (ft)	Force (lbs)	Spacing (ft)	Incl/Vert (deg)	Length (ft)	Slope/Horiz (deg)
1	81.00	715.00	6000.0	1.0	90.00	11.0	0.00

NOTE - An Equivalent Line Force Is Calculated For Each Row Of Applied Forces
Assuming A Uniform Distribution Of force Horizontally Between
Individual Applied Forces.
Specified Peak Ground Acceleration Coefficient (A) = 0.280(g)
Specified Horizontal Earthquake Coefficient (kh) = 0.150(g)
Specified Vertical Earthquake Coefficient (kv) = 0.000(g)
Specified Seismic Pore-Pressure Factor = 0.000
EARTHQUAKE DATA HAS BEEN SUPPRESSED

PIER/PILE LOAD(S)
1 Pier/Pile Load(s) Specified

Pier/Pile No.	X-Pos (ft)	Y-Pos (ft)	Load (lbs)	Spacing (ft)	Inclination (deg)	Length (ft)
1	81.50	715.00	20000.0	12.0	90.00	36.0

NOTE - An Equivalent Line Load Is Calculated For Each Row Of Piers/Piles
Assuming A Uniform Distribution Of Load Horizontally Between
Individual Piers/Piles.

REINFORCING LAYER(S)
3 REINFORCING LAYER(S) SPECIFIED
REINFORCING LAYER NO. 1
2 POINTS DEFINE THIS LAYER

POINT NO.	X-COORD	Y-COORD	FORCE	INCLINATION FACTOR
1	60.00	700.00	200.00	0.000
2	78.00	700.00	200.00	0.000

REINFORCING LAYER NO. 2
2 POINTS DEFINE THIS LAYER

POINT NO.	X-COORD	Y-COORD	FORCE	INCLINATION FACTOR
1	57.00	697.50	200.00	0.000
2	78.00	697.50	200.00	0.000

REINFORCING LAYER NO. 3
2 POINTS DEFINE THIS LAYER

POINT	X-COORD	Y-COORD	FORCE	INCLINATION

NO.				FACTOR
1	63.00	702.50	200.00	0.000
2	78.00	702.50	200.00	0.000

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
200 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 20 Points Equally Spaced
Along The Ground Surface Between X = 35.00(ft)
and X = 65.00(ft)
Each Surface Terminates Between X = 75.00(ft)
and X = 100.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00(ft)
4.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 200
Number of Trial Surfaces With Valid FS = 200
Statistical Data On All Valid FS Values:
FS Max = 5.591 FS Min = 1.517 FS Ave = 2.671
Standard Deviation = 0.833 Coefficient of Variation = 31.20 %
Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.947	697.632
2	57.925	698.054
3	61.815	698.985
4	65.554	700.408
5	69.078	702.300
6	72.330	704.629
7	75.255	707.357
8	77.806	710.438
9	79.939	713.822
10	80.484	715.000

Circle Center At X = 52.721 ; Y = 728.463 ; and Radius = 30.856
Factor of Safety
*** 1.517 ***
Individual data on the 12 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	0.7	21.4	0.0	0.0	0.	0.	0.0	0.0	0.0
2	3.3	589.8	0.0	0.0	0.	0.	0.0	0.0	0.0
3	3.9	1599.6	0.0	0.0	0.	0.	0.0	0.0	0.0
4	3.7	2211.2	0.0	0.0	0.	0.	0.0	0.0	0.0
5	3.5	2439.8	0.0	0.0	0.	0.	0.0	0.0	0.0
6	3.3	2314.9	0.0	0.0	0.	0.	0.0	0.0	0.0
7	2.9	1901.2	0.0	0.0	0.	0.	0.0	0.0	0.0
8	2.6	1294.2	0.0	0.0	0.	0.	0.0	0.0	0.0
9	2.1	611.8	0.0	0.0	0.	0.	0.0	0.0	0.0
10	0.1	9.2	0.0	0.0	0.	0.	0.0	0.0	0.0
11	0.4	35.1	0.0	0.0	0.	0.	0.0	0.0	0.0
12	0.1	0.4	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.526	698.684
2	59.498	699.163
3	63.371	700.162
4	67.079	701.662
5	70.557	703.639
6	73.743	706.056
7	76.583	708.873
8	79.027	712.039

```
    9         80.742       715.000
Circle Center At X =    53.895 ; Y =   728.910 ; and Radius =    30.270
       Factor of Safety
      ***    1.538   ***
Failure Surface Specified By 12 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
    1         47.632       695.000
    2         51.614       694.626
    3         55.611       694.795
    4         59.547       695.504
    5         63.352       696.739
    6         66.954       698.478
    7         70.288       700.688
    8         73.291       703.330
    9         75.910       706.354
   10         78.095       709.705
   11         79.806       713.320
   12         80.337       715.000
Circle Center At X =    52.395 ; Y =   723.951 ; and Radius =    29.340
       Factor of Safety
      ***    1.566   ***
Failure Surface Specified By 12 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
    1         44.474       695.000
    2         48.394       694.205
    3         52.387       693.974
    4         56.373       694.311
    5         60.271       695.210
    6         64.002       696.651
    7         67.491       698.607
    8         70.668       701.037
    9         73.469       703.893
   10         75.836       707.117
   11         77.723       710.644
   12         79.087       714.391
Circle Center At X =    52.014 ; Y =   722.129 ; and Radius =    28.157
       Factor of Safety
      ***    1.634   ***
Failure Surface Specified By 11 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
    1         44.474       695.000
    2         48.447       694.537
    3         52.445       694.649
    4         56.386       695.333
    5         60.188       696.575
    6         63.773       698.351
    7         67.066       700.622
    8         69.999       703.342
    9         72.511       706.454
   10         74.551       709.895
   11         75.388       711.925
Circle Center At X =    49.671 ; Y =   722.319 ; and Radius =    27.809
       Factor of Safety
      ***    1.641   ***
Failure Surface Specified By  7 Coordinate Points
  Point       X-Surf       Y-Surf
   No.         (ft)         (ft)
    1         63.421       703.947
    2         67.315       704.862
    3         70.985       706.453
    4         74.315       708.670
    5         77.198       711.442
    6         79.544       714.682
    7         79.554       714.702
```

Circle Center At X = 60.253 ; Y = 726.181 ; and Radius = 22.458
Factor of Safety
*** 1.644 ***
Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.368	696.579
2	56.160	697.853
3	59.832	699.440
4	63.358	701.328
5	66.714	703.505
6	69.876	705.955
7	72.822	708.661
8	75.531	711.604
9	76.202	712.468

Circle Center At X = 39.067 ; Y = 742.451 ; and Radius = 47.761
Factor of Safety
*** 1.682 ***
Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	61.842	702.895
2	65.735	703.814
3	69.357	705.511
4	72.555	707.914
5	75.193	710.920
6	75.985	712.324

Circle Center At X = 59.497 ; Y = 721.734 ; and Radius = 18.984
Factor of Safety
*** 1.701 ***
Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.947	697.632
2	57.916	697.130
3	61.908	697.385
4	65.780	698.386
5	69.395	700.099
6	72.624	702.460
7	75.350	705.388
8	77.477	708.775
9	78.928	712.503
10	79.301	714.534

Circle Center At X = 58.596 ; Y = 718.126 ; and Radius = 21.015
Factor of Safety
*** 1.722 ***
Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	49.211	695.000
2	53.108	694.100
3	57.102	693.875
4	61.076	694.331
5	64.914	695.456
6	68.506	697.215
7	71.748	699.559
8	74.544	702.419
9	76.814	705.713
10	78.492	709.344
11	79.529	713.207
12	79.674	714.783

Circle Center At X = 56.435 ; Y = 717.222 ; and Radius = 23.367
Factor of Safety
*** 1.738 ***
**** END OF GSTABL7 OUTPUT ****

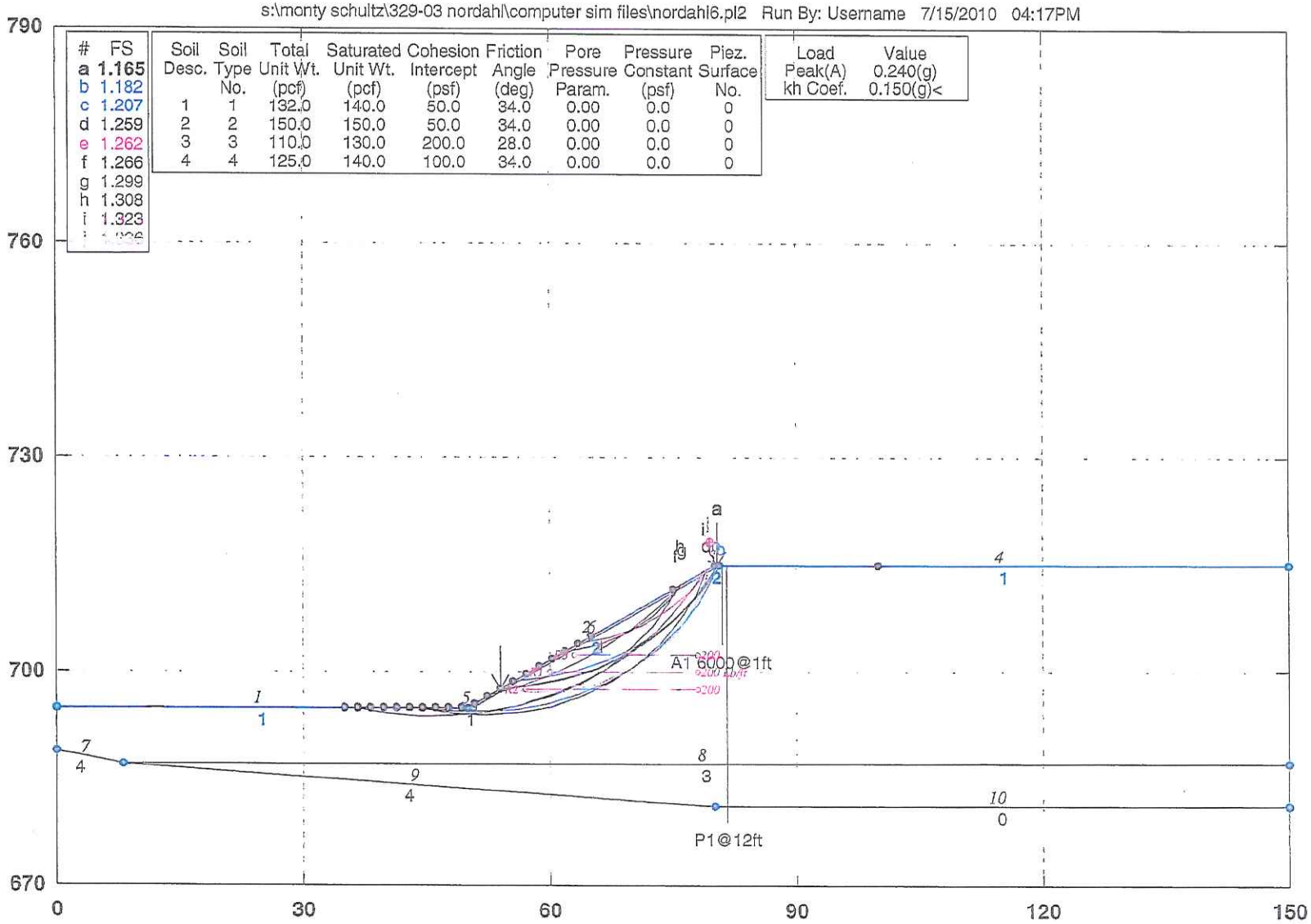
Nordahl Bridge 329-03

s:\monty schultz\329-03 nordahl\computer sim files\nordahl6.pl2 Run By: Username 7/15/2010 04:17PM

#	FS
a	1.165
b	1.182
c	1.207
d	1.259
e	1.262
f	1.266
g	1.299
h	1.308
i	1.323

Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	1	132.0	140.0	50.0	34.0	0.00	0.0	0
2	2	150.0	150.0	50.0	34.0	0.00	0.0	0
3	3	110.0	130.0	200.0	28.0	0.00	0.0	0
4	4	125.0	140.0	100.0	34.0	0.00	0.0	0

Load	Value
Peak(A)	0.240(g)
kh Coef.	0.150(g)<



GSTABL7 v.2 FSmin=1.165

Safety Factors Are Calculated By The Modified Bishop Method

GSTABL7

```
                    *** GSTABL7 ***
            ** GSTABL7 by Garry H. Gregory, P.E. **
   ** Original Version 1.0, January 1996; Current Version 2.004, June 2003 **
          (All Rights Reserved-Unauthorized Use Prohibited)
*******************************************************************************
                SLOPE STABILITY ANALYSIS SYSTEM
      Modified Bishop, Simplified Janbu, or GLE Method of Slices.
      (Includes Spencer & Morgenstern-Price Type Analysis)
      Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
      Nonlinear Undrained Shear Strength, Curved Phi Envelope,
      Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
      Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
*******************************************************************************
Analysis Run Date:        7/15/2010
Time of Run:              04:17PM
Run By:                   Username
Input Data Filename:      S:\Monty Schultz\329-03 Nordahl\Computer Sim Files\nordahl6.
in
Output Filename:          S:\Monty Schultz\329-03 Nordahl\Computer Sim Files\nordahl6.
OUT
Unit System:              English
Plotted Output Filename:  S:\Monty Schultz\329-03 Nordahl\Computer Sim Files\nordahl6.
PLT
PROBLEM DESCRIPTION:  Nordahl Bridge
                      329-03
BOUNDARY COORDINATES
    4 Top   Boundaries
   10 Total Boundaries
```

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	695.00	50.00	695.00	1
2	50.00	695.00	80.00	715.00	2
3	80.00	715.00	80.60	715.00	2
4	80.60	715.00	150.00	715.00	1
5	50.00	695.00	50.60	695.00	1
6	50.60	695.00	80.60	715.00	1
7	0.00	689.00	8.00	687.00	4
8	8.00	687.00	150.00	687.00	3
9	8.00	687.00	80.00	681.00	4
10	80.00	681.00	150.00	681.00	0

```
User Specified Y-Origin =        670.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
  4 Type(s) of Soil
```

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	132.0	140.0	50.0	34.0	0.00	0.0	0
2	150.0	150.0	50.0	34.0	0.00	0.0	0
3	110.0	130.0	200.0	28.0	0.00	0.0	0
4	125.0	140.0	100.0	34.0	0.00	0.0	0

```
APPLIED FORCE(S)
    1 Applied Force(s) Specified
APPLIED FORCE(S) DESCRIPTION:
   Abutment Wall Reistance
```

Aforce No.	X-Pos (ft)	Y-Pos (ft)	Force (lbs)	Spacing (ft)	Incl/Vert (deg)	Length (ft)	Slope/Horiz (deg)
1	81.00	715.00	6000.0	1.0	90.00	11.0	0.00

```
NOTE - An Equivalent Line Force Is Calculated For Each Row Of Applied Forces
       Assuming A Uniform Distribution Of force Horizontally Between
       Individual Applied Forces.
Specified Peak Ground Acceleration Coefficient (A) =   0.240(g)
Specified Horizontal Earthquake Coefficient (kh) =   0.150(g)
Specified Vertical Earthquake Coefficient (kv) =   0.000(g)
Specified Seismic Pore-Pressure Factor =   0.000
```

```
PIER/PILE LOAD(S)
     1 Pier/Pile Load(s) Specified
Pier/Pile  X-Pos    Y-Pos     Load     Spacing  Inclination  Length
   No.      (ft)     (ft)     (lbs)      (ft)      (deg)       (ft)
    1      81.50   715.00   20000.0    12.0      90.00        36.0
 NOTE - An Equivalent Line Load Is Calculated For Each Row Of Piers/Piles
        Assuming A Uniform Distribution Of Load Horizontally Between
        Individual Piers/Piles.
REINFORCING LAYER(S)
     3 REINFORCING LAYER(S) SPECIFIED
 REINFORCING LAYER NO.   1
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        60.00    700.00    200.00     0.000
        2        78.00    700.00    200.00     0.000
 REINFORCING LAYER NO.   2
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        57.00    697.50    200.00     0.000
        2        78.00    697.50    200.00     0.000
 REINFORCING LAYER NO.   3
   2 POINTS DEFINE THIS LAYER
      POINT     X-COORD   Y-COORD   FORCE   INCLINATION
       NO.                                    FACTOR
        1        63.00    702.50    200.00     0.000
        2        78.00    702.50    200.00     0.000
 A Critical Failure Surface Searching Method, Using A Random
 Technique For Generating Circular Surfaces, Has Been Specified.
  200 Trial Surfaces Have Been Generated.
   10 Surface(s) Initiate(s) From Each Of    20 Points Equally Spaced
 Along The Ground Surface Between  X =  35.00(ft)
                                and  X =  65.00(ft)
 Each Surface Terminates Between   X =  75.00(ft)
                              and   X = 100.00(ft)
 Unless Further Limitations Were Imposed, The Minimum Elevation
 At Which A Surface Extends Is  Y =      0.00(ft)
  4.00(ft) Line Segments Define Each Trial Failure Surface.
 Following Are Displayed The Ten Most Critical Of The Trial
       Failure Surfaces Evaluated. They Are
       Ordered - Most Critical First.
       * * Safety Factors Are Calculated By The Modified Bishop Method * *
       Total Number of Trial Surfaces Attempted =   200
       Number of Trial Surfaces With Valid FS =  200
       Statistical Data On All Valid FS Values:
          FS Max =   4.072   FS Min =   1.165   FS Ave =   1.959
          Standard Deviation =    0.541   Coefficient of Variation =   27.63 %
       Failure Surface Specified By 10 Coordinate Points
         Point      X-Surf      Y-Surf
          No.        (ft)        (ft)
           1        53.947      697.632
           2        57.925      698.054
           3        61.815      698.985
           4        65.554      700.408
           5        69.078      702.300
           6        72.330      704.629
           7        75.255      707.357
           8        77.806      710.438
           9        79.939      713.822
          10        80.484      715.000
       Circle Center At X =    52.721 ; Y =   728.463 ; and Radius =    30.856
              Factor of Safety
             ***    1.165    ***
            Individual data on the    12  slices
                      Water  Water     Tie     Tie     Earthquake
```

Slice No.	Width (ft)	Weight (lbs)	Force Top (lbs)	Force Bot (lbs)	Force Norm (lbs)	Force Tan (lbs)	Force Hor (lbs)	Force Ver (lbs)	Surcharge Load (lbs)
1	0.7	21.4	0.0	0.0	0.	0.	3.2	0.0	0.0
2	3.3	589.8	0.0	0.0	0.	0.	88.5	0.0	0.0
3	3.9	1599.6	0.0	0.0	0.	0.	239.9	0.0	0.0
4	3.7	2211.2	0.0	0.0	0.	0.	331.7	0.0	0.0
5	3.5	2439.8	0.0	0.0	0.	0.	366.0	0.0	0.0
6	3.3	2314.9	0.0	0.0	0.	0.	347.2	0.0	0.0
7	2.9	1901.2	0.0	0.0	0.	0.	285.2	0.0	0.0
8	2.6	1294.2	0.0	0.0	0.	0.	194.1	0.0	0.0
9	2.1	611.8	0.0	0.0	0.	0.	91.8	0.0	0.0
10	0.1	9.2	0.0	0.0	0.	0.	1.4	0.0	0.0
11	0.4	35.1	0.0	0.0	0.	0.	5.3	0.0	0.0
12	0.1	0.4	0.0	0.0	0.	0.	0.1	0.0	0.0

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.526	698.684
2	59.498	699.163
3	63.371	700.162
4	67.079	701.662
5	70.557	703.639
6	73.743	706.056
7	76.583	708.873
8	79.027	712.039
9	80.742	715.000

Circle Center At X = 53.895 ; Y = 728.910 ; and Radius = 30.270

Factor of Safety

*** 1.182 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	47.632	695.000
2	51.614	694.626
3	55.611	694.795
4	59.547	695.504
5	63.352	696.739
6	66.954	698.478
7	70.288	700.688
8	73.291	703.330
9	75.910	706.354
10	78.095	709.705
11	79.806	713.320
12	80.337	715.000

Circle Center At X = 52.395 ; Y = 723.951 ; and Radius = 29.340

Factor of Safety

*** 1.207 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.474	695.000
2	48.394	694.205
3	52.387	693.974
4	56.373	694.311
5	60.271	695.210
6	64.002	696.651
7	67.491	698.607
8	70.668	701.037
9	73.469	703.893
10	75.836	707.117
11	77.723	710.644
12	79.087	714.391

Circle Center At X = 52.014 ; Y = 722.129 ; and Radius = 28.157

Factor of Safety

*** 1.259 ***

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	63.421	703.947
2	67.315	704.862
3	70.985	706.453
4	74.315	708.670
5	77.198	711.442
6	79.544	714.682
7	79.554	714.702

Circle Center At X = 60.253 ; Y = 726.181 ; and Radius = 22.458

Factor of Safety

*** 1.262 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	44.474	695.000
2	48.447	694.537
3	52.445	694.649
4	56.386	695.333
5	60.188	696.575
6	63.773	698.351
7	67.066	700.622
8	69.999	703.342
9	72.511	706.454
10	74.551	709.895
11	75.388	711.925

Circle Center At X = 49.671 ; Y = 722.319 ; and Radius = 27.809

Factor of Safety

*** 1.266 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	52.368	696.579
2	56.160	697.853
3	59.832	699.440
4	63.358	701.328
5	66.714	703.505
6	69.876	705.955
7	72.822	708.661
8	75.531	711.604
9	76.202	712.468

Circle Center At X = 39.067 ; Y = 742.451 ; and Radius = 47.761

Factor of Safety

*** 1.299 ***

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	61.842	702.895
2	65.735	703.814
3	69.357	705.511
4	72.555	707.914
5	75.193	710.920
6	75.985	712.324

Circle Center At X = 59.497 ; Y = 721.734 ; and Radius = 18.984

Factor of Safety

*** 1.308 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	36.579	695.000
2	40.503	694.223
3	44.487	693.872
4	48.486	693.951
5	52.454	694.460
6	56.344	695.393

7	60.110	696.739
8	63.711	698.482
9	67.102	700.603
10	70.246	703.075
11	73.106	705.872
12	75.649	708.960
13	77.845	712.303
14	78.825	714.216

Circle Center At X = 45.758 ; Y = 730.865 ; and Radius = 37.021

Factor of Safety

*** 1.323 ***

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	53.947	697.632
2	57.916	697.130
3	61.908	697.385
4	65.780	698.386
5	69.395	700.099
6	72.624	702.460
7	75.350	705.388
8	77.477	708.775
9	78.928	712.503
10	79.301	714.534

Circle Center At X = 58.596 ; Y = 718.126 ; and Radius = 21.015

Factor of Safety

*** 1.336 ***

**** END OF GSTABL7 OUTPUT ****

APPENDIX F

PILE CALCULATIONS

PETRA

3/31/10 Petra GeoTech
329-03
Nordahl Bridge
Monty Schultz

Find unconfined compression strength of the granite found at the site from the shear wave velocity.
From Geophysics report
Line S-1 => $V_s = 5,608$ ft/s } @ depth of rock
Line S-2 => $V_s = 5,947$ ft/s }
Assume ρ for rock = 165 lb/ft^3 for s.g. = 2.65
From Table 4.4.8.2.2A of the Caltrans Bridge Design Specs.
Poissons Ratio for granite. $\nu = 0.20$ (mean value)
From CPT cone manual
"Practical applications of the cone penetration test"
Geotechnical Research group, University of British Columbia

$$G = \rho V_s^2$$

$$\& \; E = 2G(1+\nu)$$

$$\Rightarrow E = 2\rho V_s^2 (1+\nu)$$

$$\therefore E = 2\left[\frac{\left(165 \frac{lb}{ft^3}\right)}{\left(32.2 \; ft/s^2\right)}\right]\left(5,600 \frac{ft}{s}\right)^2\left(1+0.2\right) = 3.857\times10^8 \frac{lb}{ft^2}$$

$$= 2.678 \times 10^6 \text{ psi}$$

if we assume a limit strain of 0.001
Then $\sigma = E\varepsilon \Rightarrow \sigma = 2678$ psi

Say Unconfined compression $\cong$ 2,700 psi

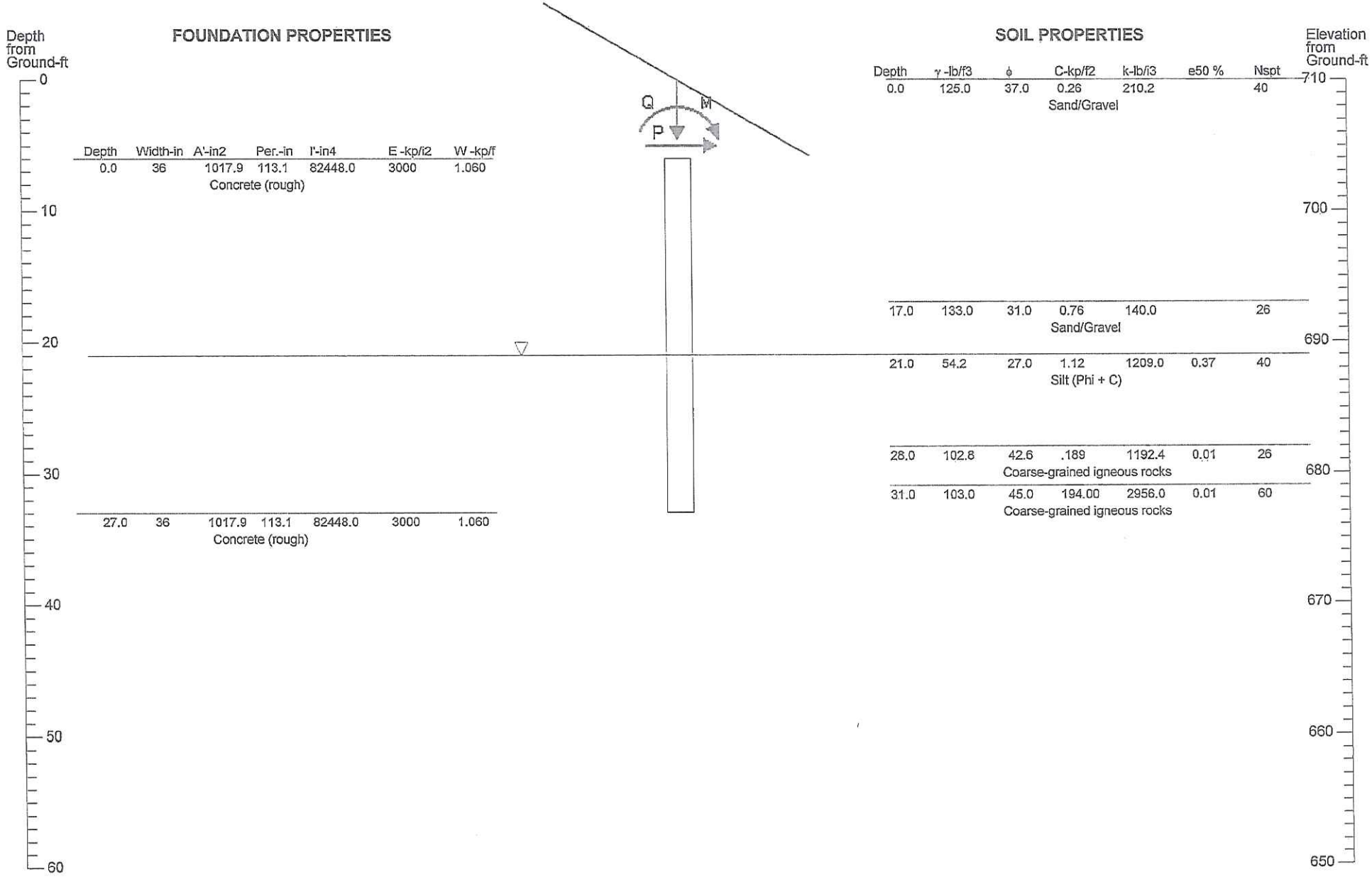
Table 4.4.8.2.2B gives mean E for granite = 3.55×10^6 psi
Table 4.4.8.1.2B gives unconfined compression strength C_o for granite ranges from 2,100 – 49,000 psi
$\therefore$ C_o of 2,700 at lower range should be reasonable.

FOUNDATION PROFILE & SOIL CONDITIONS

US FHWA publication method.
No friction on Bell Section and
Top 5'. Refer to Manual.

FOUNDATION PROPERTIES

Depth	Width-in	A'-in2	Per.-in	I'-in4	E -kp/i2	W -kp/f
0.0	36	1017.9	113.1	82448.0	3000	1.060
Concrete (rough)						
27.0	36	1017.9	113.1	82448.0	3000	1.060
Concrete (rough)						



SOIL PROPERTIES

Depth	γ -lb/f3	ϕ	C-kp/f2	k-lb/i3	e50 %	Nspt
0.0	125.0	37.0	0.26	210.2		40
Sand/Gravel						
17.0	133.0	31.0	0.76	140.0		26
Sand/Gravel						
21.0	54.2	27.0	1.12	1209.0	0.37	40
Silt (Phi + C)						
28.0	102.8	42.6	.189	1192.4	0.01	26
Coarse-grained igneous rocks						
31.0	103.0	45.0	194.00	2956.0	0.01	60
Coarse-grained igneous rocks						

Batter Angle=0 (Pile diameter not to scale) Surface Angle=30.0

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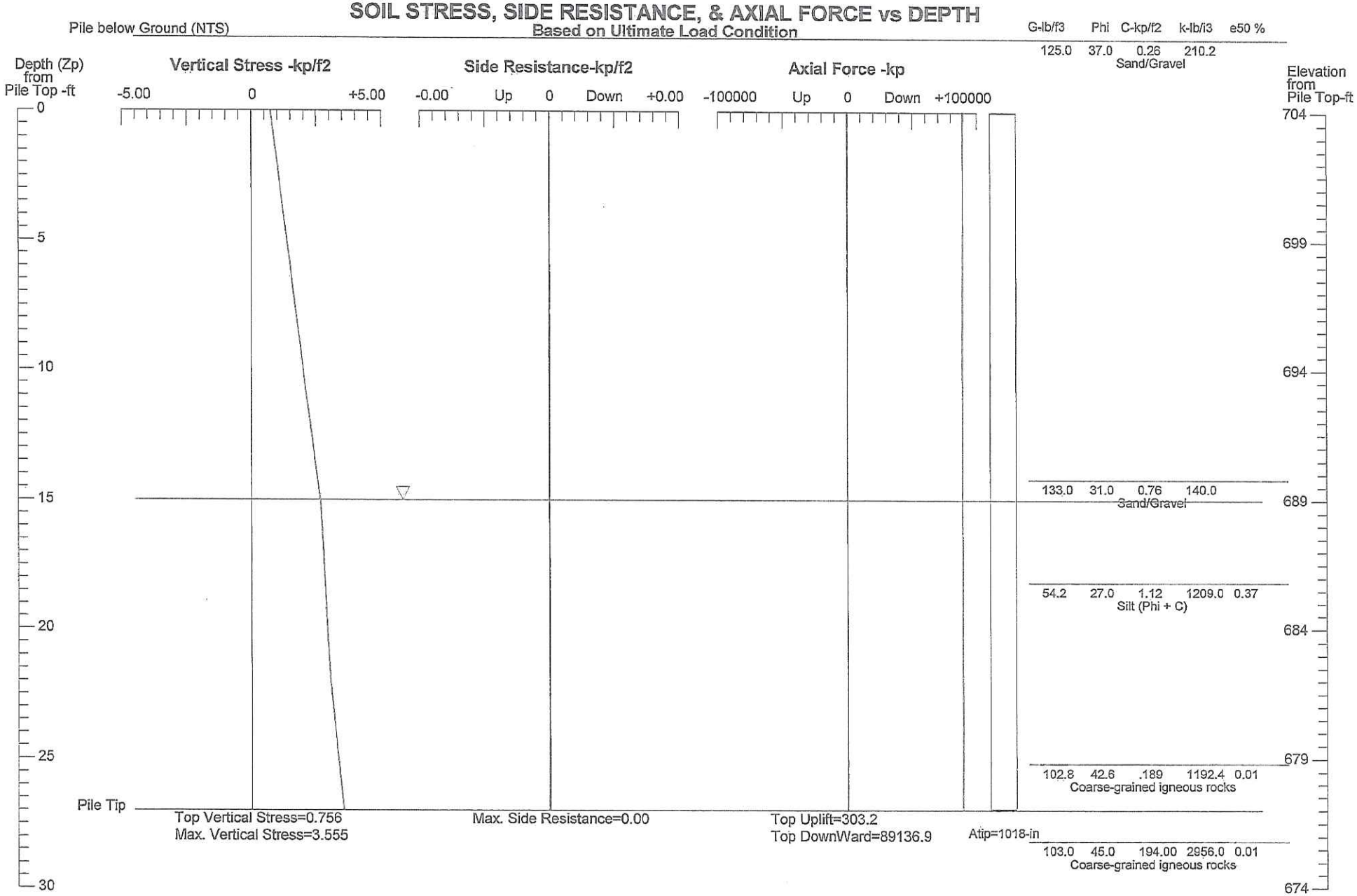
Figure 1

(13 Pile Group)

SOIL STRESS, SIDE RESISTANCE, & AXIAL FORCE vs DEPTH

Based on Ultimate Load Condition



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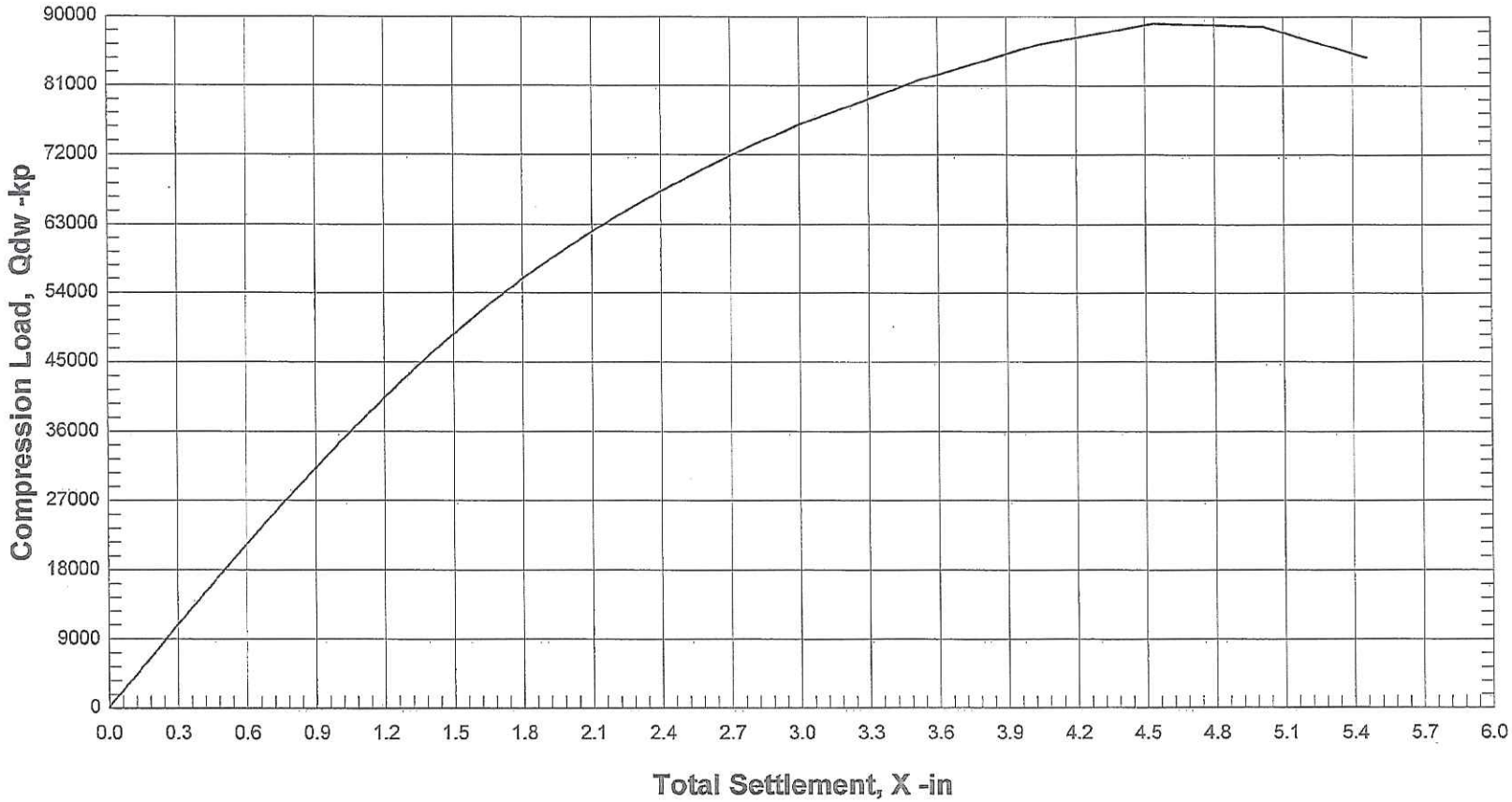
329-03

Figure 1

Vertical Load vs. Total Settlement

(13 Pile Group)



Total _____ Side _____ Tip _____

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Figure 1

(Single Pile)

SOIL STRESS, SIDE RESISTANCE, & AXIAL FORCE vs DEPTH

Based on Ultimate Load Condition

Pile below Ground (NTS)

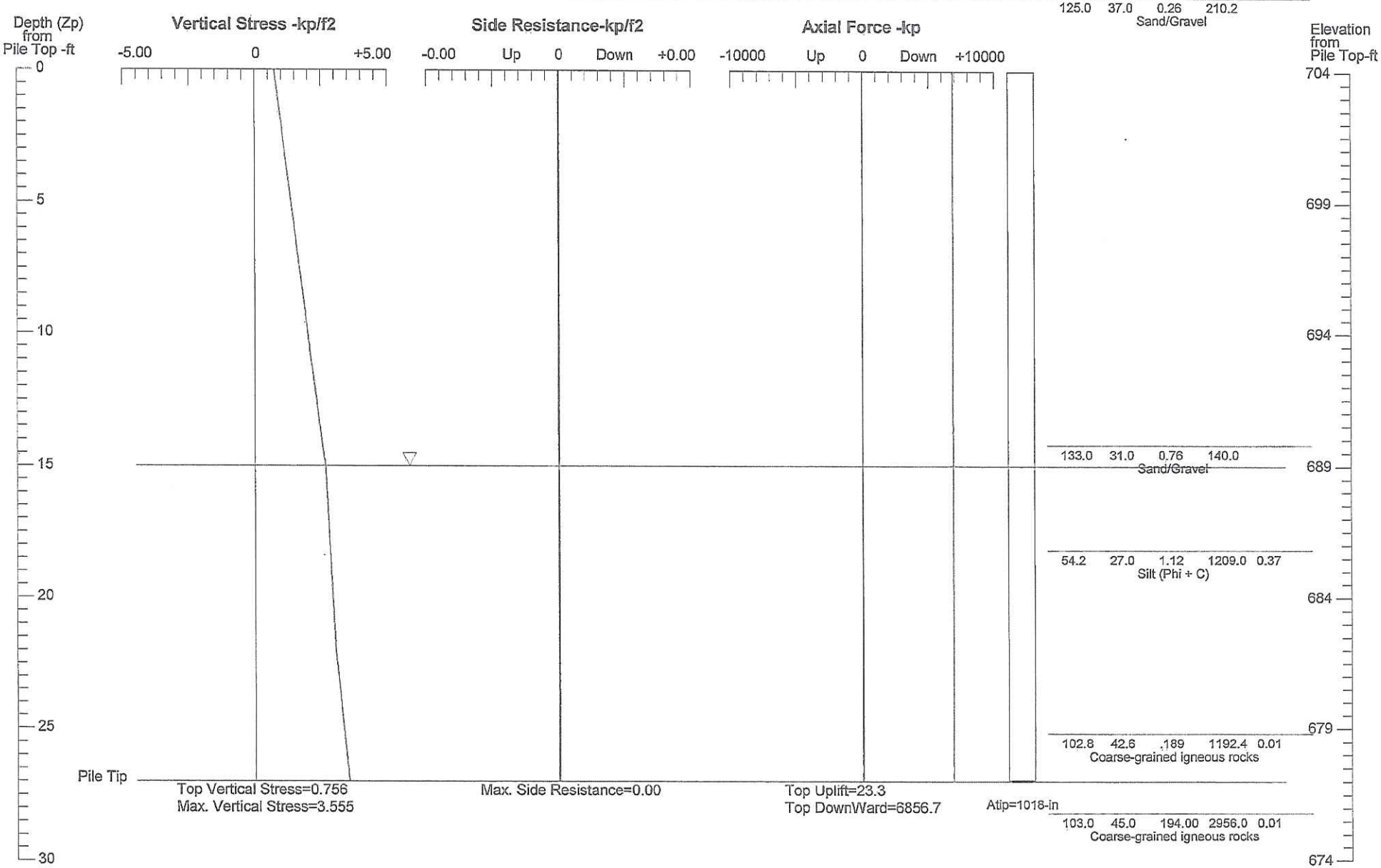

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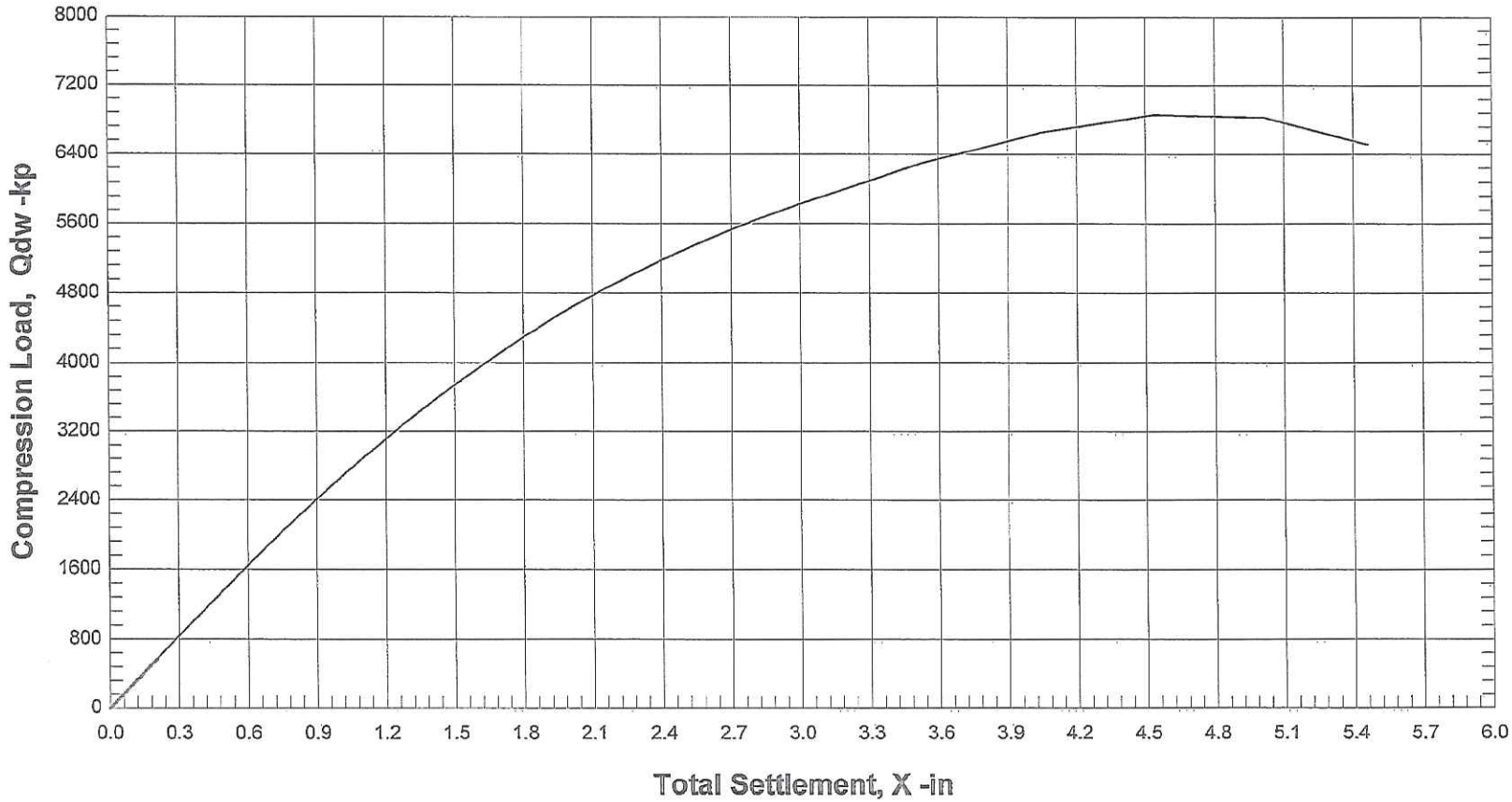
Figure 1

Vertical Load vs. Total Settlement

(single Pile)



Total _____

Stiffness, Kqx= 2788.13 -kp/-in

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Figure 1

```
*****************************************************************
                    ALLPILE 7
        VERTICAL ANALYSIS SUMMARY OUTPUT
         Copyright by CivilTech Software
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*****************************************************************
TOTAL LOADS:
        Vertical Load, Q: 7410.0 -kp
        Vertical Load with Load Factor, Q: 7410.0 -kp
          Load Factor for Vertical Loads: 1.0
        Vertical Load after Reduced by Pile Cap, Q: 7410.0 -kp
          Loads Supported by Pile Cap: 0 %

PILE PROFILE:
        Pile Length, L= 27.0 -ft
        Top Height, H= -6.0 -ft
        Slope Angle, As= 30.0
        Batter Angle, Ab= 0.00    Batter Factor, Kbat= 1.00

GROUP PILES:
Group Configuration:
        Free Head
        Average Pile Diameter= 3.00 -ft
        Sx= 121 -in
        Sy= 36.0 -in
        Nx= 13
        Ny= 1

1. Single Pile Vertical Analysis (Based on one pile):
        Vertical Load in Each Pile= 570.00 -kp
  Results:
        Total Ultimate Capacity (Down)= 6856.69-kp,  Total Ultimate Capacity (Up)= 23.32-kp
        Total Allowable Capacity (Down)= 2285.56-kp,  Total Allowable Capacity (Up)= 23.32-kp
        At Work Load= 570.00-kp,  Settlement= 0.20444-in
        At Work Load= 570.00-kp,  Secant Stiffness Kqx= 2788.13-kp/-in
        At Allowable Settlement= 0.50000-in,  Capacity= 1374.19-kp
        Work Load, 570.00-kp, OK with the Capacity at Allowable Settlement= 0.50000-in, Capacity= 1374.19-kp
        Work Load, 570.00-kp, OK with the Allowable Capacity (Down)= 2285.56-kp

2. Group Pile Vertical Analysis (Based on group of piles):
        Vertical Load in Group= 7410.00 -kp
  Results:
        Total Ultimate Capacity (Down)= 89136.95-kp,  Total Ultimate Capacity (Up)= 303.17-kp
        Total Allowable Capacity (Down)= 29712.31-kp,  Total Allowable Capacity (Up)= 303.17-kp
```

Group Settlement: Settlement Factor= 1.000 Capacity Factor= 13.000
At Work Load= 7410.00-kp, Settlement= 0.20444-in
At Work Load= 7410.00-kp Secant Stiffness Kqx= 36245.63-kp/-in

At Allowable Settlement= 0.50000-in, Capacity= 17864.44-kp
Work Load, 7410.00-kp, OK with the Capacity at Allowable Settlement= 0.50000-in, Capacity= 17864.44-kp
Work Load, 7410.00-kp, OK with the Allowable Capacity (Down)= 29712.31-kp

---

FACTOR OF SAFETY:

FSside	FStip	FSuplif	FSweight
2.0	3.0	2.5	1.0

Note: If the program cannot find a result or the result exceeds the upper limit. The result will be displayed as 99999.

1	1	1	1	1

```
*****************************************************************
                    ALLPILE 7
       VERTICAL ANALYSIS DETAILED OUTPUT
        Copyright by CivilTech Software
          www.civiltechsoftware.com
*****************************************************************
Pile Profile and Loading:
        Piletype: SHAFT (US. FHWA Methods)
        Pile Length, L= 27.0 -ft
        Top Height, H= -6.0 -ft
        Slope Angle, As= 30.0
        Batter Angle, Ab= 0.00

Group Case, Group Pile, Vertical Analysis:
        Vertical Load with Load factor, Q= 7410.0 -kp
          Load Factor for Vertical Loads= 1.0
          Loads Supported by Pile Cap: 0 %
          Kdown= 0.7      Kup= 0.4        Ka= 1.00

---------------------------1. Computation for Single Pile---------------------------
Bearing stratum from pile tip extending to 10 Diameter of pile, which is=30.0-ft Starting from Pile Tip=
33.0-ft
From Ztip=33.0 to 63.0-ft  Average Properties: Es= 72750.00-kp/f2  C=194.00-kp/f2  Friction=45.00 Cp=0.14
Ksand=1.00

*   SHAFT CALCULATION based on FHWA-IF-99-025   *


User defined Exclusion Zone.
User defined Exclusion Zone Start: 0 -ft        End: 33 -ft

Default Top Exclusion Zone (Up & Down), Ln1= 0.0-ft
Default Bottom Exclusion Zone (Down), Ln2= 0.0-ft
Default Bottom Exclusion Zone (Up), Ln3= 0.0-ft

Tip Resistance (Down):
Tip Resistance for Rock
        C=194-kp/f2      Ultimate Bearing Pressue, qult=970.0-kp/f2
Limits of Max. tip resistance, q_lim= N/A
Batter Angle, Ab= 0.00    Batter Factor, Kbat= 1.00
Qtip_dw=6856.7-kp  based on qult=970.0-kp/f2  and Base Area=7.1-ft2
Qtip_up=0.0-kp  and Base Area=0.0-ft2


SIDE RESISTANCE (Up & Down) CALCULATION vs DEPTH:
    Calculation is based on segment dZ= 0.07
Soil Type=1,2,3 Cohesive Soil: Factor=alpha; Soil Type=4 Cohesionless Soil: Factor=Beta; Soil Type=5 Rock:
Factor=N/A
```

Zs -ft	Soil Type	Nspt	C -kp/f2	Factor	f0_dw -kp/f2	f0_up -kp/f2	Per -ft	Weight -kp	Qneg -kp	Q_dw -kp	Q_up -kp
33.00	5	60.0	194.0	0.00	0.00	0.00	9.43	0.00	0.00	6856.7	0.0
32.93	5	60.0	194.0	0.00	0.00	0.00	9.43	0.04	0.00	6856.7	0.0
32.87	5	60.0	194.0	0.00	0.00	0.00	9.43	0.08	0.00	6856.7	0.1
32.80	5	60.0	194.0	0.00	0.00	0.00	9.43	0.12	0.00	6856.7	0.1
32.74	5	60.0	194.0	0.00	0.00	0.00	9.43	0.16	0.00	6856.7	0.2
32.67	5	60.0	194.0	0.00	0.00	0.00	9.43	0.20	0.00	6856.7	0.2
32.60	5	60.0	194.0	0.00	0.00	0.00	9.43	0.25	0.00	6856.7	0.2
32.54	5	60.0	194.0	0.00	0.00	0.00	9.43	0.29	0.00	6856.7	0.3
32.47	5	60.0	194.0	0.00	0.00	0.00	9.43	0.33	0.00	6856.7	0.3
32.40	5	60.0	194.0	0.00	0.00	0.00	9.43	0.37	0.00	6856.7	0.4
32.34	5	60.0	194.0	0.00	0.00	0.00	9.43	0.41	0.00	6856.7	0.4
32.27	5	60.0	194.0	0.00	0.00	0.00	9.43	0.45	0.00	6856.7	0.5
32.21	5	60.0	194.0	0.00	0.00	0.00	9.43	0.49	0.00	6856.7	0.5
32.14	5	60.0	194.0	0.00	0.00	0.00	9.43	0.53	0.00	6856.7	0.5
32.07	5	60.0	194.0	0.00	0.00	0.00	9.43	0.57	0.00	6856.7	0.6
32.01	5	60.0	194.0	0.00	0.00	0.00	9.43	0.61	0.00	6856.7	0.6
31.94	5	60.0	194.0	0.00	0.00	0.00	9.43	0.65	0.00	6856.7	0.7
31.88	5	60.0	194.0	0.00	0.00	0.00	9.43	0.70	0.00	6856.7	0.7
31.81	5	60.0	194.0	0.00	0.00	0.00	9.43	0.74	0.00	6856.7	0.7
31.74	5	60.0	194.0	0.00	0.00	0.00	9.43	0.78	0.00	6856.7	0.8
31.68	5	60.0	194.0	0.00	0.00	0.00	9.43	0.82	0.00	6856.7	0.8
31.61	5	60.0	194.0	0.00	0.00	0.00	9.43	0.86	0.00	6856.7	0.9
31.55	5	60.0	194.0	0.00	0.00	0.00	9.43	0.90	0.00	6856.7	0.9
31.48	5	60.0	194.0	0.00	0.00	0.00	9.43	0.94	0.00	6856.7	0.9
31.41	5	60.0	194.0	0.00	0.00	0.00	9.43	0.98	0.00	6856.7	1.0
31.35	5	60.0	194.0	0.00	0.00	0.00	9.43	1.02	0.00	6856.7	1.0
31.28	5	60.0	194.0	0.00	0.00	0.00	9.43	1.06	0.00	6856.7	1.1
31.21	5	60.0	194.0	0.00	0.00	0.00	9.43	1.11	0.00	6856.7	1.1
31.15	5	60.0	194.0	0.00	0.00	0.00	9.43	1.15	0.00	6856.7	1.1
31.08	5	60.0	194.0	0.00	0.00	0.00	9.43	1.19	0.00	6856.7	1.2
31.02	5	60.0	194.0	0.00	0.00	0.00	9.43	1.23	0.00	6856.7	1.2
30.95	5	26.0	0.2	0.00	0.00	0.00	9.43	1.27	0.00	6856.7	1.3
30.88	5	26.0	0.2	0.00	0.00	0.00	9.43	1.31	0.00	6856.7	1.3
30.82	5	26.0	0.2	0.00	0.00	0.00	9.43	1.35	0.00	6856.7	1.4
30.75	5	26.0	0.2	0.00	0.00	0.00	9.43	1.39	0.00	6856.7	1.4
30.69	5	26.0	0.2	0.00	0.00	0.00	9.43	1.43	0.00	6856.7	1.4
30.62	5	26.0	0.2	0.00	0.00	0.00	9.43	1.47	0.00	6856.7	1.5
30.55	5	26.0	0.2	0.00	0.00	0.00	9.43	1.51	0.00	6856.7	1.5
30.49	5	26.0	0.2	0.00	0.00	0.00	9.43	1.56	0.00	6856.7	1.6
30.42	5	26.0	0.2	0.00	0.00	0.00	9.43	1.60	0.00	6856.7	1.6
30.35	5	26.0	0.2	0.00	0.00	0.00	9.43	1.64	0.00	6856.7	1.6
30.29	5	26.0	0.2	0.00	0.00	0.00	9.43	1.68	0.00	6856.7	1.7
30.22	5	26.0	0.2	0.00	0.00	0.00	9.43	1.72	0.00	6856.7	1.7
30.16	5	26.0	0.2	0.00	0.00	0.00	9.43	1.76	0.00	6856.7	1.8
30.09	5	26.0	0.2	0.00	0.00	0.00	9.43	1.80	0.00	6856.7	1.8

30.02	5	26.0	0.2	0.00	0.00	0.00	9.43	1.84	0.00	6856.7	1.8
29.96	5	26.0	0.2	0.00	0.00	0.00	9.43	1.88	0.00	6856.7	1.9
29.89	5	26.0	0.2	0.00	0.00	0.00	9.43	1.92	0.00	6856.7	1.9
29.83	5	26.0	0.2	0.00	0.00	0.00	9.43	1.96	0.00	6856.7	2.0
29.76	5	26.0	0.2	0.00	0.00	0.00	9.43	2.01	0.00	6856.7	2.0
29.69	5	26.0	0.2	0.00	0.00	0.00	9.43	2.05	0.00	6856.7	2.0
29.63	5	26.0	0.2	0.00	0.00	0.00	9.43	2.09	0.00	6856.7	2.1
29.56	5	26.0	0.2	0.00	0.00	0.00	9.43	2.13	0.00	6856.7	2.1
29.49	5	26.0	0.2	0.00	0.00	0.00	9.43	2.17	0.00	6856.7	2.2
29.43	5	26.0	0.2	0.00	0.00	0.00	9.43	2.21	0.00	6856.7	2.2
29.36	5	26.0	0.2	0.00	0.00	0.00	9.43	2.25	0.00	6856.7	2.3
29.30	5	26.0	0.2	0.00	0.00	0.00	9.43	2.29	0.00	6856.7	2.3
29.23	5	26.0	0.2	0.00	0.00	0.00	9.43	2.33	0.00	6856.7	2.3
29.16	5	26.0	0.2	0.00	0.00	0.00	9.43	2.37	0.00	6856.7	2.4
29.10	5	26.0	0.2	0.00	0.00	0.00	9.43	2.41	0.00	6856.7	2.4
29.03	5	26.0	0.2	0.00	0.00	0.00	9.43	2.46	0.00	6856.7	2.5
28.97	5	26.0	0.2	0.00	0.00	0.00	9.43	2.50	0.00	6856.7	2.5
28.90	5	26.0	0.2	0.00	0.00	0.00	9.43	2.54	0.00	6856.7	2.5
28.83	5	26.0	0.2	0.00	0.00	0.00	9.43	2.58	0.00	6856.7	2.6
28.77	5	26.0	0.2	0.00	0.00	0.00	9.43	2.62	0.00	6856.7	2.6
28.70	5	26.0	0.2	0.00	0.00	0.00	9.43	2.66	0.00	6856.7	2.7
28.64	5	26.0	0.2	0.00	0.00	0.00	9.43	2.70	0.00	6856.7	2.7
28.57	5	26.0	0.2	0.00	0.00	0.00	9.43	2.74	0.00	6856.7	2.7
28.50	5	26.0	0.2	0.00	0.00	0.00	9.43	2.78	0.00	6856.7	2.8
28.44	5	26.0	0.2	0.00	0.00	0.00	9.43	2.82	0.00	6856.7	2.8
28.37	5	26.0	0.2	0.00	0.00	0.00	9.43	2.87	0.00	6856.7	2.9
28.30	5	26.0	0.2	0.00	0.00	0.00	9.43	2.91	0.00	6856.7	2.9
28.24	5	26.0	0.2	0.00	0.00	0.00	9.43	2.95	0.00	6856.7	2.9
28.17	5	26.0	0.2	0.00	0.00	0.00	9.43	2.99	0.00	6856.7	3.0
28.11	5	26.0	0.2	0.00	0.00	0.00	9.43	3.03	0.00	6856.7	3.0
28.04	5	26.0	0.2	0.00	0.00	0.00	9.43	3.07	0.00	6856.7	3.1
27.97	3	40.0	1.1	0.55	0.00	0.00	9.43	3.11	0.00	6856.7	3.1
27.91	3	40.0	1.1	0.55	0.00	0.00	9.43	3.15	0.00	6856.7	3.2
27.84	3	40.0	1.1	0.55	0.00	0.00	9.43	3.19	0.00	6856.7	3.2
27.78	3	40.0	1.1	0.55	0.00	0.00	9.43	3.23	0.00	6856.7	3.2
27.71	3	40.0	1.1	0.55	0.00	0.00	9.43	3.27	0.00	6856.7	3.3
27.64	3	40.0	1.1	0.55	0.00	0.00	9.43	3.32	0.00	6856.7	3.3
27.58	3	40.0	1.1	0.55	0.00	0.00	9.43	3.36	0.00	6856.7	3.4
27.51	3	40.0	1.1	0.55	0.00	0.00	9.43	3.40	0.00	6856.7	3.4
27.44	3	40.0	1.1	0.55	0.00	0.00	9.43	3.44	0.00	6856.7	3.4
27.38	3	40.0	1.1	0.55	0.00	0.00	9.43	3.48	0.00	6856.7	3.5
27.31	3	40.0	1.1	0.55	0.00	0.00	9.43	3.52	0.00	6856.7	3.5
27.25	3	40.0	1.1	0.55	0.00	0.00	9.43	3.56	0.00	6856.7	3.6
27.18	3	40.0	1.1	0.55	0.00	0.00	9.43	3.60	0.00	6856.7	3.6
27.11	3	40.0	1.1	0.55	0.00	0.00	9.43	3.64	0.00	6856.7	3.6
27.05	3	40.0	1.1	0.55	0.00	0.00	9.43	3.68	0.00	6856.7	3.7
26.98	3	40.0	1.1	0.55	0.00	0.00	9.43	3.72	0.00	6856.7	3.7
26.92	3	40.0	1.1	0.55	0.00	0.00	9.43	3.77	0.00	6856.7	3.8
26.85	3	40.0	1.1	0.55	0.00	0.00	9.43	3.81	0.00	6856.7	3.8

26.78	3	40.0	1.1	0.55	0.00	0.00	9.43	3.85	0.00	6856.7	3.8
26.72	3	40.0	1.1	0.55	0.00	0.00	9.43	3.89	0.00	6856.7	3.9
26.65	3	40.0	1.1	0.55	0.00	0.00	9.43	3.93	0.00	6856.7	3.9
26.59	3	40.0	1.1	0.55	0.00	0.00	9.43	3.97	0.00	6856.7	4.0
26.52	3	40.0	1.1	0.55	0.00	0.00	9.43	4.01	0.00	6856.7	4.0
26.45	3	40.0	1.1	0.55	0.00	0.00	9.43	4.05	0.00	6856.7	4.1
26.39	3	40.0	1.1	0.55	0.00	0.00	9.43	4.09	0.00	6856.7	4.1
26.32	3	40.0	1.1	0.55	0.00	0.00	9.43	4.13	0.00	6856.7	4.1
26.25	3	40.0	1.1	0.55	0.00	0.00	9.43	4.17	0.00	6856.7	4.2
26.19	3	40.0	1.1	0.55	0.00	0.00	9.43	4.22	0.00	6856.7	4.2
26.12	3	40.0	1.1	0.55	0.00	0.00	9.43	4.26	0.00	6856.7	4.3
26.06	3	40.0	1.1	0.55	0.00	0.00	9.43	4.30	0.00	6856.7	4.3
25.99	3	40.0	1.1	0.55	0.00	0.00	9.43	4.34	0.00	6856.7	4.3
25.92	3	40.0	1.1	0.55	0.00	0.00	9.43	4.38	0.00	6856.7	4.4
25.86	3	40.0	1.1	0.55	0.00	0.00	9.43	4.42	0.00	6856.7	4.4
25.79	3	40.0	1.1	0.55	0.00	0.00	9.43	4.46	0.00	6856.7	4.5
25.73	3	40.0	1.1	0.55	0.00	0.00	9.43	4.50	0.00	6856.7	4.5
25.66	3	40.0	1.1	0.55	0.00	0.00	9.43	4.54	0.00	6856.7	4.5
25.59	3	40.0	1.1	0.55	0.00	0.00	9.43	4.58	0.00	6856.7	4.6
25.53	3	40.0	1.1	0.55	0.00	0.00	9.43	4.63	0.00	6856.7	4.6
25.46	3	40.0	1.1	0.55	0.00	0.00	9.43	4.67	0.00	6856.7	4.7
25.39	3	40.0	1.1	0.55	0.00	0.00	9.43	4.71	0.00	6856.7	4.7
25.33	3	40.0	1.1	0.55	0.00	0.00	9.43	4.75	0.00	6856.7	4.7
25.26	3	40.0	1.1	0.55	0.00	0.00	9.43	4.79	0.00	6856.7	4.8
25.20	3	40.0	1.1	0.55	0.00	0.00	9.43	4.83	0.00	6856.7	4.8
25.13	3	40.0	1.1	0.55	0.00	0.00	9.43	4.87	0.00	6856.7	4.9
25.06	3	40.0	1.1	0.55	0.00	0.00	9.43	4.91	0.00	6856.7	4.9
25.00	3	40.0	1.1	0.55	0.00	0.00	9.43	4.95	0.00	6856.7	5.0
24.93	3	40.0	1.1	0.55	0.00	0.00	9.43	4.99	0.00	6856.7	5.0
24.87	3	40.0	1.1	0.55	0.00	0.00	9.43	5.03	0.00	6856.7	5.0
24.80	3	40.0	1.1	0.55	0.00	0.00	9.43	5.08	0.00	6856.7	5.1
24.73	3	40.0	1.1	0.55	0.00	0.00	9.43	5.12	0.00	6856.7	5.1
24.67	3	40.0	1.1	0.55	0.00	0.00	9.43	5.16	0.00	6856.7	5.2
24.60	3	40.0	1.1	0.55	0.00	0.00	9.43	5.20	0.00	6856.7	5.2
24.54	3	40.0	1.1	0.55	0.00	0.00	9.43	5.24	0.00	6856.7	5.2
24.47	3	40.0	1.1	0.55	0.00	0.00	9.43	5.28	0.00	6856.7	5.3
24.40	3	40.0	1.1	0.55	0.00	0.00	9.43	5.32	0.00	6856.7	5.3
24.34	3	40.0	1.1	0.55	0.00	0.00	9.43	5.36	0.00	6856.7	5.4
24.27	3	40.0	1.1	0.55	0.00	0.00	9.43	5.40	0.00	6856.7	5.4
24.20	3	40.0	1.1	0.55	0.00	0.00	9.43	5.44	0.00	6856.7	5.4
24.14	3	40.0	1.1	0.55	0.00	0.00	9.43	5.48	0.00	6856.7	5.5
24.07	3	40.0	1.1	0.55	0.00	0.00	9.43	5.53	0.00	6856.7	5.5
24.01	3	40.0	1.1	0.55	0.00	0.00	9.43	5.57	0.00	6856.7	5.6
23.94	3	40.0	1.1	0.55	0.00	0.00	9.43	5.61	0.00	6856.7	5.6
23.87	3	40.0	1.1	0.55	0.00	0.00	9.43	5.65	0.00	6856.7	5.6
23.81	3	40.0	1.1	0.55	0.00	0.00	9.43	5.69	0.00	6856.7	5.7
23.74	3	40.0	1.1	0.55	0.00	0.00	9.43	5.73	0.00	6856.7	5.7
23.68	3	40.0	1.1	0.55	0.00	0.00	9.43	5.77	0.00	6856.7	5.8
23.61	3	40.0	1.1	0.55	0.00	0.00	9.43	5.81	0.00	6856.7	5.8

23.54	3	40.0	1.1	0.55	0.00	0.00	9.43	5.85	0.00	6856.7	5.9
23.48	3	40.0	1.1	0.55	0.00	0.00	9.43	5.89	0.00	6856.7	5.9
23.41	3	40.0	1.1	0.55	0.00	0.00	9.43	5.93	0.00	6856.7	5.9
23.34	3	40.0	1.1	0.55	0.00	0.00	9.43	5.98	0.00	6856.7	6.0
23.28	3	40.0	1.1	0.55	0.00	0.00	9.43	6.02	0.00	6856.7	6.0
23.21	3	40.0	1.1	0.55	0.00	0.00	9.43	6.06	0.00	6856.7	6.1
23.15	3	40.0	1.1	0.55	0.00	0.00	9.43	6.10	0.00	6856.7	6.1
23.08	3	40.0	1.1	0.55	0.00	0.00	9.43	6.14	0.00	6856.7	6.1
23.01	3	40.0	1.1	0.55	0.00	0.00	9.43	6.18	0.00	6856.7	6.2
22.95	3	40.0	1.1	0.55	0.00	0.00	9.43	6.22	0.00	6856.7	6.2
22.88	3	40.0	1.1	0.55	0.00	0.00	9.43	6.26	0.00	6856.7	6.3
22.82	3	40.0	1.1	0.55	0.00	0.00	9.43	6.30	0.00	6856.7	6.3
22.75	3	40.0	1.1	0.55	0.00	0.00	9.43	6.34	0.00	6856.7	6.3
22.68	3	40.0	1.1	0.55	0.00	0.00	9.43	6.39	0.00	6856.7	6.4
22.62	3	40.0	1.1	0.55	0.00	0.00	9.43	6.43	0.00	6856.7	6.4
22.55	3	40.0	1.1	0.55	0.00	0.00	9.43	6.47	0.00	6856.7	6.5
22.48	3	40.0	1.1	0.55	0.00	0.00	9.43	6.51	0.00	6856.7	6.5
22.42	3	40.0	1.1	0.55	0.00	0.00	9.43	6.55	0.00	6856.7	6.5
22.35	3	40.0	1.1	0.55	0.00	0.00	9.43	6.59	0.00	6856.7	6.6
22.29	3	40.0	1.1	0.55	0.00	0.00	9.43	6.63	0.00	6856.7	6.6
22.22	3	40.0	1.1	0.55	0.00	0.00	9.43	6.67	0.00	6856.7	6.7
22.15	3	40.0	1.1	0.55	0.00	0.00	9.43	6.71	0.00	6856.7	6.7
22.09	3	40.0	1.1	0.55	0.00	0.00	9.43	6.75	0.00	6856.7	6.8
22.02	3	40.0	1.1	0.55	0.00	0.00	9.43	6.79	0.00	6856.7	6.8
21.96	3	40.0	1.1	0.55	0.00	0.00	9.43	6.84	0.00	6856.7	6.8
21.89	3	40.0	1.1	0.55	0.00	0.00	9.43	6.88	0.00	6856.7	6.9
21.82	3	40.0	1.1	0.55	0.00	0.00	9.43	6.92	0.00	6856.7	6.9
21.76	3	40.0	1.1	0.55	0.00	0.00	9.43	6.96	0.00	6856.7	7.0
21.69	3	40.0	1.1	0.55	0.00	0.00	9.43	7.00	0.00	6856.7	7.0
21.63	3	40.0	1.1	0.55	0.00	0.00	9.43	7.04	0.00	6856.7	7.0
21.56	3	40.0	1.1	0.55	0.00	0.00	9.43	7.08	0.00	6856.7	7.1
21.49	3	40.0	1.1	0.55	0.00	0.00	9.43	7.12	0.00	6856.7	7.1
21.43	3	40.0	1.1	0.55	0.00	0.00	9.43	7.16	0.00	6856.7	7.2
21.36	3	40.0	1.1	0.55	0.00	0.00	9.43	7.20	0.00	6856.7	7.2
21.29	3	40.0	1.1	0.55	0.00	0.00	9.43	7.24	0.00	6856.7	7.2
21.23	3	40.0	1.1	0.55	0.00	0.00	9.43	7.29	0.00	6856.7	7.3
21.16	3	40.0	1.1	0.55	0.00	0.00	9.43	7.33	0.00	6856.7	7.3
21.10	3	40.0	1.1	0.55	0.00	0.00	9.43	7.37	0.00	6856.7	7.4
21.03	3	40.0	1.1	0.55	0.00	0.00	9.43	7.41	0.00	6856.7	7.4
20.96	4	26.0	0.8	0.88	0.00	0.00	9.43	7.48	0.00	6856.7	7.5
20.90	4	26.0	0.8	0.88	0.00	0.00	9.43	7.55	0.00	6856.7	7.5
20.83	4	26.0	0.8	0.88	0.00	0.00	9.43	7.62	0.00	6856.7	7.6
20.77	4	26.0	0.8	0.88	0.00	0.00	9.43	7.69	0.00	6856.7	7.7
20.70	4	26.0	0.8	0.88	0.00	0.00	9.43	7.76	0.00	6856.7	7.8
20.63	4	26.0	0.8	0.89	0.00	0.00	9.43	7.83	0.00	6856.7	7.8
20.57	4	26.0	0.8	0.89	0.00	0.00	9.43	7.90	0.00	6856.7	7.9
20.50	4	26.0	0.8	0.89	0.00	0.00	9.43	7.97	0.00	6856.7	8.0
20.43	4	26.0	0.8	0.89	0.00	0.00	9.43	8.04	0.00	6856.7	8.0
20.37	4	26.0	0.8	0.89	0.00	0.00	9.43	8.11	0.00	6856.7	8.1

20.30	4	26.0	0.8	0.89	0.00	0.00	9.43	8.18	0.00	6856.7	8.2
20.24	4	26.0	0.8	0.89	0.00	0.00	9.43	8.25	0.00	6856.7	8.2
20.17	4	26.0	0.8	0.89	0.00	0.00	9.43	8.32	0.00	6856.7	8.3
20.10	4	26.0	0.8	0.89	0.00	0.00	9.43	8.39	0.00	6856.7	8.4
20.04	4	26.0	0.8	0.89	0.00	0.00	9.43	8.46	0.00	6856.7	8.5
19.97	4	26.0	0.8	0.90	0.00	0.00	9.43	8.53	0.00	6856.7	8.5
19.91	4	26.0	0.8	0.90	0.00	0.00	9.43	8.60	0.00	6856.7	8.6
19.84	4	26.0	0.8	0.90	0.00	0.00	9.43	8.67	0.00	6856.7	8.7
19.77	4	26.0	0.8	0.90	0.00	0.00	9.43	8.74	0.00	6856.7	8.7
19.71	4	26.0	0.8	0.90	0.00	0.00	9.43	8.81	0.00	6856.7	8.8
19.64	4	26.0	0.8	0.90	0.00	0.00	9.43	8.88	0.00	6856.7	8.9
19.58	4	26.0	0.8	0.90	0.00	0.00	9.43	8.95	0.00	6856.7	9.0
19.51	4	26.0	0.8	0.90	0.00	0.00	9.43	9.02	0.00	6856.7	9.0
19.44	4	26.0	0.8	0.90	0.00	0.00	9.43	9.09	0.00	6856.7	9.1
19.38	4	26.0	0.8	0.90	0.00	0.00	9.43	9.16	0.00	6856.7	9.2
19.31	4	26.0	0.8	0.91	0.00	0.00	9.43	9.23	0.00	6856.7	9.2
19.24	4	26.0	0.8	0.91	0.00	0.00	9.43	9.30	0.00	6856.7	9.3
19.18	4	26.0	0.8	0.91	0.00	0.00	9.43	9.37	0.00	6856.7	9.4
19.11	4	26.0	0.8	0.91	0.00	0.00	9.43	9.44	0.00	6856.7	9.4
19.05	4	26.0	0.8	0.91	0.00	0.00	9.43	9.51	0.00	6856.7	9.5
18.98	4	26.0	0.8	0.91	0.00	0.00	9.43	9.58	0.00	6856.7	9.6
18.91	4	26.0	0.8	0.91	0.00	0.00	9.43	9.65	0.00	6856.7	9.7
18.85	4	26.0	0.8	0.91	0.00	0.00	9.43	9.72	0.00	6856.7	9.7
18.78	4	26.0	0.8	0.91	0.00	0.00	9.43	9.79	0.00	6856.7	9.8
18.72	4	26.0	0.8	0.91	0.00	0.00	9.43	9.86	0.00	6856.7	9.9
18.65	4	26.0	0.8	0.92	0.00	0.00	9.43	9.93	0.00	6856.7	9.9
18.58	4	26.0	0.8	0.92	0.00	0.00	9.43	10.00	0.00	6856.7	10.0
18.52	4	26.0	0.8	0.92	0.00	0.00	9.43	10.07	0.00	6856.7	10.1
18.45	4	26.0	0.8	0.92	0.00	0.00	9.43	10.14	0.00	6856.7	10.1
18.38	4	26.0	0.8	0.92	0.00	0.00	9.43	10.21	0.00	6856.7	10.2
18.32	4	26.0	0.8	0.92	0.00	0.00	9.43	10.28	0.00	6856.7	10.3
18.25	4	26.0	0.8	0.92	0.00	0.00	9.43	10.35	0.00	6856.7	10.4
18.19	4	26.0	0.8	0.92	0.00	0.00	9.43	10.42	0.00	6856.7	10.4
18.12	4	26.0	0.8	0.92	0.00	0.00	9.43	10.49	0.00	6856.7	10.5
18.05	4	26.0	0.8	0.93	0.00	0.00	9.43	10.56	0.00	6856.7	10.6
17.99	4	26.0	0.8	0.93	0.00	0.00	9.43	10.63	0.00	6856.7	10.6
17.92	4	26.0	0.8	0.93	0.00	0.00	9.43	10.70	0.00	6856.7	10.7
17.86	4	26.0	0.8	0.93	0.00	0.00	9.43	10.77	0.00	6856.7	10.8
17.79	4	26.0	0.8	0.93	0.00	0.00	9.43	10.84	0.00	6856.7	10.8
17.72	4	26.0	0.8	0.93	0.00	0.00	9.43	10.91	0.00	6856.7	10.9
17.66	4	26.0	0.8	0.93	0.00	0.00	9.43	10.98	0.00	6856.7	11.0
17.59	4	26.0	0.8	0.93	0.00	0.00	9.43	11.05	0.00	6856.7	11.1
17.53	4	26.0	0.8	0.93	0.00	0.00	9.43	11.12	0.00	6856.7	11.1
17.46	4	26.0	0.8	0.93	0.00	0.00	9.43	11.19	0.00	6856.7	11.2
17.39	4	26.0	0.8	0.94	0.00	0.00	9.43	11.26	0.00	6856.7	11.3
17.33	4	26.0	0.8	0.94	0.00	0.00	9.43	11.33	0.00	6856.7	11.3
17.26	4	26.0	0.8	0.94	0.00	0.00	9.43	11.40	0.00	6856.7	11.4
17.19	4	26.0	0.8	0.94	0.00	0.00	9.43	11.47	0.00	6856.7	11.5
17.13	4	26.0	0.8	0.94	0.00	0.00	9.43	11.54	0.00	6856.7	11.5

17.06	4	26.0	0.8	0.94	0.00	0.00	9.43	11.61	0.00	6856.7	11.6
17.00	4	40.0	0.3	0.94	0.00	0.00	9.43	11.68	0.00	6856.7	11.7
16.93	4	40.0	0.3	0.94	0.00	0.00	9.43	11.75	0.00	6856.7	11.8
16.86	4	40.0	0.3	0.94	0.00	0.00	9.43	11.82	0.00	6856.7	11.8
16.80	4	40.0	0.3	0.95	0.00	0.00	9.43	11.89	0.00	6856.7	11.9
16.73	4	40.0	0.3	0.95	0.00	0.00	9.43	11.96	0.00	6856.7	12.0
16.67	4	40.0	0.3	0.95	0.00	0.00	9.43	12.03	0.00	6856.7	12.0
16.60	4	40.0	0.3	0.95	0.00	0.00	9.43	12.10	0.00	6856.7	12.1
16.53	4	40.0	0.3	0.95	0.00	0.00	9.43	12.18	0.00	6856.7	12.2
16.47	4	40.0	0.3	0.95	0.00	0.00	9.43	12.25	0.00	6856.7	12.2
16.40	4	40.0	0.3	0.95	0.00	0.00	9.43	12.32	0.00	6856.7	12.3
16.33	4	40.0	0.3	0.95	0.00	0.00	9.43	12.39	0.00	6856.7	12.4
16.27	4	40.0	0.3	0.95	0.00	0.00	9.43	12.46	0.00	6856.7	12.5
16.20	4	40.0	0.3	0.96	0.00	0.00	9.43	12.53	0.00	6856.7	12.5
16.14	4	40.0	0.3	0.96	0.00	0.00	9.43	12.60	0.00	6856.7	12.6
16.07	4	40.0	0.3	0.96	0.00	0.00	9.43	12.67	0.00	6856.7	12.7
16.00	4	40.0	0.3	0.96	0.00	0.00	9.43	12.74	0.00	6856.7	12.7
15.94	4	40.0	0.3	0.96	0.00	0.00	9.43	12.81	0.00	6856.7	12.8
15.87	4	40.0	0.3	0.96	0.00	0.00	9.43	12.88	0.00	6856.7	12.9
15.81	4	40.0	0.3	0.96	0.00	0.00	9.43	12.95	0.00	6856.7	12.9
15.74	4	40.0	0.3	0.96	0.00	0.00	9.43	13.02	0.00	6856.7	13.0
15.67	4	40.0	0.3	0.96	0.00	0.00	9.43	13.09	0.00	6856.7	13.1
15.61	4	40.0	0.3	0.97	0.00	0.00	9.43	13.16	0.00	6856.7	13.2
15.54	4	40.0	0.3	0.97	0.00	0.00	9.43	13.23	0.00	6856.7	13.2
15.47	4	40.0	0.3	0.97	0.00	0.00	9.43	13.30	0.00	6856.7	13.3
15.41	4	40.0	0.3	0.97	0.00	0.00	9.43	13.37	0.00	6856.7	13.4
15.34	4	40.0	0.3	0.97	0.00	0.00	9.43	13.44	0.00	6856.7	13.4
15.28	4	40.0	0.3	0.97	0.00	0.00	9.43	13.51	0.00	6856.7	13.5
15.21	4	40.0	0.3	0.97	0.00	0.00	9.43	13.58	0.00	6856.7	13.6
15.14	4	40.0	0.3	0.97	0.00	0.00	9.43	13.65	0.00	6856.7	13.6
15.08	4	40.0	0.3	0.97	0.00	0.00	9.43	13.72	0.00	6856.7	13.7
15.01	4	40.0	0.3	0.98	0.00	0.00	9.43	13.79	0.00	6856.7	13.8
14.95	4	40.0	0.3	0.98	0.00	0.00	9.43	13.86	0.00	6856.7	13.9
14.88	4	40.0	0.3	0.98	0.00	0.00	9.43	13.93	0.00	6856.7	13.9
14.81	4	40.0	0.3	0.98	0.00	0.00	9.43	14.00	0.00	6856.7	14.0
14.75	4	40.0	0.3	0.98	0.00	0.00	9.43	14.07	0.00	6856.7	14.1
14.68	4	40.0	0.3	0.98	0.00	0.00	9.43	14.14	0.00	6856.7	14.1
14.62	4	40.0	0.3	0.98	0.00	0.00	9.43	14.21	0.00	6856.7	14.2
14.55	4	40.0	0.3	0.98	0.00	0.00	9.43	14.28	0.00	6856.7	14.3
14.48	4	40.0	0.3	0.99	0.00	0.00	9.43	14.35	0.00	6856.7	14.3
14.42	4	40.0	0.3	0.99	0.00	0.00	9.43	14.42	0.00	6856.7	14.4
14.35	4	40.0	0.3	0.99	0.00	0.00	9.43	14.49	0.00	6856.7	14.5
14.28	4	40.0	0.3	0.99	0.00	0.00	9.43	14.56	0.00	6856.7	14.6
14.22	4	40.0	0.3	0.99	0.00	0.00	9.43	14.63	0.00	6856.7	14.6
14.15	4	40.0	0.3	0.99	0.00	0.00	9.43	14.70	0.00	6856.7	14.7
14.09	4	40.0	0.3	0.99	0.00	0.00	9.43	14.77	0.00	6856.7	14.8
14.02	4	40.0	0.3	0.99	0.00	0.00	9.43	14.84	0.00	6856.7	14.8
13.95	4	40.0	0.3	0.99	0.00	0.00	9.43	14.91	0.00	6856.7	14.9
13.89	4	40.0	0.3	1.00	0.00	0.00	9.43	14.98	0.00	6856.7	15.0

13.82	4	40.0	0.3	1.00	0.00	0.00	9.43	15.05	0.00	6856.7	15.0
13.76	4	40.0	0.3	1.00	0.00	0.00	9.43	15.12	0.00	6856.7	15.1
13.69	4	40.0	0.3	1.00	0.00	0.00	9.43	15.19	0.00	6856.7	15.2
13.62	4	40.0	0.3	1.00	0.00	0.00	9.43	15.26	0.00	6856.7	15.3
13.56	4	40.0	0.3	1.00	0.00	0.00	9.43	15.33	0.00	6856.7	15.3
13.49	4	40.0	0.3	1.00	0.00	0.00	9.43	15.40	0.00	6856.7	15.4
13.42	4	40.0	0.3	1.00	0.00	0.00	9.43	15.47	0.00	6856.7	15.5
13.36	4	40.0	0.3	1.01	0.00	0.00	9.43	15.54	0.00	6856.7	15.5
13.29	4	40.0	0.3	1.01	0.00	0.00	9.43	15.61	0.00	6856.7	15.6
13.23	4	40.0	0.3	1.01	0.00	0.00	9.43	15.68	0.00	6856.7	15.7
13.16	4	40.0	0.3	1.01	0.00	0.00	9.43	15.75	0.00	6856.7	15.8
13.09	4	40.0	0.3	1.01	0.00	0.00	9.43	15.82	0.00	6856.7	15.8
13.03	4	40.0	0.3	1.01	0.00	0.00	9.43	15.89	0.00	6856.7	15.9
12.96	4	40.0	0.3	1.01	0.00	0.00	9.43	15.96	0.00	6856.7	16.0
12.90	4	40.0	0.3	1.01	0.00	0.00	9.43	16.03	0.00	6856.7	16.0
12.83	4	40.0	0.3	1.02	0.00	0.00	9.43	16.10	0.00	6856.7	16.1
12.76	4	40.0	0.3	1.02	0.00	0.00	9.43	16.17	0.00	6856.7	16.2
12.70	4	40.0	0.3	1.02	0.00	0.00	9.43	16.24	0.00	6856.7	16.2
12.63	4	40.0	0.3	1.02	0.00	0.00	9.43	16.31	0.00	6856.7	16.3
12.57	4	40.0	0.3	1.02	0.00	0.00	9.43	16.38	0.00	6856.7	16.4
12.50	4	40.0	0.3	1.02	0.00	0.00	9.43	16.45	0.00	6856.7	16.5
12.43	4	40.0	0.3	1.02	0.00	0.00	9.43	16.52	0.00	6856.7	16.5
12.37	4	40.0	0.3	1.02	0.00	0.00	9.43	16.59	0.00	6856.7	16.6
12.30	4	40.0	0.3	1.03	0.00	0.00	9.43	16.66	0.00	6856.7	16.7
12.23	4	40.0	0.3	1.03	0.00	0.00	9.43	16.73	0.00	6856.7	16.7
12.17	4	40.0	0.3	1.03	0.00	0.00	9.43	16.80	0.00	6856.7	16.8
12.10	4	40.0	0.3	1.03	0.00	0.00	9.43	16.87	0.00	6856.7	16.9
12.04	4	40.0	0.3	1.03	0.00	0.00	9.43	16.94	0.00	6856.7	16.9
11.97	4	40.0	0.3	1.03	0.00	0.00	9.43	17.01	0.00	6856.7	17.0
11.90	4	40.0	0.3	1.03	0.00	0.00	9.43	17.08	0.00	6856.7	17.1
11.84	4	40.0	0.3	1.03	0.00	0.00	9.43	17.15	0.00	6856.7	17.2
11.77	4	40.0	0.3	1.04	0.00	0.00	9.43	17.22	0.00	6856.7	17.2
11.71	4	40.0	0.3	1.04	0.00	0.00	9.43	17.29	0.00	6856.7	17.3
11.64	4	40.0	0.3	1.04	0.00	0.00	9.43	17.36	0.00	6856.7	17.4
11.57	4	40.0	0.3	1.04	0.00	0.00	9.43	17.43	0.00	6856.7	17.4
11.51	4	40.0	0.3	1.04	0.00	0.00	9.43	17.50	0.00	6856.7	17.5
11.44	4	40.0	0.3	1.04	0.00	0.00	9.43	17.57	0.00	6856.7	17.6
11.37	4	40.0	0.3	1.04	0.00	0.00	9.43	17.64	0.00	6856.7	17.6
11.31	4	40.0	0.3	1.05	0.00	0.00	9.43	17.71	0.00	6856.7	17.7
11.24	4	40.0	0.3	1.05	0.00	0.00	9.43	17.78	0.00	6856.7	17.8
11.18	4	40.0	0.3	1.05	0.00	0.00	9.43	17.85	0.00	6856.7	17.9
11.11	4	40.0	0.3	1.05	0.00	0.00	9.43	17.92	0.00	6856.7	17.9
11.04	4	40.0	0.3	1.05	0.00	0.00	9.43	17.99	0.00	6856.7	18.0
10.98	4	40.0	0.3	1.05	0.00	0.00	9.43	18.06	0.00	6856.7	18.1
10.91	4	40.0	0.3	1.05	0.00	0.00	9.43	18.13	0.00	6856.7	18.1
10.85	4	40.0	0.3	1.05	0.00	0.00	9.43	18.20	0.00	6856.7	18.2
10.78	4	40.0	0.3	1.06	0.00	0.00	9.43	18.27	0.00	6856.7	18.3
10.71	4	40.0	0.3	1.06	0.00	0.00	9.43	18.34	0.00	6856.7	18.3
10.65	4	40.0	0.3	1.06	0.00	0.00	9.43	18.41	0.00	6856.7	18.4

10.58	4	40.0	0.3	1.06	0.00	0.00	9.43	18.48	0.00	6856.7	18.5
10.52	4	40.0	0.3	1.06	0.00	0.00	9.43	18.55	0.00	6856.7	18.6
10.45	4	40.0	0.3	1.06	0.00	0.00	9.43	18.62	0.00	6856.7	18.6
10.38	4	40.0	0.3	1.06	0.00	0.00	9.43	18.69	0.00	6856.7	18.7
10.32	4	40.0	0.3	1.07	0.00	0.00	9.43	18.76	0.00	6856.7	18.8
10.25	4	40.0	0.3	1.07	0.00	0.00	9.43	18.83	0.00	6856.7	18.8
10.18	4	40.0	0.3	1.07	0.00	0.00	9.43	18.90	0.00	6856.7	18.9
10.12	4	40.0	0.3	1.07	0.00	0.00	9.43	18.97	0.00	6856.7	19.0
10.05	4	40.0	0.3	1.07	0.00	0.00	9.43	19.04	0.00	6856.7	19.0
9.99	4	40.0	0.3	1.07	0.00	0.00	9.43	19.12	0.00	6856.7	19.1
9.92	4	40.0	0.3	1.07	0.00	0.00	9.43	19.19	0.00	6856.7	19.2
9.85	4	40.0	0.3	1.08	0.00	0.00	9.43	19.26	0.00	6856.7	19.3
9.79	4	40.0	0.3	1.08	0.00	0.00	9.43	19.33	0.00	6856.7	19.3
9.72	4	40.0	0.3	1.08	0.00	0.00	9.43	19.40	0.00	6856.7	19.4
9.66	4	40.0	0.3	1.08	0.00	0.00	9.43	19.47	0.00	6856.7	19.5
9.59	4	40.0	0.3	1.08	0.00	0.00	9.43	19.54	0.00	6856.7	19.5
9.52	4	40.0	0.3	1.08	0.00	0.00	9.43	19.61	0.00	6856.7	19.6
9.46	4	40.0	0.3	1.08	0.00	0.00	9.43	19.68	0.00	6856.7	19.7
9.39	4	40.0	0.3	1.09	0.00	0.00	9.43	19.75	0.00	6856.7	19.7
9.32	4	40.0	0.3	1.09	0.00	0.00	9.43	19.82	0.00	6856.7	19.8
9.26	4	40.0	0.3	1.09	0.00	0.00	9.43	19.89	0.00	6856.7	19.9
9.19	4	40.0	0.3	1.09	0.00	0.00	9.43	19.96	0.00	6856.7	20.0
9.13	4	40.0	0.3	1.09	0.00	0.00	9.43	20.03	0.00	6856.7	20.0
9.06	4	40.0	0.3	1.09	0.00	0.00	9.43	20.10	0.00	6856.7	20.1
8.99	4	40.0	0.3	1.09	0.00	0.00	9.43	20.17	0.00	6856.7	20.2
8.93	4	40.0	0.3	1.10	0.00	0.00	9.43	20.24	0.00	6856.7	20.2
8.86	4	40.0	0.3	1.10	0.00	0.00	9.43	20.31	0.00	6856.7	20.3
8.80	4	40.0	0.3	1.10	0.00	0.00	9.43	20.38	0.00	6856.7	20.4
8.73	4	40.0	0.3	1.10	0.00	0.00	9.43	20.45	0.00	6856.7	20.4
8.66	4	40.0	0.3	1.10	0.00	0.00	9.43	20.52	0.00	6856.7	20.5
8.60	4	40.0	0.3	1.10	0.00	0.00	9.43	20.59	0.00	6856.7	20.6
8.53	4	40.0	0.3	1.10	0.00	0.00	9.43	20.66	0.00	6856.7	20.7
8.46	4	40.0	0.3	1.11	0.00	0.00	9.43	20.73	0.00	6856.7	20.7
8.40	4	40.0	0.3	1.11	0.00	0.00	9.43	20.80	0.00	6856.7	20.8
8.33	4	40.0	0.3	1.11	0.00	0.00	9.43	20.87	0.00	6856.7	20.9
8.27	4	40.0	0.3	1.11	0.00	0.00	9.43	20.94	0.00	6856.7	20.9
8.20	4	40.0	0.3	1.11	0.00	0.00	9.43	21.01	0.00	6856.7	21.0
8.13	4	40.0	0.3	1.11	0.00	0.00	9.43	21.08	0.00	6856.7	21.1
8.07	4	40.0	0.3	1.12	0.00	0.00	9.43	21.15	0.00	6856.7	21.1
8.00	4	40.0	0.3	1.12	0.00	0.00	9.43	21.22	0.00	6856.7	21.2
7.94	4	40.0	0.3	1.12	0.00	0.00	9.43	21.29	0.00	6856.7	21.3
7.87	4	40.0	0.3	1.12	0.00	0.00	9.43	21.36	0.00	6856.7	21.4
7.80	4	40.0	0.3	1.12	0.00	0.00	9.43	21.43	0.00	6856.7	21.4
7.74	4	40.0	0.3	1.12	0.00	0.00	9.43	21.50	0.00	6856.7	21.5
7.67	4	40.0	0.3	1.13	0.00	0.00	9.43	21.57	0.00	6856.7	21.6
7.61	4	40.0	0.3	1.13	0.00	0.00	9.43	21.64	0.00	6856.7	21.6
7.54	4	40.0	0.3	1.13	0.00	0.00	9.43	21.71	0.00	6856.7	21.7
7.47	4	40.0	0.3	1.13	0.00	0.00	9.43	21.78	0.00	6856.7	21.8
7.41	4	40.0	0.3	1.13	0.00	0.00	9.43	21.85	0.00	6856.7	21.8

7.34	4	40.0	0.3	1.13	0.00	0.00	9.43	21.92	0.00	6856.7	21.9
7.27	4	40.0	0.3	1.14	0.00	0.00	9.43	21.99	0.00	6856.7	22.0
7.21	4	40.0	0.3	1.14	0.00	0.00	9.43	22.06	0.00	6856.7	22.1
7.14	4	40.0	0.3	1.14	0.00	0.00	9.43	22.13	0.00	6856.7	22.1
7.08	4	40.0	0.3	1.14	0.00	0.00	9.43	22.20	0.00	6856.7	22.2
7.01	4	40.0	0.3	1.14	0.00	0.00	9.43	22.27	0.00	6856.7	22.3
6.94	4	40.0	0.3	1.14	0.00	0.00	9.43	22.34	0.00	6856.7	22.3
6.88	4	40.0	0.3	1.15	0.00	0.00	9.43	22.41	0.00	6856.7	22.4
6.81	4	40.0	0.3	1.15	0.00	0.00	9.43	22.48	0.00	6856.7	22.5
6.75	4	40.0	0.3	1.15	0.00	0.00	9.43	22.55	0.00	6856.7	22.5
6.68	4	40.0	0.3	1.15	0.00	0.00	9.43	22.62	0.00	6856.7	22.6
6.61	4	40.0	0.3	1.15	0.00	0.00	9.43	22.69	0.00	6856.7	22.7
6.55	4	40.0	0.3	1.15	0.00	0.00	9.43	22.76	0.00	6856.7	22.8
6.48	4	40.0	0.3	1.16	0.00	0.00	9.43	22.83	0.00	6856.7	22.8
6.41	4	40.0	0.3	1.16	0.00	0.00	9.43	22.90	0.00	6856.7	22.9
6.35	4	40.0	0.3	1.16	0.00	0.00	9.43	22.97	0.00	6856.7	23.0
6.28	4	40.0	0.3	1.16	0.00	0.00	9.43	23.04	0.00	6856.7	23.0
6.22	4	40.0	0.3	1.16	0.00	0.00	9.43	23.11	0.00	6856.7	23.1
6.15	4	40.0	0.3	1.16	0.00	0.00	9.43	23.18	0.00	6856.7	23.2
6.08	4	40.0	0.3	1.17	0.00	0.00	9.43	23.25	0.00	6856.7	23.3
6.02	4	40.0	0.3	1.17	0.00	0.00	9.43	23.32	0.00	6856.7	23.3
5.95	4	40.0	0.3	1.17	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.89	4	40.0	0.3	1.17	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.82	4	40.0	0.3	1.17	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.75	4	40.0	0.3	1.18	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.69	4	40.0	0.3	1.18	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.62	4	40.0	0.3	1.18	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.56	4	40.0	0.3	1.18	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.49	4	40.0	0.3	1.18	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.42	4	40.0	0.3	1.19	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.36	4	40.0	0.3	1.19	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.29	4	40.0	0.3	1.19	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.22	4	40.0	0.3	1.19	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.16	4	40.0	0.3	1.19	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.09	4	40.0	0.3	1.19	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
5.03	4	40.0	0.3	1.20	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.96	4	40.0	0.3	1.20	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.89	4	40.0	0.3	1.20	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.83	4	40.0	0.3	1.20	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.76	4	40.0	0.3	1.20	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.70	4	40.0	0.3	1.21	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.63	4	40.0	0.3	1.21	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.56	4	40.0	0.3	1.21	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.50	4	40.0	0.3	1.21	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.43	4	40.0	0.3	1.22	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.36	4	40.0	0.3	1.22	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.30	4	40.0	0.3	1.22	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.23	4	40.0	0.3	1.22	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.17	4	40.0	0.3	1.22	0.00	0.00	6.28	23.32	0.00	6856.7	23.3

4.10	4	40.0	0.3	1.23	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
4.03	4	40.0	0.3	1.23	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.97	4	40.0	0.3	1.23	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.90	4	40.0	0.3	1.23	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.84	4	40.0	0.3	1.24	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.77	4	40.0	0.3	1.24	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.70	4	40.0	0.3	1.24	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.64	4	40.0	0.3	1.24	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.57	4	40.0	0.3	1.24	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.51	4	40.0	0.3	1.25	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.44	4	40.0	0.3	1.25	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.37	4	40.0	0.3	1.25	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.31	4	40.0	0.3	1.25	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.24	4	40.0	0.3	1.26	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.17	4	40.0	0.3	1.26	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.11	4	40.0	0.3	1.26	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
3.04	4	40.0	0.3	1.26	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.98	4	40.0	0.3	1.27	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.91	4	40.0	0.3	1.27	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.84	4	40.0	0.3	1.27	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.78	4	40.0	0.3	1.27	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.71	4	40.0	0.3	1.28	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.65	4	40.0	0.3	1.28	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.58	4	40.0	0.3	1.28	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.51	4	40.0	0.3	1.29	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.45	4	40.0	0.3	1.29	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.38	4	40.0	0.3	1.29	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.31	4	40.0	0.3	1.29	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.25	4	40.0	0.3	1.30	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.18	4	40.0	0.3	1.30	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.12	4	40.0	0.3	1.30	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
2.05	4	40.0	0.3	1.31	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.98	4	40.0	0.3	1.31	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.92	4	40.0	0.3	1.31	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.85	4	40.0	0.3	1.32	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.79	4	40.0	0.3	1.32	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.72	4	40.0	0.3	1.32	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.65	4	40.0	0.3	1.33	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.59	4	40.0	0.3	1.33	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.52	4	40.0	0.3	1.33	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.45	4	40.0	0.3	1.34	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.39	4	40.0	0.3	1.34	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.32	4	40.0	0.3	1.34	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.26	4	40.0	0.3	1.35	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.19	4	40.0	0.3	1.35	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.12	4	40.0	0.3	1.36	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
1.06	4	40.0	0.3	1.36	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
0.99	4	40.0	0.3	1.37	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
0.93	4	40.0	0.3	1.37	0.00	0.00	6.28	23.32	0.00	6856.7	23.3

0.86	4	40.0	0.3	1.37	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
0.79	4	40.0	0.3	1.38	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
0.73	4	40.0	0.3	1.38	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
0.66	4	40.0	0.3	1.39	0.00	0.00	6.28	23.32	0.00	6856.7	23.3
0.60	4	40.0	0.3	1.40	0.00	0.00	0.00	23.32	0.00	6856.7	23.3
0.53	4	40.0	0.3	1.40	0.00	0.00	0.00	23.32	0.00	6856.7	23.3
0.46	4	40.0	0.3	1.41	0.00	0.00	0.00	23.32	0.00	6856.7	23.3
0.40	4	40.0	0.3	1.41	0.00	0.00	0.00	23.32	0.00	6856.7	23.3
0.33	4	40.0	0.3	1.42	0.00	0.00	0.00	23.32	0.00	6856.7	23.3
0.26	4	40.0	0.3	1.43	0.00	0.00	0.00	23.32	0.00	6856.7	23.3
0.20	4	40.0	0.3	1.44	0.00	0.00	0.00	23.32	0.00	6856.7	23.3
0.13	4	40.0	0.3	1.45	0.00	0.00	0.00	23.32	0.00	6856.7	23.3
0.07	4	40.0	0.3	1.47	0.00	0.00	0.00	23.32	0.00	6856.7	23.3
0.00	4	40.0	0.3	1.50	0.00	0.00	0.00	23.32	0.00	6856.7	23.3

SETTLEMENT based on Ultimate Loading by Vesic Method (1977):
Ztip=33.00 Btip= 3.00 Cp= 0.135 Cs= 0.197
Xpp=3.817-in Xps= 0.000-in Xtip= 3.817-in
Cp & Cs are average value at bearing stratum from pile tip extend to 10 Btip

At loading: Qtip=6856.7-kp Qtop= 6856.7-kp Qside= 0.0-kp
Xtip=3.817-in Xtop= 4.544-in Xshaft= 0.727-in

LOAD - TOTAL SETTLEMENT RELATION (from t-z, and q-w curves):
Based on Reese and O'Neill Method (1988)

Xtop -in	Xshaft -in	Xtip -in	Qtip -kp	Qside -kp	Qtotal -kp
0.0010	0.0010	0.0000	9.1	0.0	9.1
0.0684	0.0206	0.0477	194.8	0.0	194.8
0.1021	0.0305	0.0716	287.8	0.0	287.8
0.1358	0.0404	0.0954	380.8	0.0	380.8
0.1695	0.0502	0.1193	473.8	0.0	473.8
0.2032	0.0601	0.1431	566.7	0.0	566.7
0.2369	0.0699	0.1670	659.3	0.0	659.3
0.2706	0.0797	0.1909	751.8	0.0	751.8
0.3042	0.0895	0.2147	843.9	0.0	843.9
0.3378	0.0992	0.2386	935.7	0.0	935.7
0.3713	0.1089	0.2624	1027.1	0.0	1027.1
0.4048	0.1185	0.2863	1118.0	0.0	1118.0
0.4383	0.1281	0.3101	1208.4	0.0	1208.4
0.4717	0.1377	0.3340	1298.2	0.0	1298.2
0.5050	0.1471	0.3579	1387.5	0.0	1387.5
0.5382	0.1565	0.3817	1476.1	0.0	1476.1
0.5714	0.1658	0.4056	1564.1	0.0	1564.1
0.6045	0.1751	0.4294	1651.3	0.0	1651.3
0.6375	0.1843	0.4533	1737.8	0.0	1737.8
0.6705	0.1934	0.4771	1823.6	0.0	1823.6
0.7034	0.2024	0.5010	1908.5	0.0	1908.5

0.7361	0.2113	0.5249	1992.6	0.0	1992.6
0.7688	0.2201	0.5487	2075.8	0.0	2075.8
0.8014	0.2288	0.5726	2158.2	0.0	2158.2
0.8339	0.2375	0.5964	2239.7	0.0	2239.7
0.8663	0.2460	0.6203	2320.2	0.0	2320.2
0.8986	0.2545	0.6441	2399.8	0.0	2399.8
0.9308	0.2628	0.6680	2478.5	0.0	2478.5
0.9629	0.2710	0.6919	2556.2	0.0	2556.2
0.9949	0.2792	0.7157	2632.9	0.0	2632.9
1.0268	0.2872	0.7396	2708.6	0.0	2708.6
1.0585	0.2951	0.7634	2783.3	0.0	2783.3
1.0902	0.3029	0.7873	2857.0	0.0	2857.0
1.1218	0.3106	0.8111	2929.7	0.0	2929.7
1.1532	0.3182	0.8350	3001.4	0.0	3001.4
1.1846	0.3257	0.8589	3072.0	0.0	3072.0
1.2158	0.3331	0.8827	3141.6	0.0	3141.6
1.2469	0.3404	0.9066	3210.2	0.0	3210.2
1.2780	0.3475	0.9304	3277.7	0.0	3277.7
1.3089	0.3546	0.9543	3344.3	0.0	3344.3
1.3397	0.3615	0.9781	3409.7	0.0	3409.7
1.3704	0.3684	1.0020	3474.2	0.0	3474.2
1.4009	0.3751	1.0259	3537.6	0.0	3537.6
1.4314	0.3817	1.0497	3600.0	0.0	3600.0
1.4618	0.3882	1.0736	3661.4	0.0	3661.4
1.4920	0.3946	1.0974	3721.8	0.0	3721.8
1.5222	0.4009	1.1213	3781.2	0.0	3781.2
1.5522	0.4071	1.1451	3839.6	0.0	3839.6
1.5822	0.4132	1.1690	3897.0	0.0	3897.0
1.6120	0.4192	1.1929	3953.4	0.0	3953.4
1.6418	0.4251	1.2167	4008.9	0.0	4008.9
1.6714	0.4308	1.2406	4063.4	0.0	4063.4
1.7009	0.4365	1.2644	4116.9	0.0	4116.9
1.7304	0.4421	1.2883	4169.5	0.0	4169.5
1.7597	0.4476	1.3121	4221.2	0.0	4221.2
1.7890	0.4530	1.3360	4272.0	0.0	4272.0
1.8181	0.4583	1.3599	4321.9	0.0	4321.9
1.8472	0.4635	1.3837	4371.0	0.0	4371.0
1.8761	0.4686	1.4076	4419.1	0.0	4419.1
1.9050	0.4736	1.4314	4466.4	0.0	4466.4
1.9338	0.4785	1.4553	4512.9	0.0	4512.9
1.9625	0.4833	1.4791	4558.5	0.0	4558.5
1.9911	0.4881	1.5030	4603.3	0.0	4603.3
2.0196	0.4928	1.5269	4647.4	0.0	4647.4
2.0481	0.4973	1.5507	4690.6	0.0	4690.6
2.0764	0.5019	1.5746	4733.1	0.0	4733.1
2.1047	0.5063	1.5984	4774.9	0.0	4774.9
2.1329	0.5106	1.6223	4815.9	0.0	4815.9
2.1610	0.5149	1.6461	4856.2	0.0	4856.2
2.1891	0.5191	1.6700	4895.8	0.0	4895.8

2.2171	0.5232	1.6938	4934.7	0.0	4934.7
2.2450	0.5273	1.7177	4973.0	0.0	4973.0
2.2728	0.5313	1.7416	5010.6	0.0	5010.6
2.3006	0.5352	1.7654	5047.6	0.0	5047.6
2.3283	0.5391	1.7893	5084.0	0.0	5084.0
2.3560	0.5428	1.8131	5119.7	0.0	5119.7
2.3836	0.5466	1.8370	5154.9	0.0	5154.9
2.4111	0.5502	1.8608	5189.5	0.0	5189.5
2.4386	0.5539	1.8847	5223.6	0.0	5223.6
2.4660	0.5574	1.9086	5257.1	0.0	5257.1
2.4933	0.5609	1.9324	5290.1	0.0	5290.1
2.5206	0.5644	1.9563	5322.5	0.0	5322.5
2.5479	0.5677	1.9801	5354.5	0.0	5354.5
2.5751	0.5711	2.0040	5386.0	0.0	5386.0
2.6022	0.5744	2.0278	5417.1	0.0	5417.1
2.6293	0.5776	2.0517	5447.7	0.0	5447.7
2.6564	0.5808	2.0756	5477.8	0.0	5477.8
2.6834	0.5840	2.0994	5507.6	0.0	5507.6
2.7104	0.5871	2.1233	5536.9	0.0	5536.9
2.7373	0.5901	2.1471	5565.8	0.0	5565.8
2.7642	0.5932	2.1710	5594.3	0.0	5594.3
2.7910	0.5961	2.1948	5622.5	0.0	5622.5
2.8178	0.5991	2.2187	5650.3	0.0	5650.3
2.8446	0.6020	2.2426	5677.7	0.0	5677.7
3.0044	0.6187	2.3857	5835.5	0.0	5835.5
3.5300	0.6672	2.8628	6292.6	0.0	6292.6
4.0451	0.7051	3.3400	6649.8	0.0	6649.8
4.5441	0.7270	3.8171	6856.7	0.0	6856.7
5.0183	0.7240	4.2943	6828.1	0.0	6828.1
5.4628	0.6913	4.7714	6520.3	0.0	6520.3

At Qwork= 570.00-kp Settlement= 0.20444-in
At Qwork= 570.00-kp Secant Stiffness Kqx= 2788.13-kp/-in
At Xallow= 0.50-in Qallow= 1374.19-kp
Note: If the program cannot find a result or the result exceeds the upper limit. The result will be displayed as 99999.

Single Pile Capacities:
Total Ultimate Capacity (Down)= 6856.688-kp Total Ultimate Capacity (Up)= 23.321-kp
Weight above Ground= 0.00 Total Pile Weight= 23.32-kp *Soil Weight is not included
Side Resistance (Down)= 0.000-kp Side Resistance (Up)= 0.000-kp
Tip Resistance (Down)= 6856.688-kp Tip Resistance (Up)= 0.000-kp

----------2. Computation for Group Piles----------
Bearing stratum from pile tip extending to 10 Diameter of pile, which is=192.4-ft Starting from Pile Tip= 33.0-ft

From Ztip=33.0 to 225.4-ft Average Properties: Es= 72750.00-kp/f2 C=194.00-kp/f2 Friction=45.00 Cp=0.14 Ksand=1.00

* SHAFT CALCULATION based on FHWA-IF-99-025 *

User defined Exclusion Zone.
User defined Exclusion Zone Start: 0 -ft End: 33 -ft

Default Top Exclusion Zone (Up & Down), Ln1= 0.0-ft
Default Bottom Exclusion Zone (Down), Ln2= 0.0-ft
Default Bottom Exclusion Zone (Up), Ln3= 0.0-ft

Tip Resistance (Down):
Tip Resistance for Rock
C=194-kp/f2 Ultimate Bearing Pressue, qult=970.0-kp/f2
Limits of Max. tip resistance, q_lim= N/A
Batter Angle, Ab= 0.00 Batter Factor, Kbat= 1.00
Qtip_dw=358966.5-kp based on qult=970.0-kp/f2 and Base Area=370.1-ft2
Qtip_up=0.0-kp and Base Area=0.0-ft2

SIDE RESISTANCE (Up & Down) CALCULATION vs DEPTH:
Calculation is based on segment dZ= 0.07
Soil Type=1,2,3 Cohesive Soil: Factor=alpha; Soil Type=4 Cohesionless Soil: Factor=Beta; Soil Type=5 Rock: Factor=N/A

Zs -ft	Soil Type	Nspt	C -kp/f2	Factor	f0_dw -kp/f2	f0_up -kp/f2	Per -ft	Weight -kp	Qneg -kp	Q_dw -kp	Q_up -kp	
33.00	5	60.0	194.0	0.00	0.00	0.00	251.42	0.00	0.00	358966.5		0.0
32.93	5	60.0	194.0	0.00	0.00	0.00	251.42	0.53	0.00	358966.5		0.5
32.87	5	60.0	194.0	0.00	0.00	0.00	251.42	1.06	0.00	358966.5		1.1
32.80	5	60.0	194.0	0.00	0.00	0.00	251.42	1.60	0.00	358966.5		1.6
32.74	5	60.0	194.0	0.00	0.00	0.00	251.42	2.13	0.00	358966.5		2.1
32.67	5	60.0	194.0	0.00	0.00	0.00	251.42	2.66	0.00	358966.5		2.7
32.60	5	60.0	194.0	0.00	0.00	0.00	251.42	3.19	0.00	358966.5		3.2
32.54	5	60.0	194.0	0.00	0.00	0.00	251.42	3.72	0.00	358966.5		3.7
32.47	5	60.0	194.0	0.00	0.00	0.00	251.42	4.26	0.00	358966.5		4.3
32.40	5	60.0	194.0	0.00	0.00	0.00	251.42	4.79	0.00	358966.5		4.8
32.34	5	60.0	194.0	0.00	0.00	0.00	251.42	5.32	0.00	358966.5		5.3
32.27	5	60.0	194.0	0.00	0.00	0.00	251.42	5.85	0.00	358966.5		5.9
32.21	5	60.0	194.0	0.00	0.00	0.00	251.42	6.39	0.00	358966.5		6.4
32.14	5	60.0	194.0	0.00	0.00	0.00	251.42	6.92	0.00	358966.5		6.9
32.07	5	60.0	194.0	0.00	0.00	0.00	251.42	7.45	0.00	358966.5		7.4
32.01	5	60.0	194.0	0.00	0.00	0.00	251.42	7.98	0.00	358966.5		8.0
31.94	5	60.0	194.0	0.00	0.00	0.00	251.42	8.51	0.00	358966.5		8.5
31.88	5	60.0	194.0	0.00	0.00	0.00	251.42	9.05	0.00	358966.5		9.0

31.81	5	60.0	194.0	0.00	0.00	0.00	251.42	9.58	0.00	358966.5	9.6
31.74	5	60.0	194.0	0.00	0.00	0.00	251.42	10.11	0.00	358966.5	10.1
31.68	5	60.0	194.0	0.00	0.00	0.00	251.42	10.64	0.00	358966.5	10.6
31.61	5	60.0	194.0	0.00	0.00	0.00	251.42	11.17	0.00	358966.5	11.2
31.55	5	60.0	194.0	0.00	0.00	0.00	251.42	11.71	0.00	358966.5	11.7
31.48	5	60.0	194.0	0.00	0.00	0.00	251.42	12.24	0.00	358966.5	12.2
31.41	5	60.0	194.0	0.00	0.00	0.00	251.42	12.77	0.00	358966.5	12.8
31.35	5	60.0	194.0	0.00	0.00	0.00	251.42	13.30	0.00	358966.5	13.3
31.28	5	60.0	194.0	0.00	0.00	0.00	251.42	13.83	0.00	358966.5	13.8
31.21	5	60.0	194.0	0.00	0.00	0.00	251.42	14.37	0.00	358966.5	14.4
31.15	5	60.0	194.0	0.00	0.00	0.00	251.42	14.90	0.00	358966.5	14.9
31.08	5	60.0	194.0	0.00	0.00	0.00	251.42	15.43	0.00	358966.5	15.4
31.02	5	60.0	194.0	0.00	0.00	0.00	251.42	15.96	0.00	358966.5	16.0
30.95	5	26.0	0.2	0.00	0.00	0.00	251.42	16.49	0.00	358966.5	16.5
30.88	5	26.0	0.2	0.00	0.00	0.00	251.42	17.03	0.00	358966.5	17.0
30.82	5	26.0	0.2	0.00	0.00	0.00	251.42	17.56	0.00	358966.5	17.6
30.75	5	26.0	0.2	0.00	0.00	0.00	251.42	18.09	0.00	358966.5	18.1
30.69	5	26.0	0.2	0.00	0.00	0.00	251.42	18.62	0.00	358966.5	18.6
30.62	5	26.0	0.2	0.00	0.00	0.00	251.42	19.16	0.00	358966.5	19.2
30.55	5	26.0	0.2	0.00	0.00	0.00	251.42	19.69	0.00	358966.5	19.7
30.49	5	26.0	0.2	0.00	0.00	0.00	251.42	20.22	0.00	358966.5	20.2
30.42	5	26.0	0.2	0.00	0.00	0.00	251.42	20.75	0.00	358966.5	20.8
30.35	5	26.0	0.2	0.00	0.00	0.00	251.42	21.28	0.00	358966.5	21.3
30.29	5	26.0	0.2	0.00	0.00	0.00	251.42	21.82	0.00	358966.5	21.8
30.22	5	26.0	0.2	0.00	0.00	0.00	251.42	22.35	0.00	358966.5	22.3
30.16	5	26.0	0.2	0.00	0.00	0.00	251.42	22.88	0.00	358966.5	22.9
30.09	5	26.0	0.2	0.00	0.00	0.00	251.42	23.41	0.00	358966.5	23.4
30.02	5	26.0	0.2	0.00	0.00	0.00	251.42	23.94	0.00	358966.5	23.9
29.96	5	26.0	0.2	0.00	0.00	0.00	251.42	24.48	0.00	358966.5	24.5
29.89	5	26.0	0.2	0.00	0.00	0.00	251.42	25.01	0.00	358966.5	25.0
29.83	5	26.0	0.2	0.00	0.00	0.00	251.42	25.54	0.00	358966.5	25.5
29.76	5	26.0	0.2	0.00	0.00	0.00	251.42	26.07	0.00	358966.5	26.1
29.69	5	26.0	0.2	0.00	0.00	0.00	251.42	26.60	0.00	358966.5	26.6
29.63	5	26.0	0.2	0.00	0.00	0.00	251.42	27.14	0.00	358966.5	27.1
29.56	5	26.0	0.2	0.00	0.00	0.00	251.42	27.67	0.00	358966.5	27.7
29.49	5	26.0	0.2	0.00	0.00	0.00	251.42	28.20	0.00	358966.5	28.2
29.43	5	26.0	0.2	0.00	0.00	0.00	251.42	28.73	0.00	358966.5	28.7
29.36	5	26.0	0.2	0.00	0.00	0.00	251.42	29.26	0.00	358966.5	29.3
29.30	5	26.0	0.2	0.00	0.00	0.00	251.42	29.80	0.00	358966.5	29.8
29.23	5	26.0	0.2	0.00	0.00	0.00	251.42	30.33	0.00	358966.5	30.3
29.16	5	26.0	0.2	0.00	0.00	0.00	251.42	30.86	0.00	358966.5	30.9
29.10	5	26.0	0.2	0.00	0.00	0.00	251.42	31.39	0.00	358966.5	31.4
29.03	5	26.0	0.2	0.00	0.00	0.00	251.42	31.93	0.00	358966.5	31.9
28.97	5	26.0	0.2	0.00	0.00	0.00	251.42	32.46	0.00	358966.5	32.5
28.90	5	26.0	0.2	0.00	0.00	0.00	251.42	32.99	0.00	358966.5	33.0
28.83	5	26.0	0.2	0.00	0.00	0.00	251.42	33.52	0.00	358966.5	33.5
28.77	5	26.0	0.2	0.00	0.00	0.00	251.42	34.05	0.00	358966.5	34.1
28.70	5	26.0	0.2	0.00	0.00	0.00	251.42	34.59	0.00	358966.5	34.6
28.64	5	26.0	0.2	0.00	0.00	0.00	251.42	35.12	0.00	358966.5	35.1

28.57	5	26.0	0.2	0.00	0.00	0.00	251.42	35.65	0.00	358966.5	35.6
28.50	5	26.0	0.2	0.00	0.00	0.00	251.42	36.18	0.00	358966.5	36.2
28.44	5	26.0	0.2	0.00	0.00	0.00	251.42	36.71	0.00	358966.5	36.7
28.37	5	26.0	0.2	0.00	0.00	0.00	251.42	37.25	0.00	358966.5	37.2
28.30	5	26.0	0.2	0.00	0.00	0.00	251.42	37.78	0.00	358966.5	37.8
28.24	5	26.0	0.2	0.00	0.00	0.00	251.42	38.31	0.00	358966.5	38.3
28.17	5	26.0	0.2	0.00	0.00	0.00	251.42	38.84	0.00	358966.5	38.8
28.11	5	26.0	0.2	0.00	0.00	0.00	251.42	39.37	0.00	358966.5	39.4
28.04	5	26.0	0.2	0.00	0.00	0.00	251.42	39.91	0.00	358966.5	39.9
27.97	3	40.0	1.1	0.55	0.00	0.00	251.42	40.44	0.00	358966.5	40.4
27.91	3	40.0	1.1	0.55	0.00	0.00	251.42	40.97	0.00	358966.5	41.0
27.84	3	40.0	1.1	0.55	0.00	0.00	251.42	41.50	0.00	358966.5	41.5
27.78	3	40.0	1.1	0.55	0.00	0.00	251.42	42.04	0.00	358966.5	42.0
27.71	3	40.0	1.1	0.55	0.00	0.00	251.42	42.57	0.00	358966.5	42.6
27.64	3	40.0	1.1	0.55	0.00	0.00	251.42	43.10	0.00	358966.5	43.1
27.58	3	40.0	1.1	0.55	0.00	0.00	251.42	43.63	0.00	358966.5	43.6
27.51	3	40.0	1.1	0.55	0.00	0.00	251.42	44.16	0.00	358966.5	44.2
27.44	3	40.0	1.1	0.55	0.00	0.00	251.42	44.70	0.00	358966.5	44.7
27.38	3	40.0	1.1	0.55	0.00	0.00	251.42	45.23	0.00	358966.5	45.2
27.31	3	40.0	1.1	0.55	0.00	0.00	251.42	45.76	0.00	358966.5	45.8
27.25	3	40.0	1.1	0.55	0.00	0.00	251.42	46.29	0.00	358966.5	46.3
27.18	3	40.0	1.1	0.55	0.00	0.00	251.42	46.82	0.00	358966.5	46.8
27.11	3	40.0	1.1	0.55	0.00	0.00	251.42	47.36	0.00	358966.5	47.4
27.05	3	40.0	1.1	0.55	0.00	0.00	251.42	47.89	0.00	358966.5	47.9
26.98	3	40.0	1.1	0.55	0.00	0.00	251.42	48.42	0.00	358966.5	48.4
26.92	3	40.0	1.1	0.55	0.00	0.00	251.42	48.95	0.00	358966.5	49.0
26.85	3	40.0	1.1	0.55	0.00	0.00	251.42	49.48	0.00	358966.5	49.5
26.78	3	40.0	1.1	0.55	0.00	0.00	251.42	50.02	0.00	358966.5	50.0
26.72	3	40.0	1.1	0.55	0.00	0.00	251.42	50.55	0.00	358966.5	50.5
26.65	3	40.0	1.1	0.55	0.00	0.00	251.42	51.08	0.00	358966.5	51.1
26.59	3	40.0	1.1	0.55	0.00	0.00	251.42	51.61	0.00	358966.5	51.6
26.52	3	40.0	1.1	0.55	0.00	0.00	251.42	52.14	0.00	358966.5	52.1
26.45	3	40.0	1.1	0.55	0.00	0.00	251.42	52.68	0.00	358966.5	52.7
26.39	3	40.0	1.1	0.55	0.00	0.00	251.42	53.21	0.00	358966.5	53.2
26.32	3	40.0	1.1	0.55	0.00	0.00	251.42	53.74	0.00	358966.5	53.7
26.25	3	40.0	1.1	0.55	0.00	0.00	251.42	54.27	0.00	358966.5	54.3
26.19	3	40.0	1.1	0.55	0.00	0.00	251.42	54.81	0.00	358966.5	54.8
26.12	3	40.0	1.1	0.55	0.00	0.00	251.42	55.34	0.00	358966.5	55.3
26.06	3	40.0	1.1	0.55	0.00	0.00	251.42	55.87	0.00	358966.5	55.9
25.99	3	40.0	1.1	0.55	0.00	0.00	251.42	56.40	0.00	358966.5	56.4
25.92	3	40.0	1.1	0.55	0.00	0.00	251.42	56.93	0.00	358966.5	56.9
25.86	3	40.0	1.1	0.55	0.00	0.00	251.42	57.47	0.00	358966.5	57.5
25.79	3	40.0	1.1	0.55	0.00	0.00	251.42	58.00	0.00	358966.5	58.0
25.73	3	40.0	1.1	0.55	0.00	0.00	251.42	58.53	0.00	358966.5	58.5
25.66	3	40.0	1.1	0.55	0.00	0.00	251.42	59.06	0.00	358966.5	59.1
25.59	3	40.0	1.1	0.55	0.00	0.00	251.42	59.59	0.00	358966.5	59.6
25.53	3	40.0	1.1	0.55	0.00	0.00	251.42	60.13	0.00	358966.5	60.1
25.46	3	40.0	1.1	0.55	0.00	0.00	251.42	60.66	0.00	358966.5	60.7
25.39	3	40.0	1.1	0.55	0.00	0.00	251.42	61.19	0.00	358966.5	61.2

25.33	3	40.0	1.1	0.55	0.00	0.00	251.42	61.72	0.00	358966.5	61.7
25.26	3	40.0	1.1	0.55	0.00	0.00	251.42	62.25	0.00	358966.5	62.3
25.20	3	40.0	1.1	0.55	0.00	0.00	251.42	62.79	0.00	358966.5	62.8
25.13	3	40.0	1.1	0.55	0.00	0.00	251.42	63.32	0.00	358966.5	63.3
25.06	3	40.0	1.1	0.55	0.00	0.00	251.42	63.85	0.00	358966.5	63.9
25.00	3	40.0	1.1	0.55	0.00	0.00	251.42	64.38	0.00	358966.5	64.4
24.93	3	40.0	1.1	0.55	0.00	0.00	251.42	64.91	0.00	358966.5	64.9
24.87	3	40.0	1.1	0.55	0.00	0.00	251.42	65.45	0.00	358966.5	65.4
24.80	3	40.0	1.1	0.55	0.00	0.00	251.42	65.98	0.00	358966.5	66.0
24.73	3	40.0	1.1	0.55	0.00	0.00	251.42	66.51	0.00	358966.5	66.5
24.67	3	40.0	1.1	0.55	0.00	0.00	251.42	67.04	0.00	358966.5	67.0
24.60	3	40.0	1.1	0.55	0.00	0.00	251.42	67.58	0.00	358966.5	67.6
24.54	3	40.0	1.1	0.55	0.00	0.00	251.42	68.11	0.00	358966.5	68.1
24.47	3	40.0	1.1	0.55	0.00	0.00	251.42	68.64	0.00	358966.5	68.6
24.40	3	40.0	1.1	0.55	0.00	0.00	251.42	69.17	0.00	358966.5	69.2
24.34	3	40.0	1.1	0.55	0.00	0.00	251.42	69.70	0.00	358966.5	69.7
24.27	3	40.0	1.1	0.55	0.00	0.00	251.42	70.24	0.00	358966.5	70.2
24.20	3	40.0	1.1	0.55	0.00	0.00	251.42	70.77	0.00	358966.5	70.8
24.14	3	40.0	1.1	0.55	0.00	0.00	251.42	71.30	0.00	358966.5	71.3
24.07	3	40.0	1.1	0.55	0.00	0.00	251.42	71.83	0.00	358966.5	71.8
24.01	3	40.0	1.1	0.55	0.00	0.00	251.42	72.36	0.00	358966.5	72.4
23.94	3	40.0	1.1	0.55	0.00	0.00	251.42	72.90	0.00	358966.5	72.9
23.87	3	40.0	1.1	0.55	0.00	0.00	251.42	73.43	0.00	358966.5	73.4
23.81	3	40.0	1.1	0.55	0.00	0.00	251.42	73.96	0.00	358966.5	74.0
23.74	3	40.0	1.1	0.55	0.00	0.00	251.42	74.49	0.00	358966.5	74.5
23.68	3	40.0	1.1	0.55	0.00	0.00	251.42	75.02	0.00	358966.5	75.0
23.61	3	40.0	1.1	0.55	0.00	0.00	251.42	75.56	0.00	358966.5	75.6
23.54	3	40.0	1.1	0.55	0.00	0.00	251.42	76.09	0.00	358966.5	76.1
23.48	3	40.0	1.1	0.55	0.00	0.00	251.42	76.62	0.00	358966.5	76.6
23.41	3	40.0	1.1	0.55	0.00	0.00	251.42	77.15	0.00	358966.5	77.2
23.34	3	40.0	1.1	0.55	0.00	0.00	251.42	77.69	0.00	358966.5	77.7
23.28	3	40.0	1.1	0.55	0.00	0.00	251.42	78.22	0.00	358966.5	78.2
23.21	3	40.0	1.1	0.55	0.00	0.00	251.42	78.75	0.00	358966.5	78.7
23.15	3	40.0	1.1	0.55	0.00	0.00	251.42	79.28	0.00	358966.5	79.3
23.08	3	40.0	1.1	0.55	0.00	0.00	251.42	79.81	0.00	358966.5	79.8
23.01	3	40.0	1.1	0.55	0.00	0.00	251.42	80.35	0.00	358966.5	80.3
22.95	3	40.0	1.1	0.55	0.00	0.00	251.42	80.88	0.00	358966.5	80.9
22.88	3	40.0	1.1	0.55	0.00	0.00	251.42	81.41	0.00	358966.5	81.4
22.82	3	40.0	1.1	0.55	0.00	0.00	251.42	81.94	0.00	358966.5	81.9
22.75	3	40.0	1.1	0.55	0.00	0.00	251.42	82.47	0.00	358966.5	82.5
22.68	3	40.0	1.1	0.55	0.00	0.00	251.42	83.01	0.00	358966.5	83.0
22.62	3	40.0	1.1	0.55	0.00	0.00	251.42	83.54	0.00	358966.5	83.5
22.55	3	40.0	1.1	0.55	0.00	0.00	251.42	84.07	0.00	358966.5	84.1
22.48	3	40.0	1.1	0.55	0.00	0.00	251.42	84.60	0.00	358966.5	84.6
22.42	3	40.0	1.1	0.55	0.00	0.00	251.42	85.13	0.00	358966.5	85.1
22.35	3	40.0	1.1	0.55	0.00	0.00	251.42	85.67	0.00	358966.5	85.7
22.29	3	40.0	1.1	0.55	0.00	0.00	251.42	86.20	0.00	358966.5	86.2
22.22	3	40.0	1.1	0.55	0.00	0.00	251.42	86.73	0.00	358966.5	86.7
22.15	3	40.0	1.1	0.55	0.00	0.00	251.42	87.26	0.00	358966.5	87.3

22.09	3	40.0	1.1	0.55	0.00	0.00	251.42	87.79	0.00	358966.5	87.8
22.02	3	40.0	1.1	0.55	0.00	0.00	251.42	88.33	0.00	358966.5	88.3
21.96	3	40.0	1.1	0.55	0.00	0.00	251.42	88.86	0.00	358966.5	88.9
21.89	3	40.0	1.1	0.55	0.00	0.00	251.42	89.39	0.00	358966.5	89.4
21.82	3	40.0	1.1	0.55	0.00	0.00	251.42	89.92	0.00	358966.5	89.9
21.76	3	40.0	1.1	0.55	0.00	0.00	251.42	90.46	0.00	358966.5	90.5
21.69	3	40.0	1.1	0.55	0.00	0.00	251.42	90.99	0.00	358966.5	91.0
21.63	3	40.0	1.1	0.55	0.00	0.00	251.42	91.52	0.00	358966.5	91.5
21.56	3	40.0	1.1	0.55	0.00	0.00	251.42	92.05	0.00	358966.5	92.1
21.49	3	40.0	1.1	0.55	0.00	0.00	251.42	92.58	0.00	358966.5	92.6
21.43	3	40.0	1.1	0.55	0.00	0.00	251.42	93.12	0.00	358966.5	93.1
21.36	3	40.0	1.1	0.55	0.00	0.00	251.42	93.65	0.00	358966.5	93.6
21.29	3	40.0	1.1	0.55	0.00	0.00	251.42	94.18	0.00	358966.5	94.2
21.23	3	40.0	1.1	0.55	0.00	0.00	251.42	94.71	0.00	358966.5	94.7
21.16	3	40.0	1.1	0.55	0.00	0.00	251.42	95.24	0.00	358966.5	95.2
21.10	3	40.0	1.1	0.55	0.00	0.00	251.42	95.78	0.00	358966.5	95.8
21.03	3	40.0	1.1	0.55	0.00	0.00	251.42	96.31	0.00	358966.5	96.3
20.96	4	26.0	0.8	0.88	0.00	0.00	251.42	97.22	0.00	358966.5	97.2
20.90	4	26.0	0.8	0.88	0.00	0.00	251.42	98.13	0.00	358966.5	98.1
20.83	4	26.0	0.8	0.88	0.00	0.00	251.42	99.04	0.00	358966.5	99.0
20.77	4	26.0	0.8	0.88	0.00	0.00	251.42	99.95	0.00	358966.5	100.0
20.70	4	26.0	0.8	0.88	0.00	0.00	251.42	100.86	0.00	358966.5	100.9
20.63	4	26.0	0.8	0.89	0.00	0.00	251.42	101.78	0.00	358966.5	101.8
20.57	4	26.0	0.8	0.89	0.00	0.00	251.42	102.69	0.00	358966.5	102.7
20.50	4	26.0	0.8	0.89	0.00	0.00	251.42	103.60	0.00	358966.5	103.6
20.43	4	26.0	0.8	0.89	0.00	0.00	251.42	104.51	0.00	358966.5	104.5
20.37	4	26.0	0.8	0.89	0.00	0.00	251.42	105.42	0.00	358966.5	105.4
20.30	4	26.0	0.8	0.89	0.00	0.00	251.42	106.33	0.00	358966.5	106.3
20.24	4	26.0	0.8	0.89	0.00	0.00	251.42	107.24	0.00	358966.5	107.2
20.17	4	26.0	0.8	0.89	0.00	0.00	251.42	108.16	0.00	358966.5	108.2
20.10	4	26.0	0.8	0.89	0.00	0.00	251.42	109.07	0.00	358966.5	109.1
20.04	4	26.0	0.8	0.89	0.00	0.00	251.42	109.98	0.00	358966.5	110.0
19.97	4	26.0	0.8	0.90	0.00	0.00	251.42	110.89	0.00	358966.5	110.9
19.91	4	26.0	0.8	0.90	0.00	0.00	251.42	111.80	0.00	358966.5	111.8
19.84	4	26.0	0.8	0.90	0.00	0.00	251.42	112.71	0.00	358966.5	112.7
19.77	4	26.0	0.8	0.90	0.00	0.00	251.42	113.62	0.00	358966.5	113.6
19.71	4	26.0	0.8	0.90	0.00	0.00	251.42	114.53	0.00	358966.5	114.5
19.64	4	26.0	0.8	0.90	0.00	0.00	251.42	115.45	0.00	358966.5	115.4
19.58	4	26.0	0.8	0.90	0.00	0.00	251.42	116.36	0.00	358966.5	116.4
19.51	4	26.0	0.8	0.90	0.00	0.00	251.42	117.27	0.00	358966.5	117.3
19.44	4	26.0	0.8	0.90	0.00	0.00	251.42	118.18	0.00	358966.5	118.2
19.38	4	26.0	0.8	0.90	0.00	0.00	251.42	119.09	0.00	358966.5	119.1
19.31	4	26.0	0.8	0.91	0.00	0.00	251.42	120.00	0.00	358966.5	120.0
19.24	4	26.0	0.8	0.91	0.00	0.00	251.42	120.91	0.00	358966.5	120.9
19.18	4	26.0	0.8	0.91	0.00	0.00	251.42	121.82	0.00	358966.5	121.8
19.11	4	26.0	0.8	0.91	0.00	0.00	251.42	122.74	0.00	358966.5	122.7
19.05	4	26.0	0.8	0.91	0.00	0.00	251.42	123.65	0.00	358966.5	123.6
18.98	4	26.0	0.8	0.91	0.00	0.00	251.42	124.56	0.00	358966.5	124.6
18.91	4	26.0	0.8	0.91	0.00	0.00	251.42	125.47	0.00	358966.5	125.5

18.85	4	26.0	0.8	0.91	0.00	0.00	251.42	126.38	0.00	358966.5	126.4
18.78	4	26.0	0.8	0.91	0.00	0.00	251.42	127.29	0.00	358966.5	127.3
18.72	4	26.0	0.8	0.91	0.00	0.00	251.42	128.20	0.00	358966.5	128.2
18.65	4	26.0	0.8	0.92	0.00	0.00	251.42	129.11	0.00	358966.5	129.1
18.58	4	26.0	0.8	0.92	0.00	0.00	251.42	130.03	0.00	358966.5	130.0
18.52	4	26.0	0.8	0.92	0.00	0.00	251.42	130.94	0.00	358966.5	130.9
18.45	4	26.0	0.8	0.92	0.00	0.00	251.42	131.85	0.00	358966.5	131.8
18.38	4	26.0	0.8	0.92	0.00	0.00	251.42	132.76	0.00	358966.5	132.8
18.32	4	26.0	0.8	0.92	0.00	0.00	251.42	133.67	0.00	358966.5	133.7
18.25	4	26.0	0.8	0.92	0.00	0.00	251.42	134.58	0.00	358966.5	134.6
18.19	4	26.0	0.8	0.92	0.00	0.00	251.42	135.49	0.00	358966.5	135.5
18.12	4	26.0	0.8	0.92	0.00	0.00	251.42	136.41	0.00	358966.5	136.4
18.05	4	26.0	0.8	0.93	0.00	0.00	251.42	137.32	0.00	358966.5	137.3
17.99	4	26.0	0.8	0.93	0.00	0.00	251.42	138.23	0.00	358966.5	138.2
17.92	4	26.0	0.8	0.93	0.00	0.00	251.42	139.14	0.00	358966.5	139.1
17.86	4	26.0	0.8	0.93	0.00	0.00	251.42	140.05	0.00	358966.5	140.1
17.79	4	26.0	0.8	0.93	0.00	0.00	251.42	140.96	0.00	358966.5	141.0
17.72	4	26.0	0.8	0.93	0.00	0.00	251.42	141.87	0.00	358966.5	141.9
17.66	4	26.0	0.8	0.93	0.00	0.00	251.42	142.78	0.00	358966.5	142.8
17.59	4	26.0	0.8	0.93	0.00	0.00	251.42	143.70	0.00	358966.5	143.7
17.53	4	26.0	0.8	0.93	0.00	0.00	251.42	144.61	0.00	358966.5	144.6
17.46	4	26.0	0.8	0.93	0.00	0.00	251.42	145.52	0.00	358966.5	145.5
17.39	4	26.0	0.8	0.94	0.00	0.00	251.42	146.43	0.00	358966.5	146.4
17.33	4	26.0	0.8	0.94	0.00	0.00	251.42	147.34	0.00	358966.5	147.3
17.26	4	26.0	0.8	0.94	0.00	0.00	251.42	148.25	0.00	358966.5	148.3
17.19	4	26.0	0.8	0.94	0.00	0.00	251.42	149.16	0.00	358966.5	149.2
17.13	4	26.0	0.8	0.94	0.00	0.00	251.42	150.07	0.00	358966.5	150.1
17.06	4	26.0	0.8	0.94	0.00	0.00	251.42	150.99	0.00	358966.5	151.0
17.00	4	40.0	0.3	0.94	0.00	0.00	251.42	151.90	0.00	358966.5	151.9
16.93	4	40.0	0.3	0.94	0.00	0.00	251.42	152.81	0.00	358966.5	152.8
16.86	4	40.0	0.3	0.94	0.00	0.00	251.42	153.72	0.00	358966.5	153.7
16.80	4	40.0	0.3	0.95	0.00	0.00	251.42	154.63	0.00	358966.5	154.6
16.73	4	40.0	0.3	0.95	0.00	0.00	251.42	155.54	0.00	358966.5	155.5
16.67	4	40.0	0.3	0.95	0.00	0.00	251.42	156.45	0.00	358966.5	156.5
16.60	4	40.0	0.3	0.95	0.00	0.00	251.42	157.37	0.00	358966.5	157.4
16.53	4	40.0	0.3	0.95	0.00	0.00	251.42	158.28	0.00	358966.5	158.3
16.47	4	40.0	0.3	0.95	0.00	0.00	251.42	159.19	0.00	358966.5	159.2
16.40	4	40.0	0.3	0.95	0.00	0.00	251.42	160.10	0.00	358966.5	160.1
16.33	4	40.0	0.3	0.95	0.00	0.00	251.42	161.01	0.00	358966.5	161.0
16.27	4	40.0	0.3	0.95	0.00	0.00	251.42	161.92	0.00	358966.5	161.9
16.20	4	40.0	0.3	0.96	0.00	0.00	251.42	162.83	0.00	358966.5	162.8
16.14	4	40.0	0.3	0.96	0.00	0.00	251.42	163.74	0.00	358966.5	163.7
16.07	4	40.0	0.3	0.96	0.00	0.00	251.42	164.66	0.00	358966.5	164.7
16.00	4	40.0	0.3	0.96	0.00	0.00	251.42	165.57	0.00	358966.5	165.6
15.94	4	40.0	0.3	0.96	0.00	0.00	251.42	166.48	0.00	358966.5	166.5
15.87	4	40.0	0.3	0.96	0.00	0.00	251.42	167.39	0.00	358966.5	167.4
15.81	4	40.0	0.3	0.96	0.00	0.00	251.42	168.30	0.00	358966.5	168.3
15.74	4	40.0	0.3	0.96	0.00	0.00	251.42	169.21	0.00	358966.5	169.2
15.67	4	40.0	0.3	0.96	0.00	0.00	251.42	170.12	0.00	358966.5	170.1

15.61	4	40.0	0.3	0.97	0.00	0.00	251.42	171.03	0.00	358966.5	171.0
15.54	4	40.0	0.3	0.97	0.00	0.00	251.42	171.95	0.00	358966.5	171.9
15.47	4	40.0	0.3	0.97	0.00	0.00	251.42	172.86	0.00	358966.5	172.9
15.41	4	40.0	0.3	0.97	0.00	0.00	251.42	173.77	0.00	358966.5	173.8
15.34	4	40.0	0.3	0.97	0.00	0.00	251.42	174.68	0.00	358966.5	174.7
15.28	4	40.0	0.3	0.97	0.00	0.00	251.42	175.59	0.00	358966.5	175.6
15.21	4	40.0	0.3	0.97	0.00	0.00	251.42	176.50	0.00	358966.5	176.5
15.14	4	40.0	0.3	0.97	0.00	0.00	251.42	177.41	0.00	358966.5	177.4
15.08	4	40.0	0.3	0.97	0.00	0.00	251.42	178.33	0.00	358966.5	178.3
15.01	4	40.0	0.3	0.98	0.00	0.00	251.42	179.24	0.00	358966.5	179.2
14.95	4	40.0	0.3	0.98	0.00	0.00	251.42	180.15	0.00	358966.5	180.1
14.88	4	40.0	0.3	0.98	0.00	0.00	251.42	181.06	0.00	358966.5	181.1
14.81	4	40.0	0.3	0.98	0.00	0.00	251.42	181.97	0.00	358966.5	182.0
14.75	4	40.0	0.3	0.98	0.00	0.00	251.42	182.88	0.00	358966.5	182.9
14.68	4	40.0	0.3	0.98	0.00	0.00	251.42	183.79	0.00	358966.5	183.8
14.62	4	40.0	0.3	0.98	0.00	0.00	251.42	184.70	0.00	358966.5	184.7
14.55	4	40.0	0.3	0.98	0.00	0.00	251.42	185.62	0.00	358966.5	185.6
14.48	4	40.0	0.3	0.99	0.00	0.00	251.42	186.53	0.00	358966.5	186.5
14.42	4	40.0	0.3	0.99	0.00	0.00	251.42	187.44	0.00	358966.5	187.4
14.35	4	40.0	0.3	0.99	0.00	0.00	251.42	188.35	0.00	358966.5	188.3
14.28	4	40.0	0.3	0.99	0.00	0.00	251.42	189.26	0.00	358966.5	189.3
14.22	4	40.0	0.3	0.99	0.00	0.00	251.42	190.17	0.00	358966.5	190.2
14.15	4	40.0	0.3	0.99	0.00	0.00	251.42	191.08	0.00	358966.5	191.1
14.09	4	40.0	0.3	0.99	0.00	0.00	251.42	191.99	0.00	358966.5	192.0
14.02	4	40.0	0.3	0.99	0.00	0.00	251.42	192.91	0.00	358966.5	192.9
13.95	4	40.0	0.3	0.99	0.00	0.00	251.42	193.82	0.00	358966.5	193.8
13.89	4	40.0	0.3	1.00	0.00	0.00	251.42	194.73	0.00	358966.5	194.7
13.82	4	40.0	0.3	1.00	0.00	0.00	251.42	195.64	0.00	358966.5	195.6
13.76	4	40.0	0.3	1.00	0.00	0.00	251.42	196.55	0.00	358966.5	196.6
13.69	4	40.0	0.3	1.00	0.00	0.00	251.42	197.46	0.00	358966.5	197.5
13.62	4	40.0	0.3	1.00	0.00	0.00	251.42	198.37	0.00	358966.5	198.4
13.56	4	40.0	0.3	1.00	0.00	0.00	251.42	199.29	0.00	358966.5	199.3
13.49	4	40.0	0.3	1.00	0.00	0.00	251.42	200.20	0.00	358966.5	200.2
13.42	4	40.0	0.3	1.00	0.00	0.00	251.42	201.11	0.00	358966.5	201.1
13.36	4	40.0	0.3	1.01	0.00	0.00	251.42	202.02	0.00	358966.5	202.0
13.29	4	40.0	0.3	1.01	0.00	0.00	251.42	202.93	0.00	358966.5	202.9
13.23	4	40.0	0.3	1.01	0.00	0.00	251.42	203.84	0.00	358966.5	203.8
13.16	4	40.0	0.3	1.01	0.00	0.00	251.42	204.75	0.00	358966.5	204.8
13.09	4	40.0	0.3	1.01	0.00	0.00	251.42	205.66	0.00	358966.5	205.7
13.03	4	40.0	0.3	1.01	0.00	0.00	251.42	206.58	0.00	358966.5	206.6
12.96	4	40.0	0.3	1.01	0.00	0.00	251.42	207.49	0.00	358966.5	207.5
12.90	4	40.0	0.3	1.01	0.00	0.00	251.42	208.40	0.00	358966.5	208.4
12.83	4	40.0	0.3	1.02	0.00	0.00	251.42	209.31	0.00	358966.5	209.3
12.76	4	40.0	0.3	1.02	0.00	0.00	251.42	210.22	0.00	358966.5	210.2
12.70	4	40.0	0.3	1.02	0.00	0.00	251.42	211.13	0.00	358966.5	211.1
12.63	4	40.0	0.3	1.02	0.00	0.00	251.42	212.04	0.00	358966.5	212.0
12.57	4	40.0	0.3	1.02	0.00	0.00	251.42	212.95	0.00	358966.5	213.0
12.50	4	40.0	0.3	1.02	0.00	0.00	251.42	213.87	0.00	358966.5	213.9
12.43	4	40.0	0.3	1.02	0.00	0.00	251.42	214.78	0.00	358966.5	214.8

12.37	4	40.0	0.3	1.02	0.00	0.00	251.42	215.69	0.00	358966.5	215.7
12.30	4	40.0	0.3	1.03	0.00	0.00	251.42	216.60	0.00	358966.5	216.6
12.23	4	40.0	0.3	1.03	0.00	0.00	251.42	217.51	0.00	358966.5	217.5
12.17	4	40.0	0.3	1.03	0.00	0.00	251.42	218.42	0.00	358966.5	218.4
12.10	4	40.0	0.3	1.03	0.00	0.00	251.42	219.33	0.00	358966.5	219.3
12.04	4	40.0	0.3	1.03	0.00	0.00	251.42	220.25	0.00	358966.5	220.2
11.97	4	40.0	0.3	1.03	0.00	0.00	251.42	221.16	0.00	358966.5	221.2
11.90	4	40.0	0.3	1.03	0.00	0.00	251.42	222.07	0.00	358966.5	222.1
11.84	4	40.0	0.3	1.03	0.00	0.00	251.42	222.98	0.00	358966.5	223.0
11.77	4	40.0	0.3	1.04	0.00	0.00	251.42	223.89	0.00	358966.5	223.9
11.71	4	40.0	0.3	1.04	0.00	0.00	251.42	224.80	0.00	358966.5	224.8
11.64	4	40.0	0.3	1.04	0.00	0.00	251.42	225.71	0.00	358966.5	225.7
11.57	4	40.0	0.3	1.04	0.00	0.00	251.42	226.62	0.00	358966.5	226.6
11.51	4	40.0	0.3	1.04	0.00	0.00	251.42	227.54	0.00	358966.5	227.5
11.44	4	40.0	0.3	1.04	0.00	0.00	251.42	228.45	0.00	358966.5	228.4
11.37	4	40.0	0.3	1.04	0.00	0.00	251.42	229.36	0.00	358966.5	229.4
11.31	4	40.0	0.3	1.05	0.00	0.00	251.42	230.27	0.00	358966.5	230.3
11.24	4	40.0	0.3	1.05	0.00	0.00	251.42	231.18	0.00	358966.5	231.2
11.18	4	40.0	0.3	1.05	0.00	0.00	251.42	232.09	0.00	358966.5	232.1
11.11	4	40.0	0.3	1.05	0.00	0.00	251.42	233.00	0.00	358966.5	233.0
11.04	4	40.0	0.3	1.05	0.00	0.00	251.42	233.91	0.00	358966.5	233.9
10.98	4	40.0	0.3	1.05	0.00	0.00	251.42	234.83	0.00	358966.5	234.8
10.91	4	40.0	0.3	1.05	0.00	0.00	251.42	235.74	0.00	358966.5	235.7
10.85	4	40.0	0.3	1.05	0.00	0.00	251.42	236.65	0.00	358966.5	236.6
10.78	4	40.0	0.3	1.06	0.00	0.00	251.42	237.56	0.00	358966.5	237.6
10.71	4	40.0	0.3	1.06	0.00	0.00	251.42	238.47	0.00	358966.5	238.5
10.65	4	40.0	0.3	1.06	0.00	0.00	251.42	239.38	0.00	358966.5	239.4
10.58	4	40.0	0.3	1.06	0.00	0.00	251.42	240.29	0.00	358966.5	240.3
10.52	4	40.0	0.3	1.06	0.00	0.00	251.42	241.20	0.00	358966.5	241.2
10.45	4	40.0	0.3	1.06	0.00	0.00	251.42	242.12	0.00	358966.5	242.1
10.38	4	40.0	0.3	1.06	0.00	0.00	251.42	243.03	0.00	358966.5	243.0
10.32	4	40.0	0.3	1.07	0.00	0.00	251.42	243.94	0.00	358966.5	243.9
10.25	4	40.0	0.3	1.07	0.00	0.00	251.42	244.85	0.00	358966.5	244.9
10.18	4	40.0	0.3	1.07	0.00	0.00	251.42	245.76	0.00	358966.5	245.8
10.12	4	40.0	0.3	1.07	0.00	0.00	251.42	246.67	0.00	358966.5	246.7
10.05	4	40.0	0.3	1.07	0.00	0.00	251.42	247.58	0.00	358966.5	247.6
9.99	4	40.0	0.3	1.07	0.00	0.00	251.42	248.50	0.00	358966.5	248.5
9.92	4	40.0	0.3	1.07	0.00	0.00	251.42	249.41	0.00	358966.5	249.4
9.85	4	40.0	0.3	1.08	0.00	0.00	251.42	250.32	0.00	358966.5	250.3
9.79	4	40.0	0.3	1.08	0.00	0.00	251.42	251.23	0.00	358966.5	251.2
9.72	4	40.0	0.3	1.08	0.00	0.00	251.42	252.14	0.00	358966.5	252.1
9.66	4	40.0	0.3	1.08	0.00	0.00	251.42	253.05	0.00	358966.5	253.1
9.59	4	40.0	0.3	1.08	0.00	0.00	251.42	253.96	0.00	358966.5	254.0
9.52	4	40.0	0.3	1.08	0.00	0.00	251.42	254.87	0.00	358966.5	254.9
9.46	4	40.0	0.3	1.08	0.00	0.00	251.42	255.79	0.00	358966.5	255.8
9.39	4	40.0	0.3	1.09	0.00	0.00	251.42	256.70	0.00	358966.5	256.7
9.32	4	40.0	0.3	1.09	0.00	0.00	251.42	257.61	0.00	358966.5	257.6
9.26	4	40.0	0.3	1.09	0.00	0.00	251.42	258.52	0.00	358966.5	258.5
9.19	4	40.0	0.3	1.09	0.00	0.00	251.42	259.43	0.00	358966.5	259.4

9.13	4	40.0	0.3	1.09	0.00	0.00	251.42	260.34	0.00	358966.5	260.3
9.06	4	40.0	0.3	1.09	0.00	0.00	251.42	261.25	0.00	358966.5	261.3
8.99	4	40.0	0.3	1.09	0.00	0.00	251.42	262.16	0.00	358966.5	262.2
8.93	4	40.0	0.3	1.10	0.00	0.00	251.42	263.08	0.00	358966.5	263.1
8.86	4	40.0	0.3	1.10	0.00	0.00	251.42	263.99	0.00	358966.5	264.0
8.80	4	40.0	0.3	1.10	0.00	0.00	251.42	264.90	0.00	358966.5	264.9
8.73	4	40.0	0.3	1.10	0.00	0.00	251.42	265.81	0.00	358966.5	265.8
8.66	4	40.0	0.3	1.10	0.00	0.00	251.42	266.72	0.00	358966.5	266.7
8.60	4	40.0	0.3	1.10	0.00	0.00	251.42	267.63	0.00	358966.5	267.6
8.53	4	40.0	0.3	1.10	0.00	0.00	251.42	268.54	0.00	358966.5	268.5
8.46	4	40.0	0.3	1.11	0.00	0.00	251.42	269.46	0.00	358966.5	269.5
8.40	4	40.0	0.3	1.11	0.00	0.00	251.42	270.37	0.00	358966.5	270.4
8.33	4	40.0	0.3	1.11	0.00	0.00	251.42	271.28	0.00	358966.5	271.3
8.27	4	40.0	0.3	1.11	0.00	0.00	251.42	272.19	0.00	358966.5	272.2
8.20	4	40.0	0.3	1.11	0.00	0.00	251.42	273.10	0.00	358966.5	273.1
8.13	4	40.0	0.3	1.11	0.00	0.00	251.42	274.01	0.00	358966.5	274.0
8.07	4	40.0	0.3	1.12	0.00	0.00	251.42	274.92	0.00	358966.5	274.9
8.00	4	40.0	0.3	1.12	0.00	0.00	251.42	275.83	0.00	358966.5	275.8
7.94	4	40.0	0.3	1.12	0.00	0.00	251.42	276.75	0.00	358966.5	276.7
7.87	4	40.0	0.3	1.12	0.00	0.00	251.42	277.66	0.00	358966.5	277.7
7.80	4	40.0	0.3	1.12	0.00	0.00	251.42	278.57	0.00	358966.5	278.6
7.74	4	40.0	0.3	1.12	0.00	0.00	251.42	279.48	0.00	358966.5	279.5
7.67	4	40.0	0.3	1.13	0.00	0.00	251.42	280.39	0.00	358966.5	280.4
7.61	4	40.0	0.3	1.13	0.00	0.00	251.42	281.30	0.00	358966.5	281.3
7.54	4	40.0	0.3	1.13	0.00	0.00	251.42	282.21	0.00	358966.5	282.2
7.47	4	40.0	0.3	1.13	0.00	0.00	251.42	283.13	0.00	358966.5	283.1
7.41	4	40.0	0.3	1.13	0.00	0.00	251.42	284.04	0.00	358966.5	284.0
7.34	4	40.0	0.3	1.13	0.00	0.00	251.42	284.95	0.00	358966.5	284.9
7.27	4	40.0	0.3	1.14	0.00	0.00	251.42	285.86	0.00	358966.5	285.9
7.21	4	40.0	0.3	1.14	0.00	0.00	251.42	286.77	0.00	358966.5	286.8
7.14	4	40.0	0.3	1.14	0.00	0.00	251.42	287.68	0.00	358966.5	287.7
7.08	4	40.0	0.3	1.14	0.00	0.00	251.42	288.59	0.00	358966.5	288.6
7.01	4	40.0	0.3	1.14	0.00	0.00	251.42	289.50	0.00	358966.5	289.5
6.94	4	40.0	0.3	1.14	0.00	0.00	251.42	290.42	0.00	358966.5	290.4
6.88	4	40.0	0.3	1.15	0.00	0.00	251.42	291.33	0.00	358966.5	291.3
6.81	4	40.0	0.3	1.15	0.00	0.00	251.42	292.24	0.00	358966.5	292.2
6.75	4	40.0	0.3	1.15	0.00	0.00	251.42	293.15	0.00	358966.5	293.1
6.68	4	40.0	0.3	1.15	0.00	0.00	251.42	294.06	0.00	358966.5	294.1
6.61	4	40.0	0.3	1.15	0.00	0.00	251.42	294.97	0.00	358966.5	295.0
6.55	4	40.0	0.3	1.15	0.00	0.00	251.42	295.88	0.00	358966.5	295.9
6.48	4	40.0	0.3	1.16	0.00	0.00	251.42	296.79	0.00	358966.5	296.8
6.41	4	40.0	0.3	1.16	0.00	0.00	251.42	297.71	0.00	358966.5	297.7
6.35	4	40.0	0.3	1.16	0.00	0.00	251.42	298.62	0.00	358966.5	298.6
6.28	4	40.0	0.3	1.16	0.00	0.00	251.42	299.53	0.00	358966.5	299.5
6.22	4	40.0	0.3	1.16	0.00	0.00	251.42	300.44	0.00	358966.5	300.4
6.15	4	40.0	0.3	1.16	0.00	0.00	251.42	301.35	0.00	358966.5	301.4
6.08	4	40.0	0.3	1.17	0.00	0.00	251.42	302.26	0.00	358966.5	302.3
6.02	4	40.0	0.3	1.17	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.95	4	40.0	0.3	1.17	0.00	0.00	251.42	303.17	0.00	358966.5	303.2

5.89	4	40.0	0.3	1.17	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.82	4	40.0	0.3	1.17	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.75	4	40.0	0.3	1.18	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.69	4	40.0	0.3	1.18	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.62	4	40.0	0.3	1.18	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.56	4	40.0	0.3	1.18	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.49	4	40.0	0.3	1.18	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.42	4	40.0	0.3	1.19	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.36	4	40.0	0.3	1.19	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.29	4	40.0	0.3	1.19	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.22	4	40.0	0.3	1.19	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.16	4	40.0	0.3	1.19	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.09	4	40.0	0.3	1.19	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
5.03	4	40.0	0.3	1.20	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.96	4	40.0	0.3	1.20	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.89	4	40.0	0.3	1.20	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.83	4	40.0	0.3	1.20	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.76	4	40.0	0.3	1.20	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.70	4	40.0	0.3	1.21	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.63	4	40.0	0.3	1.21	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.56	4	40.0	0.3	1.21	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.50	4	40.0	0.3	1.21	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.43	4	40.0	0.3	1.22	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.36	4	40.0	0.3	1.22	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.30	4	40.0	0.3	1.22	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.23	4	40.0	0.3	1.22	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.17	4	40.0	0.3	1.22	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.10	4	40.0	0.3	1.23	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
4.03	4	40.0	0.3	1.23	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.97	4	40.0	0.3	1.23	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.90	4	40.0	0.3	1.23	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.84	4	40.0	0.3	1.24	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.77	4	40.0	0.3	1.24	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.70	4	40.0	0.3	1.24	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.64	4	40.0	0.3	1.24	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.57	4	40.0	0.3	1.24	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.51	4	40.0	0.3	1.25	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.44	4	40.0	0.3	1.25	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.37	4	40.0	0.3	1.25	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.31	4	40.0	0.3	1.25	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.24	4	40.0	0.3	1.26	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.17	4	40.0	0.3	1.26	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.11	4	40.0	0.3	1.26	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
3.04	4	40.0	0.3	1.26	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.98	4	40.0	0.3	1.27	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.91	4	40.0	0.3	1.27	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.84	4	40.0	0.3	1.27	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.78	4	40.0	0.3	1.27	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.71	4	40.0	0.3	1.28	0.00	0.00	251.42	303.17	0.00	358966.5	303.2

2.65	4	40.0	0.3	1.28	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.58	4	40.0	0.3	1.28	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.51	4	40.0	0.3	1.29	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.45	4	40.0	0.3	1.29	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.38	4	40.0	0.3	1.29	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.31	4	40.0	0.3	1.29	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.25	4	40.0	0.3	1.30	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.18	4	40.0	0.3	1.30	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.12	4	40.0	0.3	1.30	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
2.05	4	40.0	0.3	1.31	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.98	4	40.0	0.3	1.31	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.92	4	40.0	0.3	1.31	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.85	4	40.0	0.3	1.32	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.79	4	40.0	0.3	1.32	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.72	4	40.0	0.3	1.32	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.65	4	40.0	0.3	1.33	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.59	4	40.0	0.3	1.33	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.52	4	40.0	0.3	1.33	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.45	4	40.0	0.3	1.34	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.39	4	40.0	0.3	1.34	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.32	4	40.0	0.3	1.34	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.26	4	40.0	0.3	1.35	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.19	4	40.0	0.3	1.35	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.12	4	40.0	0.3	1.36	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
1.06	4	40.0	0.3	1.36	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.99	4	40.0	0.3	1.37	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.93	4	40.0	0.3	1.37	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.86	4	40.0	0.3	1.37	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.79	4	40.0	0.3	1.38	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.73	4	40.0	0.3	1.38	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.66	4	40.0	0.3	1.39	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.60	4	40.0	0.3	1.40	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.53	4	40.0	0.3	1.40	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.46	4	40.0	0.3	1.41	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.40	4	40.0	0.3	1.41	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.33	4	40.0	0.3	1.42	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.26	4	40.0	0.3	1.43	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.20	4	40.0	0.3	1.44	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.13	4	40.0	0.3	1.45	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.07	4	40.0	0.3	1.47	0.00	0.00	251.42	303.17	0.00	358966.5	303.2
0.00	4	40.0	0.3	1.50	0.00	0.00	251.42	303.17	0.00	358966.5	303.2

Group Pile Capacities:

Group Analysis Ultimate Capacity (Down)= 358966.531-kp Group Ultimate Capacity (Up)= 303.174-kp
Weight above Ground= 0.00 Total Weight= 303.17-kp *Soil Weight is not included
Side Resistance (Down)= 0.000-kp Side Resistance (Up)= 0.000-kp
Tip Resistance (Down)= 358966.531-kp Tip Resistance (Up)= 0.000-kp

----------3. Group Analysis Adjustment----------

Total pile number =13

Before adjustment:

Group Analysis Ultimate Capacity (Down)= 358966.531-kp Group Ultimate Capacity (Up)= 303.174-kp
Weight above Ground= 0.00 Total Weight= 303.17-kp *Soil Weight is not included
Side Resistance (Down)= 0.000-kp Side Resistance (Up)= 0.000-kp
Tip Resistance (Down)= 358966.531-kp Tip Resistance (Up)= 0.000-kp

Single Analysis Ultimate Capacity (Down)= 6856.688-kp Single Ultimate Capacity (Up)= 23.321-kp
Single Capacity (Down) X Pile Number = 89136.944-kp Single Ultimate Capacity (Up)= 303.174-kp

Group Efficiencies = Capacity from Group Analysis / (Capacity from Single Analysis x Pile Number)
Group Efficiency (Down)= 4.027 Group Efficiency (Up)= 1.000

Settlement Adjustment:

Short Side, B= Bx or By= 3.00 Diameter of Pile= 3.00 Settlement Factor=sqrt(B/Diam.)= 1.000
Pile Number, N= 13 Capacity Factor= N= 13.000
* Because Group Efficiency= 4.027 >1. Settlement Factor is adjusted to= 1.000

* Group Efficiency (Down)>1, Q_down (Single Analysis) X Pile Number should be used.
* Group Efficiency (Up)>1, Q_up (Single Analysis) X Pile Number should be used.

After Adjustment:

Total Ultimate Capacity (Down)= 89136.945-kp Total Ultimate Capacity (Up)= 303.174-kp
Weight above Ground= 0.00 Total Pile Weight= 303.17-kp *Soil Weight is not included
Side Resistance (Down)= 0.000-kp Side Resistance (Up)= 0.000-kp
Tip Resistance (Down)= 89136.945-kp Tip Resistance (Up)= 0.000-kp

SETTLEMENT based on Ultimate Loading by Vesic Method (1977):

LOAD - TOTAL SETTLEMENT RELATION (from t-z, and q-w curves):
Based on Reese and O'Neill Method (1988)
Group Settlement: Settlement Factor= 1.000 Capacity Factor= 13.000

Xtop -in	Xshaft -in	Xtip -in	Qtip -kp	Qside -kp	Qtotal -kp
0.0010	0.0010	0.0000	117.8	0.0	117.8
0.0684	0.0206	0.0477	2531.8	0.0	2531.8
0.1021	0.0305	0.0716	3741.1	0.0	3741.1
0.1358	0.0404	0.0954	4950.5	0.0	4950.5
0.1695	0.0502	0.1193	6159.4	0.0	6159.4
0.2032	0.0601	0.1431	7366.6	0.0	7366.6
0.2369	0.0699	0.1670	8571.5	0.0	8571.5
0.2706	0.0797	0.1909	9773.2	0.0	9773.2
0.3042	0.0895	0.2147	10971.0	0.0	10971.0
0.3378	0.0992	0.2386	12164.2	0.0	12164.2
0.3713	0.1089	0.2624	13352.0	0.0	13352.0
0.4048	0.1185	0.2863	14533.9	0.0	14533.9

0.4383	0.1281	0.3101	15709.1	0.0	15709.1
0.4717	0.1377	0.3340	16877.2	0.0	16877.2
0.5050	0.1471	0.3579	18037.6	0.0	18037.6
0.5382	0.1565	0.3817	19189.7	0.0	19189.7
0.5714	0.1658	0.4056	20333.1	0.0	20333.1
0.6045	0.1751	0.4294	21467.3	0.0	21467.3
0.6375	0.1843	0.4533	22591.8	0.0	22591.8
0.6705	0.1934	0.4771	23706.3	0.0	23706.3
0.7034	0.2024	0.5010	24810.3	0.0	24810.3
0.7361	0.2113	0.5249	25903.6	0.0	25903.6
0.7688	0.2201	0.5487	26985.7	0.0	26985.7
0.8014	0.2288	0.5726	28056.5	0.0	28056.5
0.8339	0.2375	0.5964	29115.5	0.0	29115.5
0.8663	0.2460	0.6203	30162.7	0.0	30162.7
0.8986	0.2545	0.6441	31197.6	0.0	31197.6
0.9308	0.2628	0.6680	32220.1	0.0	32220.1
0.9629	0.2710	0.6919	33230.1	0.0	33230.1
0.9949	0.2792	0.7157	34227.3	0.0	34227.3
1.0268	0.2872	0.7396	35211.7	0.0	35211.7
1.0585	0.2951	0.7634	36183.0	0.0	36183.0
1.0902	0.3029	0.7873	37141.2	0.0	37141.2
1.1218	0.3106	0.8111	38086.1	0.0	38086.1
1.1532	0.3182	0.8350	39017.8	0.0	39017.8
1.1846	0.3257	0.8589	39936.1	0.0	39936.1
1.2158	0.3331	0.8827	40841.1	0.0	40841.1
1.2469	0.3404	0.9066	41732.6	0.0	41732.6
1.2780	0.3475	0.9304	42610.6	0.0	42610.6
1.3089	0.3546	0.9543	43475.3	0.0	43475.3
1.3397	0.3615	0.9781	44326.6	0.0	44326.6
1.3704	0.3684	1.0020	45164.4	0.0	45164.4
1.4009	0.3751	1.0259	45989.0	0.0	45989.0
1.4314	0.3817	1.0497	46800.3	0.0	46800.3
1.4618	0.3882	1.0736	47598.4	0.0	47598.4
1.4920	0.3946	1.0974	48383.4	0.0	48383.4
1.5222	0.4009	1.1213	49155.3	0.0	49155.3
1.5522	0.4071	1.1451	49914.4	0.0	49914.4
1.5822	0.4132	1.1690	50660.6	0.0	50660.6
1.6120	0.4192	1.1929	51394.1	0.0	51394.1
1.6418	0.4251	1.2167	52115.1	0.0	52115.1
1.6714	0.4308	1.2406	52823.6	0.0	52823.6
1.7009	0.4365	1.2644	53519.9	0.0	53519.9
1.7304	0.4421	1.2883	54204.0	0.0	54204.0
1.7597	0.4476	1.3121	54876.1	0.0	54876.1
1.7890	0.4530	1.3360	55536.5	0.0	55536.5
1.8181	0.4583	1.3599	56185.2	0.0	56185.2
1.8472	0.4635	1.3837	56822.5	0.0	56822.5
1.8761	0.4686	1.4076	57448.5	0.0	57448.5
1.9050	0.4736	1.4314	58063.4	0.0	58063.4
1.9338	0.4785	1.4553	58667.4	0.0	58667.4

1.9625	0.4833	1.4791	59260.6	0.0	59260.6
1.9911	0.4881	1.5030	59843.4	0.0	59843.4
2.0196	0.4928	1.5269	60415.9	0.0	60415.9
2.0481	0.4973	1.5507	60978.2	0.0	60978.2
2.0764	0.5019	1.5746	61530.7	0.0	61530.7
2.1047	0.5063	1.5984	62073.5	0.0	62073.5
2.1329	0.5106	1.6223	62606.7	0.0	62606.7
2.1610	0.5149	1.6461	63130.7	0.0	63130.7
2.1891	0.5191	1.6700	63645.7	0.0	63645.7
2.2171	0.5232	1.6938	64151.7	0.0	64151.7
2.2450	0.5273	1.7177	64649.1	0.0	64649.1
2.2728	0.5313	1.7416	65138.1	0.0	65138.1
2.3006	0.5352	1.7654	65618.8	0.0	65618.8
2.3283	0.5391	1.7893	66091.6	0.0	66091.6
2.3560	0.5428	1.8131	66556.5	0.0	66556.5
2.3836	0.5466	1.8370	67013.8	0.0	67013.8
2.4111	0.5502	1.8608	67463.7	0.0	67463.7
2.4386	0.5539	1.8847	67906.3	0.0	67906.3
2.4660	0.5574	1.9086	68342.0	0.0	68342.0
2.4933	0.5609	1.9324	68770.9	0.0	68770.9
2.5206	0.5644	1.9563	69193.1	0.0	69193.1
2.5479	0.5677	1.9801	69609.0	0.0	69609.0
2.5751	0.5711	2.0040	70018.6	0.0	70018.6
2.6022	0.5744	2.0278	70422.1	0.0	70422.1
2.6293	0.5776	2.0517	70819.8	0.0	70819.8
2.6564	0.5808	2.0756	71211.8	0.0	71211.8
2.6834	0.5840	2.0994	71598.3	0.0	71598.3
2.7104	0.5871	2.1233	71979.4	0.0	71979.4
2.7373	0.5901	2.1471	72355.3	0.0	72355.3
2.7642	0.5932	2.1710	72726.2	0.0	72726.2
2.7910	0.5961	2.1948	73092.2	0.0	73092.2
2.8178	0.5991	2.2187	73453.4	0.0	73453.4
2.8446	0.6020	2.2426	73810.1	0.0	73810.1
3.0044	0.6187	2.3857	75861.3	0.0	75861.3
3.5300	0.6672	2.8628	81803.7	0.0	81803.7
4.0451	0.7051	3.3400	86447.2	0.0	86447.2
4.5441	0.7270	3.8171	89136.9	0.0	89136.9
5.0183	0.7240	4.2943	88765.8	0.0	88765.8
5.4628	0.6913	4.7714	84763.6	0.0	84763.6

At Qwork= 7410.00-kp Settlement= 0.20444-in
At Qwork= 7410.00-kp Secant Stiffness Kqx= 36245.63-kp/-in
At Xallow= 0.50-in Qallow= 17864.44-kp
Note: If the program cannot find a result or the result exceeds the upper limit. The result will be displayed as 99999.

SUMMARY:
Total Ultimate Capacity (Down)= 89136.945-kp Total Ultimate Capacity (Up)= 303.174-kp

Total Allowable Capacity (Down)= 29712.314-kp Total Allowable Capacity (Up)= 303.174-kp
Weight above Ground= 0.00 Total Pile Weight= 303.17-kp *Soil Weight is not included
Side Resistance (Down)= 0.000-kp Side Resistance (Up)= 0.000-kp
Tip Resistance (Down)= 89136.945-kp Tip Resistance (Up)= 0.000-kp
Negative Friction, Qneg= 0.000-kp, which has been subtracted from Total Ultimate Capacity (Down)
Negative friction does not affect Total Uplift Ultimate Capacity (Up)

OK! Qallow > Q * Vertical Load, Q= 7410.0 -kp

FACTOR OF SAFETY:

FSside	FStip	FSup	FSweight
2.0	3.0	2.5	1.0

Notes:
* Settlement in the program is Elastic Settlement only. Consolidation Settlement is not calculated!
Length - Pile length, distance from pile top to tip (not from ground surface)
Width or D - Width of pile shaft (pile diameter)
Ds and Dl - Short Side and Long Side of Footing
Area - Section area of pile shaft or tip area of pile
Sv - Vertical stress in soils (It may be limited based on critical depth, Z_lim or Z/D
qult - Ultimate tip resistance (pressure)
Qtip_dw - Ultimate downward tip resistance (Force or Capacity)
Qtip_up - Ultimate uplift tip resistance for belled pile or uplift plate (Force or Capacity)
dz - Small Segment of Depth for Calculation
Zs - Soil Depth, Depth from ground surface
Zp - Pile Depth, Depth from pile top
Prem - Primer of pile shaft
Phi - Soil internal friction angle (between soils)
Kf - Friction factor to convert Phi to Delta
Delta - Ski friction between soil and pile (function of Phi. It is different from Phi)
f_dw - Resistance between soil and pile from Delta
f_up - Resistance between soil and pile from Delta
C - Soil cohesion (between soils)
Ca - Adhesion between soil and pile (function of C. It is different from C) Ca=KaKcC
Ka - Adhesion ratio, C/Ca
Kc - Adhesion factor defended by users
Ca_dw - Downward adhesion between pile and soil
Ca_up - Uplift adhesion between pile and soil
Sf_dw - Downward side resistance (sum of friction and adhesion, f_dw + Ca_dw)
Sf_up - Uplift side resistance (sum of friction and adhesion, f_up + Ca_up)
Weight - Weight of Pile shaft
Qneg - negative friction Resistance
Qside - Ultimate side resistance (Qside_dw or Qside_up)
Qtip - Ultimate tip resistance (Qtip_dw or Qtip_up for uplift plate)
Q_dw - Ultimate downward capacity (Qtip + Qside_dw)
Q_up - Ultimate uplift capacity (Weight + Qside_up)
E - Elastic modules
Xs - Settlement due to axial deformation of pile shaft

Xpp - Settlement due to point load from pile tip
Xps- Settlement due to load from pile shaft
Xtop - Total settlement, Xs + Xpp + Xps
Xtip - Tip settlement, Xpp + Xps
Xshaft - Shaft deformation, Xs
Xallow - Allowable settlement specified by users
Qwork - Vertical working load applied to pile
Qallow - Vertical allowable load, Qult/F.S.

APPENDIX G

FOOTINGS CALCULATIONS

PETRA

4/5/10
Nordahl Bridge
329-03
Monty Schultz

Petra
Geotechnical

Check bearing capacity at center bent for footings founded on granitic bedrock.
Assume ultimate column load = 2633 kips as given by Simon Wong Engr.
Assume a footing size of ≅ 10'×10' = 100 ft²
Footing is level, no eccentric loads,
Final bottom of footing elevation = 688.85
Ground surface ≅ 696
From Salgado (1996), the general form of bearing capacity ⇒
$q_{ult} = (s_c d_c) c N_c + (s_q d_q) q_0 N_q + \frac{1}{2}(s_\gamma d_\gamma) \gamma B N_\gamma$

From boring B-2 @ 3' in granitic bedrock
$\phi_{peak} = 40°$, $c_{peak} = 160$; $\phi_{ult} = 38°$, $c_{ult} = 50$
From Table 4.4.7.1A @ 38° $N_c = 61.35$, $N_q = 48.93$, $N_\gamma = 78.03$
shape factors
$s_c = 1 + B/L\,(N_q/N_c) = 1 + (10/10)(48.93/61.35) = 1.798$
$s_q = 1 + B/L \tan\phi = 1 + 10/10 \tan 38° = 1.781$
$s_\gamma = 1 - 0.4(B/L) = 0.6$
ignor depth effect per B.D.S.
$\Rightarrow q_{ult} = (50)(1.798)(61.35) + (1.78)(7)(120)(48.93) + \frac{1}{2}(0.6)(120)(10)(78.03)$
$= 5515 + 73{,}160 + 28{,}090$
$= 106{,}765$ psf

ignor shape factors & use N_γ from Salgado $N_\gamma = 58.92$
$\Rightarrow q_{ult} = 50(61.35) + 7(120)(48.93) + 1/2(120)(10)(58.92)$
$= 3067 + 41{,}101 + 35{,}352$
$= 79{,}520$ psf

Limit q_{ult} to 45 ksf ∴ $q_{allowable} = 15{,}000$ psf
For 8×8 footing ⇒ $(64\ ft^2)(45) = 2880$ kips > 2663 ✓
Assume full contact pressure to depth of 2B
⇒ Settlement = $45{,}000 / 3.85\times10^8 = \varepsilon = 1.167\times10^{-4}$
⇒ Settlement = 0.02 inches ✓

329-03 Nordahl Bridge
Bearing Capacity - Abutment

qult = C Nc (Sc Dc) + 1/2 B W1 Ng (Sg Dg) + W2 D (Nq-1)(Sq Dq)

Cohesion C =	200 psf } B-8 @ 2'	0	0	0	0	0
Phi =	39 deg	39	37	35	35	39
Unit Weight W1 =	120 pcf	120	120	120	120	120
Unit Weight of soil above footing W2 =	120 pcf	120	120	120	120	120
Depth of Footing Below Adjacent Ground Df =	0 ft	0	2	2	1	0
Footing Width B =	12 ft	12	10	8	10	6
Footing Length L =	120 ft	120	120	120	120	120
Nc = (Nq-1) cot (phi) =	67.87	67.87	55.63	46.12	46.12	67.87
Ng = 2*(Nq+1)*tan(phi) =	92.25	92.25	66.19	48.03	48.03	92.25
Nq = (e^pi tan (phi)) (tan^2(45+phi/2) =	55.96	55.96	42.92	33.30	33.30	55.96
Shape Factors						
Sc = 1+(B/L)(Nq/Nc) =	1.08	1.08	1.06	1.05	1.06	1.04
Sg = 1-0.4(B/L) =	0.96	0.96	0.97	0.97	0.97	0.98
Sq = 1+(B/L) Tan (Phi) =	1.08	1.08	1.06	1.05	1.06	1.04
Depth Factors						
Dc = 1+0.4 Atan (D/B) =	1.00	1.00	1.08	1.10	1.04	1.00
Dg = 1 =	1.00	1.00	1.00	1.00	1.00	1.00
Dq = 1+2 tan (phi) (1-Sin (phi))^2 (atan (D/B) =	1.00	1.00	1.05	1.06	1.03	1.00
Gross Ultimate Bearing Pressure qult =	78,453 psf	63,761	49,588	31,058	32,062	32,544
Qult =	112,972,290 lbs	91,815,158	59,505,749	29,815,612	38,474,821	23,431,993
qallowable =	26,151 psf	21,254	16,529	10,353	10,687	10,848
Qallowable =	37,657,430 lbs	30,605,053	19,835,250	9,938,537	12,824,940	7,810,664

check Settlement

Assume F.S. of 5 for E from shear wave

$\Rightarrow E = 7.71 \times 10^7$ psf

$\therefore \frac{31{,}500}{7.71 \times 10^7} = 4.08 \times 10^{-4}$ ft

$= 0.005$ in

$\therefore$ Settlement can be assumed to be small ✓

Check presumptive bearing values
Table 4.11.4.1.4-1
massive crystaline Rock = 60-100 TSF Allowable
weathered or broken Rock = 8-12 TSF
California Building Code 2007 = 12 KSF for crystaline

Check using Rock parameters from 4.4.8.1.2-1
$q_{ult} = N_{ms} C_o$
using C_o = 2,700 psi & N_{ms} from Table 4.4.8.1.2A
@ "fair" condition
$q_{ult} = 0.081 (2700)(144) = 31{,}492$ psf
@ F.S. = 3 $\Rightarrow$ $q_{all} = 10{,}500$ psf ✓

Mononobe-Okabe Analysis of Dynamic Loads on Retaining Walls

$$Kae = \frac{\text{Cos}^2\,(\text{phi-psi-theta})}{\cos(\text{psi})\,\cos^2(\text{theta})\,\cos(\text{psi+theta+delta}) * [1+\text{sqrt}[\sin(\text{phi+delta})*\sin(\text{phi-psi-beta})/\cos(\text{beta-theta})*\cos(\text{psi+theta+delta})]]^2}$$

	Radians	Degrees	
Theta =	0	0	
Beta =	0	0	
Delta =	0	0	
phi =	0.56	32	
Kv =	0.06		%g
Kh =	0.24		%g
gama =	120		pcf

psi = tan (kh/1-Kv) = 0.261

Cos^2 (phi-psi-theta) =	0.914	
Cos(psi)*cos^2(theta)*cos(psi+theta+delta) =	0.933	
Sin(phi+delta)*sin(phi-psi-beta) =	0.155	
cos(beta-theta)*cos(psi+theta+delta) =	0.966	
		pcf
Kae =	0.499	59.9
Ka =	0.307	36.9
delta Kae = Kae-Ka =	0.192	23.0

329-03 Nordahl Bridge
Bearing Capacity - RW1 and 2

qult = C Nc (Sc Dc) + 1/2 B W1 Ng (Sg Dg) + W2 D (Nq-1)(Sq Dq)

Cohesion C =	0 psf	0	0	0	0	0
Phi =	30 deg	30	30	30	30	30
Unit Weight W1 =	120 pcf	120	120	120	120	120
Unit Weight of soil above footing W2 =	120 pcf	120	120	120	120	120
Depth of Footing Below Adjacent Ground Df =	2 ft	2	2	2	2	4
Footing Width B =	2 ft	4	6	8	10	4
Footing Length L =	100 ft	100	100	100	100	100
Nc = (Nq-1) cot (phi) =	30.14	30.14	30.14	30.14	30.14	30.14
Ng = 2*(Nq+1)*tan(phi) =	22.40	22.40	22.40	22.40	22.40	22.40
Nq = (e^pi tan (phi)) (tan^2(45+phi/2) =	18.40	18.40	18.40	18.40	18.40	18.40
Shape Factors						
Sc = 1+(B/L)(Nq/Nc) =	1.01	1.02	1.04	1.05	1.06	1.02
Sg = 1-0.4(B/L) =	0.99	0.98	0.98	0.97	0.96	0.98
Sq = 1+(B/L) Tan (Phi) =	1.01	1.02	1.03	1.05	1.06	1.02
Depth Factors						
Dc = 1+0.4 Atan (D/B) =	1.31	1.19	1.13	1.10	1.08	1.31
Dg = 1 =	1.00	1.00	1.00	1.00	1.00	1.00
Dq = 1+2 tan (phi) (1-Sin (phi))^2 (atan (D/B) =	1.23	1.13	1.09	1.07	1.06	1.23
Gross Ultimate Bearing Pressure qult =	7,849 psf	10,135	12,594	15,087	17,573	15,773
Qult =	1,569,812 lbs	4,054,054	7,556,147	12,069,758	17,572,888	6,309,369
qallowable =	2,616 psf	3,378	4,198	5,029	5,858	5,258
Qallowable =	523,271 lbs	1,351,351	2,518,716	4,023,253	5,857,629	2,103,123

Riverside County

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PETRA

past + present + future
it's in our science

Engineers, Geologists
Environmental Scientists

February 11, 2011
J.N. 329-03

Mr. Andrew Sanford
SIMON WONG ENGINEERING, INC.
9968 Hibert Street, Suite 202
San Diego, California 92131

Subject: Report of Supplemental Foundation Exploration, Nordahl Road Overcrossing Replacement, Escondido, San Diego County, California – E.A. 11-259801

Dear Mr. Sanford:

Petra Geotechnical, Inc. (Petra) is pleased to submit this report of our supplemental drilling and exploration of the bedrock conditions at the south abutment foundation for the Nordahl Road Overcrossing Replacement project. Petra has provided a Foundation Report for the subject project in accordance with Caltrans standards (Petra, 2010). Pursuant to Caltrans' review of the report and geotechnical information, they requested that we perform additional field exploration to better examine the properties of the bedrock that will be encountered at the south abutment (Abutment 1). We have performed the additional field exploration activities and this letter provides the supplemental information obtained regarding in-situ bedrock properties.

Background Information

During our original exploration we encountered granitic bedrock at various locations throughout the project. At Abutment 1 the depth to bedrock encountered was approximately 30 feet below the existing ground surface. This necessitated the use of piles for support of the bridge foundation. During review of the project, Caltrans requested that continuous cores be obtained of the bedrock at this location to assist the construction contractor in determining the appropriate methods and equipment that would be required in order to drill the rock for the construction of the CIDH piles.

Previous exploration had been performed with a hollow stem auger drilling rig and samples were retrieved with a California modified soil sampler. Bedrock samples retrieved by this methodology were limited to the upper, more weathered zones of the bedrock. Previous strength testing was limited to direct shear testing of some of the granitic samples retrieved. Rock properties were estimated from the shear testing and from geophysical data obtained at the site. The retrieval of rock core has allowed Petra to perform point load testing of rock core samples to determine approximate unconfined compressive strength.

Supplemental Field Exploration

A rotary core hole, designated RC-11-1, was drilled immediately adjacent to the location of our boring A-11-10 on the west side of the southern abutment (Abutment 1). The bedrock was continuously cored, utilizing a mud-rotary coring rig, from the initial fill/bedrock contact at a depth of 30.5 feet below existing grade to a depth of 56 feet, approximately 20 feet below proposed pile tip elevation. Of the total coring interval of 25.5 feet, approximately 25 feet of 2.4-inch diameter core was retrieved. The rock description of the core is presented on the Log of Test Boring. Photographs of the rock core are attached letter. Core samples will be retained for future examination by the contractor.

Subsurface Soil and Bedrock Conditions

Earth materials exposed in the exploratory boring and cores included artificial fill and plutonic bedrock. A general description of each of these earth units is provided below.

- Fill – Artificial fills consisted of fine to coarse sand, silty sand, clayey sand and sandy clay which were brown, dark yellowish brown, dark reddish brown, greyish brown, brownish grey, grey, dark grey and black. These materials were slightly moist to very moist and loose to very dense/soft to very stiff. Soil descriptions were gleaned from previous boring A-10-11.

- Gabbro – This plutonic, igneous (intrusive) rock was dark grey, black and brown, medium- to coarse-grained, moderately hard to hard, moderately to highly weathered and moderately to intensely fractured. Iron oxidation and manganese staining was prevalent along joints and fractures. Very thin layers of clay were also present along some joints. Weathering decreased with depth.

- Tonolite – This plutonic, igneous (intrusive) rock was light gray, fine grained, hard to very hard, slightly weathered, slightly fractured and contained dark gray xenoliths. Minor manganese staining and clay was observed along a few joints and fractures.

Laboratory Testing

The nature of the retrieved bedrock core did not allow for the preferred unconfined compression testing. The jointing is very steep so continuous pieces that were retrieved were difficult to cut to the appropriate length at full diameter. We performed point load testing in lieu of the unconfined compression testing to correlate the unconfined compression strength of the intact rock matrix. Point load testing was carried out in accordance with the ASTM test method D5731-08. Samples of the bedrock are crushed between two steel points either lengthwise or crosswise to the core sample direction. The advantage with point load testing is that smaller samples can be tested. Point load strength is correlated with the unconfined compression strength through a correlation parameter K with the following equation $UCS = K * I_{50}$, see Rusnak and Mark. The K value for quartzite rock given by Singh and Singh (1993) matches with the general K value given in the ASTM procedure. We have chosen to use that conversion parameter given by the ASTM method.

A total of five point load tests were conducted with results of correlated unconfined compressive strength ranging from 3,670 psi to 7,220 psi. The results of the point load testing are summarized in attached Table 1.

Pile Design Modifications

Because of the weathered and fractured nature of the gabbro bedrock immediately below the fill contact and corresponding concerns about the uniformity of the basal surface of the CIDH pile excavation, Petra has modified the design calculation of the piles to be based on friction along the shaft instead of end bearing. The pile length will be longer than originally planned in order to allow for the full development of the capacity from friction only. Any pile capacity developed after construction from end bearing will add to the overall factor of safety of the design, thus resulting in a conservative design that should meet all project requirements for ultimate performance and ease of construction.

The allowable vertical load for CIDH piles may be derived using the methods described in the Caltrans Bridge Design Specifications (Caltrans, 2006). Capacities for CIDH piles at Abutment 1 are presented in the attached modified "Table 8" from our Foundation Report. Please note that the specified tip elevation has been changed.

Due to the type of abutment design, anticipated uplift loading will not occur on the CIDH piles, therefore we have not included values for uplift. Anticipated settlement for abutments founded on CIDH piles will be less than ½ inch.

Basis of Recommendations

The recommendations provided in this report are based on our understanding of the described project information and on our interpretation of the data collected during the subsurface exploration. We have made our recommendations based on experience with similar subsurface conditions under similar loading conditions. The recommendations apply to the specific project discussed in this report; therefore, changes in loads and/or walls or site grades should be provided to us so we may review our conclusions and recommendations and make necessary modification.

The recommendations provided in this report are also based on the assumption that representatives of Petra will perform the necessary geotechnical observations and testing during construction. The field observation services are considered a continuation of the geotechnical exploration to evaluate that the actual soil and bedrock conditions are as anticipated. This also provides for the procedure whereby Simon Wong Engineering, Inc. and the City are provided with an independent professional opinion regarding the geotechnical-related construction procedures. If another firm or agency were retained for the geotechnical observation services, our professional responsibility and liability would be limited to the extent that we would not be the geotechnical engineer of record.

We appreciate this opportunity to be of service. If you have questions, please contact this office.

Respectfully submitted,

PETRA GEOTECHNICAL, INC.

J. Montgomery Schultz, PE
Senior Project Engineer
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2/10/11

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JMS/JSO/GRW/kms

Attachments: Table 1 – Point Load Test Data
Table 8 (Modified) – CIDH Pile Capacities
Appendix A – Modified Log of Test Borings
Appendix B - Core Photographs
Appendix C – Pile Calculations

REFERENCES

American Society for Testing and Materials (ASTM) test method D5731-08.

California Department of Transportation (2006), Bridge Design Specifications, dated May.

Petra Geotechnical, Inc., 2010, *Foundation Report, Nordahl Road Overcrossing Replacement, Escondido, San Diego County, California – E.A. 11-259801, Bridge No. 57-1220, 11-SD-78-PM 15.4/15.5*, J.N. 329-03, October 13, 2010.

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Sing VK, Singh DP. Correlation Between Point Load Index and Compressive Strength for Quartzite Rocks. Geotechnical and Geological Engineering, 1993, 11, pp. 269-272.

Table 1
Point Load Test Data (ASTM D5731-08)

Specimen Number	Specimen Elevation (ft, msl)	Test Type	W (mm)	D (mm)	P (kN)	D_e^2 (mm^2)	D_e (mm)	I_s (MPa)	F	$I_{s(50)}$ (MPa)	K	σ_c (MPa)	σ_c (psi)
T-1	679±	b	40.6	38.1	4.28	2097	45.8	2.05	0.96	1.96	21	41.2	5970
T-2	671-672±	b	61.0	53.3	4.19	4142	64.4	0.97	1.13	1.10	23	25.3	3670
T-3	663±	b	36.6	43.2	5.90	3310	57.5	1.81	1.07	1.94	21	40.7	5900
T-4	661±	b	61.0	27.9	5.89	2168	46.5	2.72	0.96	2.62	19	49.8	7220
T-5	660±	d	-	61.0	3.75	3716	61.0	1.01	1.10	1.11	24.5	27.2	3940

Mean σ_c = 5340 psi

Notes:

Test Type: d – diametrical; a – axial; b – block; i – irregular lump
W - Specimen width
D – Distance between platen contact points
P – Failure load
D_e – Equivalent core diameter
I_s – Point load index
F – Size correction factor
$I_{s(50)}$ – Point load strength anisotrophy index
K – Index to compressive strength conversion factor
σ_c – Estimated compressive strength

Table 8 (Modified)
CIDH Pile Capacities

Location	Pile Type	Service-I Limit State Load (kips) per support	Cut-Off Elevation (feet)	Total Permissible Support Settlement (inches)	Required Factored Nominal Resistance (Strength Limit) Compression (kips) Phi = 0.7	Required Factored Nominal Resistance (Strength Limit) Tension (kips) Phi = 0.7	Required Factored Nominal Resistance (Extreme Event) Compression (kips) Phi = 1.0	Required Factored Nominal Resistance (Extreme Event) Tension (kips) Phi = 1.0	Design Tip Elevation[1] (feet, msl)	Specified Tip Elevation[2] (feet, msl)
Abutment No. 1	36 inch diameter CIDH	3700	704	1	400	0	570	0	674.5	674.5

Notes:

1. Design tip for both lateral design and compression
2. Pile-tip elevation based on 8 feet or more of penetration into granitic bedrock
3. Design load based on FS=2 for service load

APPENDIX A

MODIFIED LOG OF TEST BORINGS

PETRA

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO	TOTAL SHEETS
11	SD	78	15.5		

REGISTERED CIVIL ENGINEER 10-15-10 DATE

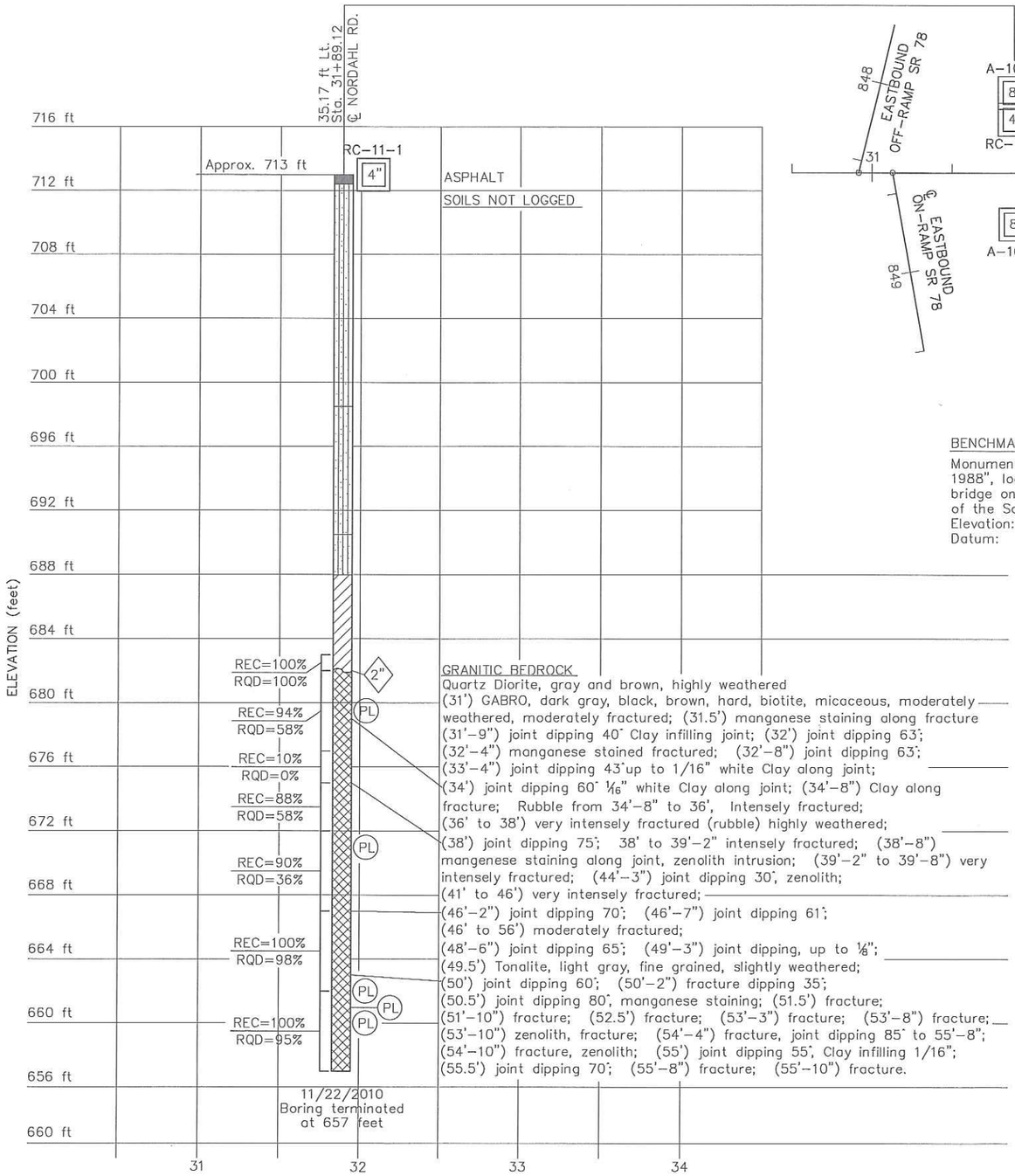
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER Montgomery Schultz No. C61144 Exp. 12/31/2012 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.

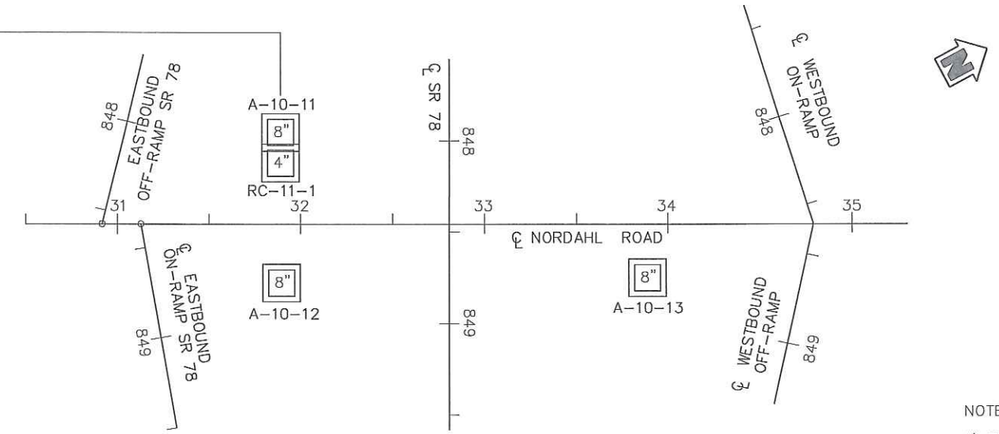
CITY OF ESCONDIDO
201 NORTH BROADWAY
ESCONDIDO, CA 92025

PETRA GEOTECHNICAL, INC.
3185-A AIRWAY AVENUE
COSTA MESA, CA 92626



GRANITIC BEDROCK
Quartz Diorite, gray and brown, highly weathered
(31') GABRO, dark gray, black, brown, hard, biotite, micaceous, moderately weathered, moderately fractured; (31.5') manganese staining along fracture
(31'-9") joint dipping 40° Clay infilling joint; (32') joint dipping 63°;
(32'-4") manganese stained fractured; (32'-8") joint dipping 63°;
(33'-4") joint dipping 43° up to 1/16" white Clay along joint;
(34') joint dipping 60° 1/16" white Clay along joint; (34'-8") Clay along fracture; Rubble from 34'-8" to 36', Intensely fractured;
(36' to 38') very intensely fractured (rubble) highly weathered;
(38') joint dipping 75°; 38' to 39'-2" intensely fractured; (38'-8") mangenese staining along joint, zenolith intrusion; (39'-2" to 39'-8") very intensely fractured; (44'-3") joint dipping 30°, zenolith;
(41' to 46') very intensely fractured;
(46'-2") joint dipping 70°; (46'-7") joint dipping 61°;
(46' to 56') moderately fractured;
(48'-6") joint dipping 65°; (49'-3") joint dipping, up to 1/8";
(49.5') Tonalite, light gray, fine grained, slightly weathered;
(50') joint dipping 60°; (50'-2") fracture dipping 35°;
(50.5') joint dipping 80°, manganese staining; (51.5') fracture;
(51'-10") fracture; (52.5') fracture; (53'-3") fracture; (53'-8") fracture;
(53'-10") zenolith, fracture; (54'-4") fracture, joint dipping 85° to 55'-8";
(54'-10") fracture, zenolith; (55') joint dipping 55°, Clay infilling 1/16";
(55.5') joint dipping 70°; (55'-8") fracture; (55'-10") fracture.

PROFILE
HOR. 1" : 40'
VER. 1" : 4'



PLAN
1" : 40'

BENCHMARK:
Monument is 2.24 inch CADT Brass Disk stamped "78-15.5 1988", located in sidewalk on the Southeast side of the bridge on Nordahl Road over Rte 78, 36.4 feet North of the South corner of the bridge.
Elevation: 714.128 feet
Datum: NAVD 1988

NOTES:

1) TEST BORINGS B-1 THROUGH B-13 WERE DRILLED UTILIZING A CME-55 DRILL RIG EQUIPPED WITH HOLLOW-STEM AUGER.

2) TEST BORINGS B-14 AND B-15 WERE DRILLED UTILIZING A LIMITED ACCESS, MINI MOLE DRILL RIG EQUIPPED WITH CONTINUOUS FLIGHT AUGER.

3) THE APPROXIMATE BORING COORDINATES AND ELEVATIONS ARE BASED ON THE TOPOGRAPHIC MAP PROVIDED BY DOKKEN ENGINEERING.

4) BORING RC-11-1 WAS DRILLED WITH A WIRELINE CONTINUOUS CORE OF NX SIZE.

5) BORING RC-11-1 DRILLED IMMEDIATELY ADJACENT TO BORING A-10-11. SEE A-10-11 FOR INFORMATION ON SOILS ABOVE BEDROCK CONTACT NOT LOGGED IN RC-11-1.

6) VISUAL CLASSIFICATION OF EARTH MATERIALS WAS BASED ON FIELD INSPECTION AND WAS CONFIRMED OR REVISED WITH LABORATORY TEST RESULTS.

7) THE BORING LOGS AND RELATED INFORMATION REPRESENT THE OPINION OF THE GEOLOGIST/ ENGINEER AS TO THE CHARACTER OF THE MATERIAL AT THE LOCATIONS SHOWN. SOIL AND GROUNDWATER CONDITIONS BETWEEN ADJACENT TEST BORINGS AND AT OTHER LOCATIONS MAY DIFFER FROM THOSE SHOWN. GROUNDWATER CONDITIONS MAY CHANGE WITH TIME.

8) THIS LOTB WAS PREPARED IN ACCORDANCE WITH THE CALTRANS SOIL AND ROCK LOGGING, CLASSIFICATION AND PRESENTATION MANUAL (2010).

DESIGN OVERSIGHT	DRAWN BY	N. Varadi	Jon Cain FIELD INVESTIGATION BY:	PREPARED FOR THE STATE OF CALIFORNIA DEPARTMENT OF TRANSPORTATION	Monty Schultz PROJECT ENGINEER	BRIDGE NO. 57-1220
SIGN OFF DATE	CHECKED BY	M. Schultz	DATE: 2011			POST MILES 15.5

NORDAHL ROAD OVERCROSSING REPLACEMENT

LOG OF TEST BORINGS 5A OF 8

GS CIVIL LOG OF TEST BORINGS SHEET (ENGLISH) (REV. 7/16/10)

ORIGINAL SCALE IN INCHES FOR REDUCED PLANS 0 1 2 3

UNIT: 2777
PROJECT NUMBER & PHASE: 11000002001 CONTRACT NO.: 11-259804

DISREGARD PRINTS BEARING EARLIER REVISION DATES

REVISION DATES 4-13-10 8-24-10 10-15-10 2011

SHEET 34A OF 37

FILE = ℄ $REQUEST

USERNAME = ℄ $USER DATE PLOTTED = ℄ $DATE TIME PLOTTED = ℄ $TIME

APPENDIX B

CORE PHOTOGRAPHS

PETRA

13
STANLEY

STANLEY

42'
46'

46'

51'
56'
NO. 79738 HQ DIV.

APPENDIX C

PILE CALCULATIONS

PETRA

APPENDIX C

Pile Calculations

329-03
Mondahl Bridge
Petra
1/26/11
Marty Schultz

Find average RQD in total for core in granite

Core From 30.5' → 56'

From 31-36' ⇒ 2.9'/5' = 58 %
36'→38' ⇒ 0/2' = 0 %
38'→41' ⇒ 1.75'/3' = 58 %
41'→46' ⇒ 1.83'/5' = 36 %
46'→51' ⇒ 4.92'/5' = 98 %
51'→56' ⇒ 4.75/5' = 95 %

Avg = 57.5 %

Find average spalling core lengths
⇒ 16.15'/25' = 64.6 %

From B.D.S. (4.6.5.3.1-2)
$C_m = \alpha_e C_o$
From B.D.S. (4.4.8.2.2-4
$\alpha_e = 0.231 (RQD) \geq 0.15 \Rightarrow \alpha_e = 0.17$

Point Load To Unconfined Compression Results (C_o) psi

PT4 = 5970
PT5 = 3940
PT6 = 5900
PT7 = 3670
PT9 = 7220
PT10 = 1130

Avg = 4638 psi

Find unconfined strength of rock mass C_m
⇒ $C_m = (0.17)(4638) = \boxed{788 \text{ psi}}$

329-03
Nordak Bridge
Petra
1/26/11
Monty Schultz

Find shaft frictional resistance & rock socket length for caissons at south abutment

From B.D.S. 4.6.5.3.1-1
$Q_{SR} = \pi B_r D_r (0.144 q_{SR})$

with C_u = 288 psi Figure 4.6.5.3.1A
$\Rightarrow q_{SR} \cong 78$ psi
B_r = Socket Diameter
D_r = Socket Length

Required Q_{SR} = 570 kips
Ignore Tip resistance due to possible construction defects
Ignore shaft resistance in overlying fill soils due to material incompatibility.
Any fill soil shaft friction gives extra F.S. (≅ 240 k)

$570 = \pi (3') D_r (0.144)(78)$
$\Rightarrow D_r = 105.9$ ksf/LF
$\Rightarrow 5.38'$

Tip from calculation would be at depth 36' in boring
From Review of core recommend Tip set at 38.5' in boring, Boring E13 718

$\boxed{\therefore \text{ New Tip El} = 674.5}$

Q_{SR} @ Tip El $\Rightarrow 8'(106$ ksf/LF$) \cong 850$ kips

329-03
Nordahl / Br.
PCTV a
1/2 6/11
Monty Schulze

Find Settlement For Shaft

From B.D.S. (4.6.5.5.2)

$$\rho_c = Q\left[\left(I_{ps}/B_r E_m\right) + \left(P_r/A E_c\right)\right]$$

$E_{concrete} = 4 \times 10^6$ psi

$E_{mass\ rock} = \alpha_e E_o$

From Figure 4.4.8.2.2A $E_o \doteq 1.0 \times 10^6$ psi

$E_m = 0.17(1.0 \times 10^6) = 1.7 \times 10^5$ psi

$\frac{E_c}{E_m} \doteq 23.5$

From Figure 4.6.5.5.2A $I_{ps} = 0.19$

$$\therefore \rho_c = 570{,}000\ \text{lb}\left[\left(0.19/36(1.7\times10^5)\right) + \left(96/(1018)(4\times10^6)\right)\right]$$

$= 3.11 \times 10^{-2}$ in

$\rho_r = 0.03$ in

Orange County / Environmental / Corporate

3185-A Airway Avenue
Costa Mesa, California 92626
T: 714-549-8921 F: 714-549-1438

San Diego County

12225 World Trade Drive, Suite P
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Riverside County

38655 Sky Canyon Drive, Suite A
Murrieta, California 92563
T: 951-600-9271 F: 951-600-9215

Los Angeles County

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Santa Clarita, California 91351
T: 661-255-5790 F: 661-255-5242

San Bernardino County

3535 Inland Empire Blvd., Suite 35
Ontario, California 91764
T: 909-941-2505 F: 909-941-2547

Desert Region

42-240 Green Way, Suite E
Palm Desert, California 92211
T: 760-340-5303 F: 760-340-5096

State of California
{PRIVATE }

Business, Transportation and Housing Agency

Memorandum

To : DIMITAR PEEV (MS 333)
Project Engineer
Project Development

Date: November 8, 2010

File: 11-SD-78
PM 15.3/R15.7
EA 11-259801

From : **DEPARTMENT OF TRANSPORTATION - DISTRICT 11**
PAVEMENT ENGINEERING SECTION

Subject: **STRUCTURAL SECTIONS RECOMMENDATIONS - Amended**

The Structural Section Recommendations for State Route 78 at Nordahl Road OC are submitted for this project. Calculations were based on a Traffic Index (TI) of 12.5 and a minimum design R-value (Rv) of 40. The Rv was determined from previous projects in the area.

The previous structural section recommendation provided by Petra Geotechnical Inc. on July 28, 2010 has been corrected for State Route 78 at Nordahl Road.

MAINLANE

TI = 12.5
Rv = 40

Alternate 1
0.65' HMA-A
1.20' AB–Class II

Shoulder

TI = 8.0
Rv = 40

Alternate 1
0.40' HMA-A
0.70' AB–Class II

Design Notes:

1) The grade of the asphalt binder for this project shall be PG 64-10.

2) The aggregate gradation for the HMA-A, dense-graded shall be ¾" maximum, coarse.

If you have questions with regards to this memorandum, please contact me at 858-467-4056 or FAX at 858-467-4063.

David Evans
District Pavement Engineer
District 11 Materials Lab

REGISTERED PROFESSIONAL ENGINEER
DAVID S. EVANS
No. C48245
Exp 6-30-12
CIVIL
STATE OF CALIFORNIA

cc: A Padilla (DME)
M Peinado (MS 330)
D Stebbins (MS 333)
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