FOR CONTRACT NO.: 05-0C3304

INFORMATIONAL HANDOUT

MATERIALS INFORMATION

FOUNDATION REPORT
Dated November 3, 2011

FOUNDATION REPORT ADDENDUM
CORROSION EVALUATION
Dated February 8, 2012

NATURALLY OCCURING ASBESTOS REPORT
Dated November 28, 2011

ROUTE: 05-SLO-46-4.1

State of California
DEPARTMENT OF' TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

Flex your power!
Be energy efficient!

To: MR. GARY JOE
Senior Bridge Engineer
Bridge Design Branch 12

Date: November 3, 2011

Attn: Ramon Reyes

File: 05-SLO-46-4.15
0500000018
Mueller's Slide
Soldier Pile Ground Anchor Wall
Br. No. TBD

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES – MS 5

Subject: Foundation Report

INTRODUCTION

Per your request, the Office of Geotechnical Design North (OGDN) is providing a Foundation Report (FR) for a soldier pile tieback retaining wall on State Route 46 at postmile 4.15 in San Luis Obispo County, California. The proposed 180 ft long tieback wall is intended to stabilize a landslide that has been a problem at this site for several years. The estimated maximum design wall height is 22 feet.

PERTINENT REPORTS AND INVESTIGATIONS

The following publications and plans were reviewed to assist in the assessment of site conditions:

1. Duffy, J., March 26, 2010, *Structures Preliminary Geotechnical Report (SPGR),* California Department of Transportation.
2. Beck, T.J., November 8, 2007, *Geotechnical Design report Update,* California Department of Transportation.

SITE DESCRIPTION AND GEOLOGY

California Route 46 at this site is a two-lane undivided highway paved with asphalt concrete. Lanes are 12 feet wide and the shoulders are 8 feet in width. This section of the roadway was built on a 15-foot thick fill just above Green Valley Creek.

The geologic unit at the project site is part of the Franciscan Formation. Regionally, the project area is comprised of weathered soft shale, graywacke and serpentine rocks. The shale forms a zone of structural weakness that is readily sheared.

SEISMICITY

Table 1 lists active and potentially active faults located in the project vicinity based on the *Caltrans Seismic Design Procedure 1.6 and the ARS online tool.*

Table 1. Active and potentially active faults

Fault Name	*Maximum Magnitude*	*Distance to Project Site (miles)*	*Fault Type*	*Peak Ground Acceleration (g)*
Oceanic Fault Zone	7.4	2.3	Reverse	0.49

Ground rupture hazard at the project location is considered low, as no known faults cross the site.

Liquefaction is a loss of soil strength and stiffness due to an increase in pore water pressure during cyclic loading, such as during an earthquake. Soils with liquefaction potential include loose cohesionless soils such as loose sands and gravels with 35 percent fines or less, and that have the potential of becoming saturated. Liquefaction potential at the project site is low, as on-site materials are generally cohesive or composed of rock.

CORROSION EVALUATION

The department considers a site to be corrosive to the foundation elements if the following conditions exist for the representative soil and/or water samples taken at the site: minimum resistivity of 1000 ohm-cm or less and/or PH of 5.5 or less. Samples were obtained during the subsurface investigation and tested for corrosion potential at the District Materials Laboratory. The results of the corrosion testing are presented in Table 2. Based upon the results of the corrosion testing, the site is considered corrosive and mitigation measures should be taken to provide protection to structure elements.

Table 2. Corrosion Testing Summary

Boring	*Depth (ft)*	*pH*	*Resistivity ohm-cm*	*Chloride ppm*	*Sulphate ppm*	*Corrosive*
B2-99	7.0	7.7	530	-	-	YES
B3-00	3.7	8.6	1000	-	-	YES

FIELD INVESTIGATION

Eight mud-rotary borings were drilled at the site to determine the subsurface conditions for construction of the proposed retaining wall. Four borings were drilled in 1999 and 2000, including two Slope Inclinometer installations that were used to determine the depth of the slide plane. Four borings were also drilled in September, 2011. Borings were located at the ends of the proposed wall, in the tieback zone, and in the body of the slide. An additional Slope Inclinometer

was installed in the body of the slide, but did not exhibit any movement prior to the issue of this report. Continued monitoring of the Slope Inclinometer will be performed throughout the winter.

Field mapping and observation of surface landslide features was performed to identify the aerial limits of the landslide. Historic maintenance reports and communications with maintenance personnel were also gathered to provide a history of the landslide as it pertains to the highway.

In-situ soil strength parameters were determined using the Standard Penetration Test (SPT) and pocket penetrometer for the soils overlying rock. Rock quality was generally poor and intact core samples were not available for testing. The Log of Test Boring sheets will be provided at a future date to be included in the project plans.

SLOPE STABILITY ANALYSIS

Slope stability analyses were performed using SLOPE-W 2007 and cross-section A-A' located on the site map. Figure 2 shows the output for the existing failure model using a fully specified failure surface and the Spencer method. This is a simplified three layer model in which strength parameters were back calculated for the basal shear zone with a piezometric groundwater surface based on field measurements to achieve a factor of safety of 1.0. Based on the subsurface exploration and slope inclinometer readings (Appendix A), the depth of movement at the wall layout line is approximately 22 feet, and is moving as a block slide near the contact with the Franciscan Melange. The residual strength parameters for the shear zone in the weathered and decomposed shale are Phi = 15 degrees, Cohesion = 0, Unit Weight = 132 pcf.

The ground anchor forces (lateral force) required to resist the landslide force were then evaluated per FHWA Geotechnical Engineering Circular No. 4 and BDS Section 5.5.5.7.1. The assumed design height was 22 feet, and groundwater surface at the bottom of the wall. A concentrated horizontal force (P_{TOTAL}) was applied at the wall face at the mid-point of the wall height. P_{TOTAL} was then increased in the stability analysis until the target factor of safety of 1.3 was achieved. The results of the stability analysis indicate that a total horizontal force of 18,000 pounds per foot (18 kips/ft) is required to stabilize the slope to a factor of safety of 1.3, as shown in Figure 3. No surcharges or seismic loadings were applied for this analysis.

GEOTECHNICAL DESIGN RECOMMENDATIONS

The recommended walls limits for the 180 foot long soldier pile ground anchor wall are shown on Figure 1. The following parameters are recommended for determining lateral earth pressures for tieback wall design assuming 1 or 2 levels of ground anchors and 8 foot pile spacing.

1. Maximum Design height = 22 feet (bottom of lagging)
2. P_{TOTAL} = 18 kips/foot of wall
3. Full drainage to bottom lagging

The recommended unbonded length of the ground anchors is 30 feet. The recommended ground anchor inclination is 20 degrees.

Table 3 outlines the recommendations for the soil and rock design parameters to be used for determining soldier pile design for the critical x-section at the maximum wall height. The recommended pile length is 35 feet for all the piling.

Table 3. Design Parameters

LAYER	APPROXIMATE THICKNESS (ft)[1]	TOTAL UNIT WEIGHT (pcf)	ANGLE OF INTERNAL FRICTION (degrees)	COHESION (c, psf)
(1) Sandy Clay with Cobbles and Boulders	15	117	22	50
(2) Weathered and Decomposed Shale	9	132	15	0
(3) Franciscan Melange	50	140	27	200

Notes: 1 – At maximum wall height (critical x-section)

It is recommended that the wall design be based P_{TOTAL} or from earth pressure theory per BDS Section 5.5.5.7.1, whichever produces the highest wall pressures. For wall design the groundwater elevation should be assumed to be at the base of the wall and full drainage should be provided to that elevation.

CONSTRUCTION CONSIDERATIONS

Caving conditions will likely be encountered during drilling for the piles and ground anchors due to the intensely fractured nature of the rock. Difficult drilling may be encountered due to the presence of cobbles and boulders in the upper clay material. Temporary casing, drilling under slurry, or placement of slurry cement backfill or concrete and re-drilling may be required to control caving and should be performed in conformance with the provisions in Section 49-4.03 "Drilled Holes," of the Standard Specifications.

Groundwater may be encountered in the pile and ground anchor holes. Pile and ground anchor installations may require dewatering or the placement of concrete and grout under water. If water is present and the holes are not dewatered, displacement of the water by means of a closed system using a concrete pump or tremie tube to place concrete and grout at the bottom of the holes will be required in conformance with the provisions in Section 51-1.10 "Concrete Deposited Under Water," of the Standard Specifications.

Drill fluid circulation was lost during drilling of exploratory borings and is interpreted to indicate the presence of cracks and voids in the subsurface materials. The potential for the loss of concrete and grout into voids should be expected. Controlling measures such as the use of a "grout sock," could greatly reduce the potential for grout loss.

Standard Special Provision S5-280, "Project Information", discloses to bidders and contractors a list of pertinent information available for their inspection prior to bid opening. The following is an excerpt from SSP S5-280 disclosing information originating from Geotechnical Services. Items listed to be included in the Information Handout will be provided in Acrobat (.pdf) format to the Addressee of this report via electronic mail.

Data and information attached with the project plans are:

A. Log of Test Borings.

Data and information included in the Information Handout provided to the Bidders and Contractors are:

A. Foundation Report for the Retaining Wall dated November 3, 2011.

Data and Information available for inspection at the District Office:

A. Borehole core samples.

The District Office is located at 50 Higuera Street, San Luis Obispo, California, 93401. Contact Ryan Turner at (805) 549-3750 to arrange core sample inspection.

If you have any questions or comments, please call James Morris at (530) 265-9867, Mike Finegan at (805) 549-3194, or Ryan Turner at (805) 549-3750.

REGISTERED PROFESSIONAL ENGINEER
Ryan Turner
No. C 73956
Exp. 6-30-2013
CIVIL
STATE OF CALIFORNIA

RYAN TURNER, PE
Transportation Engineer Civil
Geotechnical Design - North

REGISTERED PROFESSIONAL ENGINEER
Michael S. Finegan
No. C050138
Exp. 6-30-2013
CIVIL
STATE OF CALIFORNIA

REGISTERED PROFESSIONAL ENGINEER
JAMES E. MORRIS
No. CE036925
Exp. 6-30-12
CIVIL ENGINEER
STATE OF CALIFORNIA

MIKE FINEGAN, PE
Senior Transportation Engineer
Geotechnical Design - North

JAMES MORRIS, P.E.
Senior Materials and Research Engineer
Geotechnical Design - North

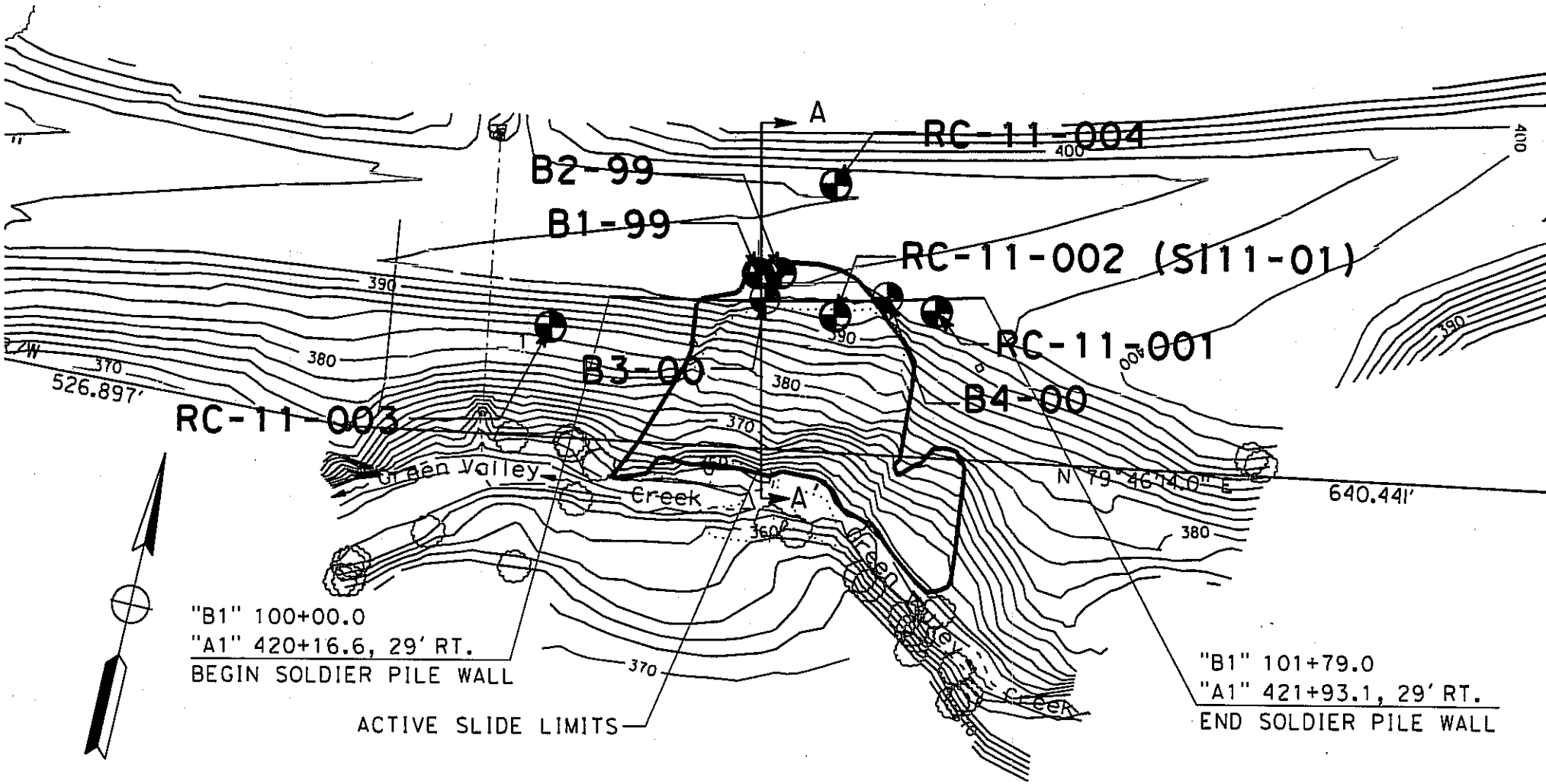
Attachments:

c: Roy Bibbens / GDN Records
Job File / Branch D Records
GS Corporate (email Mark_Willian@dot.ca.gov)
Structure Construction RE Pending File (email RE_pending_file@dot.ca.gov)
DES Office Engineer
Douglas Lambert / DME
Wesley Thompson/ District PE

LIST OF ATTACHMENTS

Site Map and Boring Layout	Figure 1
Slope Stability Analysis: Existing Landslide	Figure 2
Slope Stability Analysis: Retaining Wall	Figure 3

Site Map and Boring Layout



05-SLO-46.15
Mueller's Slide Soldier Pile Wall
0500000018

FIGURE1

...\Boring Locations.dgn 10/6/2011 3:42:10 PM

05-SLO-46-4.15
Mueller's Slide
0500000018

Back Analysis - Existing Failure

Exising Failure1.gsz
10/6/2011
3:59:34 PM

Factor of Safety = 1.01

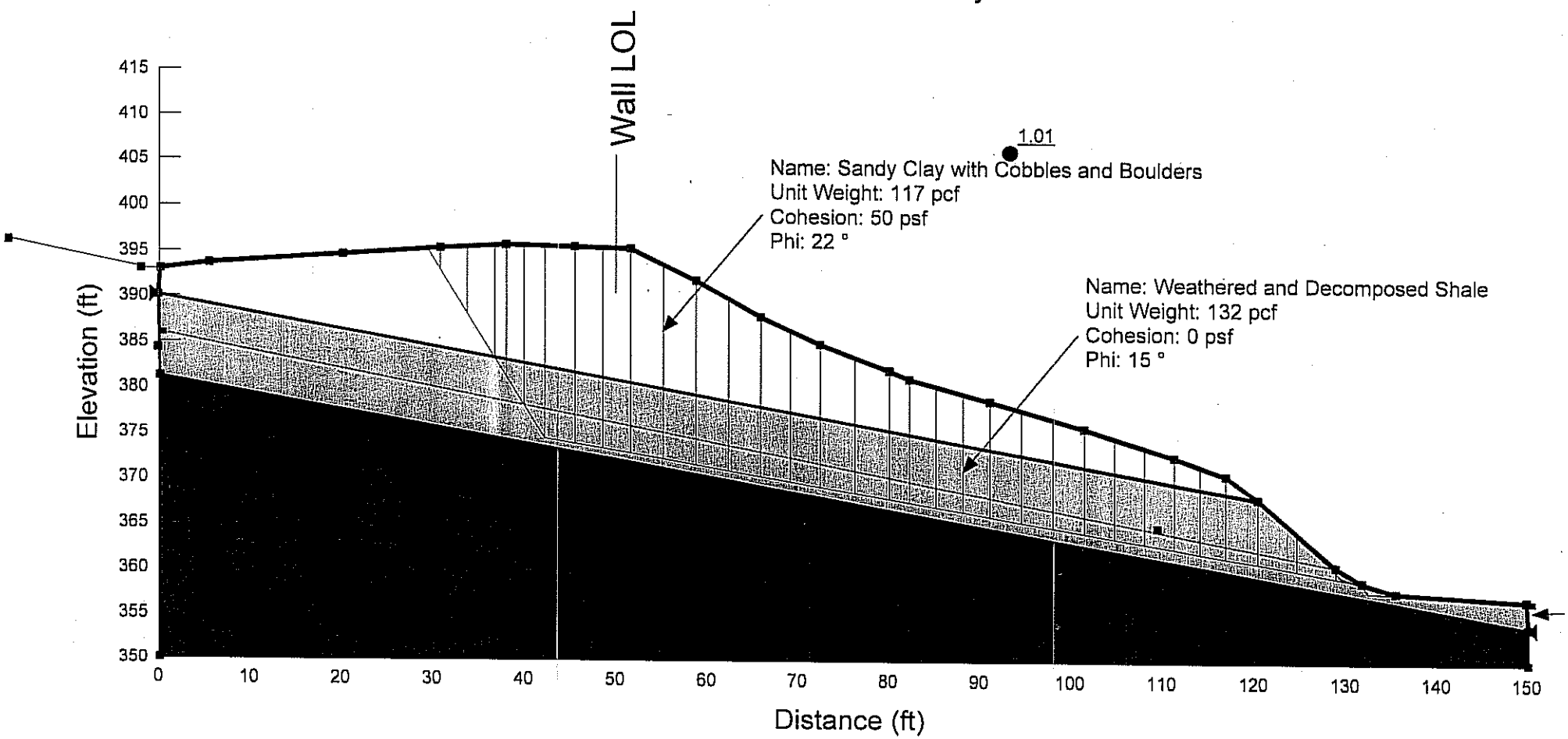


FIGURE 2

05-SLO-46-4.15
Mueller's Slide
0500000018

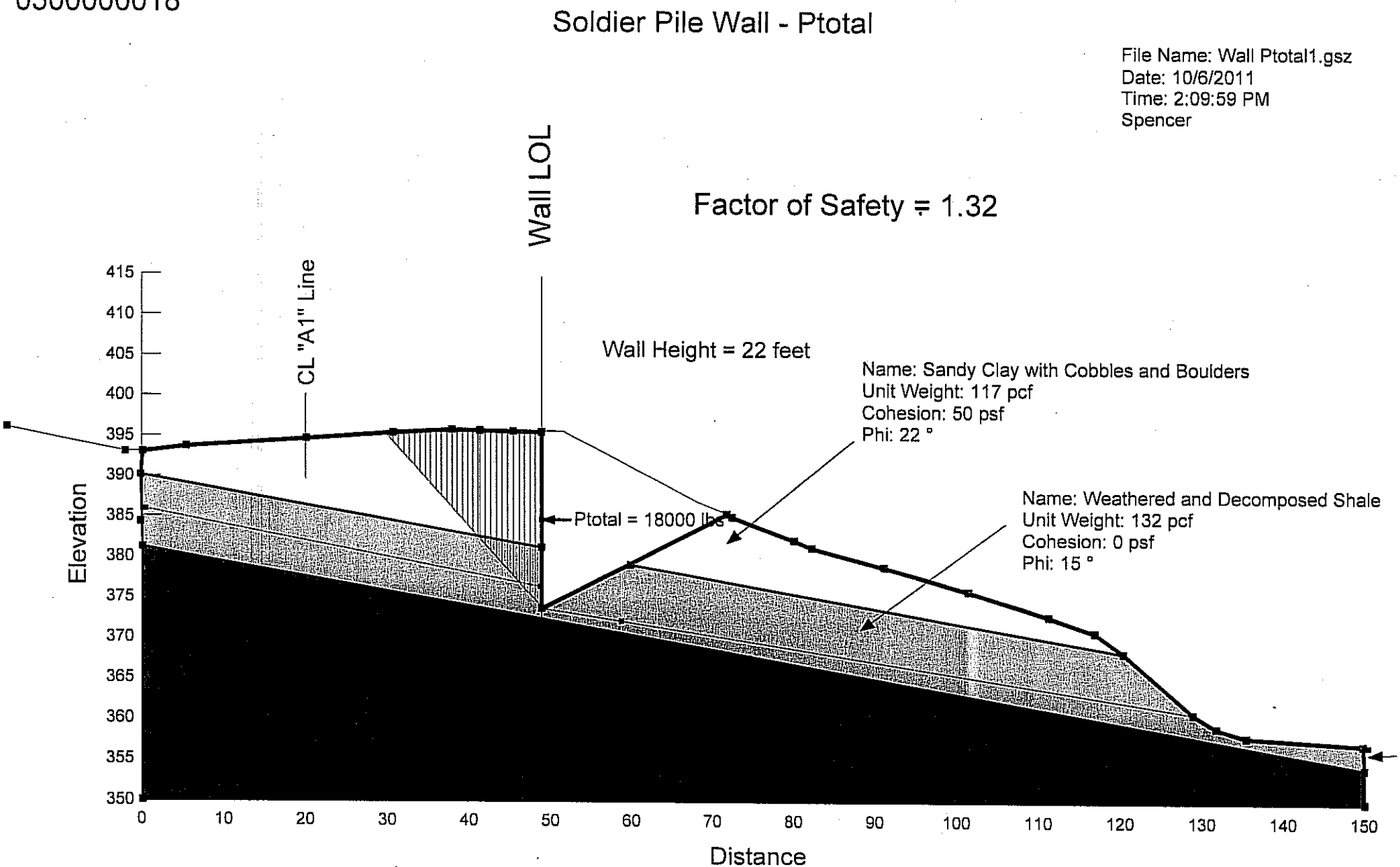


FIGURE 3

State of California

Memorandum

Business, Transportation and Housing Agency

Flex your power!
Be energy efficient!

To: MR GARY JOE
Structure Design Branch 12
DIVISION OF ENGINEERING SERVICES
STRUCTURE DESIGN

Attn: Rene Coria

Date: February 8, 2012
File: 05-SLO-46-4.15
Mueller Slide
Retaining Wall
EA 05-0C3301

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES

Subject: Foundation Report Addendum

CORROSION EVALUATION

Upon review of the corrosion recommendations in the Foundation Report dated November 3, 2011, it was discovered that chloride and sulphate testing results were not included in the corrosion summary table. Chloride and sulphate concentration testing was performed on the original samples collected in 1999 and 2000, and the results were on file with Materials Engineering and Testing Services. Table 1 summarizes the complete corrosion testing results. Based upon the laboratory test results, the site is not considered corrosive to foundation elements.

Table 1a. Corrosion Testing Summary

Boring	*Depth (ft)*	*pH*	*Resistivity ohm-cm*	*Chloride ppm*	*Sulphate ppm*	*Corrosive*
B2-99	7.0	7.7	530	330	120	NO
B3-00	3.7	8.6	1000	18	25	NO

If you have any questions or comments, please contact Ryan Turner at (805) 549-3750.

REGISTERED PROFESSIONAL ENGINEER
Ryan Turner
No. C 73956
Exp. 6-30-2013
CIVIL
STATE OF CALIFORNIA

Ryan Turner

RYAN TURNER, P.E.
Transportation Engineer Civil
Geotechnical Design – North
Branch D

c: James Morris/ OGDN
Rob Reis/ METS

Memorandum

Flex your power!
Be energy efficient!

To: MR. JIM TKACH

Date: November 28, 2011

Attn:

File: 05-SLO-46-4.15
0500000018
Mueller's Slide
Soldier Pile Ground Anchor Wall

From: **DEPARTMENT OF TRANSPORTATION**
DIVISION OF ENGINEERING SERVICES
GEOTECHNICAL SERVICES – MS 5

Subject: NOA Report

INTRODUCTION

Per your request, the Office of Geotechnical Design North (OGDN) is providing an assessment of the presence of NOA for a soldier pile tieback retaining wall on State Route 46 at postmile 4.15 in San Luis Obispo County, California. The proposed 180 ft long tieback wall is intended to stabilize a landslide that has been a problem at this site for several years. The estimated maximum design wall height is 22 feet.

PERTINENT REPORTS AND INVESTIGATIONS

The following publications and plans were reviewed to assist in the assessment of site conditions:

1. Serafini, D., July 18, 2001, *Preliminary Geotechnical Report (PGR),* California Department of Transportation.
2. Beck, T.J., November 8, 2007, *Geotechnical Design report Update,* California Department of Transportation.

SITE DESCRIPTION AND GEOLOGY

California Route 46 at this site is a two-lane undivided highway paved with asphalt concrete. Lanes are 12 feet wide and the shoulders are 8 feet in width. This section of the roadway was built on a 15 to 20 foot thick fill just above Green Valley Creek.

The geologic unit at the project site is part of the Franciscan Formation. Regionally, the project area is comprised of weathered soft shale, graywacke and serpentine rocks. The shale forms a zone of structural weakness that is readily sheared.

FIELD INVESTIGATION

Eight mud-rotary borings were drilled at the site to determine the subsurface conditions for construction of the proposed retaining wall. Four borings were drilled in 1999 and 2000, and

four borings were also drilled in September, 2011. Borings were located at the ends of the proposed wall, in the tieback zone, and in the body of the slide.

Field mapping and observation of surface landslide features was performed to identify area geology and the aerial limits of the landslide. Historic maintenance reports and communications with maintenance personnel were also gathered to provide a history of the landslide as it pertains to the highway.

In-situ soil samples were collected from Standard Penetration Tests (SPT) for the soils overlying rock. Rock samples were collected from diamond core drilling and sampling. Refer to the Log of Test Boring sheets for boring locations and data.

WALL DESIGN AND EXCAVATION REQUIREMENTS

Based on the subsurface exploration the depth of movement at the wall layout line is approximately 22 feet, and is moving as a block slide within the Franciscan meta-sediments and above the Franciscan basic and ultra basic rocks. Groundwater was also encountered at this contact. The wall height will be 22 feet extending from the sliding zone to the existing ground elevation. The wall will be founded on piles that will be 35 feet long extending 13 feet below the base of the wall. There will be two rows of tie back ground anchors. The recommended minimum length of the ground anchors is 30 feet on an inclination of 20 degrees below horizontal. Groundwater is expected to be encountered in the piles and the ground anchors.

NOA CONSIDERATIONS

The excavation required to construct the 22 foot high wall will not be in NOA bearing materials. The materials excavated will be imported fill and Franciscan meta-sedimentary rocks.

The foundation pile portions below the bottom elevation of the wall and the tie back ground anchors will encounter Franciscan serpentine and metamorphic rock. These rock types are classified as basic and ultra basic rock, rock types known to contain NOA.

No sampling has been performed to determine if NOA is present at this site. It is recommended that drilling the foundation pile portions below the bottom elevation of the wall and the tie back ground anchors be performed and the spoils managed as if the material contained NOA.

If you have any questions or comments, please call John Duffy at (805) 549-3663.

JOHN D DUFFY, PG, CEG
Senior Engineering Geologist
Geotechnical Design - North

Attachments:

C: RBibbens (E-copy)
GS File Room (email gs_file_room@dot.ca.gov)
RE – Charlie Hench
Structure Construction – Wayne Walker