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30 YEARS

Project No. E14145.000
9 July 2014

County of El Dorado
Department of Transportation
3000 Fair Lane
Placerville, California 95667

Attention: Mr. Matt Smelzer

Subject: **LATROBE ROAD REMEDIATION**
El Dorado County, California

Dear Mr. Smelzer,

Youngdahl Consulting Group, Inc. is pleased to present this report presenting the results of our forensic assessment for a portion of Latrobe Road where slope instability and retaining wall movement was identified. The purpose of this study was to evaluate the probable causes of the instability observed and prepare recommendations for mitigation. The scope of our study included a review of the existing gabion wall design prepared by the County of El Dorado, review of photos and documentation prepared during the wall construction operations, provide an opinion as to potential causes of the instability, and provide recommendations for slope and retaining wall repair.

Background

We understand that a section of Latrobe Road, extending approximately 3,400 feet north of Ryan Ranch Road, was reconstructed in August/September of 2013. The reconstruction generally consisted of roadway widening and some realignment. A gabion retaining wall was constructed to support a new sliver fill along a portion of the east side of Latrobe Road, north of Ryan Ranch Road, to accommodate the wider roadway.

We understand that the wall was constructed in late August and early September 2013. The gabion wall was constructed between Station 17+95 to Station 19+55 and ranges in height from 3 to 13½ feet. The gabion wall was positioned at the base of the original east roadway fill slope, with the back face of the gabion wall approximately 8 feet east of the new edge of pavement. The gabion wall system was constructed as a gravity stacked wall, consisting of a series of uniformly sized rock filled baskets founded directly on soil, with uniform baskets for the wall with either a 3 or 4½ foot width and either 1½ or 3 foot heights. Filter fabric appears to have been placed at the base of the wall and behind the baskets.

We understand that during the past few months, tension cracks have formed and soil separation was observed along the eastern edge of the roadway. Additionally, bulging of portions of the gabion retaining wall was observed by County personnel.

Site Description

We observed that the upper portion of the gabion retaining structure has rotated away from the roadway and the edge of the road has settled up to about 1½ feet adjacent to the tallest portion of the wall. It appears that observed conditions are generally confined to the outer roadway prism adjacent to the gabion wall.

Subsurface Conditions

Our field study included a site reconnaissance by a representative of our firm followed by a subsurface exploration program conducted on 5 and 6 June 2014. The exploration program included the advancement of 6 exploratory borings under the direction of our representative at the approximate locations shown on Figure A-2, Appendix A. A description of the field exploration program is provided in Appendix A.

Subsurface soil conditions along the roadway consisted of approximately 6 inches of asphalt underlain by 6 to 18 inches of aggregate baserock. These materials were underlain by FILL soils ranging in depth from 3½ to 10 feet below the roadway surface. The fill was composed of loose to medium dense clayey SAND and silty SAND and soft to medium stiff sandy CLAY and sandy SILT. The native soils beneath the fill consist of a thin layer medium dense to dense clayey SAND. These native materials were underlain by highly weathered metavolcanic bedrock.

A more detailed description of the subsurface conditions encountered during our subsurface exploration is presented graphically on the “Exploratory Test Boring Logs", Figures A-2 through A-8, Appendix A. These logs show a graphic interpretation of the subsurface profile, and the location and depths at which samples were collected. Cross-sections of the subsurface soils encountered and the adjacent wall conditions are depicted on Figures A-10 and A-11.

Groundwater Conditions

Groundwater conditions were not observed at drilled boring locations. Generally, subsurface water conditions vary in the foothill regions because of many factors such as, the proximity to bedrock, fractures in the bedrock, topographic elevations, and proximity to surface water. Some evidence of past repeated exposure to subsurface water may include black staining on fractures, clay deposits, and surface markings indicating previous seepage. Based on our experience in the area, at varying times of the year water may be perched on less weathered rock and/or present in the fractures and seems of the weathered rock.

Laboratory Testing

Laboratory testing of the collected samples was directed towards determining the physical and engineering properties of the soils underlying the site. A description of the tests performed for this project and the associated test results are presented in Appendix B. In summary, the following tests were performed for the preparation of this report:

Laboratory Test	Test Standard	Summary of Results	
Direct Shear (@ 90%)	ASTM D3080	Bulk 1:	Φ = 24.4°, c = 2,332 psf
Direct Shear (@ 95%)	ASTM D3080	Bulk 1:	Φ = 29.4°, c = 2,716 psf
Maximum Dry Density	Cal 216	Bulk 1:	WD = 139.2 pcf, MC = 12.4 %
Moisture Density Tests	ASTM D2937	See Boring Logs	

Review of Design Parameters

Strength of Soil and Unit Weight

We understand that the gabion wall design was performed by County of El Dorado Department of Transportation (EDCDOT) staff. It appears that the wall design soil parameters used for the design and stability analysis were assumed values since no laboratory testing was provided for our review. Based on the information provided to our firm, the assumed soil parameters included a frictional strength value of 34 degrees and a unit weight of 120 pcf. Additionally, a unit weight of 120 pcf was used for the gabion wall itself and underlying bedrock. The design documents indicate the wall design was evaluated with a surcharge load of 240 psf, located at the top of the slope (roadway), and without vehicle surcharge. The ascending design slopes behind the wall assessed included 3 degrees, 13 degrees, and 26 degrees. These angles correlate to gradients of 19H:1V (Horizontal:Vertical), 4⅓H:1V, and 2H:1V, respectively. Filter fabric was included in the design for the back of the retaining wall; however, calculations to include filter fabric on the base of the retaining wall foundation were only included for one section (12 feet height with a 26 degree backslope).

Direct shear testing of soil collected from our borings at the project site was performed to evaluate the suitability of the assumed design values used in the design of the gabion wall. The collected representative soils samples were evaluated for maximum density by California Test Method (CTM) 216 then remolded to 90 and 95 percent of the maximum density. For the remolded conditions, the direct shear test indicated that the soil has a frictional strength of 24.4 degrees and 29.4 degrees respectively. Additionally, cohesion values were approximately 2,332 psf and 2,716 psf, respectively.

Due to the size limitations of the device used for direct shear testing, the testing involves screening of the soil through the No. 4 sieve (0.187 inches); consequently, the effects of larger soil particles such as gravels are not accounted for in the test method. The larger particles are generally advantageous for increasing the frictional strength. Therefore, it is our opinion that the actual frictional strength value is likely between the values obtained in our laboratory testing and the assumed value of 34 degrees used in the design analysis by EDCDOT.

Design Analysis

Back calculations require the assumption of numerous parameters including an estimate of the frictional strength of the in-situ soil, unit weight of all materials and adequate drainage conditions. Because of these numerous variables, the presented back calculations could vary. Other sources of wall failure include eccentricity, unanticipated loading, and imperfect construction. Additionally, an increase in cohesion strength could provide a strength benefit to the soil so long as it does not become saturated.

For the purpose of back calculations, we evaluated the 12 foot wall section with a 26 degree backslope as designed, 240 psf surcharge, without a potential increase in cohesion strength, and with an increased bearing capacity to adjust for the size of the foundation. The resulting EDCDOT design for this retained height was a 4½ foot wide by 3 foot high base and a 3 foot wide by 9 foot tall wall. The results for various friction angles are provided below.

Design Result	**Friction Angle**					
	24 degrees	**26 degrees**	**28 degrees**	**30 degrees**	**32 degrees**	**34 degrees**
Sliding FS	0.62	0.74	1.18	1.40	1.66	1.97
Overturning FS	1.10	1.21	1.36	1.51	1.67	1.85
Eccentricity	1.95	1.67	1.34	1.08	0.85	0.63
Global Stability FS	0.81	1.00	1.08	1.18	1.27	1.37

We understand that Caltrans recommends a global (overall) stability minimum factor of safety (FS) of 1.3 for non-critical structures and 1.5 for critical structures. Based on the analyses performed by EDCDOT, the retaining wall was designed as a non-critical structure. As shown in the above table, the soil at the foundation and back of wall would need to have a minimal frictional strength of 34 degrees to satisfy global stability, but still had issues with eccentricity. When considering the cross section of wall used in this analysis, marginal to complete global instability occurs for frictional strengths of 28 degrees or less.

Safety Factor and Eccentricity

For general retaining wall design, eccentricity should be between 0 and B/6, where B is the width of the foundation. At numerous locations within the design calculations, the eccentricity of the retaining wall is negative, which indicates that the soil at the heel of the retaining wall can provide tensional strength; this strength condition is not a property of soils. Following discussions with Maccaferri, Inc., we understand that they suggest designing retaining walls to avoid negative eccentricity and be less than B/6.

Review of Wall Construction

Youngdahl was not present during roadway reconstruction; however, we understand that EDCDOT staff observed the gabion wall installation and backfill compaction efforts. The following comments and background information are based on a review of photos and documentation of the construction operations during retaining wall placement.

Implementation of Design and Compaction Testing

The photos show that compaction adjacent to the wall in the lower portions of the wall backfill was achieved using jumping jack style plate compactors. At an elevation of about 4 feet below the roadway surface, it appears that a lightweight vibratory sheepsfoot compactor was used for compaction efforts. We understand that the backfill materials consisted of reused excavation spoils. Additionally, the photos indicate that filter fabric was used at the base of the retaining wall; however, the design does not incorporate this fabric with the exception of 1 design location.

Three compaction tests were provided to be representative of the retaining wall backfill. The tests were obtained with a nuclear gauge using Caltrans test Method (CTM) 231. Test No. 3 was performed at Station 18+50, the test depth states “varies,” and a relative compaction of 92 percent of CTM 216 was reported. Test No. 8 was performed at Station 17+95, at a depth of 6 feet below finished grade, and a relative compaction of 93 percent of CTM 216 was reported. Test No. 11 was performed between Station 17+95 and 19+55, at a depth of 3 feet below finished grade, and a relative compaction of 95 percent of CTM 216 was reported.

The specified compaction indicates 90 percent on the density sheets. Section 19 of the standard Caltrans Specifications states that structural backfill shall be compacted to a relative compaction of not less than 95 percent and that structural backfill placed behind retaining walls be compacted to a relative compaction of not less than 90 percent *except for portions under any surfacing.*

Our laboratory testing of the moisture content and density of the underlying fill soils indicate relatively low densities of the fill mass. We suspect that some of the results may be erroneous due to the proximity of these samples to the active failure zone. Generally, the relative densities appear to be less than 90 percent of the maximum density even near the roadway centerline, well away from the failed slope.

Tying into Existing Construction
Due to space restrictions and the desire to maintain roadway traffic, keying and benching into the existing fill prism did not appear to be performed. Based on photos taken during construction by EDCDOT staff, it appears that a near vertical excavation into the eastern lane of the previous alignment for Latrobe Road was made to allow for wall construction. We suspect that stability of the new fill placement may be exacerbated due to this condition. The wall excavation appears stepped to accommodate for elevation changes along the retaining wall base. Numerous roots can be seen in the photos in the fill soils beneath the roadway.

It appears that the base of the wall was excavated into the slope of an existing sliver fill at depths of approximately 2 feet below the 2013 site grade. The angle of the photos makes it difficult to positively identify if the wall is founded below the base of the previously placed sliver fill; however, it does not appear in the photos that the wall was founded into weathered bedrock. The photos show that a horizontal gap (estimated to be about 1 foot) between the downslope wall face and the excavation was present during wall construction. Minor amounts of loose fill appear to have been cast over the slope descending from the wall excavation. Fills proposed to be placed in front of the wall provide passive and frictional resistance. If this void at the base of the wall was not filled with compacted engineered fill, then less resisting forces are available against sliding and rotation.

Compaction with hand held equipment is difficult, requiring very thin lifts and multiple passes. If less than prescribed compaction was achieved in either of these zones in front of or behind the wall, additional driving forces in the backfill and less resisting forces at the toe are present for stability.

Conclusions

Based on the results of our study it appears that the soil strength parameters used in design were greater than actual soil strength values obtained from laboratory testing of the on-site soils. This appears to have resulted in a gabion wall design that was under-designed for the actual site conditions. Additionally, even with the assumed soil design values, wall eccentricity was negative in several design sections, resulting in a wall configuration with an increased probability of rotational failure.

Based on the factors of safety at the lower shear strengths of the on-site soils, the failures could be a combination of global, overturning, and sliding. In our opinion, the primary mode of wall failure is rotational and appears to be related to the slender shape of the taller wall section.

Drainage on the roadway is also likely a contributing factor to the instability and may have been the initial trigger; there is no AC dike along the eastern edge of pavement and water flow appears to have concentrated and discharged behind the tallest portion of the wall where the failure occurred. We also suspect the lack of keying and benching into the existing fill slope and possible lack of compaction adjacent to the toe of the wall *may* have contributed to wall instability.

Recommendations

The existing gabion wall should be removed and reconstructed or the existing wall stabilized in place by alternative methods such as soil nailing. Recommendations for these alternatives are presented below:

Retaining Wall Reconstruction

Should wall reconstruction be considered, the gabion wall could be disassembled and restacked. Based on a redesign of a 12 foot section with a 26 degree backslope and a vehicle surcharge of 250 psf the base of the wall should be a minimum of 9 feet wide and each basket placed above the foundation should be a minimum of 6 feet wide and placed such that the inside portion of the wall is stepped from the back of the foundation (i.e. flat wall face). Additionally, filter fabric such as Mirafi 140NC should be placed at the base and back of the retaining wall. This new design uses the strength values (and associated laterals pressures) obtained from our laboratory testing and Gawacwin program by Maccaferri, Inc.

This alternative would allow for re-use of the baskets, although additional materials would be required, and could *possibly* be performed with County equipment and crews. We reviewed other retaining wall systems such as a concrete wall and sheet pile systems. Given the space restrictions and presence of shallow bedrock the use of a gravity gabion wall appears the most feasible and cost effective wall system. The major disadvantage to this approach is the requirement for additional materials, the time of reconstruction and the associated roadway closures. Only one section was provided above since we understand that this is not the preferred approach. If desired, additional sections can be produced under a separate design letter.

Soil Nailing

The use of soil nails is a common approach to increase the resisting forces of a failed soil mass. Nails consist of steel or fiberglass tendons that are inserted through the failed mass and extend beyond the failure plane. This repair system can be cost effective as the nails can be installed directly through the existing gabion structure without disassembly. This system has the advantage that construction can occur from the top down and construction occurs relatively rapidly, without wall reconstruction and total roadway closure. In this system there is no need to embed any structural element below the bottom of the excavation as required in soldier beams used in ground anchor walls. Additionally, the wall could be stabilized without needing to move the failed wall elements back into place.

For the Latrobe Road remediation the use of a traditional drilled or self drilling soil nail system may be considered. The following design recommendations are based on the results our laboratory testing and our review of the failure plane location using the laboratory derived soils strength values. Based on our analysis the soil nails should extend a minimum of 20 feet behind the back of the retaining wall or a minimum of 3 feet into competent bedrock, whichever is less. For design purposes, we recommend that the ultimate bond stresses for the soil nail design be based on cohesive soils with an ultimate unit bond stress of 10.0 psi. The ultimate pull out resistance of soil nails within the bedrock should be taken as not greater than 20 psi. Based on these values, we estimate the ultimate pull out strength of a single nail in soil to be approximately 564 lbs/ft of nail for 1½ inch diameter nails and 2,256 lbs/ft of nail for 6 inch diameter nails with grout.

The use of a mesh, composed of a high tensile strength steel wire, over the face of the existing wall to provide additional wall stability is recommended. Additionally, due to the exposed height of the retaining wall, the following seismic design parameters should be incorporated into the design:

ASCE 7-10	Design Parameter	Value
Figure 22-7	Maximum Considered Earthquake Geometric Mean (MCE_C) PGA	0.140g
Table 11.8-1	Site Coefficient F_{PGA}	1.200
Equation 11.8-1	$PGA_M = F_{PGA}\ PGA$	0.168g

In order to provide equipment access, we understand that a few alternatives have been considered. One alternative is to construct a bench between the retaining wall and the edge of the roadway. Construction of the bench would be anticipated to consist of removal of the existing soil materials above the retaining wall. We recommend that, following use for equipment access, the bench area be scarified, moisture conditioned, and recompacted to a minimum of 95 percent relative compaction. Additionally, backfill placed above the bench to reestablish the slope from the roadway to the retaining wall should consist of controlled density fill (CDF) with a minimum thickness of 3 inches measured perpendicular to the slope face. The CDF material should have a minimum of 282 lbs of cement per cubic yard (3 sack slurry). Soil nails may be installed through or prior to the placement of the CDF materials, depending on the contractor preference. The second alternative is to construct an access road below the existing gabion wall. If this alternative is selected, a portion of the fill slope above the retaining wall will still be recommended to be reconstructed due to disturbance resulting from the wall failure. We estimate this area to be generally 75 feet long between the shoulder and the top back of the retaining wall. Reconstruction of the slope is recommended to be similar to that as described above. Following this reconstruction of the disturbed slope areas, the CDF cap and final row of nails can be installed.

We understand that some of the guard rail may have been disturbed as a result of the wall failure. The final details for the repair of the guard rail remain the purview of the County.

An asphalt drainage curb is recommended to be constructed in front of the guard rail posts that would direct sheet flow drainage from the road down toward the nearest culvert crossing. Extension of the curb beyond the wall may be necessary with an AC curb as well as retrofit of the culvert pipe to accommodate a drop inlet. The final details for this curb and inlet are the purview of the County.

Final design and configuration for spacing and inclination angle should be based on the design prepared by the specialty contractor.

Prior to production, a minimum of two nails should be tested to at least 1.6 times the design load, not exceeding the yield strength of the anchor. Testing can be performed by tensioning with a test jack or by torque tensioning under the observation of the geotechnical engineer.

Limitations

1. This report has been prepared for the exclusive use of the County of El Dorado Department of Transportation and their consultants for specific application to the Latrobe Road project. Youngdahl Consulting Group, Inc. has endeavored to comply with generally accepted geotechnical engineering practice common to the local area. Youngdahl Consulting Group, Inc. makes no other warranty, expressed or implied.

2. As of the present date, the findings of this report are valid for the property studied. With the passage of time, changes in the conditions of a property can occur whether they be due to natural processes or to the works of man on this or adjacent properties. Legislation or the broadening of knowledge may result in changes in applicable standards. Changes outside of our control may cause this report to be invalid, wholly or partially. Therefore, this report should not be relied upon after a period of three years without our review nor should it be used or is it applicable for any properties other than those studied.

3. Section [A] 107.3.4 of the 2013 California Building Code states that, in regard to the design professional in responsible charge, the building official shall be notified in writing by the owner if the registered design professional in responsible charge is changed or is unable to continue to perform the duties.

   WARNING: Do not apply any of this report's conclusions or recommendations if the nature, design, or location of the facilities is changed. If changes are contemplated, Youngdahl Consulting Group, Inc. must review them to assess their impact on this report's applicability. Also note that Youngdahl Consulting Group, Inc. is not responsible for any claims, damages, or liability associated with any other party's interpretation of this report's subsurface data or reuse of this report's subsurface data or engineering analyses without the express written authorization of Youngdahl Consulting Group, Inc.

4. The analyses and recommendations contained in this report are based on limited windows into the subsurface conditions and data obtained from subsurface exploration. The methods used indicate subsurface conditions only at the specific locations where samples were obtained, only at the time they were obtained, and only to the depths penetrated. Samples cannot be relied on to accurately reflect the strata variations that usually exist between sampling locations. Should any variations or undesirable conditions be encountered during the development of the site, Youngdahl Consulting Group, Inc. will provide supplemental recommendations as dictated by the field conditions.

5. The recommendations included in this report have been based in part on assumptions about strata variations that may be tested only during earthwork. Accordingly, these recommendations should not be applied in the field unless Youngdahl Consulting Group, Inc. is retained to perform construction observation and thereby provide a complete professional geotechnical engineering service through the observational method. Youngdahl Consulting Group, Inc. cannot assume responsibility or liability for the adequacy of its recommendations when they are used in the field without Youngdahl Consulting Group, Inc. being retained to observe construction. Unforeseen subsurface conditions containing soft native soils, loose or previously placed non-engineered fills should be a consideration while preparing for the grading of the property. It should be noted that it is the responsibility of the owner or his/her representative to notify

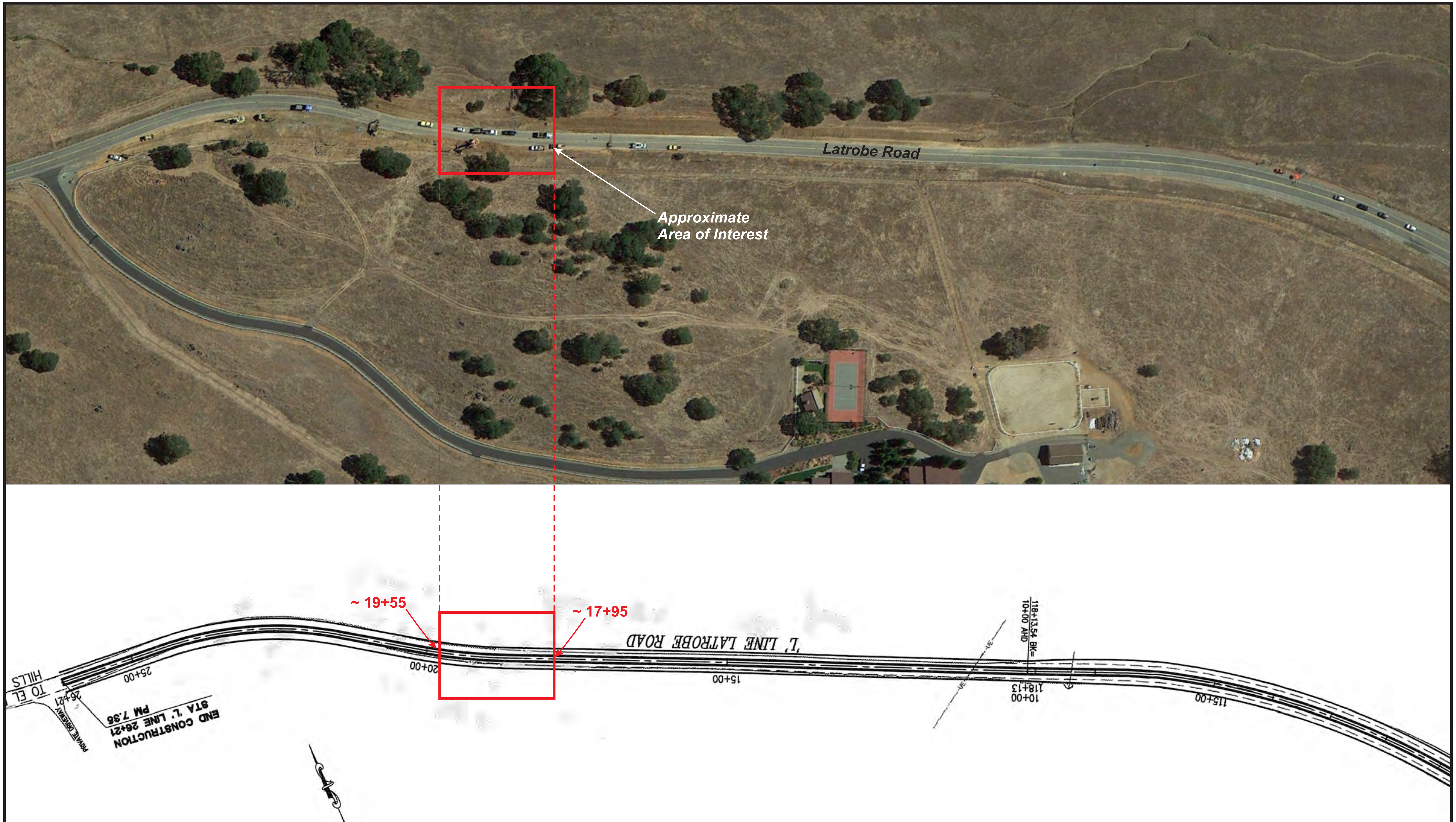
Youngdahl Consulting Group, Inc., in writing, a minimum of 48 hours before any excavations commence at the site.

Should you have any questions or require additional information, please contact our office at your convenience.

Very truly yours,
Youngdahl Consulting Group, Inc.

Martha A. McDonnell

Martha A. McDonnell, P.E.
Associate Engineer



REFERENCE: *Latrobe Road North Of Ryan Ranch Road, El Dorado County Department Of Transportation Sheet EC-1, Dated 3/22/13*

0 75 150 300

Approximate Scale: 1" = 150'

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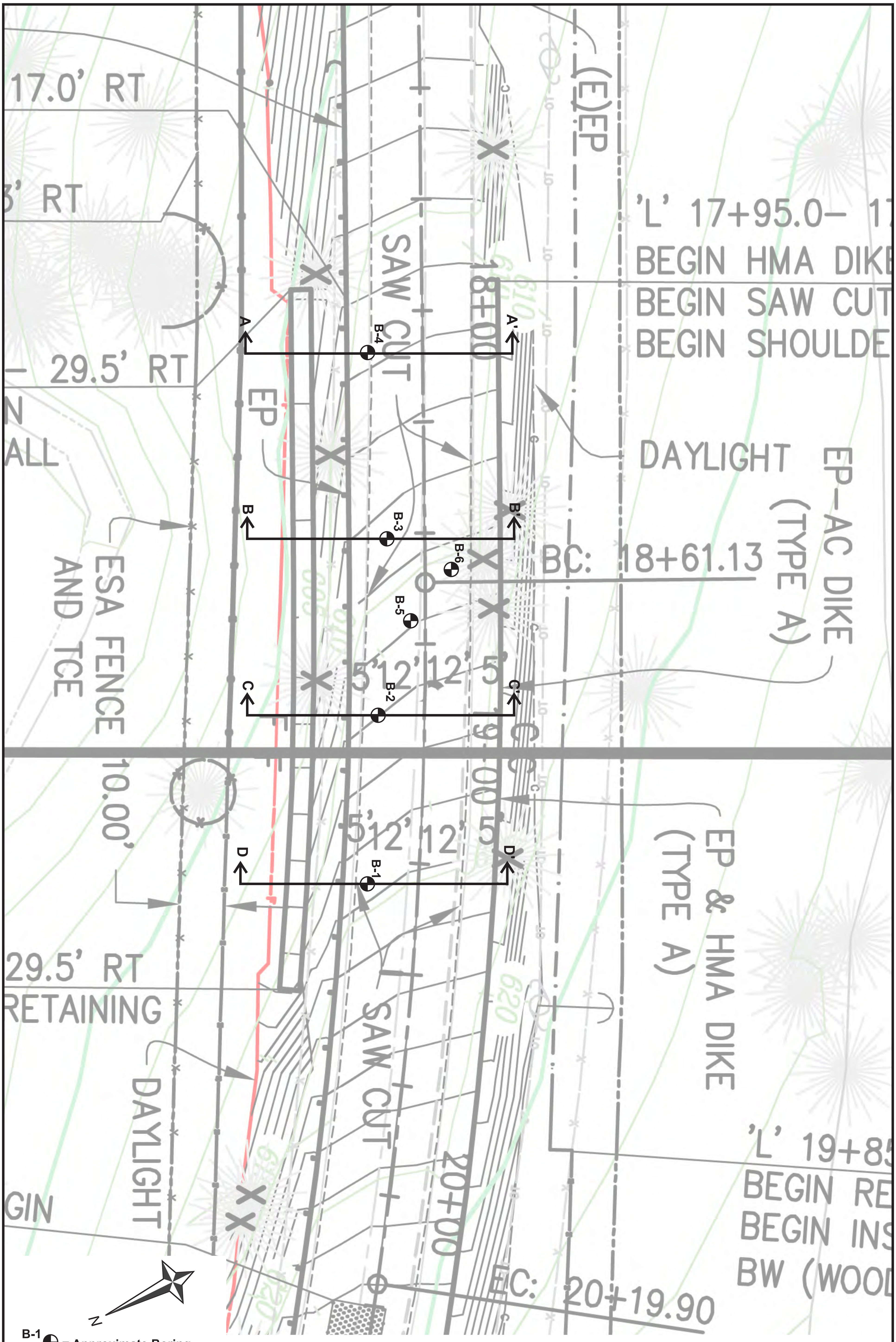
VICINITY MAP

Latrobe Road Remediation
El Dorado Hills, California

FIGURE
A-1



REFERENCE: *Latrobe Road North Of Ryan Ranch Road, El Dorado County Department Of Transportation Sheet L-1, Dated 3/22/13*

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SITE PLAN

Latrobe Road Remediation
El Dorado Hills, California

FIGURE
A-2

Logged By: **DHR**	Date: **5 June 2014**	Elevation: **~ 614.7'**	Boring No. **B-1**
Equipment: **CME - 55**		Station: **19 + 30**	

Depth (Feet)	Graphic Log	Ground Water	Geotechnical Description & Unified Soil Classification	Sample	Blow Count	Dry Density (pcf)	Moisture Content (%)	Tests & Comments
			Asphalt					
			Aggregate Base (AB)					
1			Red brown clayey **SAND (SC)** with few gravel, loose, moist (FILL)					
2								
3								
					10	97.1	10.5	
4								
			Red brown clayey **SILT (ML)** with trace gravel, soft to medium stiff, moist (FILL)					
5								
					22	104.8	15.1	
6								
7			Red brown clayey **SAND (SC)** with trace gravel, medium dense to dense, dry to moist (FILL)					
8								
					79	114.9	12.7	
9								
10			Light brown clayey **SAND (SC)** with trace gravel, medium dense to dense, moist (NATIVE)					
11			Light brown metavolcanic **BEDROCK**, highly weathered, closely fractured, weakly indurated, dry					
					77/12"			
12			*Grades moderately weathered, moderately indurated*					
					50/3.5"			
13			Boring terminated at 13' No free groundwater encountered					
14								
15								

Note: The boring log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at the sampling locations. Note, too, that the passage of time may affect conditions at the sampling locations.

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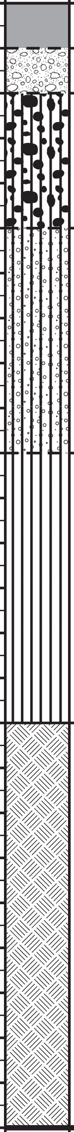
EXPLORATORY BORING LOG

Latrobe Road Remediation
El Dorado Hills, California

FIGURE
A-3

Logged By: **DHR**	Date: **5 June 2014**	Elevation: **~ 611.9'**	Boring No.
Equipment: **CME - 55**		Station: **18 + 90**	**B-2**



Depth (Feet)	Graphic Log	Ground Water	Geotechnical Description & Unified Soil Classification	Sample	Blow Count	Dry Density (pcf)	Moisture Content (%)	Tests & Comments
			Asphalt **Aggregate Base (AB)**					
1			Red brown silty **GRAVEL (GM)** with sand, dense, moist (FILL)					
2								
3			Red brown silty **SAND (SM)** with trace clay and few gravel, soft, dry to moist (FILL) *Grades yellow brown, with trace gravel*					
4					7	105.2	15.9	
5			Dark brown sandy **SILT (ML)** with trace clay and few gravel, soft, dry (FILL)					
6			*Grades yellow brown with trace gravel*		19	108.1	11.2	
7								
8			Orange brown metavolcanic **BEDROCK**, highly weathered, closely fractured, weakly indurated, dry *Grades moderately indurated*					
9					69	100.7	19.2	
10					50/6"			*No Sample*
11								
12								
13			Boring terminated at 12.5' No free groundwater encountered					
14								
15								

Note: The boring log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at the sampling locations. Note, too, that the passage of time may affect conditions at the sampling locations.

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EXPLORATORY BORING LOG

Latrobe Road Remediation
El Dorado Hills, California

FIGURE
A-4

Logged By: **DHR**	Date: **5 June 2014**	Elevation: **~ 609.4'**	Boring No. **B-3**
Equipment: **CME - 55**		Station: **18 + 51**	

Depth (Feet)	Graphic Log	Ground Water	Geotechnical Description & Unified Soil Classification	Sample	Blow Count	Dry Density (pcf)	Moisture Content (%)	Tests & Comments
			Asphalt					
1			**Aggregate Base (AB)**					
2			Brown sandy **SILT (ML)** with trace clay and few gravel, soft, dry to moist (FILL)					
3								
4			*Grades dark brown, with few clay*		11	101.8	16.2	
5								
6			*Grades with rock fragments*		27	98.0	11.4	
7								
8			Dark red brown sandy **CLAY (CL)** with trace gravel, very stiff dry to moist (NATIVE)					
9			Yellow brown metavolcanic **BEDROCK**, highly weathered, closely fractured, weakly indurated, dry		91			
10			*Grades moderately indurated*					
11								
12			Boring terminated at 11.5' No free groundwater encountered					
13								
14								
15								

Note: The boring log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at the sampling locations. Note, too, that the passage of time may affect conditions at the sampling locations.

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EXPLORATORY BORING LOG

Latrobe Road Remediation
El Dorado Hills, California

FIGURE **A-5**

Logged By: **DHR**	Date: **5 June 2014**	Elevation: **~ 606.8'**	Boring No. **B-4**
Equipment: **CME - 55**		Station: **18 + 10**	

Depth (Feet)	Graphic Log	Ground Water	Geotechnical Description & Unified Soil Classification	Sample	Blow Count	Dry Density (pcf)	Moisture Content (%)	Tests & Comments
			Asphalt					**Bulk 1** East Shoulder Station ~18+00
1			**Aggregate Base (AB)**					
2			Dark brown sandy **CLAY (CL)** with trace asphalt and fine roots, soft, moist (FILL)					
3								
4			Red brown sandy **SILT (ML)** with trace gravel and trace fine roots, soft, moist (FILL)		10	102.8	18.0	
5			Red gray metasedimentary **BEDROCK**, highly weathered, thinly bedded, weakly indurated, with manganese and iron oxide staining, dry					
6					78			
7			*Grades moderately indurated*					
8					50/6"			*No Sample*
9								
10								
11			Boring terminated at 11' No free groundwater encountered					
12								
13								
14								
15								

Note: The boring log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at the sampling locations. Note, too, that the passage of time may affect conditions at the sampling locations.

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Project No.:
E14145.000

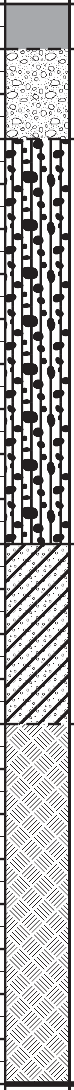
June 2014

EXPLORATORY BORING LOG

Latrobe Road Remediation
El Dorado Hills, California

FIGURE
A-6

Logged By: **DHR**	Date: **5 June 2014**	Elevation: **~ 610'**	Boring No. **B-5**
Equipment: **CME - 55**		Station: **18 + 70**	



Depth (Feet)	Graphic Log	Ground Water	Geotechnical Description & Unified Soil Classification	Sample	Blow Count	Dry Density (pcf)	Moisture Content (%)	Tests & Comments
			Asphalt					
1			**Aggregate Base (AB)**					
2			Yellow brown silty **GRAVEL (GM)** with trace clay and trace sand, medium dense, dry to moist (FILL)					
4					26	91.1	13.3	
5			*Grades dark brown*					
6			Yellow brown clayey **SAND (SC)**, medium dense, dry to moist (FILL)		31	106.5	10.2	
8			Yellow gray metasedimentary **BEDROCK**, highly weathered, closely fractured, weakly indurated, dry					
9					50/6"			
10			*Grades moderately weathered, moderately indurated*					
12			Boring terminated at 12' No free groundwater encountered					
13								
14								
15								

Note: The boring log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at the sampling locations. Note, too, that the passage of time may affect conditions at the sampling locations.

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June 2014

EXPLORATORY BORING LOG

Latrobe Road Remediation
El Dorado Hills, California

FIGURE
A-7

Logged By: **DHR**

Date: **5 June 2014**

Elevation: **~ 610.5'**

Boring No. **B-6**

Equipment: **CME - 55**

Station: **18 + 59**

Depth (Feet)	Graphic Log	Ground Water	Geotechnical Description & Unified Soil Classification	Sample	Blow Count	Dry Density (pcf)	Moisture Content (%)	Tests & Comments
	▇		**Asphalt**					
1	░		**Aggregate Base (AB)**					
2	●		Yellow brown silty **GRAVEL (GM)** with trace asphalt, medium dense, dry to moist (FILL)					
3	●			▯				
4	▨		Yellow gray metasedimentary **BEDROCK**, moderately weathered, closely fractured, moderately indurated, dry	▯	105	85.2	10.3	
	▨		*Grades indurated*	▯				
5			Boring terminated at 5' No free groundwater encountered		58/6"			*No Sample*
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								

Note: The boring log indicates subsurface conditions only at the specific location and time noted. Subsurface conditions, including groundwater levels, at other locations of the subject site may differ significantly from conditions which, in the opinion of Youngdahl Consulting Group, Inc., exist at the sampling locations. Note, too, that the passage of time may affect conditions at the sampling locations.

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EXPLORATORY BORING LOG

Latrobe Road Remediation
El Dorado Hills, California

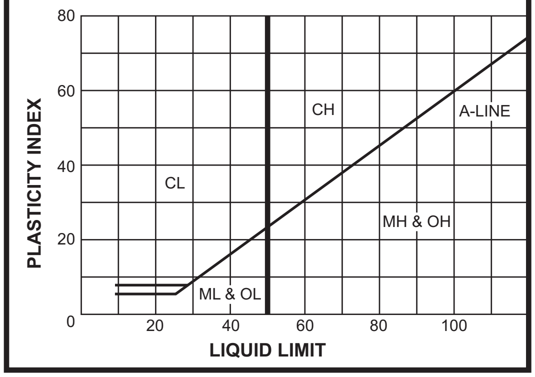
FIGURE
A-8

UNIFIED SOIL CLASSIFICATION SYSTEMS

MAJOR DIVISION			SYMBOLS	TYPICAL NAMES
COARSE GRAINED SOILS Over 50% > #200 sieve	**GRAVELS** Over 50% > #4 sieve	Clean **GRAVELS** With Little Or No Fines	GW	Well graded **GRAVELS**, **GRAVEL-SAND** mixtures
			GP	Poorly graded **GRAVELS**, **GRAVEL-SAND** mixtures
		GRAVELS With Over 12% Fines	GM	Silty **GRAVELS**, poorly graded **GRAVEL-SAND-SILT** mixtures
			GC	Clayey **GRAVELS**, poorly graded **GRAVEL-SAND-CLAY** mixtures
	SANDS Over 50% < #4 sieve	Clean **SANDS** With Little Or No Fines	SW	Well graded **SANDS**, gravelly **SANDS**
			SP	Poorly graded **SANDS**, gravelly **SANDS**
		SANDS With Over 12% Fines	SM	Silty **SANDS**, poorly graded **SAND-SILT** mixtures
			SC	Clayey **SANDS**, poorly graded **SAND-CLAY** mixtures
FINE GRAINED SOILS Over 50% < #200 sieve	**SILTS & CLAYS** Liquid Limit < 50		ML	Inorganic **SILTS**, silty or clayey fine **SANDS**, or clayey **SILTS** with plasticity
			CL	Inorganic **CLAYS** of low to medium plasticity, gravelly, sandy, or silty **CLAYS**, lean **CLAYS**
			OL	Organic **CLAYS** and organic silty **CLAYS** of low plasticity
	SILTS & CLAYS Liquid Limit > 50		MH	Inorganic **SILTS**, micaceous or diamacious fine sandy or silty soils, elastic **SILTS**
			CH	Inorganic **CLAYS** of high plasticity, fat **CLAYS**
			OH	Organic **CLAYS** of medium to high plasticity, organic **SILTS**
HIGHLY ORGANIC CLAYS			PT	PEAT & other highly organic soils

PLASTICITY CHART

USED FOR CLASSIFICATION OF FINE GRAINED SOILS



SAMPLE DRIVING RECORD

BLOWS PER FOOT	DESCRIPTION
25	25 Blows drove sampler 12 inches, after initial 6 inches of seating
50/7"	50 Blows drove sampler 7 inches, after initial 6 inches of seating
50/3"	50 Blows drove sampler 3 inches during or after initial 6 inches of seating

Note: To avoid damage to sampling tools, driving is limited to 50 blows per 6 inches during or after seating interval.

SOIL GRAIN SIZE

U.S. STANDARD SIEVE 6" 3" ¾" 4 10 40 200

BOULDER	COBBLE	GRAVEL		SAND			SILT	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

SOIL GRAIN SIZE IN MILLIMETERS 150 75 19 4.75 2.0 .425 0.075 0.002

KEY TO PIT & BORING SYMBOLS

⧄	Standard Penetration test
◫	2.5" O.D. Modified California Sampler
▥	3" O.D. Modified California Sampler
▮	Shelby Tube Sampler
⊡	2.5" Hand Driven Liner
🛍	Bulk Sample
▽	Water Level At Time Of Drilling
▼	Water Level After Time Of Drilling
P ▽	Perched Water

KEY TO PIT & BORING SYMBOLS

┳	Joint
▼	Foliation
∿	Water Seepage
NFWE	No Free Water Encountered
FWE	Free Water Encountered
REF	Sampling Refusal
DD	Dry Density (pcf)
MC	Moisture Content (%)
LL	Liquid Limit
PI	Plasticity Index
PP	Pocket Penetrometer
UCC	Unconfined Compression (ASTM D2166)
TVS	Pocket Torvane Shear
EI	Expansion Index (ASTM D4829)
Su	Undrained Shear Strength

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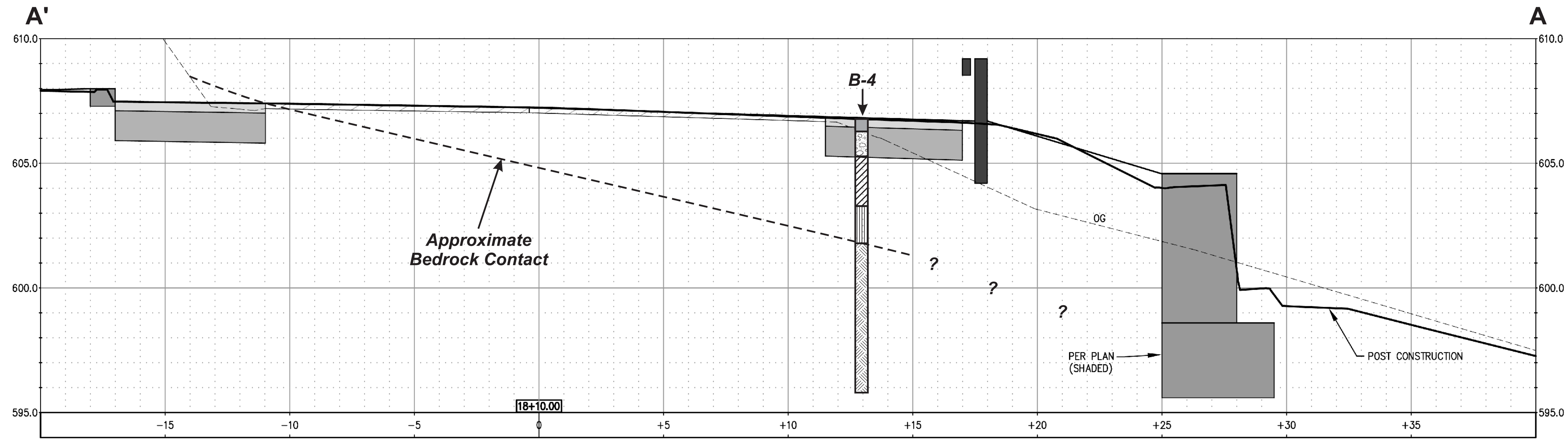
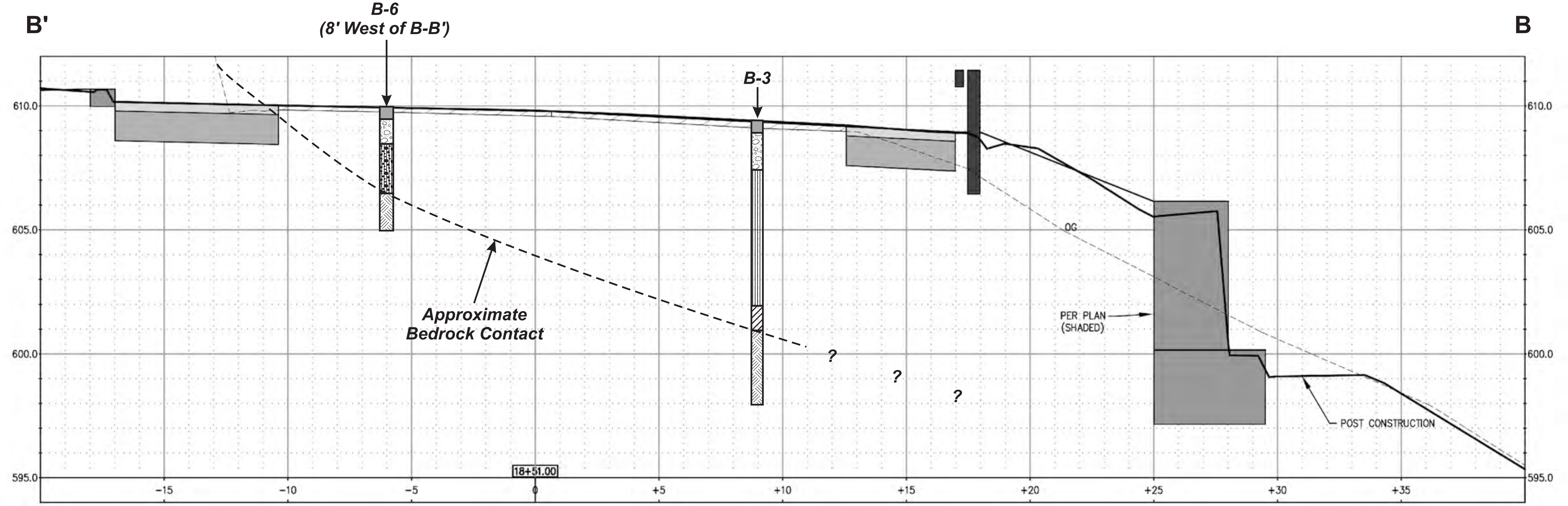
SOIL CLASSIFICATION CHART AND LOG EXPLANATION
Latrobe Road Remediation
El Dorado Hills, California

FIGURE
A-9





Approximate Scale: 1" = 5' Horizontal
1" = 5' Vertical

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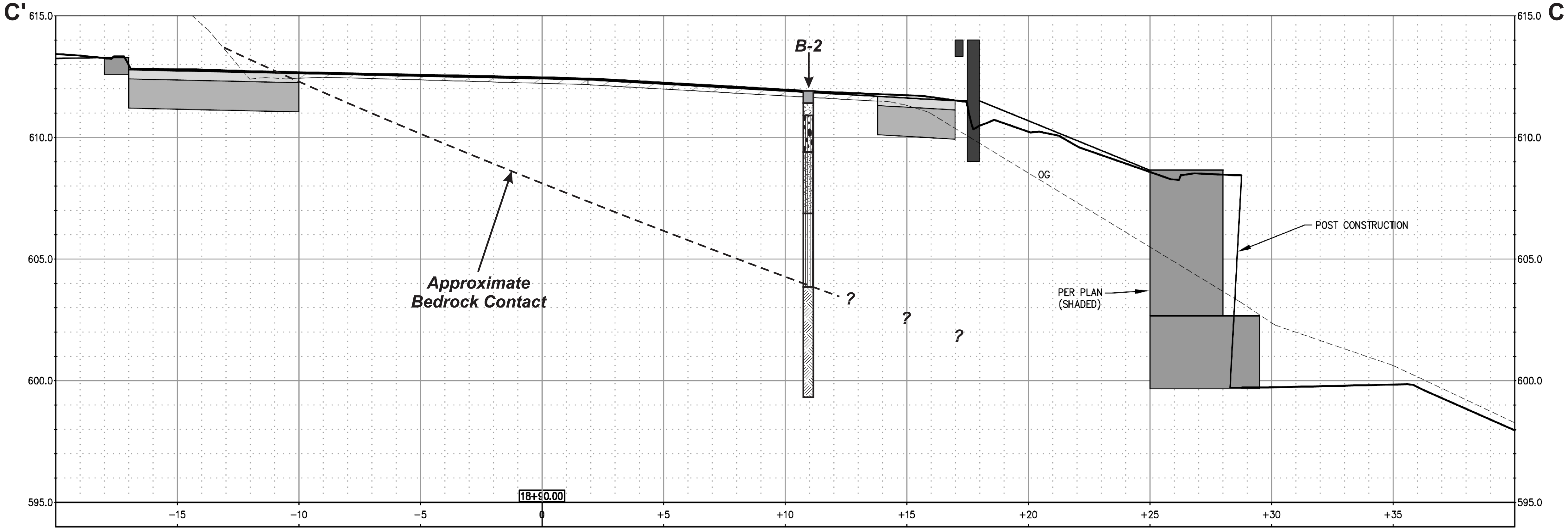
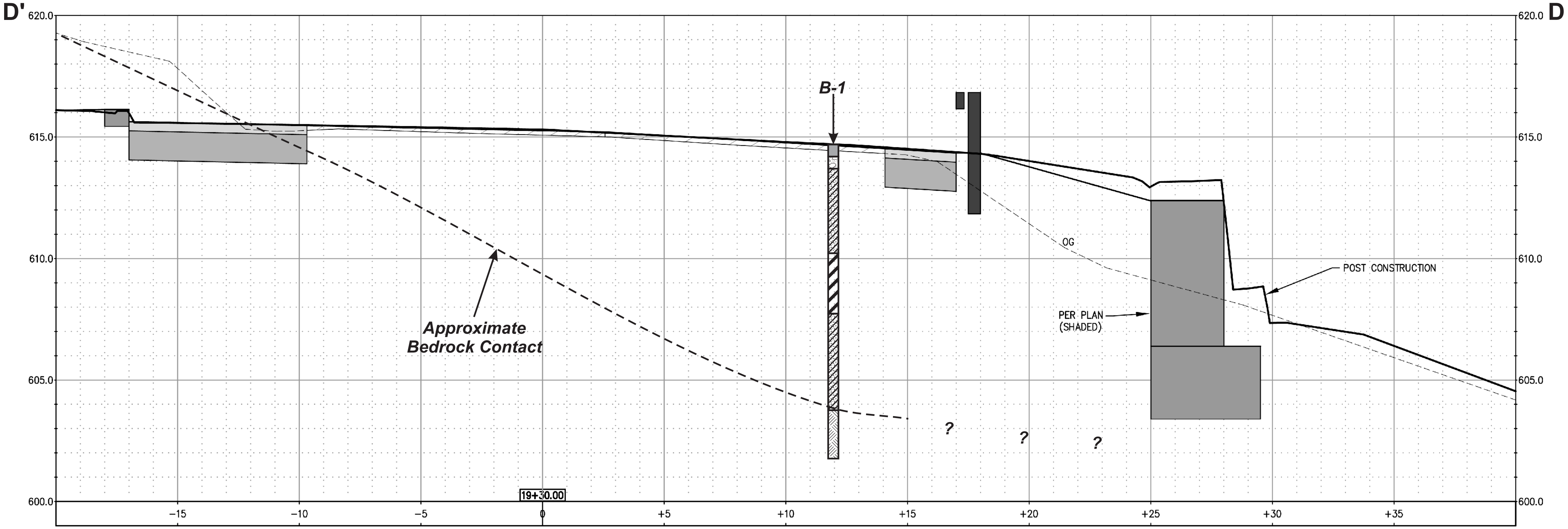
CROSS-SECTIONS A-A' & B-B'

Latrobe Road Remediation
El Dorado Hills, California

FIGURE
A-10





Approximate Scale: 1" = 5' Horizontal
1" = 5' Vertical

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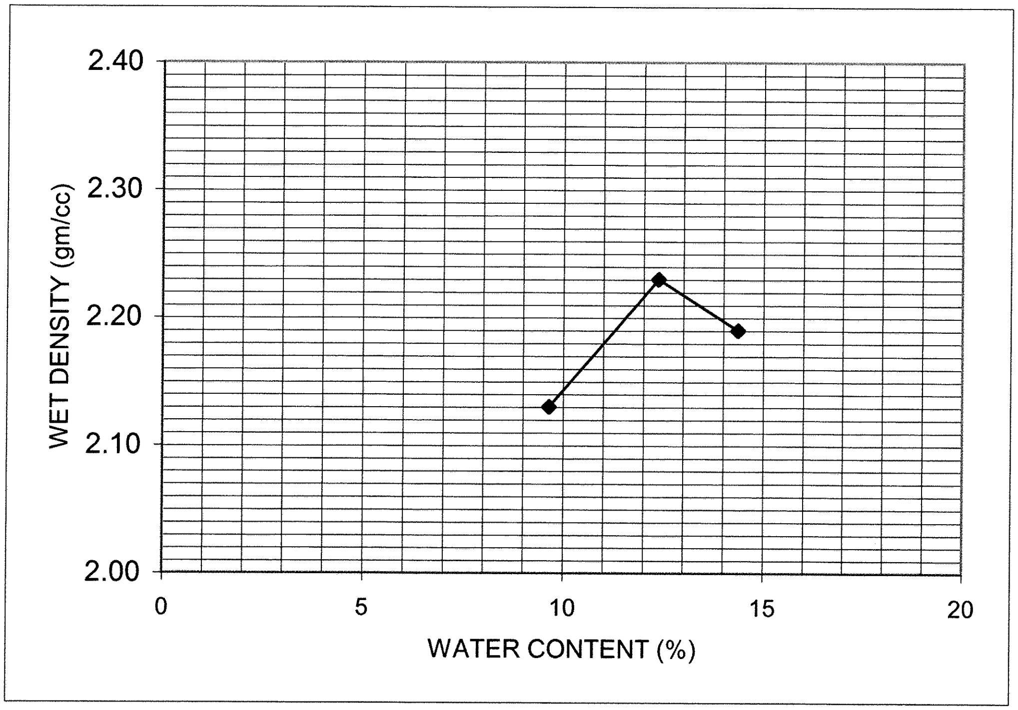
CROSS-SECTIONS C-C' & D-D'

Latrobe Road Remediation
El Dorado Hills, California

FIGURE
A-11

Method of Test for Relative Compaction of Untreated and Treated Soils and Aggregates

California Test Method 216



Maximum Wet Density (g/cc):	2.23	**Material Description:**	**%> 3/4"**
Adjusted Max Wet Density (g/cc)	2.27	Brown Silty CLAY	12.4
Optimum Water Content (g/cc):	0.28		
Sample No.:	Bulk-1	**Elev./Depth (ft.):**	
Date Sampled:		**Source:**	
Date Tested:	6/16/2014	**Notes:**	

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Building Innovative Solutions
30 YEARS

1234 Glenhaven Court, El Dorado Hills, CA 95762
ph 916.933.0633 · fx 916.933.6482 · www.youngdahl.net

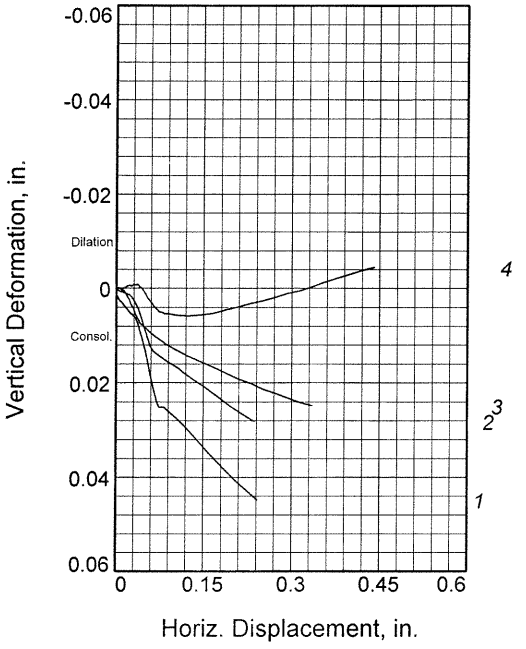
Project: Latrobe Road

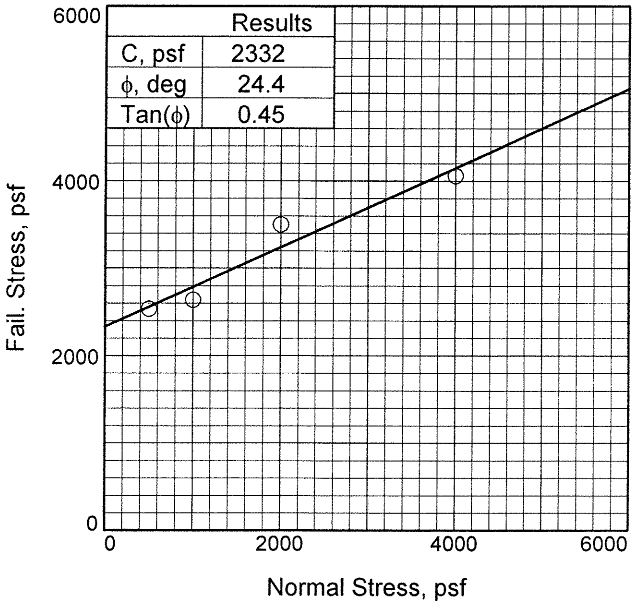
Project No.: E14145.000

Reviewed By: JLC

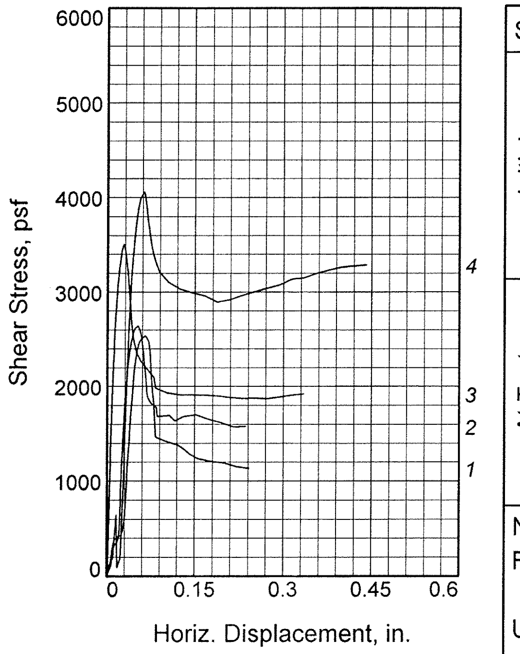
Date: 6/17/2014

Figure No. 1





Results	
C, psf	2332
ϕ, deg	24.4
Tan(ϕ)	0.45



Sample No.		1	2	3	4
Initial	Water Content, %	10.5	10.5	10.5	10.5
	Dry Density, pcf	105.7	105.8	105.7	105.7
	Saturation, %	49.2	49.2	49.2	49.2
	Void Ratio	0.5649	0.5643	0.5649	0.5649
	Diameter, in.	2.500	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000	1.000
At Test	Water Content, %	20.8	19.9	20.5	19.8
	Dry Density, pcf	106.6	108.3	107.2	108.5
	Saturation, %	100.0	100.0	100.0	100.0
	Void Ratio	0.5520	0.5282	0.5434	0.5251
	Diameter, in.	2.500	2.500	2.500	2.500
	Height, in.	0.992	0.977	0.986	0.975
Normal Stress, psf		500	1000	2000	4000
Fail. Stress, psf		2536	2638	3501	4057
Displacement, in.		0.065	0.051	0.027	0.062
Ult. Stress, psf					
Displacement, in.					
Strain rate, %/min.		0.0020	0.0020	0.0020	0.0020

Sample Type:

Description: Light Brown Sandy SILT with Trace Clay

Assumed Specific Gravity= 2.65

Remarks: Remolded to 90% of 139. PCF

Figure 2

Client:

Project: Latrobe Road

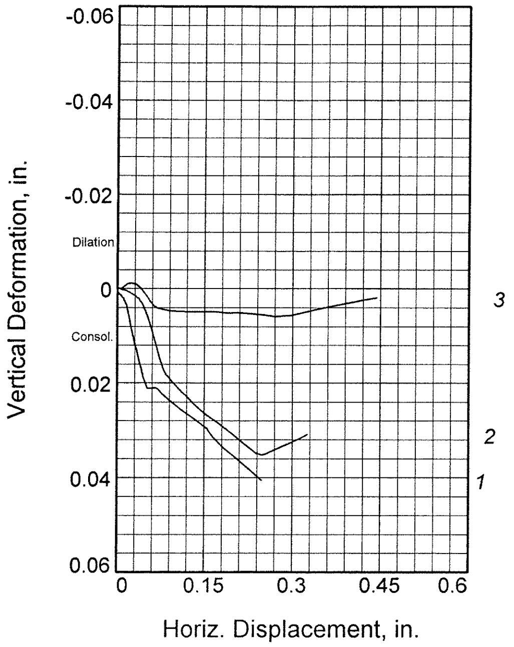
Source of Sample: Native

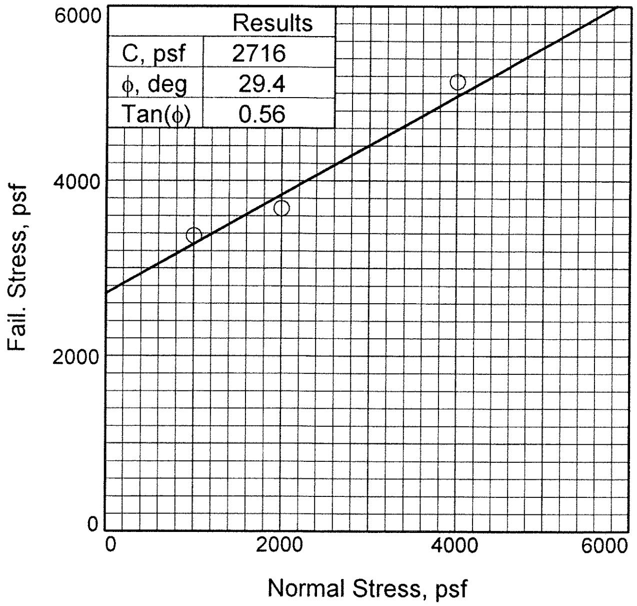
Sample Number: Bk-1

Proj. No.: E14145.000 **Date Sampled:**

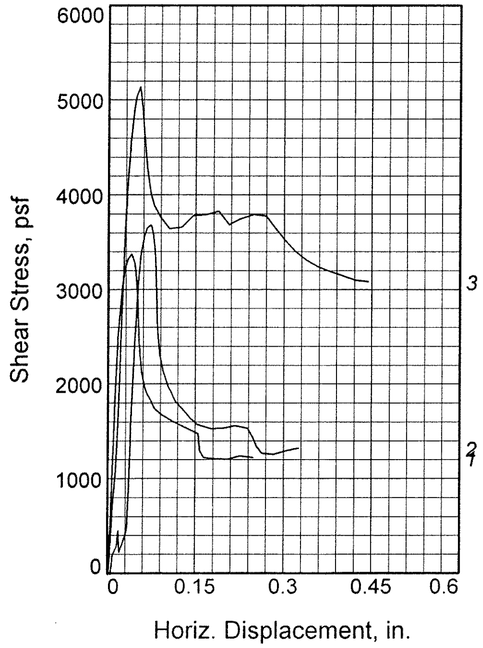
DIRECT SHEAR TEST REPORT
YOUNGDAHL CONSULTING GROUP, INC.
El Dorado Hills, California

Tested By: A3 **Checked By:** JLC





	Results
C, psf	2716
ϕ, deg	29.4
Tan(ϕ)	0.56



Sample No.		1	2	3
Initial	Water Content, %	10.5	10.5	10.5
	Dry Density, pcf	110.3	110.3	110.3
	Saturation, %	55.5	55.5	55.5
	Void Ratio	0.5005	0.5005	0.5005
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	18.2	18.1	16.5
	Dry Density, pcf	111.5	111.8	115.1
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.4835	0.4795	0.4368
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.989	0.986	0.958
Normal Stress, psf		1000	2000	4000
Fail. Stress, psf		3370	3682	5134
Displacement, in.		0.039	0.072	0.053
Ult. Stress, psf				
Displacement, in.				
Strain rate, %/min.		0.0020	0.0020	0.0020

Sample Type:

Description: Light Brown Sandy SILT with Trace Clay

Assumed Specific Gravity= 2.65

Remarks: Remolded to 95% of 139.2

Figure 3

Client:

Project: Latrobe Road

Source of Sample: Native

Sample Number: Bk-1

Proj. No.: E14145.000 **Date Sampled:**

DIRECT SHEAR TEST REPORT
YOUNGDAHL CONSULTING GROUP, INC.
El Dorado Hills, California

Tested By: A3 **Checked By:** JLC