APPENDIX E1

GEOTECHNICAL REPORT

GEOTECHNICAL INVESTIGATION REPORT
WESTSIDE RESERVOIR SEISMIC AND STRUCTURAL EVALUATION
CITY OF SOUTH PASADENA, CALIFORNIA

Prepared for:

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Group Delta Project No. IR794
August 10, 2022

GROUP DELTA

AKD Consulting
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August 10, 2022
Group Delta Project No IR794

Attention: Ashok Dhingra

Subject: Geotechnical Investigation Report
Westside Reservoir Seismic and Structural Evaluation
City of South Pasadena, California

Dear Ash,

Group Delta Consultants (Group Delta) is pleased to submit our geotechnical investigation report for the proposed Westside Reservoir Seismic and Structural Evaluation located at 821 Glen Place in the City of South Pasadena, California. This work was performed in general accordance with our proposal dated July 26, 2021, and your subsequent authorization. The project will provide the seismic and structural evaluation of the above-mentioned reservoir to determine if upgrade or replacement is required to bring the reservoir up to current code standards.

If you have any questions regarding this report, please feel free to call the undersigned at (949) 450-2100.

Sincerely,
Group Delta Consultants, Inc.

REGISTERED PROFESSIONAL ENGINEER
CURT SCHEYHING
No. 2766
Exp. 06-30-23
GEOTECHNICAL
STATE OF CALIFORNIA

Curt Scheyhing, PE, GE
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GEOTECHNICAL INVESTIGATION REPORT
WESTSIDE RESERVOIR SEISMIC AND STRUCTURAL EVALUATION
PASADENA, CALIFORNIA

1.0 INTRODUCTION

This report presents the results of our geotechnical investigation for the existing Westside Reservoir located at 821 Glen Place in the City of South Pasadena, California. The site location map is presented in Figure 1 and aerial photograph of the reservoir is shown in Figure 2. The purpose of our investigation was to evaluate the existing subsurface conditions at the site and provide geotechnical parameters for the seismic and structural evaluation of the existing reservoir.

Tables are presented within the report text and Figures are presented at the end of the report text, followed by Appendices A through E, which present the Field Investigation, Laboratory Testing, Calculations, Site Photographs, and As-Built Plans, respectively.

Note that the as-built plans appear to be based on NGVD29 datum. About 2 to 2.5 feet needs to be added to as-built elevation data to estimate current elevations based on NAVD88.

1.1 Scope of Work

The objective of this report is to provide our geotechnical investigations and recommendations to aid in the proposed seismic and structural evaluation of the existing reservoir at the site. Our scope of work for the project includes the following tasks:

- Review of available geologic and seismic information for the project site and surrounding area.
- Perform site reconnaissance.
- Perform a geotechnical investigation to evaluate the subsurface conditions that included two (2) Hollow Stem Auger (HSA) borings.
- Perform laboratory testing on selected Bulk, Standard Penetration and Modified California collected soil samples to evaluate characteristics of the soils encountered during our field exploration.
- Evaluate geologic and seismic hazards including expansive soils, surface fault rupture, liquefaction, and seismically induced landslides and settlement.
- Perform engineering analysis.
- Prepare this report presenting the findings of our investigation and geotechnical recommendations for tank evaluation and design: seismic design criteria, bearing capacity, settlement estimate, soil pressure, liquefaction potential and geologic hazards.

1.2 Existing Structure and Site Description

The existing Westside Reservoir is located at 821 Glen Place in the City of South Pasadena, California. The reservoir is a partially buried cast-in-place prestressed-wall concrete reservoir built in 1963 and is vital to the City's water distribution system. It was constructed by cutting into the upslope hillside, and placing fill around the downslope perimeter. Slope angles vary, but maximum cut and fill inclinations are 1.5H:1V, and contain intermediate benches.

The tank is located partially up a 170 foot high slope with residential development both above and below. Per NAVD88 elevations, the top of the hillside is near El. 780 feet, the perimeter road around the tank is near El. 710 feet, and the toe of the slope below is at about El. 610 feet (see Figure 2). The project site is currently occupied by the aged reservoir, access roads, and some small pump station buildings. An asphalt paved access roadway is present around the reservoir perimeter, and the area immediately around the reservoir is vegetated with grass and scattered trees. Residential units are present in the surrounding area, both above and below the reservoir. Vehicular access to the site is provided by Glen Place, which is a narrow, steep paved private street. Selected site photographs are presented in Appendix D.

Per the as-built drawings, the reservoir has an interior diameter of 105-feet and a capacity of about 2 million gallons, with a design water depth of 31-feet. The reservoir floor is a 6-inch thick reinforced concrete slab, that flares to 12-inch near the tank wall. The top of floor slab at El. 679-feet around the perimeter and at El. 678.4-feet in a central low point, with maximum water level of El. 710-feet, per as-built datum. The tank walls are 8-inch cast-in-place prestressed concrete. Exterior wall height is about 33 feet, with about 6 feet above finished grade and 27 feet buried below grade. The roof of the reservoir is a 6.5-inch thick reinforced concrete slab, flaring to 14-inches near the outside reservoir edge, supported on the prestressed concrete perimeter walls, and on one (1) center and six (6) intermediate interior columns. The top of roof slab is at El. 711.4-feet at the outer perimeter, and El. 712.5 at the center column location, per the as-built datum. The perimeter wall is supported on a continuous ring-wall footing 3-feet wide. The columns are supported on individual square footings with dimensions between 7.3-feet and 8 feet. The tank walls are surrounded by 6 inches of washed concrete sand for drainage to prevent buildup of hydrostatic pressures, with underdrains located on the top of perimeter footing on the outside of the reservoir. Another underdrain is present under the floor slab immediately adjacent to the interior edge of perimeter footing. As-built drawings are presented in Appendix E for reference.

2.0 GEOTECHNICAL INVESTIGATION

2.1 Field Investigation

The purpose of the field investigation was to evaluate the subsurface conditions within the proposed project site and collect soil samples for laboratory tests to evaluate the engineering characteristics of the underlying soils. The drilling program was performed on June 29, 2022, and

the boring locations are shown on Figure 2. The drilling program consisted of advancing one (1) HSA boring to a depth of approximately 55-feet below the existing ground surface (bgs), and one (1) HSA boring to a depth of approximately 45-feet bgs. The upper 5-feet of each boring was advanced with hand auger to clear for utilities and then the remaining depths were advanced with a truck mounted drilling rig. A detailed description of the field work and the associated boring logs are provided in Appendix A.

Bulk samples and relatively undisturbed drive samples of representative soil layers were obtained during drilling. Blow counts were recorded for both standard penetration test (SPT-N value) and California Modified Samplers. Upon withdrawal from borings, the samples were cleaned, the material was classified visually, and the information was entered on a field boring log by the field engineer. Visual descriptions and classifications of samples was performed in accordance with ASTM D2488 procedures. Samples were then sealed to prevent moisture loss, packed in appropriate protective containers or bags, and transported to the laboratory for further evaluation. Soil samples were handled and transported to our laboratory in accordance with ASTM D4220 guidelines. Borings were backfilled with soil cutting and the surface was patched with Quickset concrete.

2.2 Laboratory Testing Program

Laboratory testing of select soil samples was performed in accordance with ASTM and/or CTM specifications. The laboratory testing program consisted of the following:

- Moisture content and dry density
- Grain size distribution and percent passing No. 200 sieve
- Atterberg Limits
- Direct Shear Test
- Corrosion Evaluation Tests.

The performed tests are identified on the boring logs in Appendix A and a brief description of the laboratory test results are presented in Appendix B.

3.0 GEOTECHNICAL CONDITIONS

3.1 Geology

A published Regional Geologic Map of the area showing natural geologic units exposed at the ground surface is shown in Figure 3. The map shows that the project site is in hilly terrain underlain by Tertiary age Monterey Formation silty shale and siltstone (Tmsl). This is a sedimentary rock considered to be a “soft rock” formation, which can be considered siltstone/claystone with beds of silty to clayey sandstone, and is similar to a hard clay or very dense sandy soil. As shown in the figure, mapped bedding attitudes indicate bedding which

generally dips to the north, while the slope angle descends towards the east. Therefore, there is no evidence to suggest that the formation contains adverse bedding that dips out of slope that could be a stability concern. In the relatively flat lying areas at the base of the formational slopes, native geology is mapped as young alluvium (Qa) consisting of unconsolidated gravel, sand, and silt.

During tank grading, cuts were made into the formational slope to the west, and fills were placed around the eastern perimeter of the tank, as part of tank construction. As-built plans required benching of the fill into the formational materials. Additional cuts and fills were likely made during adjacent residential development. Geometric cross-sections from the as-built plans showing the approximate configuration of the tank and slopes, annotated to show interpreted geology and cut/fill, are presented in Figures 4A and 4B.

3.2 Subsurface Conditions

The geotechnical borings performed at the site generally encountered compacted tank backfill overlying siltstone/claystone tertiary formation. Previously placed fill material was estimated to be about 27-feet thick at Boring B-1 location on the upslope cut side of the tank, underlain directly by the formational material, right near the tank subgrade level. This is consistent with the expected temporary cut and backfill shown in Figure 4A. The fill material was observed to be similar in grain size and plasticity characteristics to the formational sandy siltstone/claystone, indicating that native cut material was likely used as tank backfill.

At Boring B-2 location, similar formation-derived backfill was observed to a depth of about 25-feet, again near the tank subgrade level. At this location, about 6 feet of relatively clean sand was encountered below the general backfill. This is near the location of the tank outlet pipes as shown in Figure 4B, and the sand is interpreted to likely be trench bedding material for the piping. The formational material was found below this bedding layer.

The tank backfill was observed to range from very stiff to hard Sandy Lean Clay (CL) to dense to very dense Clayey Sand (SC), with variable claystone fragments. Limited testing of the fill materials indicated 15 to 26 percent gravel, 34 to 37 percent sand, and 37 to 51 percent fines (passing No. 200 sieve), Liquid Limit (LL) of 44, Plastic Limit (PL) of 23, and Plasticity Index (PI) of 21. Natural moisture content was below the plastic limit with an average of about 13%. Pocket Penetrometer readings on fine-grained materials estimated the undrained shear strength to mostly exceed 4.5 ksf.

Formational material was observed to consist of siltstone/claystone soft rock, that readily breaks down to a soil very similar to the fill. When classified as soil it ranges from hard Sandy Lean Clay (CL) to dense to very dense Clayey Sand (SC). Limited testing of the formational materials indicated 5 to 9 percent gravel, 37 to 56 percent sand, and 39 to 54 percent fines (passing No. 200 sieve), Liquid Limit (LL) of 40, Plastic Limit (PL) of 25, and Plasticity Index (PI) of 15. Natural

moisture content was below the plastic limit at about 17%. Pocket penetrometer readings on fine-grained materials estimated the undrained shear strength to mostly exceed 4.5 ksf.

The boring records for the exploratory boreholes are presented in Appendix A, and laboratory test results are presented in Appendix B.

3.3 Groundwater

No groundwater was encountered during the current site investigation to a maximum depth of 55-feet bgs. Historically highest groundwater contours published by California Geological Survey show that the groundwater is deeper than 150-feet bgs, as shown in Figure 5.

3.4 Expansive Soils

Expansion and contraction can occur when expansive soils undergo alternating cycles of wetting (swelling) and drying (shrinking). During these cycles, the volume of the soil changes markedly, and can cause structural damage to buildings and infrastructure. Expansive soils are generally high plasticity clays.

The fill materials overlying the Monterey Formation siltstone are generally sandy lean clay to lean clay with sand (CL) with trace to few shale fragments. These materials are considered low to medium-expansive. Atterberg limit testing was performed on two (2) clay (CL) soil samples collected at 2.5-feet and 35-feet bgs at the site. These soils have plasticity indices ranging from 15 to 21 and liquid limits ranging from 40 to 44. Based on the Atterberg limit testing performed for this study, the clay soils (fill materials) are expected to have low to medium-expansion potential. No signs of serious damage due to expansive soil movement was observed at the site.

3.5 Soil Corrosivity

One representative sample of the near surface soils from Boring B-1 was tested to evaluate corrosion characteristics. The test included pH, electrical resistivity, soluble chloride, and soluble sulfate concentrations. Test results are summarized in Table 1 below and are provided in Appendix B.

Table 1: Soil Corrosivity Test Results

Sample/Depth	pH	Resistivity (Ohm-cm)	Sulfate Content (ppm)	Chloride Content (ppm)
B-1 @ 0-5’	7.38	1,894	100	100

Caltrans currently defines a corrosive environment as an area where the soil has either a chloride concentration of 500 ppm or greater, a sulfate concentration of 1500 ppm or greater, or has a pH of 5.5 or less. With the exception of MSE walls, soil and water are not tested for chloride and sulfates if the minimum resistivity is greater than 1,100 ohm-cm.

The pH of the soil is 7.38 which is considered mildly alkaline. The soil sulfate and chloride content was less than 100 ppm (0.01% by weight). The minimum soil resistivity detected was 1,894 Ohm-cm. The on-site soils were determined to be not corrosive in accordance with Caltrans Corrosion Guidelines. No specific corrosion mitigation is required for concrete structures designed in accordance with California Amendments to AASHTO LRFD Bridge Design Specifications and Caltrans Standard Specifications.

In accordance with published correlations (see corrosion result sheets in Appendix B), the minimum resistivity indicates the site is considered generally “corrosive” to buried ferrous metals. In accordance with California Building Code, testing indicates that potential for sulfate and chloride attack on concrete structures is considered “negligible”.

Group Delta does not practice in the specialty field of corrosion engineering. If further recommendations for corrosion protection beyond the information provided above are required, it is recommended to contact a qualified corrosion specialist.

4.0 POTENTIAL SEISMIC AND GEOLOGIC HAZARDS

4.1 Seismic Setting

The site is in an area with numerous active earthquake faults. A regional fault map is presented in Figure 6. The two closest active faults to the site are the Raymond Fault, located at an approximate distance of about 1.6-miles north of the project site, and the Verdugo-Eagle Rock Fault located about 2.5-miles northeast of the site. The Raymond Fault extends in an easterly to westerly roughly through South Pasadena and north of Highland Park. To the west, the Raymond Fault trends to the southeast into the Hollywood Fault. The Verdugo-Eagle Rock Fault extends along the southwesterly flank of the Verdugo Mountains to the southerly side of the Pacoima Hills. Other active faults within the area of the site include the Elysian Park (Upper) about 3.4-miles to the south, the Sierra Madre Fault Zone (Sierra Madre C) about 7.5-miles north-northeast, and the Puente Hills (LA) about 6-miles south-southwest.

The subject site is located in a seismically active region of Southern California, and strong seismic shaking should be anticipated within the design life of any structure constructed at the site. Potential seismic hazards include ground surface rupture due to faulting, ground shaking, liquefaction and seismic settlement, slope instability, flooding, and tsunamis. These hazards are discussed in the following sections.

4.2 Ground Surface Rupture

The site is not located within an Alquist-Priolo Earthquake Fault Zone as shown in Figure 7. The closest fault is the Raymond fault located at about 1.6-miles north of the site. Due to lack of any known active fault crossing the site, fault rupture hazard at the site is considered low. The site location on the USGS 2014 Fault Map is shown in Figure 6.

4.3 Liquefaction

Liquefaction involves the sudden loss in strength of a saturated, cohesionless soil (sand and non-plastic silts) caused by the build-up of pore water pressure during cyclic loading, such as produced by an earthquake. This increase in pore water pressure can temporarily transform the soil into a fluid mass, resulting in vertical settlement and can also cause lateral ground deformations. Typically, liquefaction occurs in areas where loose to medium dense sands and silts are present, and where the depth to groundwater is less than 50-feet below ground surface.

The site is not located in a State of California designated Liquefaction Hazard Zone (Figure 7). Due to the presence of tertiary formation and lack of groundwater in the upper 60-feet, the potential for liquefaction is negligible.

4.4 Liquefaction Induced Lateral Spreading

Liquefaction-induced lateral spreading is not a concern for the site, as liquefaction potential is low.

4.5 Landslide

The site is located in a mapped seismic landslide hazard zone as shown in Figure 7. Slope stability is a potential concern for the site and two-dimensional limit equilibrium slope stability analyses were performed to assess the global stability of the slope in the site for the static and seismic conditions. The stability analyses are discussed in Section 5.2.

4.6 Flood Hazard

According to FEMA's National Flood Hazard Map, this site is considered as an area of minimal flood hazard with less than 0.2% annual probability of being flooded.

4.7 Tsunami Hazard

The project site is not within the State of California Tsunami Inundation Map. Due to the relatively high site elevation and distance from shore, tsunami is not a hazard at this site.

4.8 Seismic Design Parameters per CBC 2019/ASCE 7-16

Seismic design acceleration parameters were developed per the 2019 California Building Code (CBC) and ASCE 7-16 (ASCE/SEI 7-16) for the proposed project and are presented in Table 2. Based on the underlying geology and subsurface exploration data the site classification for seismic design is Site Class C per Chapter 20 of ASCE 7-16. The site coordinates used in our seismic hazard analysis are 34.104572 (Latitude) and -118.160000 (Longitude).

Table 2. Mapped Seismic Design Acceleration Parameters

Parameter	Value
Site Class	C
Mapped MCE Spectral Response Acceleration at Short Period (S_S)	2.109g
Mapped MCE Spectral Response Acceleration at Period of 1 Second (S_1)	0.717g
Site Coefficient, F_a	1.2
Site Coefficient, F_v	1.4
Adjusted MCE Spectral Response Acceleration at Short Period (S_{MS})	2.531g
Adjusted MCE Spectral Response Acceleration at 1.0 Second (S_{M1})	1.004g
Design Earthquake Spectral Response Acceleration at Short Period (S_{DS})	1.687g
Design Earthquake Spectral Response Acceleration at 1.0 Second (S_{D1})	0.669g
MCE Geometric Mean Peak Ground Acceleration Adjusted for Site Class (PGA_M)	1.102g

Peak Ground Acceleration (PGA) for the design earthquake is taken as 2/3 of PGA_M = 0.73g.

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Foundation

The water in the existing tank is supported on a 6 inch thick reinforced concrete floor slab, the walls are supported on a 3 foot wide continuous ring wall footing, and the roof is supported on the ring wall and 7 square interior column footings ranging from about 7.5 to 8 feet wide.

5.1.1 Bearing Capacity

As shown in Figures 4A and 4B, the tank is supported in cut within the formational material, which has more than adequate bearing capacity. Design bearing pressures were not found in the as-built plans. For all existing footings, an allowable bearing capacity of 5 ksf may be used, which has a factor of safety of more than 3 on ultimate values. The allowable bearing pressure may be increased by one-third for short-term wind or seismic loads. Settlement of footings loaded to the allowable bearing pressure (not considering settlement due to water weight over the entire footprint) is estimated at ¼ inch or less. Settlement from weight of water over the footprint is discussed in the next section.

5.1.2 Settlement

The tank is supported on cut in very dense / hard formational soils. During original construction, the structure would have settled under the self-weight of the structure itself, plus the full depth of water when the tank was first filled. We estimate that the average loading over the tank bottom may be on the order of 2,250 psf, including concrete and water weight. Based on estimated shear wave velocity, and using 15% of the estimated low strain modulus, the

settlement of the entire tank loading was estimated to range from about 1 to 1.5 inches in the center of tank, and from about ½ inch to ¾ inch around the perimeter, with a differential settlement of about ½ inch to ¾ inch between the center and perimeter. Additional settlement due to load concentration under the footings is estimated to be less than about ¼ inch and not significant compared to the overall settlement due to tank and water weight. Differential settlement between interior footings is estimated at less than ½ inch, and between interior footings and ring wall less than ½ inch. Total and differential settlement due to seismic shaking is expected to be negligible.

Modulus of Subgrade Reaction (K) is defined as the applied bearing pressure (q) divided by the corresponding settlement (δ), or $K = q / \delta$. If needed, the modulus of subgrade reaction for ring wall footing may be taken as 300 kcf, for the column footings may be taken as 240 kcf, and for the tank as a whole (under water loading) may be taken as 22.5 kcf based on settlement analysis. No additional adjustment for size effect is needed.

Note that, from our field visit, it appears that the backfill surrounding the reservoir may have settled up to about 6-inches relative to the reservoir and manhole over the years, as evidenced by the visible line of asphalt remnants on the tank perimeter and differential movement between asphalt concrete and manhole (see photos in Appendix D). The apparent differential movement between pavement and reservoir is explained by the fill settling significantly, and the reservoir and manhole settling much less or not at all due to both being founded on cut in low compressibility bedrock.

5.1.3 Lateral Resistance

Resistance to lateral loads can be provided by friction developed between the bottom of footings and the supporting soil, and by the passive soil pressure developed on the face of the footing. An ultimate passive resistance (factor of safety = 1) of 400 psf per foot of depth may be used. The amount of movement required to mobilize ultimate passive resistance is equal to 2% of the height of the pressure surface upon which the passive pressure acts. For lesser movement, the mobilized passive resistance should be reduced by the ratio of allowable movement to ultimate movement. For cast-in-place concrete on native soils an ultimate coefficient of friction of 0.57 may be used for lateral sliding resistance of footings.

5.2 Slope Stability

Two-dimensional limit equilibrium slope stability analyses were performed using the computer program SLIDE, Version 7 (RocScience) to assess the global stability of the overall slope for both static and seismic conditions. The analyses were performed using the Spencer method of slices. Global stability under seismic loading conditions were conducted using a pseudo-static horizontal acceleration coefficient (k_h) of ½ x PGA = 0.367. Slope stability calculations are presented in Appendix C. Strength parameters were selected considering the results of laboratory direct shear testing as shown in Appendix B. The computed factor of safety for the static and seismic loading

conditions are 2.67 and 1.19, respectively, which satisfies the minimum factor of safety requirements of California Building Code (CBC) 2019, so the slope within which the tank is supported is considered statically and seismically stable.

5.3 Lateral Earth Pressures

The backfill around the tank wall exerts soil pressures on the tank. The tank is considered a rigid structure, so at-rest conditions apply. The tank was backfilled with soils that have significant clay content, which is not normally recommended. There is significant uncertainty in earth pressures from clayey soils. Typically earth pressures on buried rigid structures can be taken as triangular (equivalent fluid), rectangular (uniform), or trapezoidal. Due to the uncertainty and relatively clayey wall backfill, it is recommended to utilize the trapezoidal pressure diagram shown in Figure 8 to represent soil pressures outside the tank walls, and in addition, it is suggested that an equivalent fluid method be used to verify which of the two cases is more critical, using the following parameters:

- Unit Weight = 120 pcf
- Coefficient of Lateral Earth Pressure At-Rest, Ko = 0.5
- At-Rest Equivalent Fluid Unit Weight = 60 pcf

Lateral pressure from uniform vertical surcharge loads at the ground surface may be taken as a uniform lateral pressure equal to 50% of the vertical pressure.

6.0 LIMITATIONS

The conclusions and recommendations contained in this report are professional opinions, intended for the use of AKD Consulting and subconsultants. The recommendations should not be extrapolated to areas not covered by this report or used for other facilities without the review and approval of Group Delta Consultants.

Our investigation and evaluations were performed in accordance with generally accepted local standards 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.

7.0 REFERENCES

American Society for Testing and Materials, ASTM International (ASTM), 2008, Annual Book of Standards, Volumes 4.08 and 4.09, Soil and Rock.

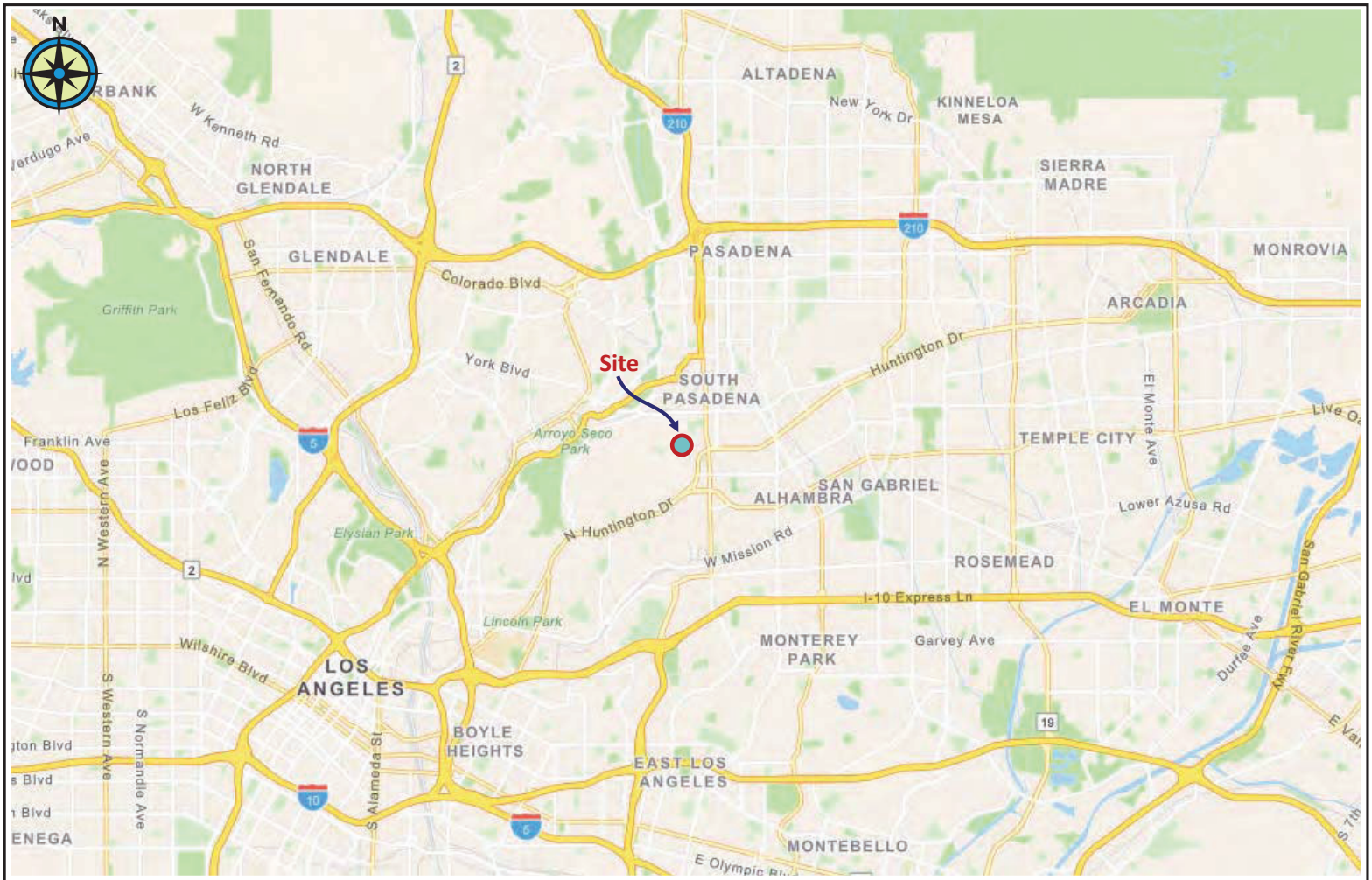
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Dibblee, T.W., and Ehrenspeck, H.E., ed. (1989). Geologic map of the Los Angeles quadrangle, Los Angeles County, California. Dibblee Foundation Map DF-22.

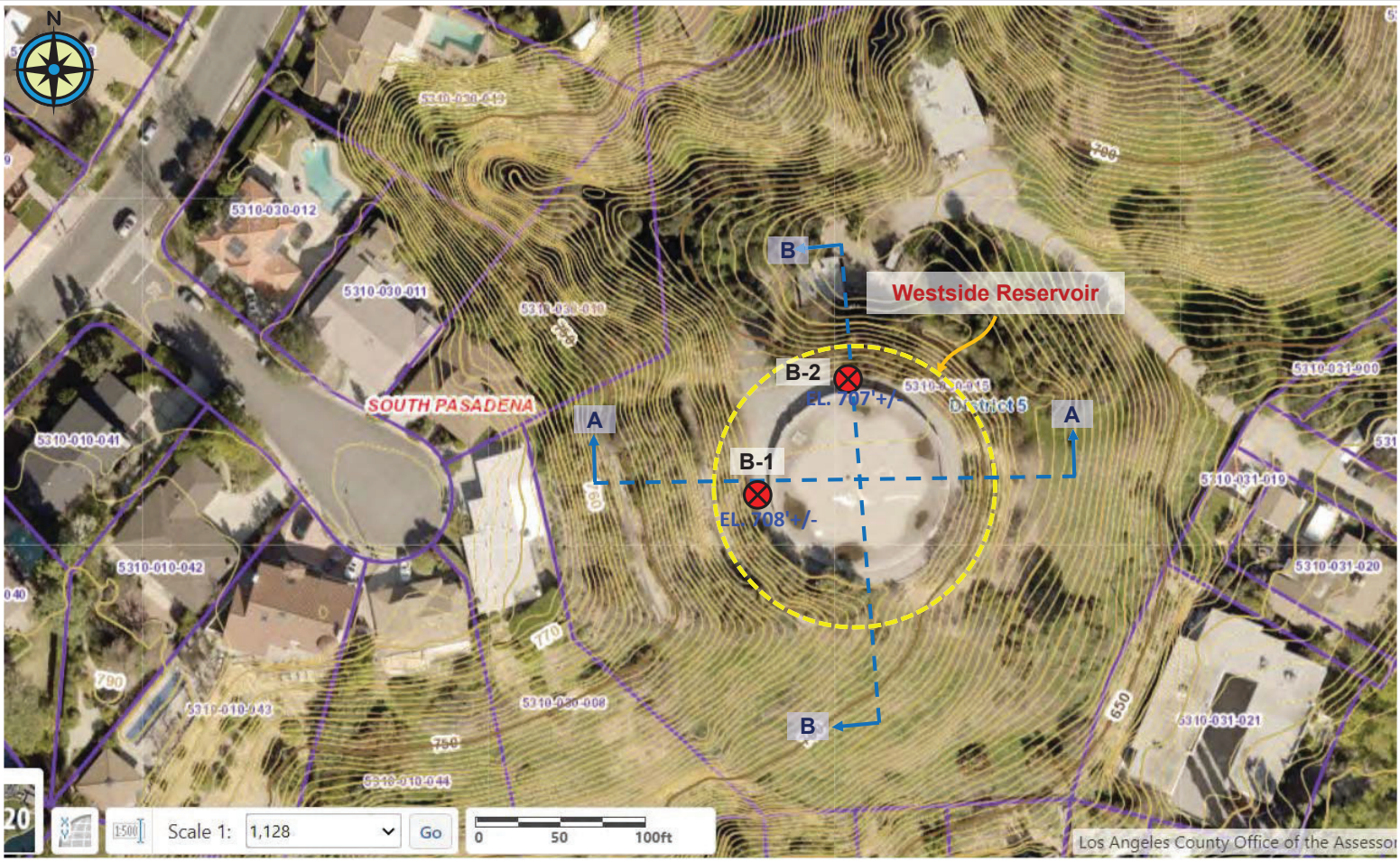
Greenbook, Standard Specifications for Public Works Construction, 2018.

Occupational Safety and Health Administration (OSHA), United States Department of Labor, 2018.



Reference: Google Map

GROUP DELTA	GROUP DELTA CONSULTANTS, INC. ENGINEERS AND GEOLOGISTS 32 MAUCHLY, SUITE B IRVINE, CA 92618, (949) 450-2100	**FIGURE NUMBER** 1
	PROJECT NAME Westside Reservoir Seismic & Structural Evaluation South Pasadena, California	**PROJECT NUMBER** IR794
	SITE VICINITY MAP	



Reference: https://apps.gis.lacounty.gov/m/?viewer=GISViewer/

B-#

⊗ Approximate Boring Location

Note:
1. The elevation contours in this figure are based on NAVD88.
2. The elevation datum for the as-built drawings (July 1963) are likely NGVD29 (add about 2 to 2.5' to as-built elevations to approximate NAVD88 elevations).

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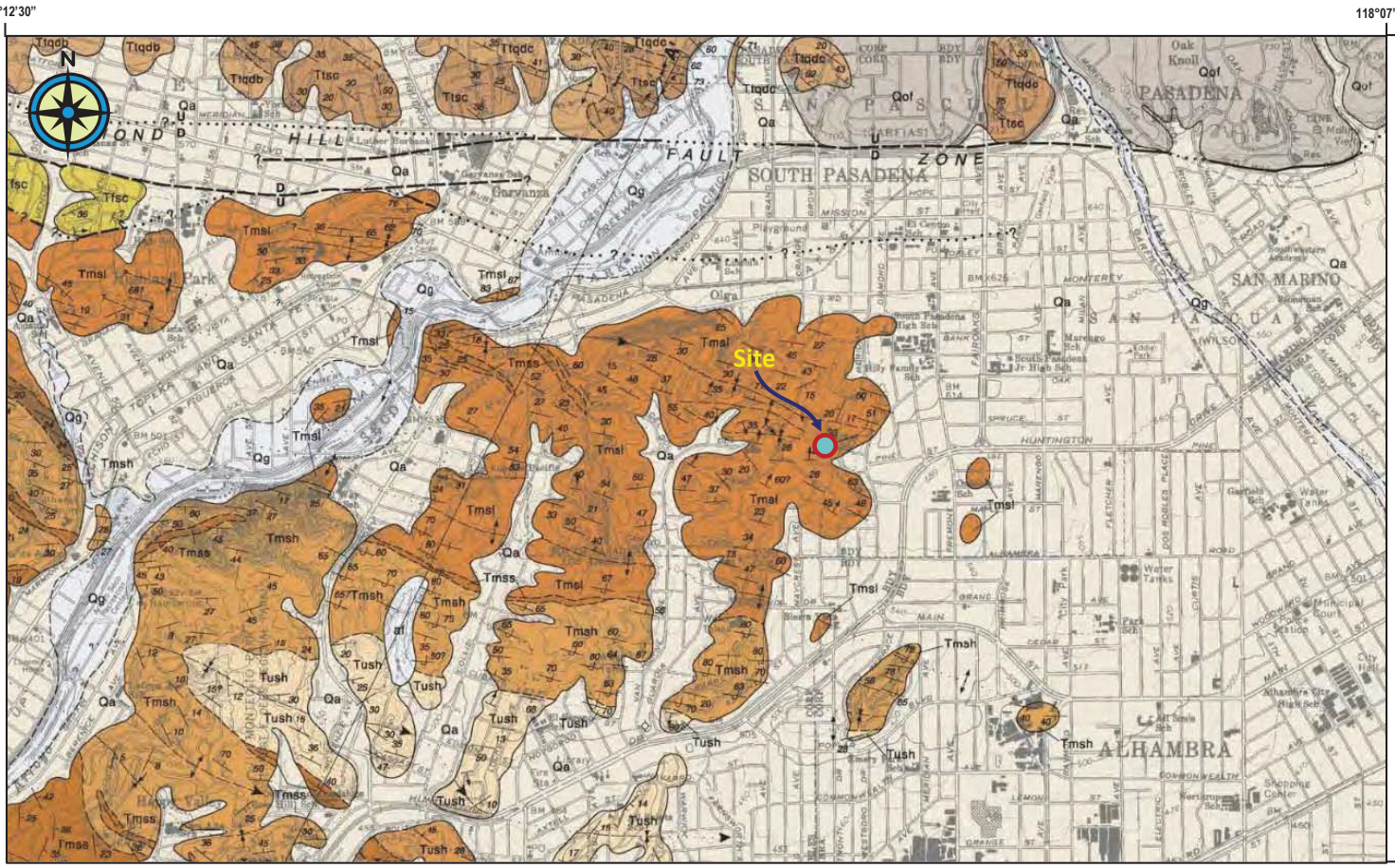
GROUP DELTA CONSULTANTS, INC.
ENGINEERS AND GEOLOGISTS
32 MAUCHLY, SUITE B
IRVINE, CA 92618, (949) 450-2100

FIGURE NUMBER 2

PROJECT NAME Westside Reservoir Seismic & Structural Evaluation South Pasadena, California

PROJECT NUMBER IR794

SITE AERIAL PHOTO & EXPLORATION LOCATION PLAN



Reference: Dibblee, T.W., and Ehrenspeck, H.E., ed. (1989). Geologic map of the Los Angeles quadrangle, Los Angeles County, California. Dibblee Foundation Map DF-22.

Legend:

Qa – Alluvium: unconsolidated floodplain deposits of silt, sand and gravel
Qg – Alluvial clay and sand of valley areas
Tmsl – Gray, micaceous silty shale and siltstone (Monterey Formation)

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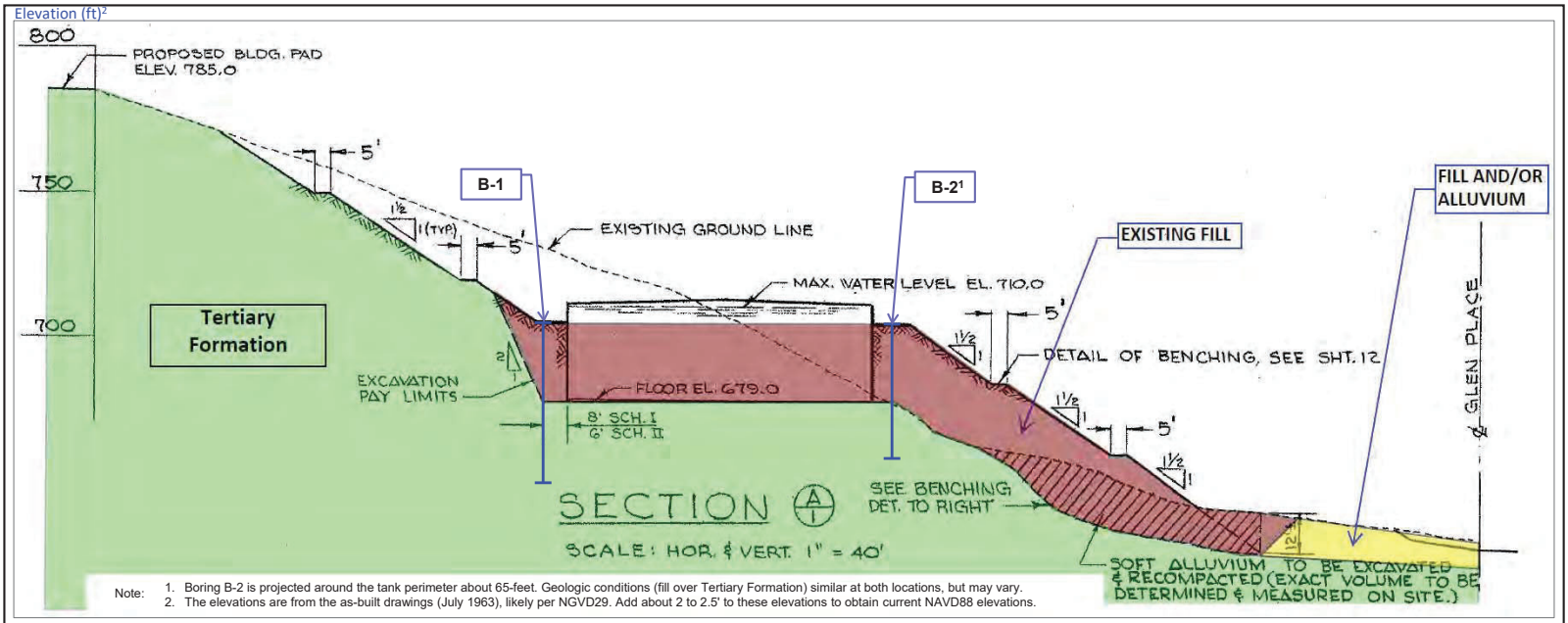
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FIGURE NUMBER 3

PROJECT NAME Westside Reservoir Seismic & Structural Evaluation South Pasadena, California

PROJECT NUMBER IR794

REGIONAL GEOLOGIC MAP



Note:
1. Boring B-2 is projected around the tank perimeter about 65-feet. Geologic conditions (fill over Tertiary Formation) similar at both locations, but may vary.
2. The elevations are from the as-built drawings (July 1963), likely per NGVD29. Add about 2 to 2.5' to these elevations to obtain current NAVD88 elevations.

Not to Scale

GROUP DELTA

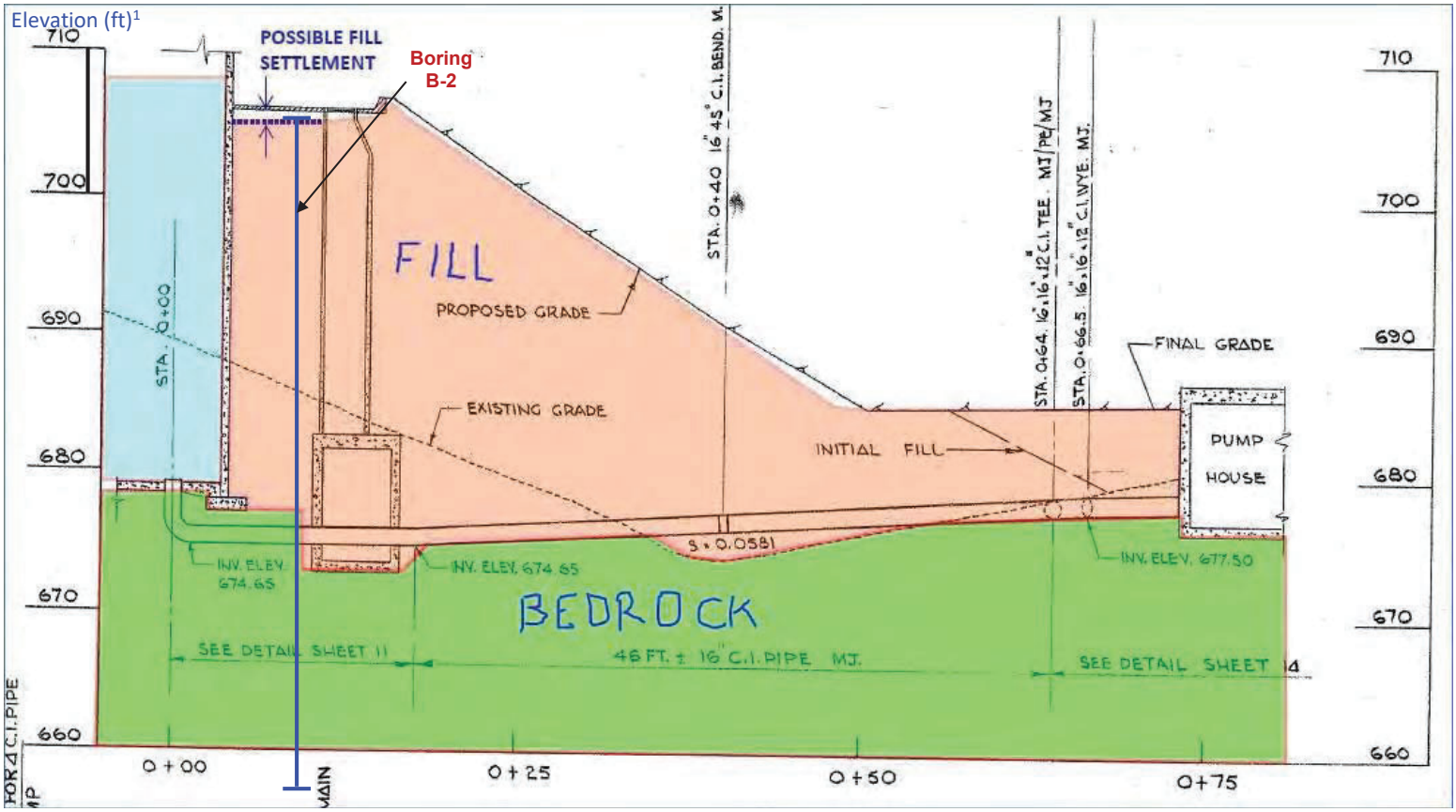
GROUP DELTA CONSULTANTS, INC.
ENGINEERS AND GEOLOGISTS
32 MAUCHLY, SUITE B
IRVINE, CA 92618, (949) 450-2100

FIGURE NUMBER
4A

PROJECT NAME
Westside Reservoir Seismic & Structural Evaluation
South Pasadena, California

PROJECT NUMBER
IR794

INTERPRETED SUBSURFACE PROFILE THROUGH SECTION A

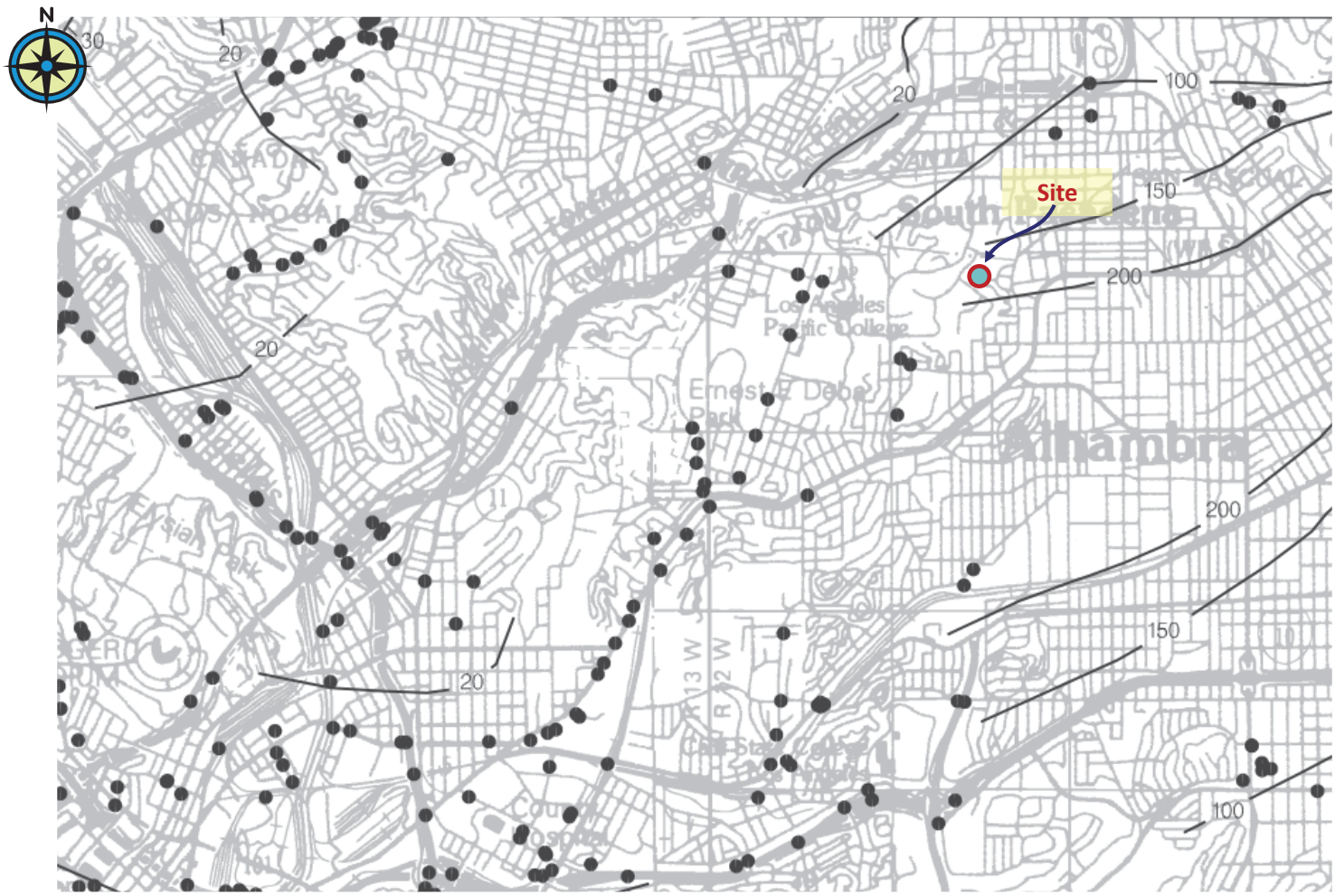


Not to Scale

Note:

1. The elevations are from the as-built drawings (July 1963), likely per NGVD29. Add about 2 to 2.5' to these elevations to obtain current NAVD88 elevations.

GROUP DELTA	GROUP DELTA CONSULTANTS, INC. ENGINEERS AND GEOLOGISTS 32 MAUCHLY, SUITE B IRVINE, CA 92618, (949) 450-2100	**FIGURE NUMBER** 4B
	PROJECT NAME Westside Reservoir Seismic & Structural Evaluation South Pasadena, California	**PROJECT NUMBER** IR794
	INTERPRETED SUBSURFACE PROFILE THROUGH SECTION B	



Reference: Department of Conservation (1998). Seismic Hazard Zone Report for the Los Angeles 7.5-Minute Quadrangle, Los Angeles County, California.

● Borehole Site

30 Depth to ground water in feet

GROUP DELTA

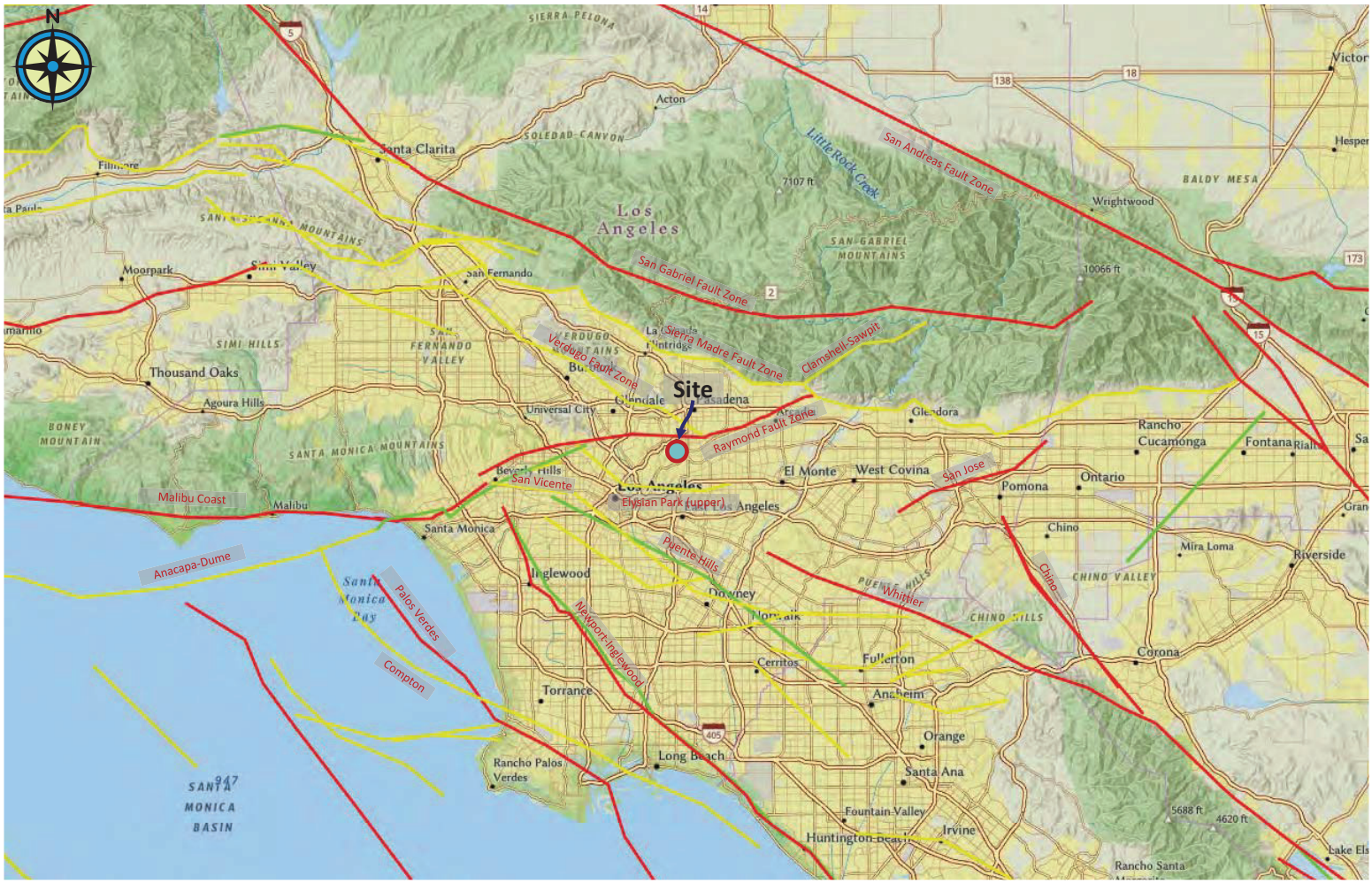
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FIGURE NUMBER
5

PROJECT NAME
Westside Reservoir Seismic & Structural Evaluation
South Pasadena, California

PROJECT NUMBER
IR794

HISTORICALLY HIGHEST GROUNDWATER MAP



Reference: https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf

GROUP DELTA

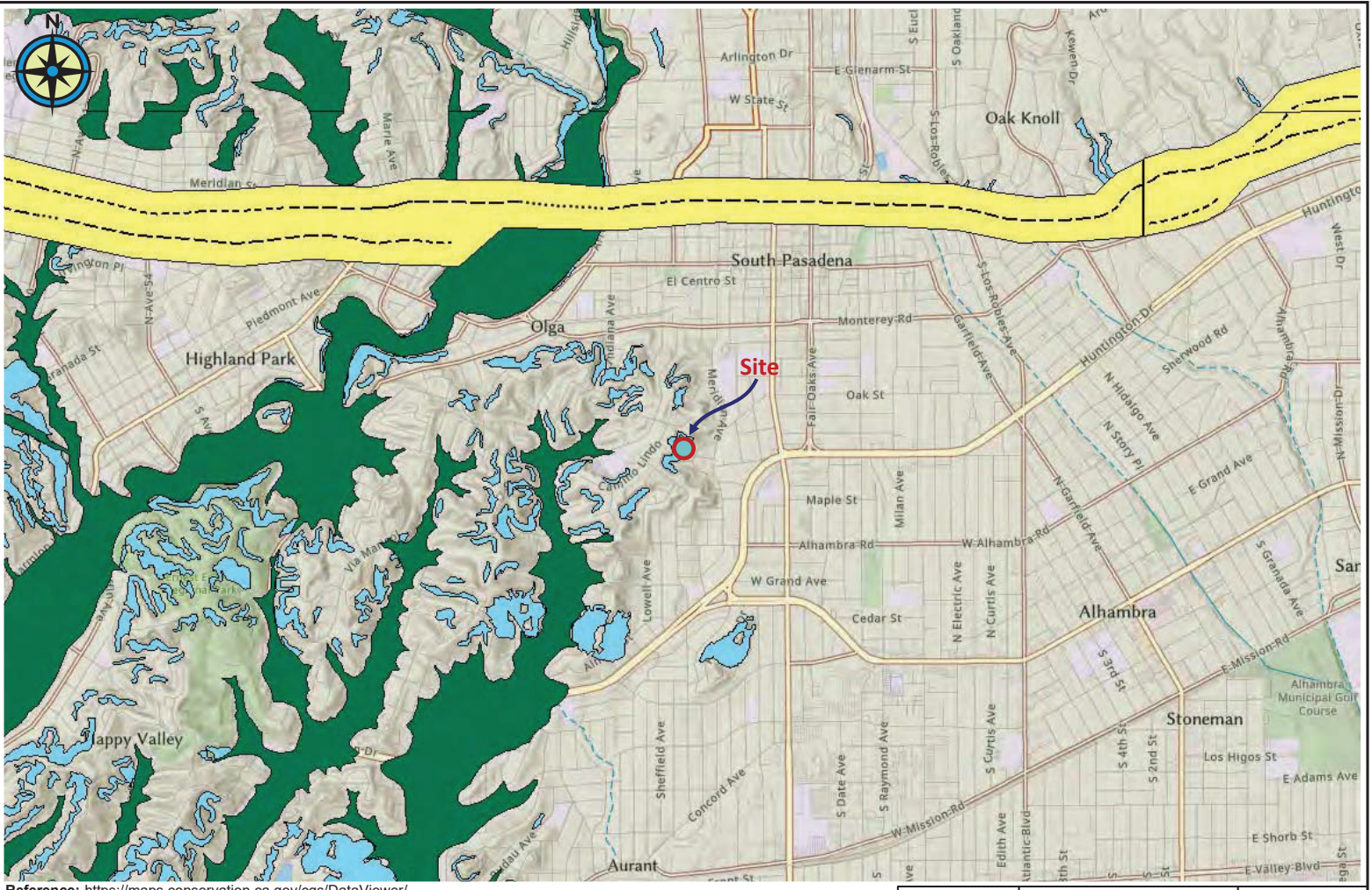
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IRVINE, CA 92618, (949) 450-2100

FIGURE NUMBER
6

PROJECT NAME
Westside Reservoir Seismic & Structural Evaluation
South Pasadena, California

PROJECT NUMBER
IR794

NSHM 2014 FAULT MAP



Reference: https://maps.conservation.ca.gov/cgs/DataViewer/

Legend:

- Alquist-Priolo Fault Hazard Zones
- Landslide Zones
- Liquefaction Zones

Fault Traces

- Accurately Located
- Approximately Located
- Approximately Located, Queried
- Inferred
- Inferred, Queried
- Concealed
- Concealed, Queried
- Aerial Photo Lineament

GROUP DELTA

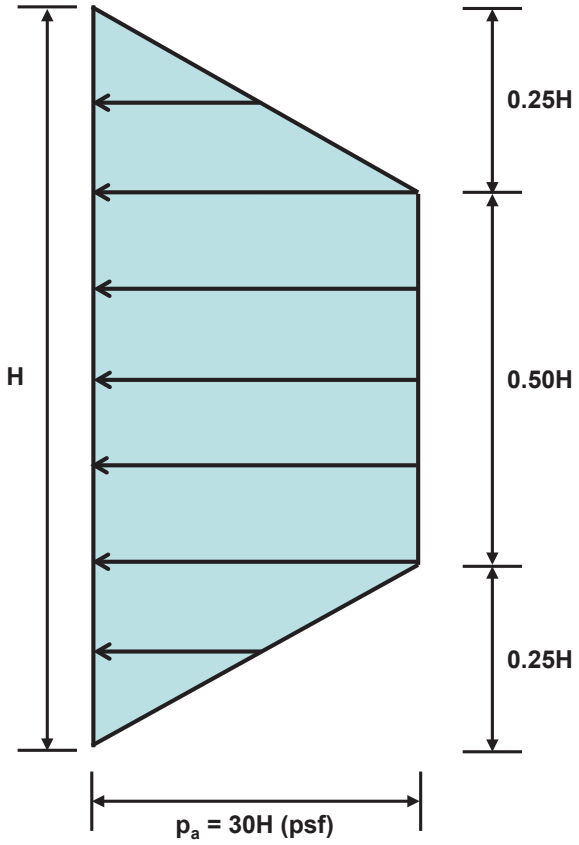
GROUP DELTA CONSULTANTS, INC.
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FIGURE NUMBER 7

PROJECT NAME
Westside Reservoir Seismic & Structural Evaluation
South Pasadena, California

PROJECT NUMBER IR794

SEISMIC HAZARD ZONES



GROUP DELTA	GROUP DELTA CONSULTANTS, INC. ENGINEERS AND GEOLOGISTS 32 MAUCHLY, SUITE B IRVINE, CA 92618, (949) 450-2100	**FIGURE NUMBER** 8
	PROJECT NAME Westside Reservoir Seismic & Structural Evaluation South Pasadena, California	**PROJECT NUMBER** IR794
	APPARENT PRESSURE ENVELOPE FOR BURIED RIGID STRUCTURE WITH CLAYEY BACKFILL	

APPENDIX A
FIELD INVESTIGATION

APPENDIX A
FIELD INVESTIGATION

APPENDIX A
FIELD INVESTIGATION

INTRODUCTION

The subsurface conditions at the project site were investigated by performing borings and geophysics as described below. A summary of field explorations (Table A-1), boring record legend, key for soil classification, boring records, drive hammer energy calibrations, and other relevant information are presented in the attachments to this appendix. Specific details for each boring are presented in the title block of each boring record.

Prior to beginning the exploration program, access permission and drilling permits were obtained as necessary. Subsurface utility maps were reviewed prior to selecting locations for subsurface investigations. Underground Service Alert (USA) was notified, and each exploration location was cleared for underground utilities using geophysical techniques as needed. Approved traffic control plans were implemented where necessary during field activities. The exploration methods are described in the following sections.

SOIL DRILLING AND SAMPLING

Drilling, Logging, and Soil / Rock Classification

Borings were performed by Group Delta's drilling subcontractors under the continuous technical supervision of a Group Delta field engineer or geologist, who visually inspected the soil samples, maintained detailed records of the borings, measured groundwater levels, and visually / manually classified the soils in accordance with the ASTM D 2488 and the Unified Soil Classification System (USCS). Logging and classification was performed in general accordance with Caltrans "Soil and Rock Logging, Classification, and Presentation Manual (2010 Edition)". A Boring Record Legend, Key for Soil Classification, and boring records are presented in the attachments to this appendix.

Sampling

Bulk samples of soil cuttings were collected at selected depths and drive and/or push samples were collected at a typical interval of 5 feet from the borings (closer or wider sample spacing was employed where considered necessary or appropriate). The sampling was performed using Standard Penetration Test (SPT) samplers in accordance with ASTM D 1586, Ring-Lined "California" Split Barrel samplers in accordance with ASTM D 3550, and/or Thin-Walled "Shelby" Tube Samplers in accordance with ASTM D 1587.

Bulk samples were collected from auger cuttings and placed in plastic bags.

SPT drive samples were obtained using a 2-inch outside diameter and 1.375-inch inside diameter split-spoon sampler without lining. The soil recovered from the SPT sampling was sealed in plastic bags to preserve the natural moisture content.

Modified California ("MODCAL") drive samples were collected with a 3.0 inch outside diameter (OD) (unless indicated otherwise on the boring record) ring-lined split barrel sampler with a 2.42-inch inside diameter (ID) cutting shoe. The sampler barrel is lined with 18-inches of metal rings for sample collection and has an additional length of waste barrel. Stainless steel or brass liner rings for sample collection are 1-inch high, 2.42-inch inside diameter, and 2.5-inch outside diameter. California samples were removed from the sampler, retained in the metal rings, and placed in sealed plastic canisters to prevent loss of moisture.

At each sampling interval, the drive samplers were fitted onto sampling rod, lowered to the bottom of the boring, and driven 18 inches or to refusal (50 blows per 6 inches) with a 140-lb hammer free-falling a height of 30-inches (unless otherwise indicated on the boring record).

Shelby tube samplers (if used) were pushed to collect undisturbed samples of soft to stiff cohesive soils where encountered. The samples were secured within the tubes and the tubes were sealed with plastic caps and electric tape in the field to prevent moisture loss.

Compared to the SPT, the California sampler provides less disturbed samples. Shelby Tubes provide the least sample disturbance and are considered undisturbed.

Penetration Resistance

SPT blow counts adjusted to 60% hammer efficiency (N_{60}) are routinely used as an index of the relative density of coarse-grained soils, and are sometimes used (but less reliable) to estimate consistency of cohesive soils. For samples collected using non-SPT samplers, different hammer weight and drop height, and/or efficiency different than 60%, correction factors can be applied to estimate the equivalent SPT N60 value following the approach of Burmister (1948) as follows:

$$N^*_{60} = N_R * C_E * C_H * C_S$$

where

N^*_{60} = equivalent SPT N_{60}

N_R = Raw Field Blowcount (blows per foot)

C_E = Hammer Efficiency Correction = Er_i / 60%

C_H = Hammer Energy Correction = (W * H) / (140 lb * 30 in)

C_S = Sampler Size Correction = $[(2.0\text{ in})^2-(1.375\text{ in})^2]/[D_o^2-D_i^2]$

Er_i = hammer efficiency, %

W= actual drive hammer weight, lbs

H = actual drive hammer drop, inch

D_o, D_i = actual sampler outside and inside diameter, respectively, inches

Burmister's correction assumes that penetration resistance (blowcount) is inversely proportional to the hammer energy. For a hammer other than a 140# hammer with 30" drop the hammer energy correction is equal to the ratio of the theoretical hammer energy (weight times drop) to the theoretical SPT hammer energy, or C_H = (W * H) / (140 lb * 30 in).

Burmister's correction assumes that penetration resistance (blowcount) is proportional to the annular end area of the drive sampler. For example, California drive samplers with Do=3 inch and Di=2.42 inch the sampler size correction factor is the ratio of the annular area of an SPT split spoon to that of the California Sampler, or C_S =[2.02-1.3752]/[32-2.422] = 0.67.

To normalize the field SPT and California blowcounts to a hammer with 60% efficiency, an energy correction factor equal to Hammer Efficiency (%) / 60% was applied to the field blowcounts. Hammer efficiency was determined by Pile Driving Analyzer (PDA) measurement and/or by published correlations with the CME Automatic Hammer blow count rate (USBR, 1999). Hammer efficiency measurements are presented in the attachments to this appendix.

The correction factors applied to obtain N^*_{60} are shown in the "NOTES" section of the boring record title block. Corrected N^*_{60} are primarily used, with due engineering judgment, for qualitative assessment of in place density or consistency.

Relative Density and Consistency

Equivalent SPT N^*_{60} values were used as the basis for classifying relative density of granular/cohesionless soils. Wherever possible consistency classification of cohesive soils was based on undrained shear strength estimated in the field with a pocket penetrometer and/or Torvane or by testing in the laboratory. Where pocket penetrometer or other tests could not be performed, consistency of cohesive soils was estimated by correlations to Equivalent SPT N^*_{60}. The correlations for consistency and relative density are shown in the Boring Record Legend in the attachments to this appendix. Drive sample field blow counts, SPT N^*_{60} values, pocket penetrometer/Torvane readings, and corresponding density/consistency classifications are presented on the boring records.

Borehole Abandonment

At the completion of the drilling groundwater was measured (where possible) and the borings were abandoned by backfilling the borehole with as indicated on the records. The surface was

patched with quickset concrete, as necessary. Notes describing the borehole abandonment are presented in the title block of each boring record.

Sample Handling and Transport

Geotechnical samples were sealed to prevent moisture loss, packed in appropriate protective containers, and transported to the geotechnical laboratory for further examination and geotechnical testing.

Laboratory Testing

The soil samples were further examined and tested in the laboratory and classified in accordance with the Unified Soil Classification System following ASTM D 2487 and D 2488 (see the Key for Soil Classification in the attachments to this appendix). Field classifications presented on the records were modified where necessary on the basis of the laboratory test results. Descriptions of the laboratory tests performed and a summary of the results are presented in Appendix B.

LIST OF ATTACHMENTS

Tables

Summary of Field Explorations

Figures

Boring Record Legend

Key for Soil Classification

Boring Records

Hammer Efficiency Calibrations

Summary of Field Explorations

Table A-1: Summary of Field Explorations

Exploration No.	Exploration		Ground Surface Elevation (feet)	Total Depth (feet)	Groundwater	
	Latitude	Longitude			Depth (feet)	Elevation (feet)
B-1	34.104485	-118.160172	708	56.5	N/E	N/E
B-2	34.104688	-118.159986	707	46.5	N/E	N/E

Notes: N/E = Not Encountered

Boring Record Legend, Key for Soil Classification, and Boring Records

SOIL IDENTIFICATION AND DESCRIPTION SEQUENCE

Sequence		Refer to Section		Required	Optional
		Field	Lab		
1	Group Name	2.5.2	3.2.2	●	
2	Group Symbol	2.5.2	3.2.2	●	
	Description Components				
3	Consistency of Cohesive Soil	2.5.3	3.2.3	●	
4	Apparent Density of Cohesionless Soil	2.5.4		●	
5	Color	2.5.5		●	
6	Moisture	2.5.6		●	
7	Percent or Proportion of Soil	2.5.7	3.2.4	●	◍
	Particle Size	2.5.8	2.5.8	●	◍
	Particle Angularity	2.5.9			○
	Particle Shape	2.5.10			○
8	Plasticity (for fine-grained soil)	2.5.11	3.2.5		○
9	Dry Strength (for fine-grained soil)	2.5.12			○
10	Dilatency (for fine-grained soil)	2.5.13			○
11	Toughness (for fine-grained soil)	2.5.14			○
12	Structure	2.5.15			○
13	Cementation	2.5.16		●	
14	Percent of Cobbles and Boulders	2.5.17		●	
	Description of Cobbles and Boulders	2.5.18		●	
15	Consistency Field Test Result	2.5.3		●	
16	Additional Comments	2.5.19			○

Describe the soil using descriptive terms in the order shown

Minimum Required Sequence:

USCS Group Name (Group Symbol); Consistency or Density; Color; Moisture; Percent or Proportion of Soil; Particle Size; Plasticity (optional).

◍ = optional for non-Caltrans projects

Where applicable:

Cementation; % cobbles & boulders;
Description of cobbles & boulders;
Consistency field test result

Ref.: Caltrans Soil and Rock Logging Classification, and Presentation Manual (2010)

HOLE IDENTIFICATION

Holes are identified using the following convention:

H-YY-NNN

Where:
H: Hole Type Code
YY: 2-digit year
NNN: 3-digit number (001-999)

Hole Type Code	Description
A	Auger boring (hollow or solid stem, bucket)
R	Rotary drilled boring (conventional)
RC	Rotary core (self-cased wire-line, continuously-sampled)
RW	Rotary core (self-cased wire-line, not continuously sampled)
P	Rotary percussion boring (Air)
HD	Hand driven (1-inch soil tube)
HA	Hand auger
D	Driven (dynamic cone penetrometer)
CPT	Cone Penetration Test
O	Other (note on LOTB)

Description Sequence Examples:

SANDY lean CLAY (CL); very stiff; yellowish brown; moist; mostly fines; some SAND, from fine to medium; few gravels; medium plasticity; PP=2.75.

Well-graded SAND with SILT and GRAVEL and COBBLES (SW-SM); dense; brown; moist; mostly SAND, from fine to coarse; some fine GRAVEL; few fines; weak cementation; 10% GRANITE COBBLES; 3 to 6 inches; hard; subrounded.

Clayey SAND (SC); medium dense, light brown; wet; mostly fine sand,; little fines; low plasticity.

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BORING RECORD LEGEND #1

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 elastic 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 TESTS

C	Consolidation (ASTM D 2435-04)
CL	Collapse Potential (ASTM D 5333-03)
CP	Compaction Curve (CTM 216 - 06)
CR	Corrosion, Sulfates, Chlorides (CTM 643 - 99; CTM 417 - 06; CTM 422 - 06)
CU	Consolidated Undrained Triaxial (ASTM D 4767-02)
DS	Direct Shear (ASTM D 3080-04)
EI	Expansion Index (ASTM D 4829-03)
M	Moisture Content (ASTM D 2216-05)
OC	Organic Content (ASTM D 2974-07)
P	Permeability (CTM 220 - 05)
PA	Particle Size Analysis (ASTM D 422-63 [2002])
PI	Liquid Limit, Plastic Limit, Plasticity Index (AASHTO T 89-02, AASHTO T 90-00)
PL	Point Load Index (ASTM D 5731-05)
PM	Pressure Meter
PP	Pocket Penetrometer
R	R-Value (CTM 301 - 00)
SE	Sand Equivalent (CTM 217 - 99)
SG	Specific Gravity (AASHTO T 100-06)
SL	Shrinkage Limit (ASTM D 427-04)
SW	Swell Potential (ASTM D 4546-03)
TV	Pocket Torvane
UC	Unconfined Compression - Soil (ASTM D 2166-06) Unconfined Compression - Rock (ASTM D 2938-95)
UU	Unconsolidated Undrained Triaxial (ASTM D 2850-03)
UW	Unit Weight (ASTM D 4767-04)
VS	Vane Shear (AASHTO T 223-96 [2004])

SAMPLER GRAPHIC SYMBOLS

- Standard Penetration Test (SPT)
- Standard California Sampler
- Modified California Sampler
- Shelby Tube
- Piston Sampler
- NX Rock Core
- HQ Rock Core
- Bulk Sample
- Other (see remarks)

DRILLING METHOD SYMBOLS

- Auger Drilling
- Rotary Drilling
- Dynamic Cone or Hand Driven
- Diamond Core

WATER LEVEL SYMBOLS

- First Water Level Reading (during drilling)
- Static Water Level Reading (after drilling, date)

DEFINITIONS FOR CHANGE IN MATERIAL

Term	Definition	Symbol
Material Change	Change in material is observed in the sample or core, and the location of change can be accurately measured.	———
Estimated Material Change	Change in material cannot be accurately located because either the change is gradational or because of limitations in the drilling/sampling methods used.	- - - - - - - -
Soil/Rock Boundary	Material changes from soil characteristics to rock characteristics.	~~~~~

Ref.: Caltrans Soil and Rock Logging Classification, and Presentation Manual (2010)

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BORING RECORD LEGEND #2

CONSISTENCY OF COHESIVE SOILS

Descriptor	Shear Strength (tsf)	Pocket Penetrometer, PP Measurement (tsf)	Torvane, TV. Measurement (tsf)	Vane Shear, VS. Measurement (tsf)
Very Soft	< 0.12	< 0.25	< 0.12	< 0.12
Soft	0.12 - 0.25	0.25 - 0.50	0.12 - 0.25	0.12 - 0.25
Medium Stiff	0.25 - 0.50	0.50 - 1.0	0.25 - 0.50	0.25 - 0.50
Stiff	0.50 - 1.0	1.0 - 2.0	0.50 - 1.0	0.50 - 1.0
Very Stiff	1.0 - 2.0	2.0 - 4.0	1.0 - 2.0	1.0 - 2.0
Hard	> 2.0	> 4.0	> 2.0	> 2.0

APPARENT DENSITY OF COHESIONLESS SOILS

Descriptor	SPT N_{60} - Value (blows / foot)
Very Loose	0 - 5
Loose	5 - 10
Medium Dense	10 - 30
Dense	30 - 50
Very Dense	> 50

MOISTURE

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

PERCENT OR PROPORTION OF SOILS

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

PARTICLE SIZE

Descriptor		Size (in)
Boulder		> 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		< 1/300

PLASTICITY OF FINE-GRAINED SOILS

Descriptor	Criteria
Nonplastic	A 1/8-inch thread cannot be rolled at any water content.
Low	The thread can barely be rolled, and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll, and not much time is required to reach the plastic limit; it cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

CONSISTENCY OF COHESIVE SOILS VS. N_{60}

Description	SPT N_{60} (blows / foot)
Very Soft	0 - 2
Soft	2 - 4
Medium Stiff	4 - 8
Stiff	8 - 15
Very Stiff	15 - 30
Hard	> 30

Ref: Peck, Hansen, and Thornburn, 1974, "Foundation Engineering", Second Edition

Note: Only to be used (with caution) when pocket penetrometer or other data on undrained shear strength are unavailable. Not allowed by Caltrans Soil and Rock Logging and Classificaton Manual, 2010

CEMENTATION

Descriptor	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.

Ref.: Caltrans Soil and Rock Logging Classification, and Presentation Manual (2010), with the exception of consistency of cohesive soils vs. N_{60}.

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BORING RECORD LEGEND #3

ROCK GRAPHIC SYMBOLS


IGNEOUS ROCK


SEDIMENTARY ROCK


METAMORPHIC ROCK

BEDDING SPACING

Descriptor	Thickness or Spacing
Massive	> 10 ft
Very thickly bedded	3 to 10 ft
Thickly bedded	1 to 3 ft
Moderately bedded	3-5/8 inches to 1 ft
Thinly bedded	1-1/4 to 3-5/8 inches
Very thinly bedded	3/8 inch to 1-1/4 inches
Laminated	< 3/8 inch

WEATHERING DESCRIPTORS FOR INTACT ROCK

	Diagnostic Features					
	Chemical Weathering-Discoloration-Oxidation		Mechanical Weathering and Grain Boundary Conditions	Texture and Solutioning		
Descriptor	Body of Rock	Fracture Surfaces		Texture	Solutioning	General Characteristics
Fresh	No discoloration, not oxidized	No discoloration or oxidation	No separation, intact (tight)	No change	No solutioning	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 may be noted	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 (refer to grain boundary conditions)	All fracture surfaces are discolored or oxidized; surfaces are friable	Partial separation, rock is friable; in semi-arid conditions, granitics are disaggregated	Altered by chemical disintegration such as via hydration or 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 of 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".

Note: Combination descriptors (such as "slightly weathered to fresh") are used where equal distribution of both weathering characteristics is present over significant intervals or where characteristics present are "in between" the diagnostic feature. However, combination descriptors should not be used where significant identifiable zones can be delineated. Only two adjacent descriptors shall be combined. "Very intensely weathered" is the combination descriptor for "decomposed to intensely weathered".

RELATIVE STRENGTH OF INTACT ROCK

Descriptor	Uniaxial Compressive Strength (psi)
Extremely Strong	> 30,000
Very Strong	14,500 - 30,000
Strong	7,000 - 14,500
Medium Strong	3,500 - 7,000
Weak	700 - 3,500
Very Weak	150 - 700
Extremely Weak	< 150

ROCK HARDNESS

Descriptor	Criteria
Extremely Hard	Specimen cannot be scratched with pocket knife or sharp pick; can only be chipped with repeated heavy hammer blows
Very hard	Specimen cannot be scratched with pocket knife or sharp pick; breaks with repeated heavy hammer blows
Hard	Specimen can be scratched with pocket knife or sharp pick with heavy pressure; heavy hammer blows required to break specimen
Moderately Hard	Specimen can be scratched with pocket knife or sharp pick with light or moderate pressure; breaks with moderate hammer blows
Moderately Soft	Specimen can be grooved 1/6 in. with pocket knife or sharp pick with moderate or heavy pressure; breaks with light hammer blow or heavy hand pressure
Soft	Specimen can be grooved or gouged with pocket knife or sharp pick with light pressure, breaks with light to moderate hand pressure
Very Soft	Specimen can be readily indented, grooved, or gouged with fingernail, or carved with pocket knife; breaks with light hand pressure

CORE RECOVERY CALCULATION (%)

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

RQD CALCULATION (%)

$$\frac{\Sigma \text{ Length of intact core pieces} > 4 \text{ in.}}{\text{Total length of core run (in.)}} \times 100$$

FRACTURE DENSITY

Descriptor	Criteria
Unfractured	No fractures
Very Slightly Fractured	Lengths greater 3 ft
Slightly Fractured	Lengths from 1 to 3 ft, few lengths outside that range
Moderately Fractured	Lengths mostly in range of 4 in. to 1 ft, with most lengths about 8 in.
Intensely Fractured	Lengths average from 1 in. to 4 in. with scattered fragmented intervals with lengths less than 4 in.
Very Intensely Fractured	Mostly chips and fragments with few scattered short core lengths

Ref.: Caltrans Soil and Rock Logging Classification, and Presentation Manual (2010)

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BORING RECORD LEGEND #4

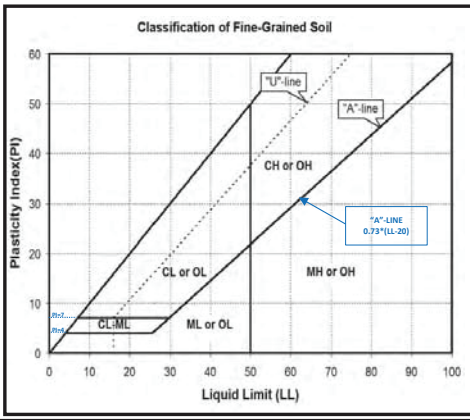
CLASSIFICATION OF INORGANIC FINE GRAINED SOILS (Soils with ≥50% finer than No. 200 Sieve)

GROUP SYMBOL				GROUP NAME
CL	<30% plus No. 200	<15% plus No. 200		Lean clay
		15-25% plus No. 200	%sand ≥%gravel	Lean clay with sand
			%sand <%gravel	Lean clay with gravel
	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel	Sandy lean clay
			≥15% gravel	Sandy lean clay with gravel
		% sand < % gravel	<15% sand	Gravelly lean clay
			≥15% sand	Gravelly lean clay with sand
ML	<30% plus No. 200	<15% plus No. 200		Silt
		15-25% plus No. 200	%sand ≥%gravel	Silt with sand
			%sand <%gravel	Silt with gravel
	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel	Sandy silt
			≥15% gravel	Sandy silt with gravel
		% sand < % gravel	<15% sand	Gravelly silt
			≥15% sand	Gravelly silt with sand
CH	<30% plus No. 200	<15% plus No. 200		Fat clay
		15-25% plus No. 200	%sand ≥%gravel	Fat clay with sand
			%sand <%gravel	Fat clay with gravel
	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel	Sandy fat clay
			≥15% gravel	Sandy fat clay with gravel
		% sand < % gravel	<15% sand	Gravelly fat clay
			≥15% sand	Gravelly fat clay with sand
MH	<30% plus No. 200	<15% plus No. 200		Elastic silt
		15-25% plus No. 200	%sand ≥%gravel	Elastic silt with sand
			%sand <%gravel	Elastic silt with gravel
	≥30% plus No. 200	% sand ≥ % gravel	<15% gravel	Sandy elastic silt
			≥15% gravel	Sandy elastic silt with gravel
		% sand < % gravel	<15% sand	Gravelly elastic silt
			≥15% sand	Gravelly elastic silt with sand

Reference:
ASTM D 2487 and 2488

Laboratory Classification of Clay and Silt

REFERENCE: Caltrans Soil and Rock Logging, Classification, and Presentation Manual (2010).



CL: LL<50; above A-Line.

CH: LL≥50; above A-Line.

ML: LL<50; below A-Line, or PI<4, or Non-Plastic

MH: LL≥50; below A-Line.

CL-ML: above A-Line and PI=4 to 7

CL/CH, ML/MH: at or near LL=50

ML/CL, MH/CH: at or near the A-Line

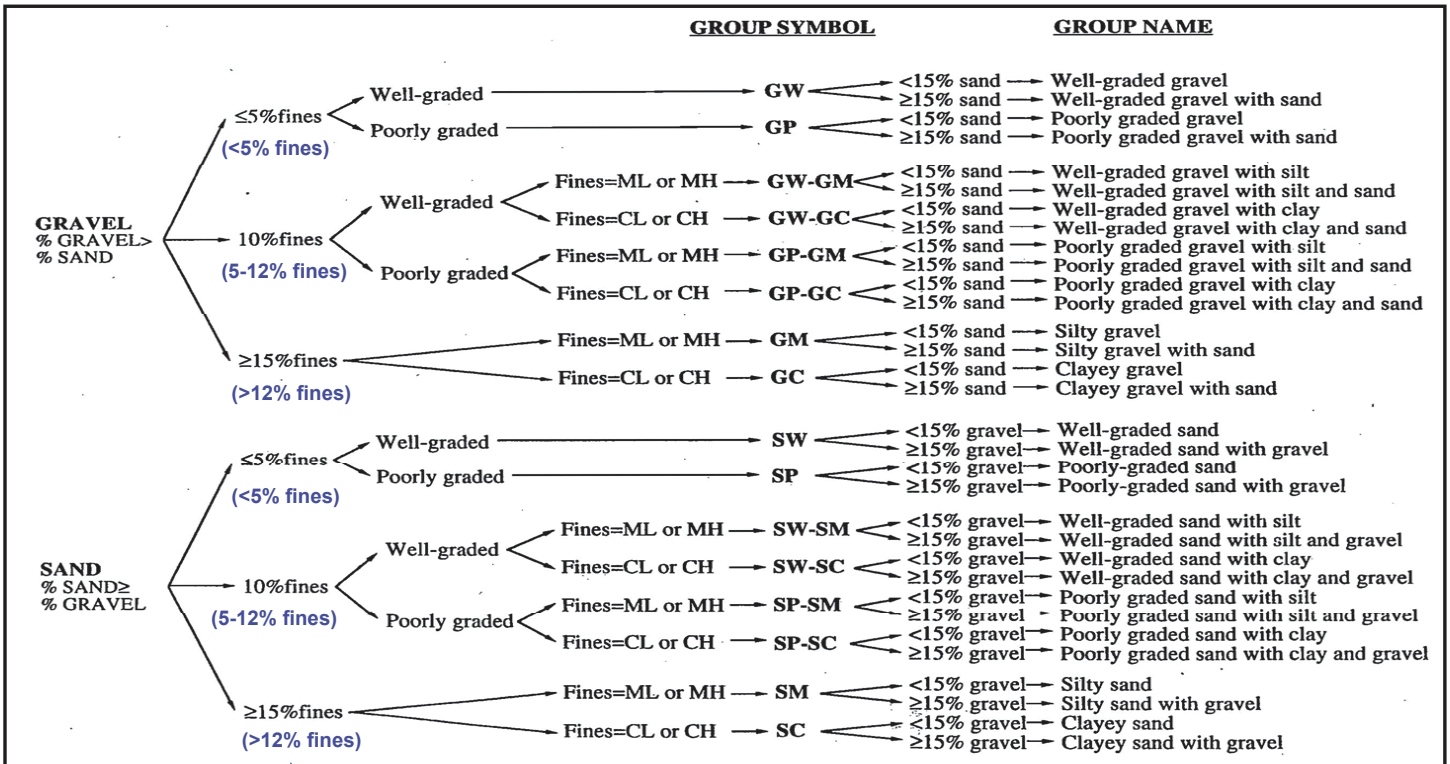
Field Identification of Clays and Silts

Group Symbol	Dry Strength	Dilatancy	Toughness	Plasticity
ML	None to low	Slow to rapid	Low or thread cannot be formed	Low to nonplastic
CL	Medium to high	None to slow	Medium	Medium
MH	Low to medium	None to slow	Low to medium	Low to medium
CH	High to very high	None	High	High

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KEY FOR SOIL CLASSIFICATION #1

CLASSIFICATION OF COARSE-GRAINED SOILS (Soils with <50% "fines" passing No. 200 Sieve)



Reference:

ASTM D 2487 and 2488

Note: Values estimated to nearest 5% to be used for visual identification, values in parentheses to be used for classification when based on laboratory grain size data.

Granular Soil Gradation Parameters

Coefficient of Uniformity: $C_u = D_{60}/D_{10}$

Coefficient of Curvature: $Cc = D_{30}^2 / (D_{60} \times D_{10})$

D_{10} = 10% of soil is finer than this diameter

D_{30} = 30% of soil is finer than this diameter

D_{60} = 60% of soil is finer than this diameter

Group Symbol	Gradation or Plasticity Requirement
SW	$C_u > 6$ and $1 \leq C_c \leq 3$
GW	$C_u > 4$ and $1 \leq C_c \leq 3$
GP or SP	Clean gravel or sand not meeting requirement for SW or GW
SM or GM	Non-plastic fines or below A-Line or PI<4
SC or GC	Plastic fines or above A-Line and PI>7

GROUP DELTA

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KEY FOR SOIL CLASSIFICATION #2

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Westside Reservoir Seismic & Structural Evaluation	IR794	**B-1**

DIST.	CO.	ROUTE	POSTMILE	BRIDGE NO.	CALTRANS PROJECT NUMBER & PHASE	START DATE	FINISH DATE	SHEET NO.
						6/29/2022	6/29/2022	1 of 3

SITE LOCATION	BOREHOLE LOCATION (Latitude; Longitude) DATUM: NAD 83	BOREHOLE LOCATION (Offset, Station, Line)
821 Glen Pl., S. Pasadena	34.104485°, -118.160172°	

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Liovin	CME 75	Hollow Stem Auger	G. Valdivia	C. Scheyhing

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
Hammer: 140 lbs., Drop: 30 in.	80	8	56.5	708 NAVD 88	▽ NE / *NE* DURING DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES	BOREHOLE BACKFILL & COMPLETION	
Bulk; SPT (1.4"); MC (2.4")	N_{60} =1.3 N_{SPT} =0.89N_{MC}	Soil cutting & rapidset concrete	AFTER DRILLING ▼ NE / *NE*

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOWS/FT	SPT N^*_{60}	RECOVERY (%)	RQD (%)	MOISTURE (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (LL:PI)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
															ASPHALT CONCRETE; 3-Inch
	705		B-1 R-2-2 R-2-1	24 38 50	88	78					44:21	PA CR PI			Clayey SAND with GRAVEL (SC); light brown; moist; some fine to medium grained SAND; some fines; little GRAVEL with CLAYSTONE fragments; low plasticity (FILL). (GRAVEL = 26%, SAND = 37%, fines = 37%). Very dense / Hard; PP > 4.5.
5			S-3	16 50/6"	100	133									
	700														
10			R-4-2 R-4-1	20 37 48	85	76			12	95		PA			SANDY lean CLAY (CL); hard; light brown; moist; some SAND; little GRAVEL with CLAYSTONE fragments; low plasticity. PP > 4.5 (GRAVEL = 15%, SAND = 34%, fines = 51%).
	695														
15			S-5	9 27 50	77	100									Lean CLAY with SAND (CL); hard; moist; light yellowish brown; little fine SAND; few CLAYSTONE fragments; medium plasticity; PP = 4.5.
	690														
20			R-6-1 R-6-2	39 50/5"	120	107			14	104					PP > 4.5.
	685														

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32 Mauchly, Suite B
Irvine, CA 92618

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FIGURE
a

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Westside Reservoir Seismic & Structural Evaluation	IR794	**B-1**

DIST.	CO.	ROUTE	POSTMILE	BRIDGE NO.	CALTRANS PROJECT NUMBER & PHASE	START DATE	FINISH DATE	SHEET NO.
						6/29/2022	6/29/2022	2 of 3

SITE LOCATION	BOREHOLE LOCATION (Latitude; Longitude) DATUM: NAD 83	BOREHOLE LOCATION (Offset, Station, Line)
821 Glen Pl., S. Pasadena	4485, -118.160172	

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Liovin	CME 75	Hollow Stem Auger	G. Valdivia	C. Scheyhing

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
Hammer: 140 lbs., Drop: 30 in.	80	8	56.5	708 NAVD 88	▽ NE / *NE* DURING DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES	BOREHOLE BACKFILL & COMPLETION	
Bulk; SPT (1.4"); MC (2.4")	N_{60} =1.3 N_{SPT} =0.89N_{MC}	Soil cutting & rapidset concrete	▼ NE / *NE* AFTER DRILLING

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOWS/FT	SPT N^*_{60}	RECOVERY (%)	RQD (%)	MOISTURE (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (LL:PI)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
			S-7	9 13 19	32	42									Lean CLAY with SAND (CL) (continued). PP > 4.5
	680														SEDIMENTARY ROCK (POORLY INDURATED SILTSTONE/CLAYSTONE); brown; very soft; (SANDY lean CLAY to Lean CLAY with SAND (CL); hard; brown; moist; little fine SAND; few of CLAYSTONE fragments; medium plasticity.)
30			R-8-2 R-8-1	7 29 50	79	70						DS			PP > 4.5
	675														
35			S-9	31 50/6"	100	130									
	670														
40			R-10-1	10 50/6"	100	89			17	99					PP = 4.5.
	665														
45			S-11	50/2"	REF	REF									Red Brown.
	660														

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FIGURE
b

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Westside Reservoir Seismic & Structural Evaluation	IR794	**B-1**

DIST.	CO.	ROUTE	POSTMILE	BRIDGE NO.	CALTRANS PROJECT NUMBER & PHASE	START DATE	FINISH DATE	SHEET NO.
						6/29/2022	6/29/2022	3 of 3

SITE LOCATION	BOREHOLE LOCATION (Latitude; Longitude) DATUM: NAD 83	BOREHOLE LOCATION (Offset, Station, Line)
821 Glen Place, South Pasadena, CA	34.114485, -118.160172	

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Liovin	CME 75	Hollow Stem Auger	G. Valdivia	C. Scheyhing

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
Hammer: 140 lbs., Drop: 30 in.	80	8	56.5	708 NAVD 88	▽ NE / *NE* DURING DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES	BOREHOLE BACKFILL & COMPLETION	
Bulk; SPT (1.4"); MC (2.4")	N_{60} =1.3 N_{SPT} =0.89N_{MC}	Soil cutting & rapidset concrete	▼ NE / *NE* AFTER DRILLING

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOWS/FT	SPT N^*_{60}	RECOVERY (%)	RQD (%)	MOISTURE (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (LL:PI)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
			R-12-1	12 50/6"	100	89									PP > 4.5.
	655														
55			S-13	35 41 50	91	118						PA			Few GRAVEL. (GRAVEL = 9%, SAND = 37%, fines = 54%).
															Bottom of borehole at 56.5 ft. Boring terminated at planned depth.
	650														This Boring Record was prepared in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual (2010).
60															
	645														
65															
	640														
70															
	635														

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FIGURE
C

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Westside Reservoir Seismic & Structural Evaluation	IR794	**B-2**

DIST.	CO.	ROUTE	POSTMILE	BRIDGE NO.	CALTRANS PROJECT NUMBER & PHASE	START DATE	FINISH DATE	SHEET NO.
						6/29/2022	6/29/2022	1 of 2

SITE LOCATION	BOREHOLE LOCATION (Latitude; Longitude) DATUM: NAD 83	BOREHOLE LOCATION (Offset, Station, Line)
821 Glen Pl., S. Pasadena	34.104688°, -118.159986°	

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Liovin	CME 75	Hollow Stem Auger	G. Valdivia	C. Scheyhing

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
Hammer: 140 lbs., Drop: 30 in.	80	8	46.5	707 NAVD 88	▽ NE / *NE* DURING DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES	BOREHOLE BACKFILL & COMPLETION	
Bulk; SPT (1.4"); MC (2.4")	N_{60} =1.3 N_{SPT} =0.89N_{MC}	Soil cutting & rapidset concrete	▼ NE / *NE* AFTER DRILLING

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOWS/FT	SPT N^*_{60}	RECOVERY (%)	RQD (%)	MOISTURE (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (LL:PI)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
															ASPHALT CONCRETE: 3-Inch
	705														SANDY lean CLAY (CL); light brown; moist; some fine SAND; medium plasticity (FILL). Hard; trace of GRAVEL; PP > 4.5
			B-1 R-2-2 R-2-1	28 33 50	83	74						DS			
5			R-3-2 R-3-1	25 30 42	72	64			13	100					Lean CLAY with SAND (CL); hard; light brown; moist; little fine SAND; trace of GRAVEL and CLAYSTONE; medium plasticity; PP > 4.5.
	700														
10			S-4	7 10 13	23	30									
	695														
15			R-5-2 R-5-1	5 11 16	27	35									PP = 4.25
	690														
20			S-6	7 9 9	18	23									SANDY lean CLAY (CL); very stiff; light brown; moist; some fine SAND; trace of CLAYSTONE fragments; medium plasticity.
	685														

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GROUP DELTA CONSULTANTS, INC.
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Irvine, CA 92618

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FIGURE
a

BORING RECORD

PROJECT NAME	PROJECT NUMBER	HOLE ID
Westside Reservoir Seismic & Structural Evaluation	IR794	**B-2**

DIST.	CO.	ROUTE	POSTMILE	BRIDGE NO.	CALTRANS PROJECT NUMBER & PHASE	START DATE	FINISH DATE	SHEET NO.
						6/29/2022	6/29/2022	2 of 2

SITE LOCATION	BOREHOLE LOCATION (Latitude; Longitude) DATUM: NAD 83	BOREHOLE LOCATION (Offset, Station, Line)
821 Glen Place, South Pasadena, CA	34.104688, -118.159986	

DRILLING COMPANY	DRILL RIG	DRILLING METHOD	LOGGED BY	CHECKED BY
ABC Liovin	CME 75	Hollow Stem Auger	G. Valdivia	C. Scheyhing

HAMMER TYPE (WEIGHT/DROP)	HAMMER EFFICIENCY (ERi)	BORING DIA. (in)	TOTAL DEPTH (ft)	GROUND ELEV (ft)	DEPTH/*ELEV.* GW (ft)
Hammer: 140 lbs., Drop: 30 in.	80	8	46.5	707 NAVD 88	▽ NE / *NE* DURING DRILLING

DRIVE SAMPLER TYPE(S) & SIZE (ID)	NOTES	BOREHOLE BACKFILL & COMPLETION	
Bulk; SPT (1.4"); MC (2.4")	N_{60} =1.3 N_{SPT} =0.89N_{MC}	Soil cutting & rapidset concrete	▼ NE / *NE* AFTER DRILLING

DEPTH (feet)	ELEVATION (feet)	SAMPLE TYPE	SAMPLE NO.	PENETRATION RESISTANCE (BLOWS / 6 IN)	BLOWS/FT	SPT N^*_{60}	RECOVERY (%)	RQD (%)	MOISTURE (%)	DRY DENSITY (pcf)	ATTERBERG LIMITS (LL:PI)	OTHER TESTS	DRILLING METHOD	GRAPHIC LOG	DESCRIPTION AND CLASSIFICATION
			R-7-2 R-7-1	3 8 11	19	17									Poorly graded SAND with SILT (SP-SM); medium dense; light gray; moist; mostly coarse SAND. Note: likely utility trench backfill.
	680														
30			S-8	4 3 3	6	8									SEDIMENTARY ROCK (POORLY INDURATED SILTSTONE / CLAYSTONE); gray brown; very soft; (Lean CLAY with SAND (CL); hard; brown; moist; little fine SAND; medium plasticity; PP = 4.5).
	675														
35			R-9-2 R-9-1	17 18 29	47	42					40:15	PA PI			(CLAYEY SAND (SC); dense; olive brown; moist; mostly fine grained SAND; some fines; trace GRAVEL). (GRAVEL = 5%, SAND = 56%, fines = 39%).
	670														
40			S-10	7 17 50	67	87									(Lean CLAY with SAND (CL); hard; yellowish brown; moist; little fine SAND; medium plasticity; PP = 4.5).
	665														
45			R-11-1	12 14 15	29	26									PP > 4.5.
	660														Bottom of borehole at 46.5 ft. Boring terminated at planned depth. This Boring Record was prepared in accordance with the Caltrans Soil & Rock Logging, Classification, and Presentation Manual (2010).

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FIGURE
b

Hammer Efficiency Calibration

EARTHSPECTIVES
1920 E Warner Avenue, Suite 3-M
Santa Ana, California 92705

Phone: (949) 777-1270
Fax: (949) 777-1283

January 4, 2022

ABC Liovin Drilling Inc.
1180 East Burnett Street
Signal Hill, California 90755
Attention: Mr. Mario Romero

Dear Mr. Romero:

SPT Hammer Energy Measurement
Drill Rigs # R-9
ES Project No. 220101-365

INTRODUCTION

This letter report summarizes the results of EarthSpectives' (ES) SPT hammer energy measurements performed on January 3, 2022. It provides a description of the test program and the results.

SPT energy measurements were accomplished using a Pile Driving Analyzer (PDA-8G) system manufactured by Pile Dynamics, Inc. and was conducted in general accordance with ASTM 4945 and 6066 test standards. Results are summarized in Table 1, while more details regarding energy records are provided in Appendix A.

TESTING CONDITIONS

SPT hammer energy measurements were performed on drill rig R-9 (CME75 Serial Number 177367). Testing was performed on a Drill Rig equipped with an auto Trip hammer. Samplings were performed using AWJ drilling rod.

INSTRUMENTATION

SPT energy measurements were performed by placing a 2 ft instrumented section of drill rod at the top of the drill string between the hammer and the sampling rods. The instruments consist of two sets of accelerometers and strain transducers, mounted on opposite sides of the drill rod, with a view to evaluate normal and eccentric effects. The analyzer acquired and processed the signals during sampling, and provided real-time evaluations of the maximum SPT hammer transferred energy. The raw data were stored directly on a portable field computer for subsequent analysis in the office.

RESULTS

Results from SPT hammer energy measurements are summarized in Tables 1. It shows the Energy Transfer Ratio (ETR) for every sampling depth for the tested drill rig/hammer. ETR is the ratio of the measured maximum transferred energy to rated energy of the hammer which is the product of the weight of the hammer times the height of fall (140 lb x 30 inches = 4200 lb-in = 0.35 kip-ft).

Plots of the maximum transferred energy, energy transfer ratio, and blow rate is provided as function of depth in Appendix A. Table immediately following the plot also provides the minimum, maximum, and average values at every sampling depth. In general, average ETR value for the tested hammer R-9 was 80%, over all the sampling intervals as shown in Table 1.

TABLE 1 – SUMMARY OF SPT HAMMER ENERGY MEASUREMTS

Drill Rig Number Model	**AVERAGE SPT HAMMER EFFICIENCY (ENERGY TRANSFER RATIO)**			
	Data Set # 1	Data Set # 2	Data Set # 3	Data Set # 4
Drill Rig R-9	78%	80%	81%	80%

LIMITATIONS

Professional judgments represented in this report are based on evaluations of the technical information gathered, our understanding of the proposed construction, and our general experience in the geotechnical field. We do not guarantee the performance of the project in any respect, only that our engineering work and judgments are rendered while striving to meet the standard of care of our profession at this time.

CLOSURE

We hope the above information satisfies the project needs at this time. Please call if you have any question or need more information.

Sincerely submitted for EarthSpectives,

Hossein Rashidi

Hossein K. Rashidi, PhD, PE
Principal Engineer

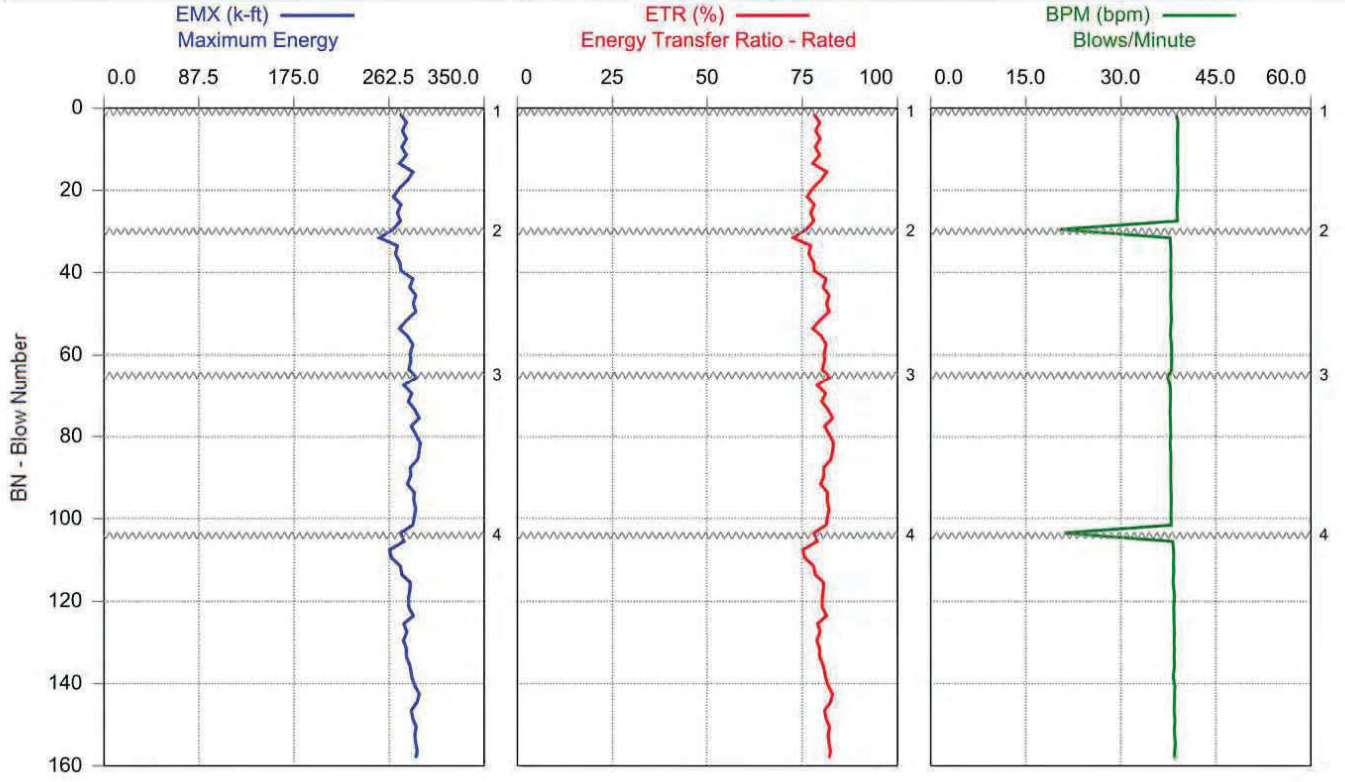


Appendix A
SPT Hammer Energy Data

Pile Dynamics, Inc. - PDIPLOT2 Ver 2021.1.61.0 - Case Method & iCAP® Results

Printed: 03-January-2022 **Test started: 03-January-2022**

ABC Liovin Drilling - Rig No: R9
CME 75, Hammer SN: 177367



1 - Sample #1
2 - Sample #2
3 - Sample #3
4 - Sample #4

Case Method & iCAP® Results

ABC Liovin Drilling - Rig No: R9
OP: US

CME 75, Hammer SN: 177367
Date: 03-January-2022

AR: 1.18 in²
LE: 8.50 ft
WS: 16,807.9 f/s

SP: 0.492 k/ft³
EM: 30,000 ksi
JC: 0.90

EMX: Maximum Energy
ETR: Energy Transfer Ratio - Rated

BPM: Blows/Minute

BL#	TYPE	EMX k-ft	ETR (%)	BPM bpm
30	AV30	274	78	37.7
	MAX	289	83	39.1
	MIN	256	73	1.9
66	AV36	278	80	37.9
	MAX	296	85	38.1
	MIN	241	69	36.9
104	AV38	284	81	37.0
	MAX	293	84	38.1
	MIN	261	75	4.0
158	AV53	281	80	38.4
	MAX	291	83	38.7
	MIN	260	74	38.1
Average		280	80	37.8
Maximum		296	85	39.1
Minimum		241	69	1.9

Total number of blows analyzed: 157

BL# Sensors

1-158 F3: [583 AWJ-1] 212.2 (1.00); F4: [583 AWJ-2] 210.2 (1.00); A1: [K3041] 313.4 (1.00); A2: [K11285] 370.6 (1.00)

Time Summary

Drive	43 seconds	9:32 AM - 9:32 AM (1/3/2022) BN 1 - 29
Stop	7 minutes 29 seconds	9:32 AM - 9:40 AM
Drive	55 seconds	9:40 AM - 9:41 AM BN 30 - 65
Stop	6 minutes 16 seconds	9:41 AM - 9:47 AM
Drive	58 seconds	9:47 AM - 9:48 AM BN 66 - 103
Stop	8 minutes 59 seconds	9:48 AM - 9:57 AM
Drive	1 minute 28 seconds	9:57 AM - 9:59 AM BN 104 - 158

Total time [00:26:51] = (Driving [00:04:05] + Stop [00:22:45])

APPENDIX B
LABORATORY TESTING

APPENDIX B
LABORATORY TESTING

B.1 General

The laboratory testing was performed using appropriate American Society for Testing and Materials (ASTM) and Caltrans Test Methods (CTM).

Modified California drive samples, Standard Penetration Test (SPT) drive samples and bulk samples collected during the field investigation were carefully sealed in the field to prevent moisture loss. The samples of earth materials were then transported to the laboratory for further examination and testing. Tests were performed on selected samples as an aid in classifying the earth materials and to evaluate their physical properties and engineering characteristics. Laboratory testing for this investigation included:

- Soil Classification: USCS (ASTM D 2487) and Visual Manual (ASTM D 2488);
- Moisture content (ASTM D 2216) and Dry Unit Weight (ASTM D 2937);
- Atterberg Limits (ASTM D 4318);
- Grain Size Distribution (ASTM D 422) & % Passing #200 Sieve (ASTM D 1140);
- Direct Shear (ASTM D 3080);
- Soil Corrosivity:
    - pH (CTM 643);
    - Water-Soluble Sulfate (ASTM D 516, CTM 417);
    - Water-Soluble Chloride(Ion-Specific Probe, CTM 422);
    - Minimum Electrical Resistivity (CTM 643);

A summary of laboratory test results is presented in Table B-1. Brief descriptions of the laboratory testing program and test results are presented below.

B.2 Soil and Rock Classification

Earth materials recovered from subsurface explorations were classified in general accordance with Caltrans' "Soil and Rock Logging Classification Manual, 2010". The subsurface soils were classified visually / manually in the field in accordance with the Unified Soil Classification System (USCS) following ASTM D 2488; soil classifications were modified as necessary based on testing in the laboratory in accordance with ASTM D 2487. Rock materials were classified using a hybrid of the International Society of Rock Mechanics (ISRM) (1981) standards and the Bureau of Reclamation (2001) standards, and modified where necessary on the basis of laboratory test results. The details of the soil and rock classification systems and boring records presenting the classifications are presented in Appendix A.

B.3 Moisture Content and Dry Unit Weight

The in-situ moisture content of selected bulk, SPT and Ring samples was determined by oven drying in general accordance with ASTM D 2216. Selected California samples were trimmed flush in the metal rings and wet weight was measured. After drying, the dry weight of each sample was measured, volume and weight of the metal containers was measured, and moisture content and dry density were calculated in general accordance with ASTM D 2216 and D 2937. Results of these tests are presented in Table B-1 and on the boring records in Appendix A.

B.4 Atterberg Limits

Characterization of the fine-grained fractions of soils was evaluated using the Atterberg Limits. This test includes Liquid Limit and Plastic Limit tests to determine the Plasticity Index in accordance with ASTM D 4318. Results of these tests are presented on the boring records in Appendix A, are summarized in Table B-1, and are plotted on a Plasticity Chart in Figures of this Appendix.

B.5 Grain Size Distribution and Percent Passing No. 200 Sieve:

Representative samples were dried, weighed, soaked in water until individual soil particles were separated, and then washed on the No. 200 sieve. The percentage of fines (soil passing No. 200 sieve) was determined for selected samples in accordance with ASTM D 1140. For selected samples the washed fraction retained on the No. 200 sieve was then screened on a No. 4 sieve, and the fraction retained on No. 4 was weighed to determine the percentage of gravel. For selected samples, the washed material retained on No. 200 sieve was shaken through a standard stack of sieves in accordance with ASTM D 422 to determine the grain size distribution. The results of grain size distribution tests are plotted in Figures of this appendix. The relative proportion (or percentage) by dry weight of gravel (retained on No. 4 sieve), sand (passing No. 4 and retained on No. 200 sieve), and fines (passing No. 200 sieve) are listed on the boring records in Appendix A and summarized in Table B-1.

B.6 Direct Shear Test

To determine the drained shear strength parameters of the on-site soils, direct shear tests were performed on selected in situ samples in accordance with ASTM D 3080. After the initial weight and volume measurements were made, the sample was placed in the shear machine, and a selected normal load was applied. The sample was saturated or kept at field moisture (to model worst case field conditions), allowed to consolidate under the selected normal load, and then sheared to failure. Shear rate was selected to maintain drained conditions. Shear stress and vertical/horizontal sample deformations were monitored throughout the test. The process was repeated on additional samples of the same soil material at two additional normal loads. The test results are presented in Figures of this appendix.

B.7 Soil Corrosivity

Tests were performed in order to determine corrosion potential of site soils on concrete and ferrous metals. Corrosivity testing included minimum electrical resistivity and soil pH (Caltrans method 643), water-soluble chlorides (Orion 170A+ Ion Probe or Caltrans Test Method 422), and water-soluble sulfates (ASTM D 516). The test results are summarized presented in Figures in Table B-1 of this appendix.

B.8 List of Attached Figures

The following tables and figures are attached and complete this appendix:

List of Tables

Table B-1 Summary of Laboratory Test Results

List of Figures

- Atterberg Limits Test Results
- Grain Size Analysis Test Results
- Direct Shear Test Results
- Corrosion Test Results

Boring No.	Sample No.	Depth (ft)	Sample Type	Geologic Unit	USCS Group Symbol	SPT N*60 (blows/ft)	Undrained Shear Strength, Su (ksf)			Moisture Content (%)	Dry Unit Weight (pcf)	Total Unit Wt (pcf)	Atterberg Limits			Grain Size Distribution (%) by dry weight			Clay	Other Tests
							Pocket Pen.	Mini Vane	UU Test				LL	PL	PI	Gravel	Sand	Fines		
B-1	B-1	0.3	BULK	Fill	CL											26	37	37		PA, CR
B-1	R-2	2.5	MC	Fill	CL	78	>4.5													
B-1	R-2-2	3.0	MC	Fill	CL		>4.5						44	23	21					PI
B-1	R-2-1	3.5	MC	Fill	CL		>4.5													
B-1	S-3	5.0	SPT	Fill	CL	133														
B-1	R-4	10.0	MC	Fill	CL	76	>4.5													
B-1	R-4-2	10.5	MC	Fill	CL		>4.5			12.0	95	106				15	34	51		PA
B-1	R-4-1	11.0	MC	Fill	CL		>4.5													
B-1	S-5	15.0	SPT	Fill	CL	100	4.5													
B-1	R-6-2	20.0	MC	Fill	CL	107	>4.5													
B-1	R-6-1	20.4	MC	Fill	CL		>4.5			14.0	104	119								
B-1	S-7	25.0	SPT	Fill	CL	42	>4.5													
B-1	R-8	30.0	MC	Tmsl	CL	70														
B-1	R-8-2	30.5	MC	Tmsl	CL															
B-1	R-8-1	31.0	MC	Tmsl	CL															DS
B-1	S-9	35.0	SPT	Tmsl	CL	130	3.0													
B-1	R-10	40.0	MC	Tmsl	CL	89	4.0													
B-1	R-10-1	40.5	MC	Tmsl	CL		4.0			17.0	99	116								
B-1	S-11	45.0	SPT	Tmsl	CL	REF														
B-1	R-12	50.0	MC	Tmsl	CL	89	>4.5													
B-1	R-12-1	50.5	MC	Tmsl	CL		>4.5													
B-1	S-13	55.0	SPT	Tmsl	CL	118	>4.5									9	37	54		PA
B-2	B-1	0.3	BULK	Fill	CL															
B-2	R-2	2.5	MC	Fill	CL	74	>4.5													
B-2	R-2-2	3.0	MC	Fill	CL		>4.5													
B-2	R-2-1	3.5	MC	Fill	CL		>4.5													DS
B-2	R-3	5.0	MC	Fill	CL	64	>4.5													
B-2	R-3-2	5.5	MC	Fill	CL		>4.5			13.0	100	113								
B-2	R-3-1	6.0	MC	Fill	CL		>4.5													
B-2	S-4	10.0	SPT	Fill	CL	30	>4.5													

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TABLE B-1: Summary of Laboratory Results

Project: Westside Reservoir Seismic and Structural Evaluation

Location: 821 Glen Place, South Pasadena, CA 91030

Number: IR794

GDC TABLE B-1 (2014) IR794 - WESTSIDE RESERVOIR SEISMIC & STRUCTURAL.GPJ GDC2013.GDT 7/25/22

Boring No.	Sample No.	Depth (ft)	Sample Type	Geologic Unit	USCS Group Symbol	SPT N*60 (blows/ft)	Undrained Shear Strength, Su (ksf)			Moisture Content (%)	Dry Unit Weight (pcf)	Total Unit Wt (pcf)	Atterberg Limits			Grain Size Distribution (%) by dry weight			Clay	Other Tests
							Pocket Pen.	Mini Vane	UU Test				LL	PL	PI	Gravel	Sand	Fines		
B-2	R-5	15.0	MC	Fill	CL	35	4.25													
B-2	R-5-2	15.5	MC	Fill	CL		4.25													
B-2	R-5-1	16.0	MC	Fill	CL		4.25													
B-2	S-6	20.0	SPT	Fill	CL	23														
B-2	R-7	25.0	MC	Fill	SP-SM	17														
B-2	R-7-2	25.5	MC	Fill	SP-SM															
B-2	R-7-1	26.0	MC	Tmsl	SP-SM															
B-2	S-8	30.0	SPT	Tmsl	CL	30	4.5													
B-2	R-9	35.0	MC	Tmsl	SC	42	>4.5													
B-2	R-9-2	35.5	MC	Tmsl	SC		>4.5									5	56	39		PA
B-2	R-9-1	36.0	MC	Tmsl	CL		>4.5						40	25	15					PI
B-2	S-10	40.0	SPT	Tmsl	CL	87	4.5													
B-2	R-11	45.0	MC	Tmsl	CL	26	>4.5													
B-2	R-11-1	46.0	MC	Tmsl	CL		>4.5													

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TABLE B-1: Summary of Laboratory Results

Project: Westside Reservoir Seismic and Structural Evaluation

Location: 821 Glen Place, South Pasadena, CA 91030

Number: IR794

GDC TABLE B-1 (2014) IR794 - WESTSIDE RESERVOIR SEISMIC & STRUCTURAL.GPJ GDC2013.GDT 7/25/22

Moisture Density Test Results

GROUP DELTA

Moisture, Density and Classification of Soil (ASTM D-2937 / 2487 / 2488)

Project Number : _____ **Project Name :** D e t e e er or e mc tructural aluat o **Lab #**

Test Standard : ☐ CAL TRANS ☑ ASTM ☐ Other **Unit Used (English / SI) :** E

Sampled By :	Received By :	Tested By : rc .	Computed By : rc .	Checked By :
Date :	Date :	Date :	Date :	Date :

Boring No .																							
Sample No. (B-Bulk, S-SPT, D-Drive, T-Tube)	D			D			D				D												
Sample Depth (ft/m)	.	.		.	.		.	.			.	.											
Sample Type (R-Ring, B-Bulk, MB-Medium , SB-Small Bag)																							
U.S.C.S.																							
Description (Well, Poorly, Graded) (Boulder>1', Cobbles>3"<1')	a la			la e a			la e a				la w t a												
Trace (< 5%), Few (5-10%), Little (15-25%), Some (30-45%), Mostly (> 50%)	w t la to e			w t cru e			w t cru e				cru e												
(Stratified, Laminated, Fissured, Blocky, Lensed, Homogeneous)	lt to e			oc			oc				oc												
Presence of Roots or R Holes, Mica, Gypsum, Calcium Carbonate, Caliche				la to e			la to e				la to e												
Shale Chunk, Crush Sand Stone/Rock, Broken Shells, Slag, Granite, Nodule				lt to e			lt to e				lt to e												
Color (Brown, Dark, Gray or Grayish, Light, Olive)	Dar ellow			Dar ellow			row				Dar ellow												
(Pale, Red or Redish, Very, Yellow or Yellowish)	row			row							row												
Moisture State (Dry, Moist, Wet)	o t			o t			o t				o t												
Maximum Particle Size (inch or No. of Sieve)																							
Grain Size Distribution (%) (Gravel : Sand : Fine)																							
Sand Size (Coarse / Medium / Fine)																							
Plasticity (N-No, L-Low, M-Medium, H-High)																							
Consistency / Relative Density																							
Reaction to 10% of HCL (None, Weak, Strong)																							
Moisture Content (%)	.			.			.				.												
Wet Density (pcf)	.			.			.				.												
Dry Density (pcf)	.			.			.				.												
Void Ratio	.			.			.				.												
Porosity (%)	.			.			.				.												
Container Number																							
Total Wet Wt. Soil + (Ring / Tube),(gm)	.			.			.				.												
Total Length of Sample (inch)																							
Wet Weight of Soil + Container (gm)	.			.			.				.												
Dry Weight of Soil + Container (gm)	.			.			.				.												
Weight of Container (gm)	.			.			.				.												
Unit Weight of Tube or Ring (gm/inch)	.			.			.				.												
Average Interior Diameter (inch)	.			.			.				.												
Unit Volume (ft^3)	.			.			.				.												
Specific Gravity (Assuming)	.			.			.			.	.			.			.			.			
Pocket Penetrometer (tsf)																							
Torvane Shear (kg/cm^2)																							
Grain Size Distribution (%) (Gravel : Sand : Fine)																							
Sand Equivalent																							
Atterberg Limits (LL/PL/PI)																							
Soil-Minimum Resisivity / (ohm-cm)																							
Soil-(pH)																							
Soil-Soluble Sulfate Content-(ppm)																							
Soil-Moisture Free Chloride Content-(ppm)																							
Max. Dry Density/OPT Moisture (pcf/%)																							
" R " Value																							
Sample Remained (Ring, gm, Ran Out)																							

Atterberg Limit Test Results

ATTERBERG LIMITS

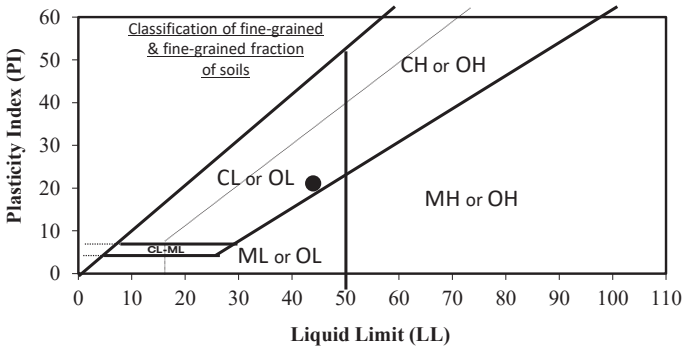
ASTM D-4318 / AASHTO T-89 / CTM 204

Project Name:	*AKD Westside Reservoir*	Tested By :	*Eric Y.*	Date:	*07/06/22*
Project No. :	*IR794*	Data Input By:	*Eric Y.*	Date:	*07/07/22*
Boring No.:	*B-1*	Checked By:		Date:	
Sample No. :	*R2-2*	Depth (ft.) :	*2.5*		
Initial Moisture:	*11.43%*	Container No.:	*AL-9*		
Description.:	*Yellowish Brown Sandy Silty Clay with Claystone/Siltstone*				

	PLASTIC LIMIT		LIQUID LIMIT			
TEST NO.	1	2	1	2	3	4
Number of Blows [N]			33	24	17	
Container No.	6	7	8	9	10	
Wet Wt. of Soil + Cont. (gm.)	33.14	33.50	37.13	39.33	39.06	
Dry Wt. of Soil + Cont. (gm.)	31.82	32.14	33.36	35.31	34.72	
Wt. of Container (gm.)	25.99	26.13	24.52	26.22	25.23	
Moisture Content (%) [Wn]	22.64	22.63	42.65	44.22	45.73	

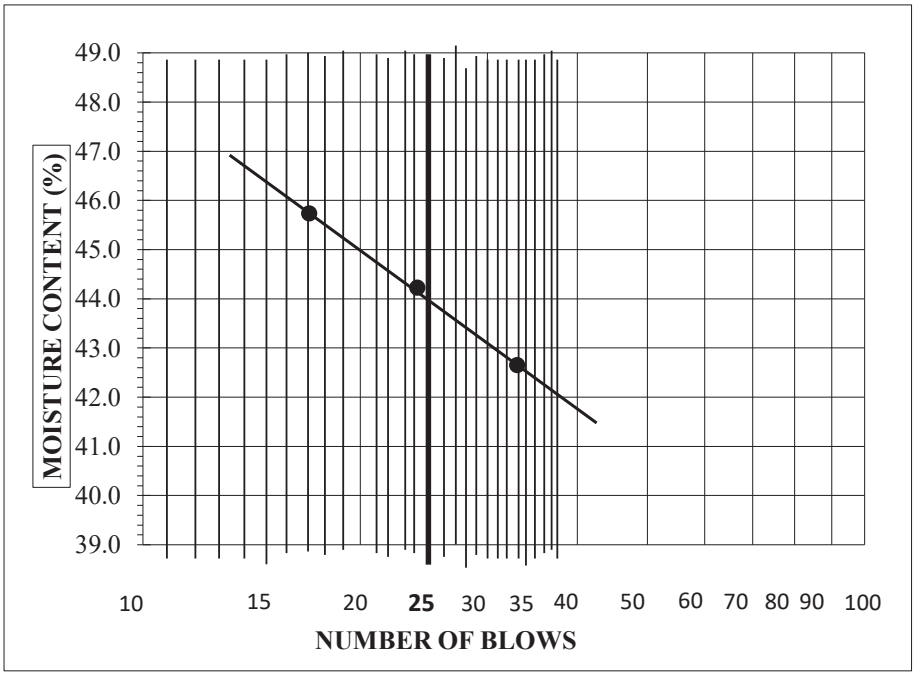
LIQUID LIMIT	**44**
PLASTIC LIMIT	**23**
PLASTICITY INDEX	**21**
PI at "A" - Line = 0.73(LL-20) =	**17.5**

One - Point Liquid Limit Calculation $LL=Wn(N/25)^{0.121}$



PROCEDURES USED

- ☐ Wet Preparation
  - Multipoint Wet Preparation
- ☒ Dry Preparation
  - Multipoint Dry Preparation
- ☒ Procedure A
  - Multipoint Test
- ☐ Procedure B
  - One-point Test



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ATTERBERG LIMITS

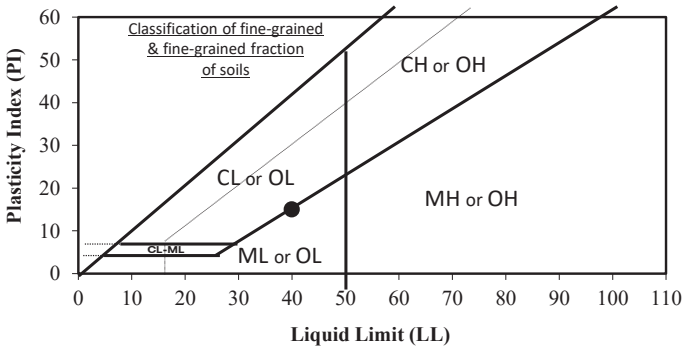
ASTM D-4318 / AASHTO T-89 / CTM 204

Project Name:	*AKD Westside Reservoir*	Tested By :	*Eric Y.*	Date:	*07/06/22*
Project No. :	*IR794*	Data Input By:	*Eric Y.*	Date:	*07/07/22*
Boring No.:	*B-2*	Checked By:		Date:	
Sample No. :	*R9-1*	Depth (ft.) :	*35*		
Initial Moisture:	*21.16%*	Container No.:	*AL-10*		
Description.:	*Yellowish Brown Sandy Clay/ Sandy Silt with Claystone/Siltstone*				

	PLASTIC LIMIT		LIQUID LIMIT			
TEST NO.	1	2	1	2	3	4
Number of Blows [N]			34	25	17	
Container No.	16	17	18	19	20	
Wet Wt. of Soil + Cont. (gm.)	32.17	31.50	38.87	40.09	37.62	
Dry Wt. of Soil + Cont. (gm.)	30.76	30.14	35.50	36.23	33.74	
Wt. of Container (gm.)	25.04	24.60	26.72	26.60	24.54	
Moisture Content (%) [Wn]	24.65	24.55	38.38	40.08	42.17	

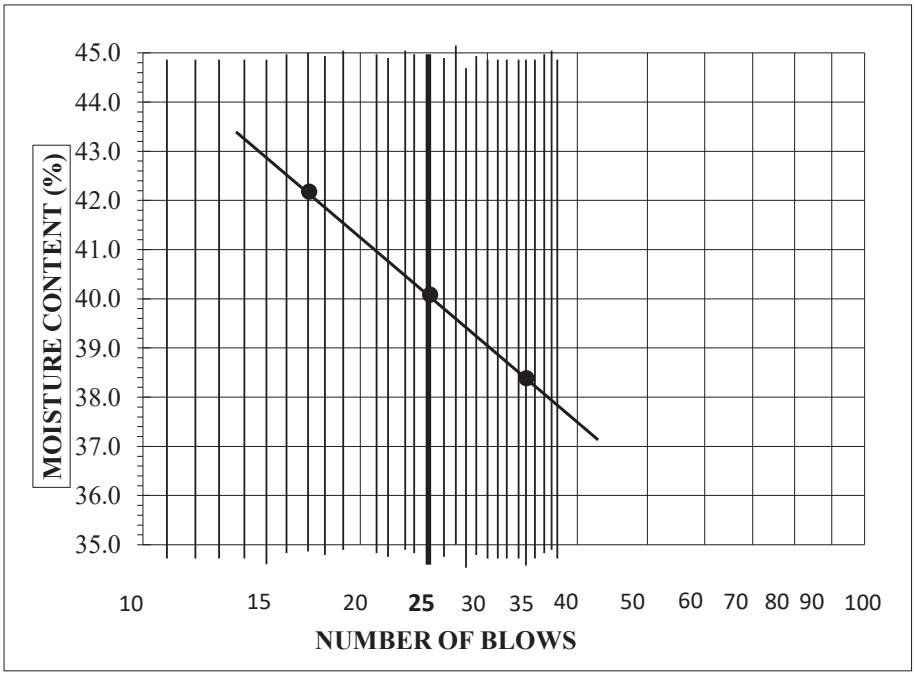
LIQUID LIMIT	**40**
PLASTIC LIMIT	**25**
PLASTICITY INDEX	**15**
PI at "A" - Line = 0.73(LL-20) =	**14.6**

One - Point Liquid Limit Calculation $LL=Wn(N/25)^{0.121}$



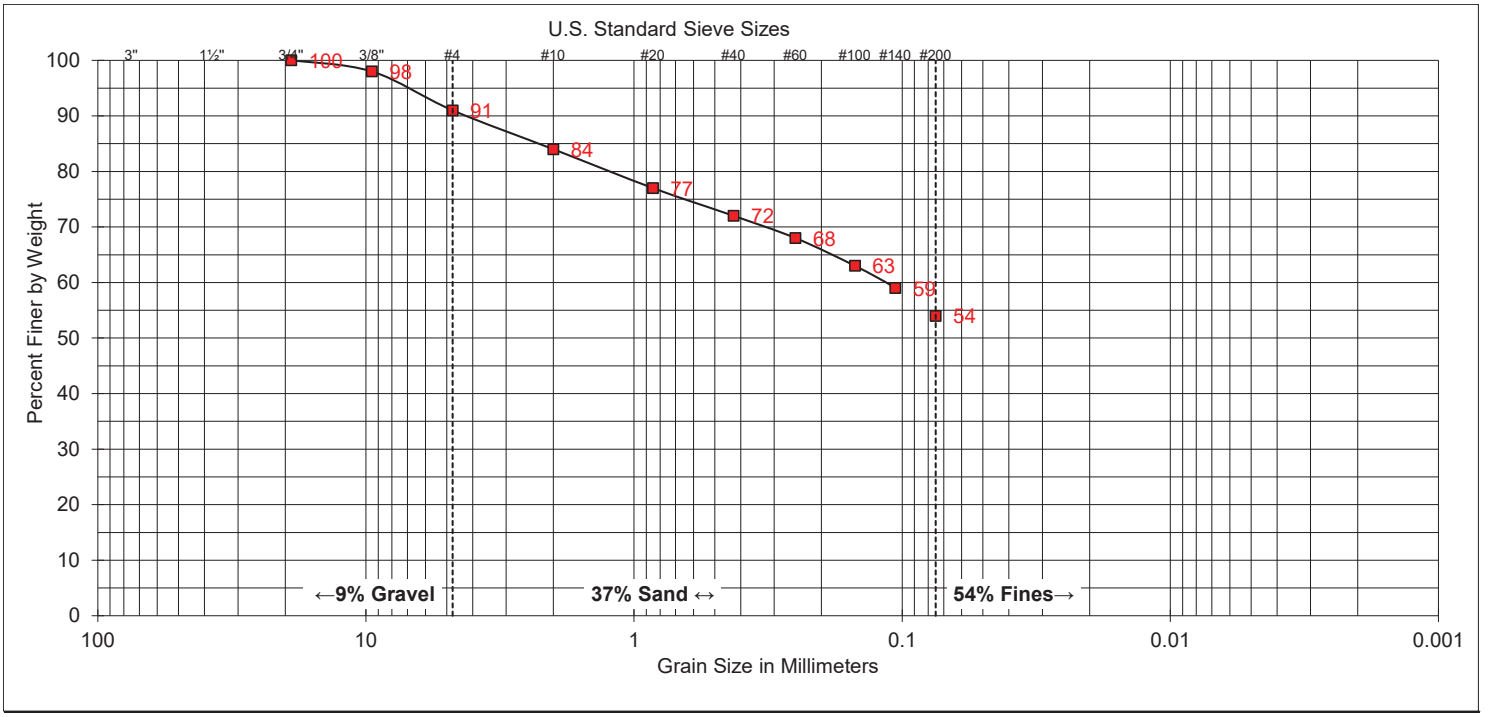
PROCEDURES USED

- ☐ Wet Preparation
  - Multipoint Wet Preparation
- ☒ Dry Preparation
  - Multipoint Dry Preparation
- ☒ Procedure A
  - Multipoint Test
- ☐ Procedure B
  - One-point Test



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Sieve Analysis & % Passing #200 Test Results



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE	B-1
SAMPLE NUMBER:	S-13
SAMPLE DEPTH:	55'

UNIFIED SOIL CLASSIFICATION: CL

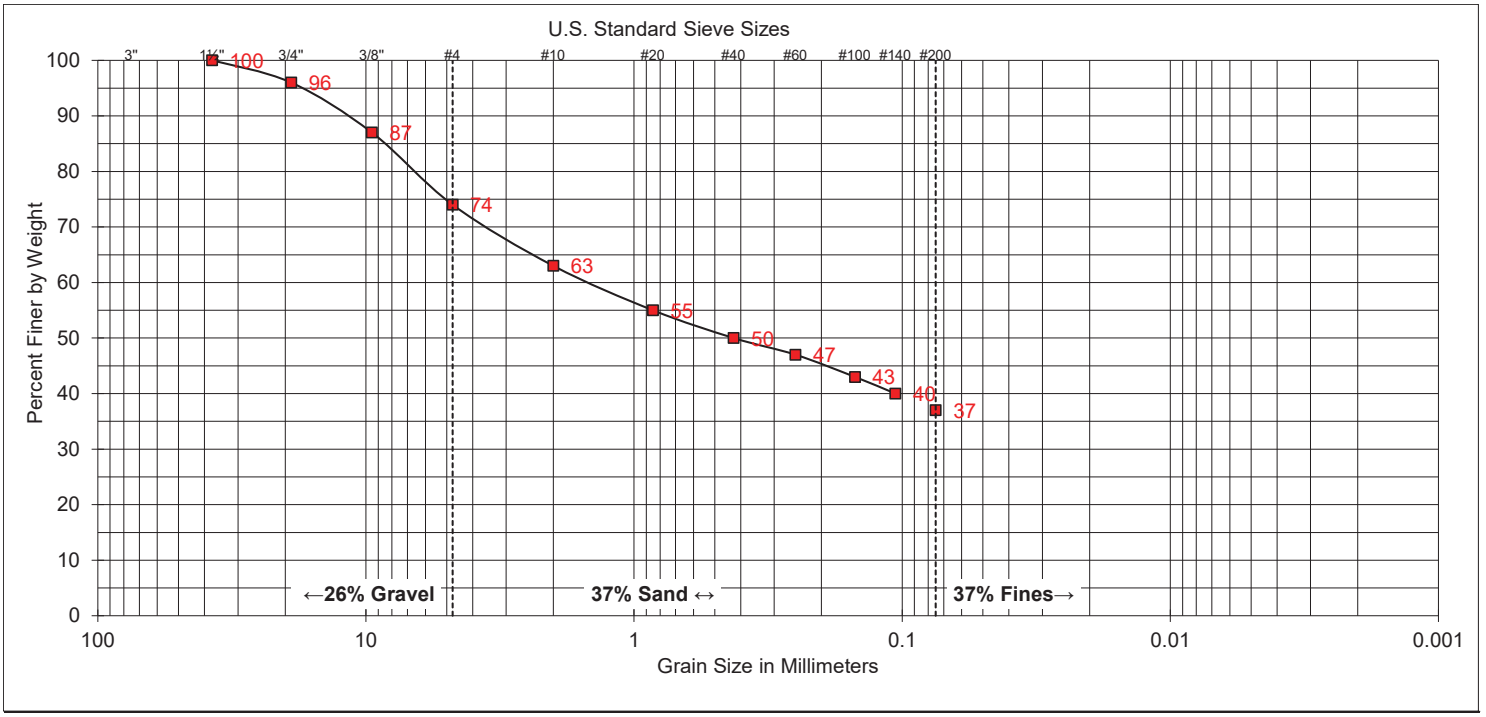
DESCRIPTION: SANDY CLAY

ATTERBERG LIMITS	
LIQUID LIMIT:	-
PLASTIC LIMIT:	-
PLASTICITY INDEX:	-

GROUP DELTA

SOIL CLASSIFICATION

Laboratory No. SO6486
Project No. IR794



COARSE	FINE	COARSE	MEDIUM	FINE	SILT AND
GRAVEL		SAND			CLAY

SAMPLE	B-1
SAMPLE NUMBER:	Bulk-1
SAMPLE DEPTH:	0 - 5'

UNIFIED SOIL CLASSIFICATION: SC

DESCRIPTION: CLAYEY SAND with GRAVEL, SILTSTONE/CLAYSTONE & ASPHALT

ATTERBERG LIMITS	
LIQUID LIMIT:	-
PLASTIC LIMIT:	-
PLASTICITY INDEX:	-

GROUP DELTA

SOIL CLASSIFICATION

Laboratory No. SO6486
Project No. IR794

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PERCENT PASSING NO. 200 SIEVE (ASTM D1140)

Lab No.:

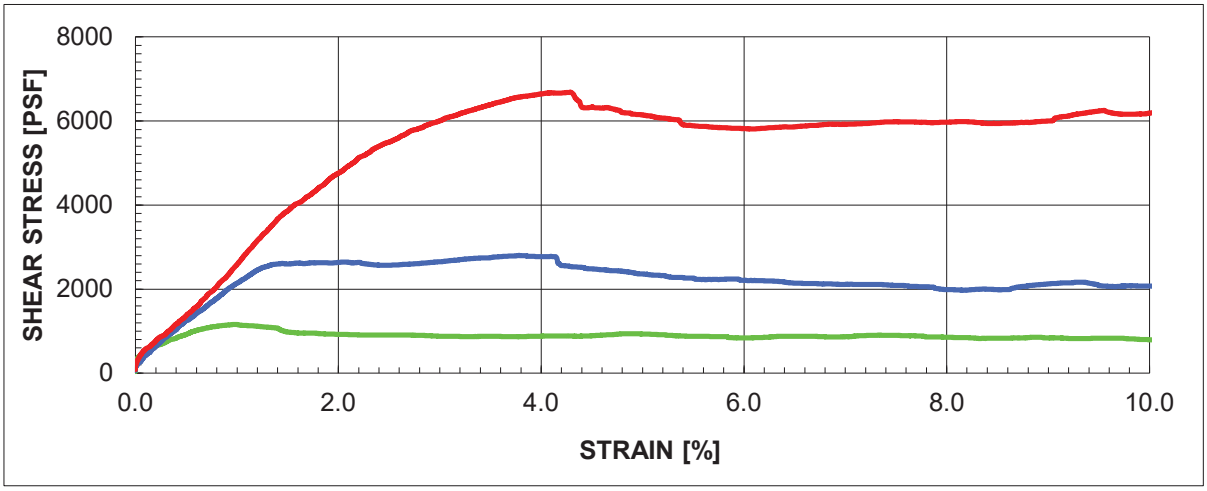
Project Name: *E* Date Sampled:

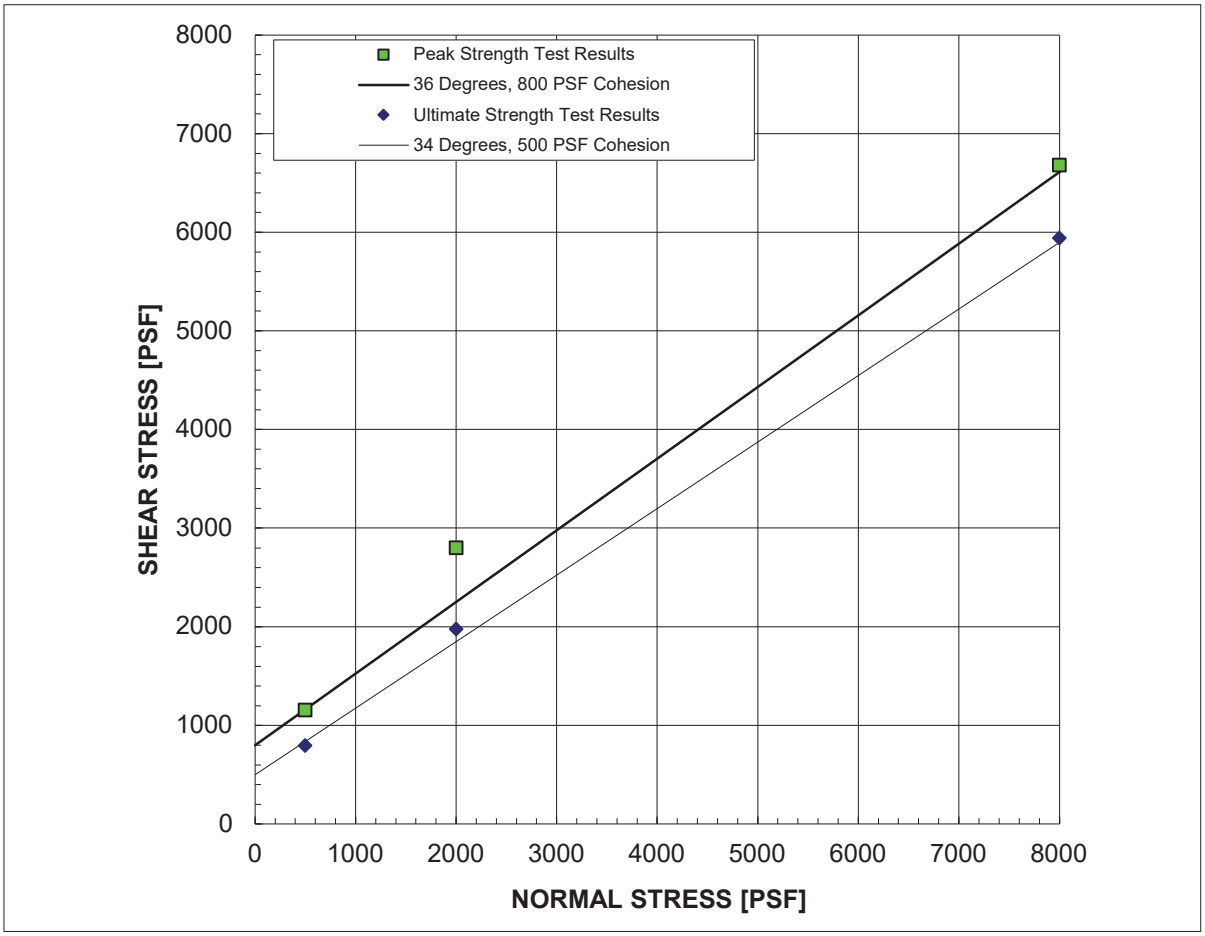
Project No.: Sampled By:

Equipment Used: Tested By: *E* Date:

	Boring No.												
	Sample No.												
	Depth												
	Soil Description												
BEFORE WASH	Container No.												
	Wet Soil Weight & Tare												
	Dry Soil Weight & Tare												
	Tare Weight												
	Weight of Dry Soil												
	Moisture Loss												
	Percent Moisture												
AFTER WASH	Dry Weight of Soil Retained on #200 Sieve												
	Dry Weight of Soil Retained on #4 Sieve												
	Weight of Ret. #200 Soil Minus Ret. #4												
	Percent Gravel												
	Percent Sand												
	Percent Fines												

Direct Shear Test Results





SAMPLE: B-1 @ 30'

Description:
Yellowish brown lean claystone (CL)

STRAIN RATE: 0.0002 IN/MIN
(Sample was consolidated and drained)

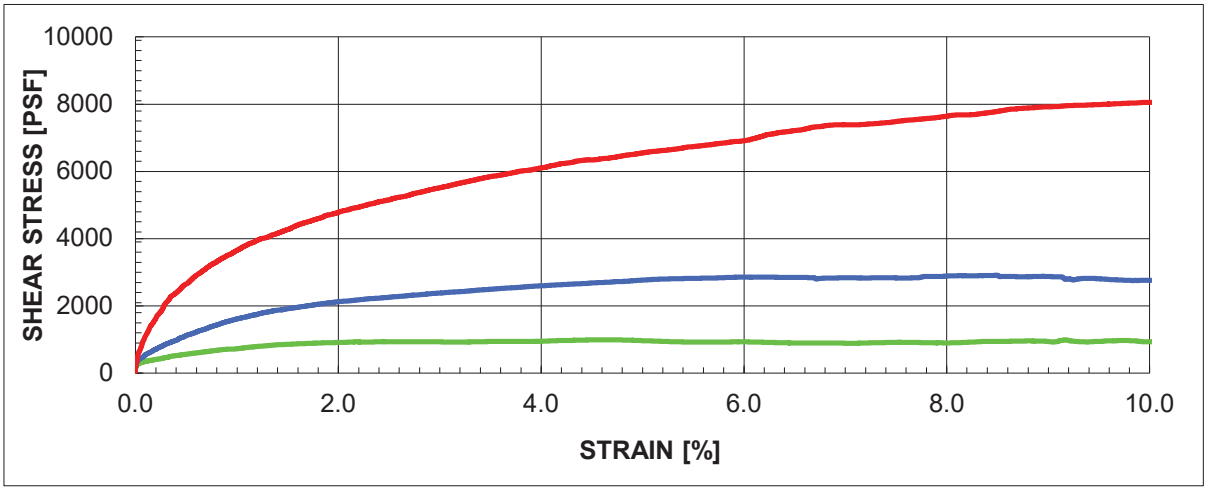
	PEAK	ULTIMATE
ϕ'	36 °	34 °
C'	800 PSF	500 PSF

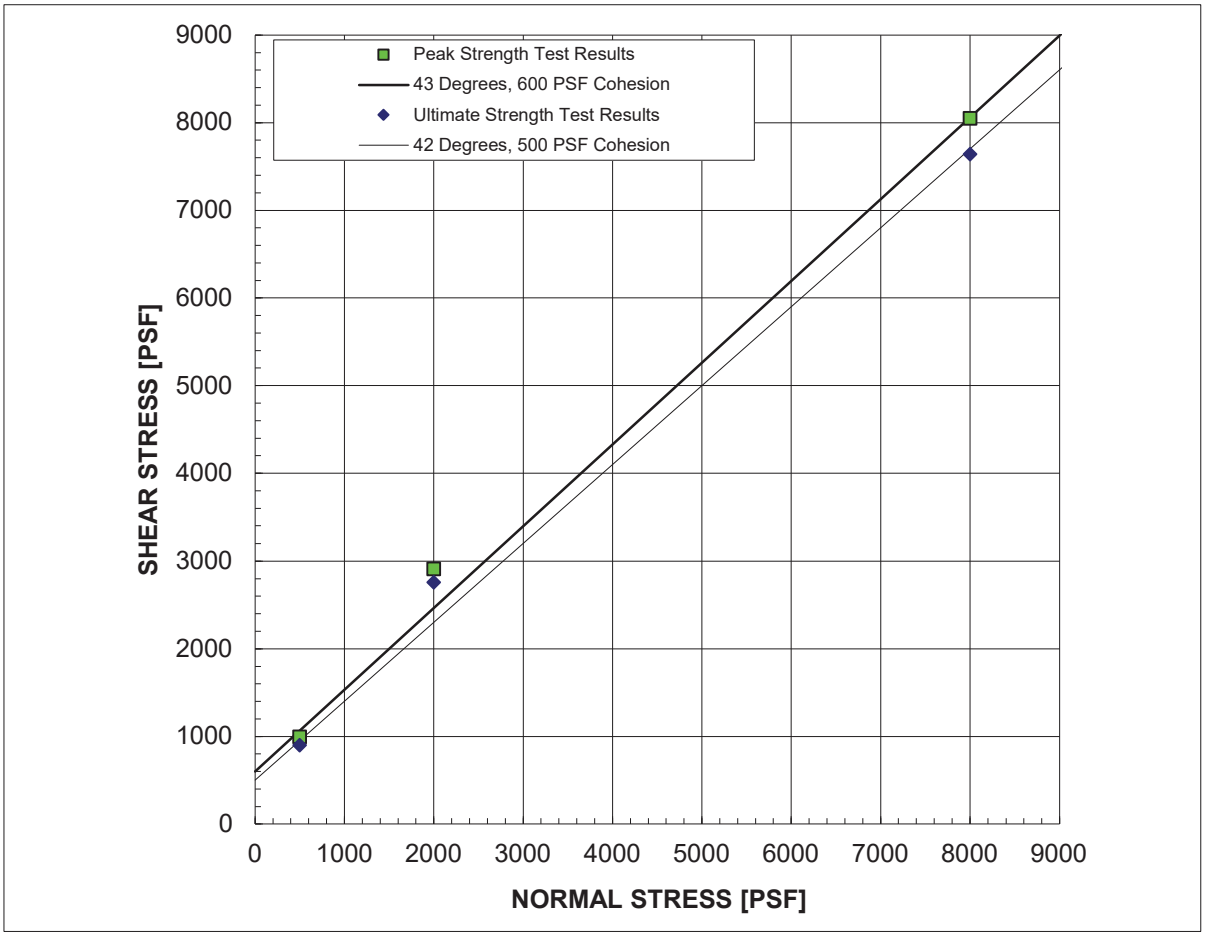
	IN-SITU	AS-TESTED
γ_d	104.5 PCF	104.5 PCF
w_c	16.8 %	22.7 %

GROUP DELTA

DIRECT SHEAR TEST RESULTS

Project No. IR794
FIGURE B-X.X





SAMPLE: B-2 @ 2.5'

Description:
Fill derived from Yellowish brown siltstone (ML)

	PEAK	ULTIMATE
ϕ'	43 °	42 °
C'	600 PSF	500 PSF

STRAIN RATE: 0.0007 IN/MIN
(Sample was consolidated and drained)

	IN-SITU	AS-TESTED
γ_d	100.6 PCF	100.6 PCF
w_c	11.3 %	25.0 %

GROUP DELTA **DIRECT SHEAR TEST RESULTS**

Project No. IR794
FIGURE B-X.X

Soil Corrosivity Test Results

CORROSIVITY TEST RESULTS
(ASTM D516, CTM 643)

SAMPLE	pH	RESISTIVITY (OHM-CM)	SULFATE CONTENT (%)	CHLORIDE CONTENT (%)
B-1 @ 0 - 5'	*7.38*	*1,894*	*< 0.01*	*< 0.01*

CORROSIVITY PARAMETERS

SULFATE CONTENT (%)	SULFATE EXPOSURE	CEMENT TYPE
0.00 to 0.10	Negligible	--
0.10 to 0.20	Moderate	II, IP(MS), IS(MS)
0.20 to 2.00	Severe	V
Above 2.00	Very Severe	V plus pozzolan

SOIL RESISTIVITY (OHM-CM)	GENERAL DEGREE OF CORROSIVITY TO FERROUS METALS
0 to 1,000	Very Corrosive
1,000 to 2,000	Corrosive
2,000 to 5,000	Moderately Corrosive
5,000 to 10,000	Mildly Corrosive
Above 10,000	Slightly Corrosive

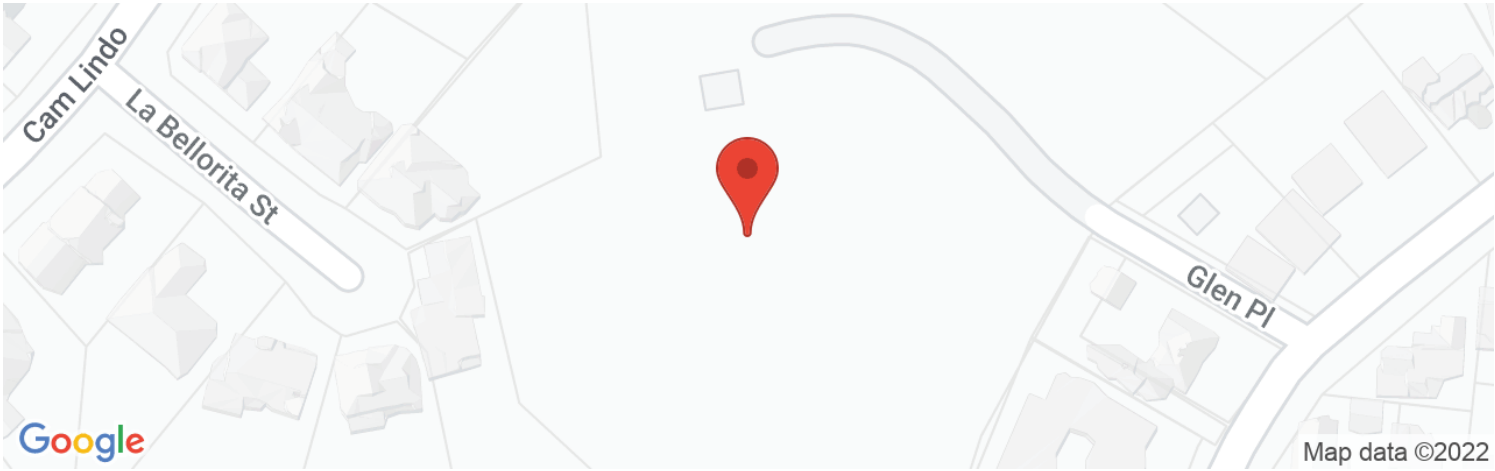
CHLORIDE (CI) CONTENT (%)	GENERAL DEGREE OF CORROSIVITY TO METALS
0.00 to 0.03	Negligible
0.03 to 0.15	Corrosive
Above 0.15	Severely Corrosive

GROUP DELTA CONSULTANTS
9245 Activity Road, Suite 103
San Diego, CA 92126

Project Name: AKD - Westside Resevoir
Project Number: IR794

APPENDIX C
CALCULATIONS

Latitude, Longitude: 34.10457228, -118.15999941



Date	7/1/2022, 4:46:28 PM
Design Code Reference Document	ASCE7-16
Risk Category	II
Site Class	C - Very Dense Soil and Soft Rock

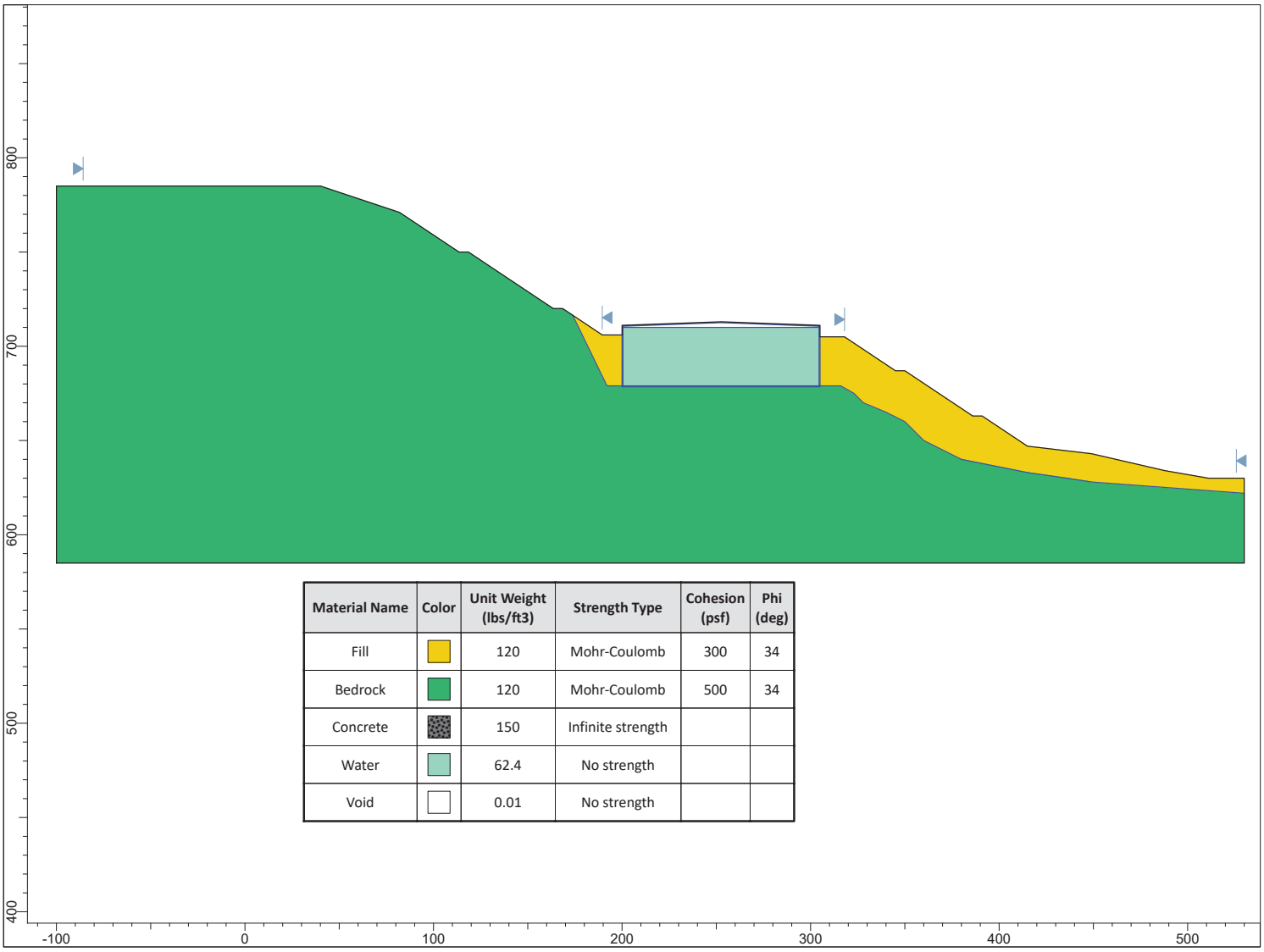
Type	Value	Description
S_S	2.109	MCE_R ground motion. (for 0.2 second period)
S_1	0.717	MCE_R ground motion. (for 1.0s period)
S_{MS}	2.531	Site-modified spectral acceleration value
S_{M1}	1.004	Site-modified spectral acceleration value
S_{DS}	1.687	Numeric seismic design value at 0.2 second SA
S_{D1}	0.669	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	D	Seismic design category
F_a	1.2	Site amplification factor at 0.2 second
F_v	1.4	Site amplification factor at 1.0 second
PGA	0.918	MCE_G peak ground acceleration

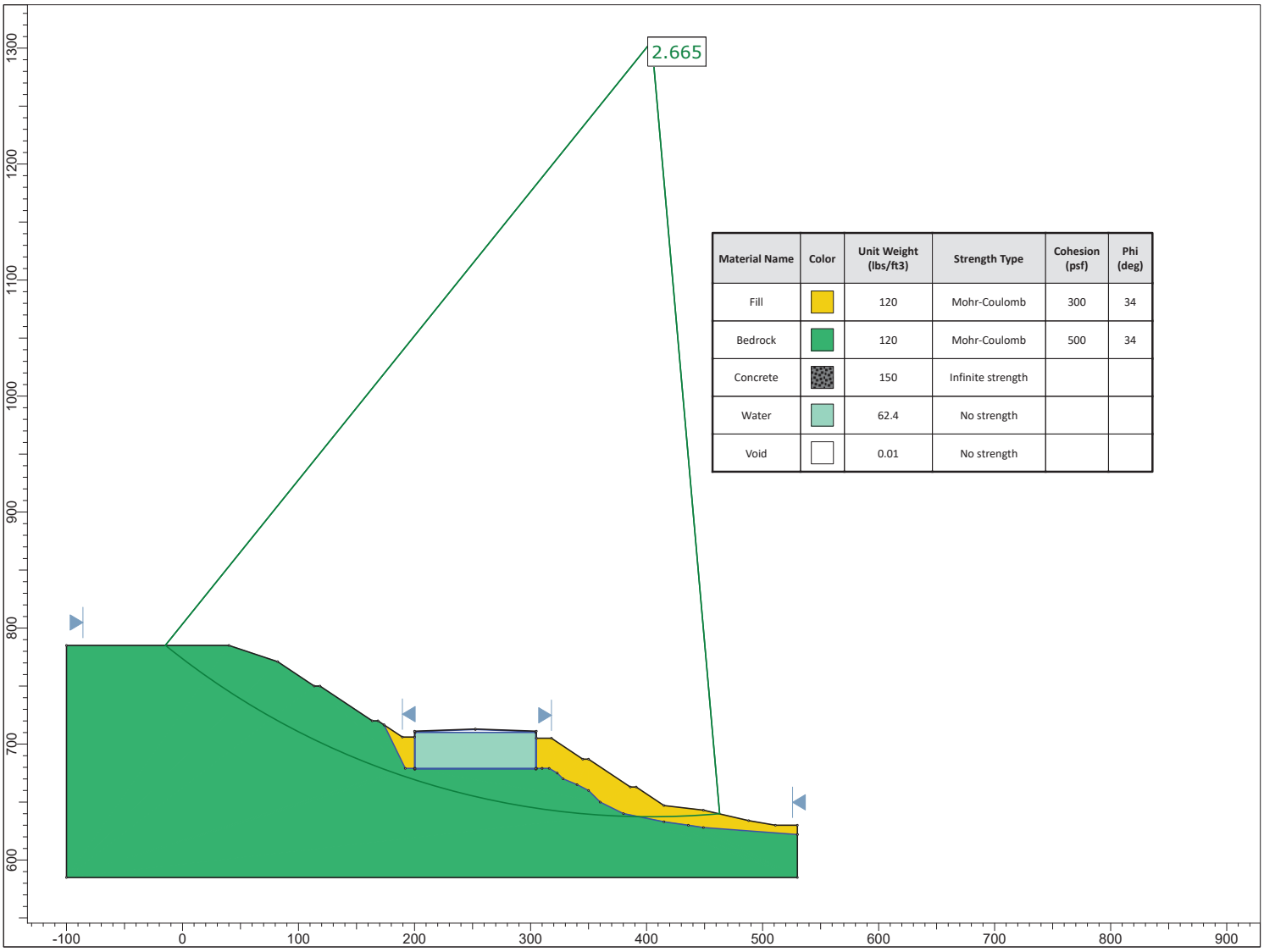
Type	Value	Description
F_{PGA}	1.2	Site amplification factor at PGA
PGA_M	1.102	Site modified peak ground acceleration
T_L	8	Long-period transition period in seconds
SsRT	2.109	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	2.398	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	2.377	Factored deterministic acceleration value. (0.2 second)
S1RT	0.759	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.855	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.717	Factored deterministic acceleration value. (1.0 second)
PGAd	0.946	Factored deterministic acceleration value. (Peak Ground Acceleration)
C_{RS}	0.88	Mapped value of the risk coefficient at short periods
C_{R1}	0.887	Mapped value of the risk coefficient at a period of 1 s

DISCLAIMER

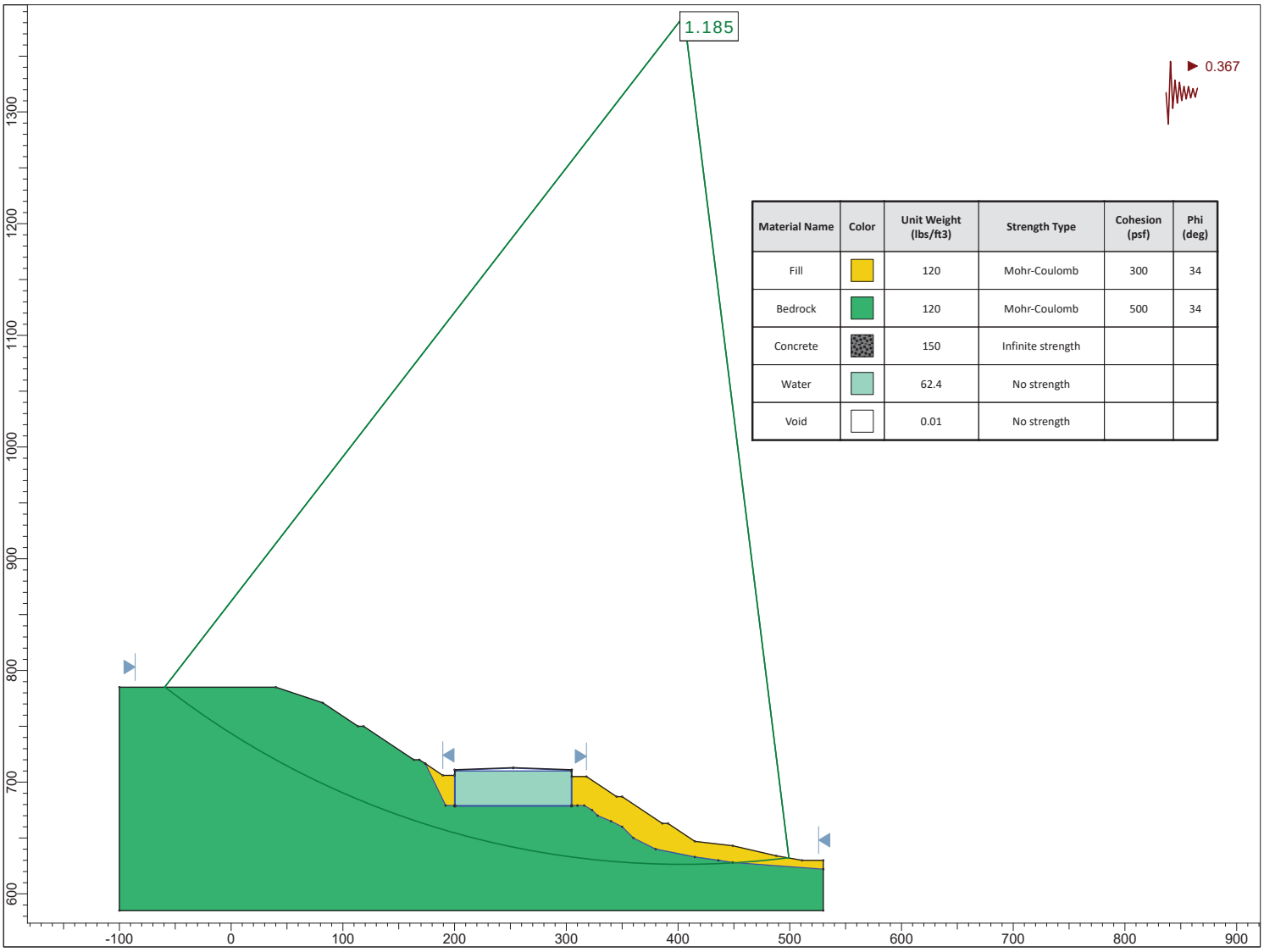
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Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	Mohr-Coulomb	300	34
Bedrock		120	Mohr-Coulomb	500	34
Concrete		150	Infinite strength		
Water		62.4	No strength		
Void		0.01	No strength		



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Fill		120	Mohr-Coulomb	300	34
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Bedrock		120	Mohr-Coulomb	500	34
Concrete		150	Infinite strength		
Water		62.4	No strength		
Void		0.01	No strength		

APPENDIX D
SELECTED SITE PHOTOS

















