November 20, 2017
File No.: 20180195

Provost and Prichard Consulting Group
286 West Cromwell Avenue
Fresno, California

Attn: Mr. Nicholas Jacobson

SUBJECT: Geotechnical Investigation Report
Proposed Cantua Creek and El Porvenir Pipeline Improvements
Fresno County, California

Dear Mr. Jacobson:

The attached report presents the results of the geotechnical investigation for the proposed Cantua Creek and El Porvenir Pipeline Improvements in Fresno County, California. This report describes the study, findings, conclusions, and recommendations for use in project design.

Kleinfelder appreciates the opportunity to provide geotechnical engineering services during the design phase of this project. If there are any questions concerning the information presented in this report, please contact this office at your convenience.

Respectfully submitted,
KLEINFELDER, INC.

Victoria Tinoco
Staff Engineer

Nathan L. Dahlen, PE
Senior Project Manager

NMP:DLP:sj

GEOTECHNICAL INVESTIGATION REPORT
PROPOSED CANTUA CREEK AND EL PORVENIR PIPELINE IMPROVEMENTS
FRESNO COUNTY, CALIFORNIA

Prepared For:
Provost and Prichard Consulting Group
286 West Cromwell Avenue
Fresno, California

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TABLE OF CONTENTS

Page

PLATES

APPENDIX A

APPENDIX B

1. INTRODUCTION

1.1 GENERAL

This report presents the results of the geotechnical investigation for the proposed Cantua Creek and El Porvenir Pipeline Improvements in Fresno County, California. The pipeline will service an elementary school and residential area at locations near Cantua Creek and El Porvenir. The purpose of the investigation was to evaluate the subsurface conditions along the alignment and develop geotechnical engineering recommendations to aid in design and construction of the project.

The Site Vicinity Map, Figures 1 and 3, shows the approximate location of the projects. The Boring Location Map, presented on Figures 2 and 4, displays the approximate boring locations performed for this study.

This report includes recommendations related to the geotechnical aspects of project design. Conclusions and recommendations presented in this report are based on the subsurface conditions encountered at the locations of exploration and the provisions and requirements outlined in the “Limitations” Section of this report. Recommendations presented herein should not be extrapolated to other areas or used for other projects without prior review.

1.2 PROJECT DESCRIPTION

Understanding of the project is based upon a general site plan and discussions with representatives of Provost and Prichard Consulting Group.

Improvements at the sites include new wells, pipelines, and pumping facilities. The proposed well at the Cantua Creek site location will be installed next to the County storm water basin located northeast of Cantua Elementary School and will include approximately 500 feet of pipeline connecting the well to the existing tank located at the surface water treatment plant. It is also anticipated that the site have an approximately 5,800 foot water main pipeline. It is understood the pipe diameter will be 8 inches and the trench will follow County Standards.

The proposed well at the El Porvenir site located at the northwest corner of Clarkson and SR 33 will be installed next to the existing tank and booster pump in the residential neighborhood park

and will also include the installation of an approximately 200 foot supply main running from the newly installed well to the existing tank and booster pump located at the southwest corner of the residential neighborhood on Clarkson Avenue. This site will also include the addition of 500 feet of a new sewer main. It is anticipated that the El Porvenir well site will include the addition of a light metal frame building.

Other improvements at each well installation location will include the addition of one 5,000 gallon hydropneumatic tank, one standby generator, site grading, concrete slabs for electrical cabinets, and other various well site improvements including but not limited to new booster pumps, valves, and pipes.

1.3 PURPOSE AND SCOPE OF SERVICES

The purpose of this investigation was to explore the general subsurface conditions along the alignment and each site and provide comments and recommendations to aid in design and construction. This report includes the following:

- ☑ A description of the proposal project, including a plan showing the locations of the exploration points for this study
- ☑ A description of the site surface and subsurface conditions encountered during the field investigation, including boring logs
- ☑ A summary of the field exploration and laboratory testing programs
- ☑ General discussion of the regional geology and site engineering seismology including potential for liquefaction
- ☑ Comments and parameters for use in evaluating backfill criteria
- ☑ Recommended E'_n for trench wall soil and E'_b and density of backfill for use in initial pipe deformation analysis
- ☑ Recommended frictional resistance along pressured pipe and lateral bearing parameters for thrust blocks for use in resisting sustained and test condition lateral loading
- ☑ Recommendations for site preparation and earthwork grading, including a discussion concerning the use of on-site soils for engineered fill, recommended import fill specifications, and overexcavation requirements (if any)
- ☑ Seismic design parameters and other requirements for site based on 2016 CBC

- ☑ Recommendations for foundation design for building and pneumatic tank including bearing capacity of foundation soil for sustained loading and total combined loading

- ☑ Comments on regional subsidence and general recommendations to minimize local subsidence and settlement

- ☑ Comments on groundwater conditions encountered

- ☑ Comments on the general corrosion potential of on-site soil

2. FIELD EXPLORATION AND LABORATORY TESTING

2.1 FIELD EXPLORATION

The exploration included nine (9) borings along the alignment and each site, which were performed May 1, 2017. The borings were advanced to depths ranging from 16.5 to 36.5 feet below existing ground surface. The test borings were drilled with a CME-75 truck mounted drill rig using hollow-stem auger techniques. The approximate locations of the test borings are indicated on the Boring Location Plan, Figures 2 and 4.

The earth materials encountered in the test borings were visually classified in the field and a continuous log was recorded. In-place sample collection was achieved at selected depths by driving a 2.5-inch I.D. split barrel sampler containing brass liners into the undisturbed soil with a 140-pound automatic safety hammer free falling a distance of 30-inches. Sampling also utilized an ASTM D1586 standard penetrometer without liners (barrel I.D. of 1.5 inches), driven 18-inches in the same manner. This latter sampling procedure generally conformed to the ASTM D1586 test procedure. Resistance to sampler penetration over the last 12-inches is noted on the boring logs. The penetration indices listed on the boring logs have not been corrected for the effects of overburden pressure, sampler size, rod length, or hammer efficiency. Bulk samples were also obtained from cuttings at selected locations.

2.2 FIELD AND LABORATORY TESTING

SPT penetration rates, determined in general accordance with ASTM D1586, were used to aid in evaluating the consistency, compression, and strength characteristics of the soils.

Kleinfelder performed laboratory tests on selected samples to evaluate certain physical characteristics. The following laboratory tests were used to develop the design geotechnical parameters:

- Unit Weight (ASTM D2937)
- Moisture Content (ASTM D2216)
- Grain-Size Distribution (ASTM D422, without hydrometer)
- Direct Shear (ASTM D3080)

- Atterberg Limits (ASTM D4318)
- One Dimensional Consolidation (ASTM D2435)
- Maximum Dry Density and Optimum Moisture (ASTM D1557)
- pH and Minimum Resistivity (California Test Method No. 643)
- Soluble Sulfate and Chloride Content (California Test Method Nos. 417 and 422)

The dry density, moisture content, and percent passing the 75-micron (#200 sieve) test results are shown on the borings in Appendix A. The pH, minimum resistivity, and soluble sulfate and chloride results are summarized in Section 6.4 (“Corrosion Potential”). The remaining test results are provided in Appendix B.

3. SITE CONDITIONS

3.1 SURFACE CONDITIONS

The pipeline alignment along the Cantua Creek site is generally surrounded by agricultural land the well site is adjacent to a storm water basin. The pipeline alignment at the El Porvenir site is within a small residential area surrounded by agricultural land. In general, the site is relatively flat and slopes downhill gently to the east. The Cantua Creek pipeline alignment runs along Clarkson Avenue between San Mateo Avenue and Stanislaus Avenue.

3.2 EARTH MATERIALS

The following description provides a general summary of the subsurface conditions encountered during the field exploration and further verified by the laboratory testing program. For a more thorough description of the actual conditions encountered at specific boring locations, refer to the boring logs presented in Appendix A. All soils have been classified in general accordance with the Unified Soil Classification System (ASTM D2487).

The natural earth material consists of Great Valley fan deposits, which have a geologic age of Holocene. The general soil profile encountered along the Cantua Creek pipeline alignment consist of fat clay underlain by interbedded, laterally discontinuous layers of lean clay, clayey sand and silty sands with clay. The general soil profile encountered at the El Porvernir site consist of clayey sand underlain by interbedded, laterally discontinuous layers of lean clay, clayey sand and poorly graded sand.

3.3 GROUNDWATER CONDITIONS

Groundwater was encountered in boring B-1 at 35.5 feet. The encountered water is likely a perched condition from the nearby storm water basin. Department of Water Resources indicates the depth to ground water in the general project area is generally about 400 feet or deeper. Groundwater is not anticipated to be within construction limits. Groundwater conditions at the site could change at some time in the future due to variations in rainfall, groundwater withdrawal, construction activities, or other factors not apparent at the time the test borings were made. The variation could be most pronounced adjacent to ponds, canals, creeks, and other bodies which periodically contain water.

3.4 REGIONAL SUBSIDENCE

Deep regional subsidence is surface settlement attributed to fluid withdrawal. In the San Joaquin Valley, deep subsidence is primarily related to groundwater overdraft. Deep subsidence can also occur due to oil production, but is generally confined to close proximity of oil producing fields. Shallow subsidence would be the result of near surface soil collapse in response to surface moisture infiltration.

In preparation for development of the California Aqueduct, an evaluation of land subsidence was undertaken by an Inter-Agency Committee comprised of representatives of the U.S. Geologic Survey, California Department of Water Resources (DWR), California Division of Highways, U.S. Bureau of Reclamation, U.S. Corps of Engineers, and various California universities. With regards to deep subsidence, research by the committee determined land subsidence was first observed in about 1935 along the west side of the valley between about Los Banos and Kettleman City. Measurements between 1943 and 1953 showed as much as 7 feet of deep subsidence in the area between Los Banos and Kettleman City. The maximum angular distortion indicated by subsidence contours during this ten year period was 0.000335 radian (about four feet over 2.25 miles). Another area of deep subsidence was observed in the area from Tulare to Wasco, where ground water levels lowered between 125 to 230 feet (not elevation) from 1905 to 1952. The maximum measured subsidence from 1926 to 1954 was ten feet. The maximum angular distortion was 0.000473 radian (about 4 feet over 1.6 miles).

Evaluation of regional deep subsidence in the general project area was based on recent satellite imagery. NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California, prepared a report (subsidence in the Central Valley of California) on deep subsidence for the California DWR. Report co-author, Mr. Tom Fair, provide Kleinfelder with three sets of data which covered the project area. This data showed deep subsidence generally throughout both sites and alignments. Data from Japan's PALSAR satellite indicated subsidence of about 2 to 5 inches between June 2007 and December 2010, with an angular distortion of about 0.0000625 radian (about 3 inches over 4000 feet). The second set of data was from the European Space Agency's Sentinel satellite between May 7, 2015 and May 25, 2016. This data also showed the deep subsidence within the area between about 4 and 8 inches, with a maximum angular distortion of 0.00033 radian (about 4 inches in 4000 feet). The third set of data was from the Canadian Space Agency's Radarsat-2 indicated subsidence of about 2 to 4 inches between May 3, 2014 to January 22, 2015, with an angular distortion of about 0.000042 radian (about 2 inches over 4000 feet).

These movements are typically not significant to linear structures.

4. GEOLOGIC CONDITIONS

4.1 FAULTS LOCAL TO THE PROPOSED ALIGNMENT

The project site is located in an area characterized by relatively low to moderate historic seismic activity. The site is not located in an Alquist-Priolo Earthquake Fault Zone as established by the Alquist-Priolo Fault Zoning Act (Section 2622 of Chapter 7.5, Division 2 of the California Public Resources Code).

Numerous faults and shear zones within the region could influence the project site. The most significant of these faults, with respect to the project site, is the Great Valley Fault (modal magnitude 7.0, about 19 kilometers away from the site), and the San Andreas Fault (modal magnitude 7.9, about 53 kilometers away from the site). A major seismic event on this, or other regional, faults could cause moderate ground shaking at the site.

4.2 SEISMIC DESIGN CRITERIA

If any components of the project require seismic design, the 2016 California Building Code (CBC) code based design could be used. The estimated Maximum Considered Earthquake (MCE), mapped spectral accelerations for 0.2 second and 1 second periods (S_S and S_1) and associated soil amplification factors (F_a and $F_{v)}$ are presented in Table 4.2-1. Corresponding site modified maximum (S_{MS} and S_{M1}) and design (S_{DS} and S_{D1}) spectral accelerations are also presented in Table 4.2-1.

Based on Table 20.3-1 of ASCE 7-10, the project is categorized as Site Class D. Site Class D is defined as a stiff soil profile with average shear wave velocities within the upper 100 feet between 600 ft/sec and 1,200 ft/sec, average SPT N value of 15<N<50, or average undrained shear strength (Su) of 1,000 psf <Su< 2,000 psf.

TABLE 4.2-1
2016 CBC SEISMIC DESIGN PARAMETERS

Parameter	Value
S_S	1.500
S_1	0.489
Site Class	D
Seismic Design Category	D
F_a	1.000
F_v	1.511
PGA	0.500g
S_{MS}	1.500g
S_{M1}	0.739g
S_{DS}	1.000g
S_{D1}	0.492g
F_{PGA}	1.000
PGA_M	0.500g
C_{RS}	0.977
C_{R1}	1.014
T_L	8

4.3 LIQUEFACTION POTENTIAL AND SEISMIC SETTLEMENT

In order for liquefaction, and possible associated effects, of soils due to ground shaking to occur, it is generally accepted that four conditions will exist:

- The subsurface soils are in a relatively loose state,
- The soils are saturated,
- The soils are non-plastic, and
- Ground shaking is of sufficient intensity and duration to act as a triggering mechanism.

Based on the ground shaking which may be expected at this site, the soil relative density, soil type, and depth to groundwater, analysis utilizing Youd (2001) indicates liquefaction, and associated seismically induced settlement, is considered unlikely

5. EARTHWORK

5.1 GENERAL

Based on the laboratory data, field exploration, and geotechnical analyses conducted by Kleinfelder for this study, it is geotechnically feasible to construct the proposed project, as currently envisioned. It is anticipated required earthwork can be accomplished with conventional grading equipment and techniques. All references to compaction, maximum density and optimum moisture content are based on ASTM D1557, unless otherwise noted.

The investigation has indicated moderate to high expansion potential for the near surface clayey soils. Expansive soils are susceptible to volume changes associated with changes in soil moisture content. The potential for future differential movement resulting from these soils can be reduced to normally tolerable levels by following the recommendations presented in this report. The intent of the recommendations is to result in a degree of saturation of about 80% to 85% at the time of construction. Moisture conditioning and compaction mitigation implemented during grading should be consistent with the soil expansiveness. For structures, careful attention must be paid to future maintenance, including site drainage and irrigation practices.

5.2 STRUCTURE SITE PREPARATION

5.2.1 Stripping

At the time of the site reconnaissance, sparse vegetation was present on the site. It is likely the amount of surface vegetation will vary with time. Any surface vegetation and any miscellaneous surface or subsurface obstructions should be removed from the project area, prior to any site grading. Based on site observation, stripping will likely involve the upper 2 to 6 inches of surface soil. Surface strippings should not be incorporated into fill unless they can be sufficiently blended to result in an organic content less 3 percent by weight (ASTM D2974).

5.2.2 Existing Obstructions and Fill

During the initial site grading, a reasonable search should be conducted to locate and remove any unsuitable material, unengineered fill or soil disturbed by previous activity that may exist within the area of construction (i.e. animal burrows, irrigation pipes). If any areas or pockets of soft or unstable soils are encountered, they should be over-excavated to firm native material approved by a representative of the project Geotechnical Engineer. Excavations for removal of unsuitable conditions should be backfilled with engineered fill (see Sections 5.2.4 and 5.3).

5.2.3 Over-Excavation

Over-excavation is typically reserved for soils that, in their natural state, will not provide adequate bearing for structures. The native soils at the project site should provide adequate bearing for the proposed structures. Therefore, provided the recommendations in Section 5.2 are followed, no general site over-excavation is required.

5.2.4 Scarification and Compaction

Following site stripping and any necessary removal, any areas to receive engineered fill should be properly prepared. The exposed surface should be scarified to a depth of 8 inches and moisture conditioned to at least 4% above optimum and compacted to at least 88%, but not more than 92%, of maximum dry density.

5.2.5 Non-Expansive Engineered Fill

All engineered fill soils should be nearly free of organic or other deleterious debris and less than 3 inches in maximum dimension. Table 5.3-1 provides recommended compliance criteria for the quality of imported non-expansive engineered fill to be used at the site.

TABLE 5.3-1
IMPORTED ENGINEERED FILL CRITERIA

Gradation		Test Procedures	
Sieve Size	**Percent Passing**	**ASTM[1]**	**Caltrans[2]**
76 mm (3 inch)	100	C136	202
19 mm (¾ inch)	80 – 100	C136	202
No. 4	60 - 100	C136	202
No. 200	20 – 50	C136	202
Plasticity			
Liquid Limit	Plasticity Index		
< 25	< 9	D4318	204
Soluble Sulfates			
< 2000 ppm		-	417
Soluble Chloride			
<300 ppm		-	422
Resistivity			
>3000 ohm-cm		-	643

Notes:
[1] American Society for Testing and Materials Standards (latest edition)
[2] State of California, Department of Transportation, Standard Test Methods (latest edition)

Any imported materials to be used for engineered fill should be sampled and tested by a representative of the project Geotechnical Engineer prior to being transported to the site.

5.2.6 Compaction Criteria

On-site soil used for engineered fill should be uniformly moisture-conditioned to at least 4% above optimum, placed in horizontal lifts less than 8 inches in loose thickness, and compacted to at least 88 percent, but not more than 92 percent, as determined by ASTM D1557. The general intent is to bring the expansive material to about 80% to 85% saturation at the time of construction. Moisture and compaction may be adjusted, as necessary, to achieve this intent. Disking and/or blending may be required to uniformly moisture-condition soils used for engineered fill.

Imported 'non-expansive' soils used for engineered fill should be uniformly moisture conditioned to at, or above, optimum moisture, placed in horizontal lifts less than 8 inches in loose thickness, and compacted to 90 percent relative compaction. Disking and/or blending may be required to uniformly moisture-condition soils used for engineered fill**.**

5.2.7 Construction Considerations

Should site grading be performed during or subsequent to wet weather, near-surface site soils may be significantly above optimum moisture content. These conditions could hamper equipment maneuverability and efforts to compact site soils to the recommended compaction criteria. Disking to aerate, chemical treatment, replacement with drier material, stabilization with a geotextile fabric or grid, or other methods may be required to mitigate the effects of excessive soil moisture and facilitate earthwork operations. Any consideration of chemical treatment (e.g. lime) to facilitate construction would require additional soil chemistry evaluation and could affect landscape areas and some construction materials (e.g. aluminum).

If construction is performed during dry, hot or windy weather, it may be necessary to periodically apply surface watering to counter evaporative loss or re-establish moisture prior to constructing structures.

5.3 LIME TREATED SUBGRADE OPTION

Amendment with quicklime can be used to increase workability, reduce post-construction expansion potential, reduce pavement sections and reduce subgrade moisture sensitivity for soil used as engineered fill or structure or pavement subgrade. In general, the lime treated soil

should be uniformly mixed and moisture conditioned, mellowed, remixed and moisture conditioned, compacted and cured. In cut areas, initial mixing and moisture conditioning could be performed in-place after the subgrade area is cut to approximate rough grade. In fill areas, the untreated soil could be transported to, and spread over, the fill area and then mixed and moisture conditioned in-place or treated soil could be transported from a "mixing table." The blended material would initially be mixed, moisture conditioned to 4% above optimum and mellowed for 48 hours to allow for formation of any ettringite mineral associates with the presence of sulfates.

If lime treatment is used it is recommended a 4.0% lime amendment to the subgrade soil be used for a minimum depth of 18 inches. This would result in an unconfined compressive strength for the lime treated subgrade (LTS) of about 400 psi. 4.0% would be the practical minimum amendment to result in a constructible uniform mixture.

5.4 TEMPORARY EXCAVATIONS

5.4.1 General

All excavations must comply with applicable local, State, and Federal safety regulations including the current OSHA Excavation and Trench Safety Standards. Construction site safety is generally the responsibility of the contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. The information below is provided as a service to the client. Under no circumstances should the information provided be interpreted to mean that Kleinfelder is assuming responsibility for construction site safety or the contractor's activities; such responsibility is not being implied and should not be inferred.

5.4.2 Excavations and Slopes

The contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, State, and/or Federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations). Such regulations are strictly enforced and, if they are not followed, the owner, contractor, and/or earthwork and utility subcontractors could be liable for substantial penalties.

All excavations should be constructed and maintained in conformance with current OSHA requirements (29 CFR Part 1926).

5.4.3 Construction Considerations

Heavy construction equipment, building materials, excavated soil, and vehicular traffic should be kept sufficiently away from the top of any excavation to prevent any unanticipated surcharging. If it is necessary to encroach upon the top of an excavation, Kleinfelder can provide comments on slope gradients or loads on shoring to address surcharging, if provided with the geometry. Shoring, bracing, or underpinning required for the project (if any), should be designed by a professional engineer registered in the State of California.

During wet weather, earthen berms or other methods should be used to prevent runoff water from entering all excavations. All runoff should be collected and disposed of outside the construction limits.

5.5 TRENCH BACKFILL

5.5.1 Materials

Pipe embedment zone backfill (i.e., bedding, haunching, pipe zone, and initial backfill per ASTM D2321) should consist of soil compatible with design requirements for the specific types of pipes. It is recommended the project designer or pipe supplier develop the material specifications based on planned pipe types, bedding conditions, tolerable deflection and other factors beyond the scope of this study. Randomly excavated on-site soil will likely be Class IV material per ASTM D2321.

Trench zone backfill (i.e., material placed between the pipe zone backfill and finished subgrade) may consist of native soil that meets the requirements for engineered fill.

5.5.2 Compaction Criteria

Trench backfill should be placed and compacted in accordance with recommendations provided above for engineered fill. Reduced compaction (85% minimum) could be specified for trench zone backfill in non-structural areas. Mechanical compaction is recommended; ponding or jetting should not be used.

Table 5.6-1 provides estimated geotechnical parameters for designers to consider in evaluating pipe zone backfill criteria that is compatible with pipe types and deformation tolerances. Data is presented for site soil and imported Class III (per ASTM D 2321) soil. Use of site soil as backfill will be very labor intensive to provide adequate placement and compaction under and around pipes.

TABLE 5.6-1
PIPE ZONE BACKFILL PARAMETERS

Site	Soil Stiffness Modulus (psi)			Backfill Density (pcf)	
	E'_n (Trench Sidewall)	E'_b (Backfill)		85% Compaction	90% Compaction
		85% Compaction	90% Compaction		
Cantua	3000	700	1000	96	102
El Porvenir	3000	700	1000	100	106
Class III	3000	900	1350	116	123

E'_n represents the modulus for the undisturbed natural soil and is based on relative density and data by Howard (1996). E'_b is the modulus for backfill derived from random excavation of on-site soil and is based on data by Hartley and Duncan (1982) and Watkins and Anderson (2000). The design E' will be dependent upon the pipe diameter and trench width, which dictates the relative influence of E'_n and E'_b. Methods by Howard (1996) are suggested for evaluating the design E'.

In evaluating the maximum load (W_c) on pipes, a Kμ' of 0.19 (K = 0.42 and μ' = 0.45) can be used in determining the load coefficient C_d for the Cantua site and a Kμ' of 0.19 (K = 0.35 and μ' = 0.55) can be used for the El Porvenir site.

6. DESIGN RECOMEDATIONS

6.1 GENERAL

The investigation has indicated a moderate to high expansion potential for the surface clay soils. Expansive soils are susceptible to volume changes associated with changes in soil moisture content. The potential for future differential movement of conventional slabs resulting from these soils can be reduced to normally tolerable levels by following the moisture conditioning and compaction recommendations presented in this report. The intent of the recommendations is to result in a degree of saturation of about 80% to 85% at the time of construction. Moisture conditioning and compaction mitigation implemented during grading should be consistent with the soil expansion potential. Considering the potential for variation in soil expansion, Atterberg Limits tests should be performed in conjunction with the maximum density testing during site grading to determine the appropriate moisture conditioning. Careful attention must be paid to maintaining site drainage, preventing the ponding of water.

6.2 SPREAD AND MAT FOUNDATIONS

6.2.1 General

The proposed structures may be supported by conventional shallow spread or mat footings supported on approved undisturbed native soil or properly engineered fill. The following recommendations are based on the assumption that the recommendations in Section 5, “Earthwork”, have been implemented. Recommendations regarding the geotechnical aspects of building and equipment foundation design are presented in subsequent sections.

6.2.2 Available Bearing Capacity – Buildings and Tank Mats

Generally two geotechnical issues determine the design bearing pressure for conventional spread footing or mat foundations: (1) available soil bearing capacity based on the strength of the soil and foundation geometry and/or (2) tolerable settlement.

The available bearing capacity of the foundation soil is dependent upon the effective foundation width and depth of embedment and the shear strength of the soil. Table 6.2-1 provides the expressions for the available allowable bearing capacity for static loading (D+L loads) and total combined loading (D+L+transient loads). In these expressions, B represents the effective foundation width (least dimension) and D is the total foundation embedment below the lowest adjacent grade (both in feet). Due to the high expansive potential of the soils present at the Cantua site the footings should be established at a depth of at least 24 inches below the lowest adjacent exterior grade. Footings to be located at El Porvenir should be placed at a depth of at least 18 inches below the lowest adjacent exterior grade.

TABLE 6.2-1
AVAILABLE VERTICAL BEARING CAPACITY

Site	Loading Conditions	Available Bearing Capacity (psf)
Cantua	Static	4050 + 85 B + 350 D
	Total Combined	6075 + 130 B + 525 D
El Porvenir	Static	2950 + 200B + 640D
	Total Combined	4450 + 310B + 960D

Concrete mat slabs are planned at each site. The slabs will be 8'W x 22'L x 8"T at Cantua and 10'W x 37'L x 10"T at El Porvenir. The available bearing capacity for items supported on the slabs can be estimated by from the equations in Table 6.2-1 by using the surface bearing width of elements plus 3T (slab thickness) to determine B and the slab thickness (T) as D. The size of the planned mat slabs could result edge movement due to expansion and contraction of unprotected clay soil subgrade. Consequently, the clayey subgrade should be moisture conditioned and protected with a draped PVC membrane as indicated in Section 6.3.

6.2.3 Estimated Settlement – Buildings and Tank Mats

Analysis, based on Hough, determined the following estimated static settlement based on a range of assumed design bearing and estimated structural loads. Results are presented in Table 6.2-2.

TABLE 6.2-2
ESTIMATED STATIC SETTLEMENTS

Site	Footing Type	Loading	Design Bearing (psf)	Estimated Settlement (inch)
Cantua	Mat	50 kips	200 psf	0.3
El Porvenir	Square	25 kips	2500 psf	0.8
	Mat	50 kips	200 psf	Less than 0.25
	Strip	2 klf	2500 psf	0.3

6.2.4 Pipe Line Design

If pressurized pipelines are utilized, the lateral thrust can be resisted by friction between the pipe and pipe zone backfill and lateral bearing on thrust blocks. Frictional resistance and lateral bearing may be used in combination. Table 6.2-3 provides the recommended frictional resistance and lateral bearing for sustained loading and test loading conditions.

TABLE 6.2-3
LATERAL RESISTANCE FOR PIPES

Site	Resistance Mode	Sustained Loading	Test Loading
Cantua	Frictional Coefficient		
	Smooth	0.20	0.24
	Rough	0.38	0.46
El Porvenir	Smooth	0.19	0.22
	Rough	0.35	0.42
Cantua	Lateral Bearing		
	Shallow Thrust Block (1)	270 psf/ft	360 psf/ft
	Deep Thrust Block (2)	610H psf + 4000 psf (3)	920H psf + 6000 psf
El Porvenir	Shallow Thrust Block (1)	250 psf/ft	330 psf/ft
	Deep Thrust Block (2)	1170H psf	1750H psf

Notes: (1) Shallow thrust block has a height greater than 70% of the depth to the center of the pipe, and if not covered by hardscape, the upper 24 inches should not be included.
(2) Deep thrust block has a height less than 70% of the depth to the center of the pipe
(3) H is height of the thrust block in feet

The horizontal deflection associated with developing the allowable lateral bearing on shallow thrust blocks is about 0.005D for sustained loading and 0.008D for test loading. D represents the depth below the ground surface to the base of the thrust block. The estimated horizontal deflection associated with the lateral bearing on deep thrust blocks is about 0.06 inch per 1000 psf of lateral bearing.

6.3 CONCRETE SLABS-ON-GRADE

Conventional (4 to 5 inch thick) building slabs-on-grade or hardscape (concrete less than 12 inches thick) should be supported on approved moisture conditioned and compacted fill or lime treated subgrade.

Untreated clay subgrade soil should have a moisture content of at least 4% above optimum and compaction between 88% and 92% of maximum density, to a depth of at least 30 inches below pad grade. Moisture needs to be maintained throughout the life of the slab or hardscape. To minimize moisture loss at the free (unabutted by structures or pavement) edges of hardscape or exterior slabs, a thickened edge or a vapor barrier should be provided. The vapor barrier could consist of a 10-mil PVC membrane. At the free edges of the slab, the membrane should extend below the ground surface to a depth of 30 inches.

Due to the expansive potential of untreated soils, the minimum reinforcement of conventional concrete building slabs should be #3 bars spaced at 18 inches center-to-center in both directions. The reinforcement is based on engineering judgment and experience with expansive soils and is not based on any structural analysis. The reinforcement assumes a nominal slab thickness of 4 to 5 inches. Slab thickness and reinforcement must also satisfy structural considerations. Any additional reinforcement for structural considerations should be provided by a structural engineer or building designer. No additional reinforcement (besides structural reinforcement) is needed if a lime treated subgrade option is chosen.

Slabs on grade could be supported on 18 inches of compacted lime treated subgrade. With this amended soil subgrade, reinforcement should be consistent with structural considerations.

Table 6.6-1 provides the design modulus of subgrade reaction k_1 (1-foot square plate) for elastic evaluation of footings or slabs placed on lime stabilized soil or untreated site soil.

TABLE 6.6-1

MODULUS OF SUBGRADE REACTION

Subgrade Soil	Subgrade Modulus (pci)
	K_1
Lime Stabilized	500
Untreated Clayey Soil	180

It should be noted the subgrade modulus reflects the response of the subgrade under primarily elastic conditions and small deflections. It is not a characteristic intended to define soil compressibility (settlement) or load-bearing capacity.

6.4 CORROSION POTENTIAL

Soil obtained from borings was tested for pH, minimum resistivity, soluble sulfates and chlorides. Specific test results are presented in Table 6.4-1.

TABLE 6.4-1
CORROSION TEST RESULTS

Sample	Depth (feet)	pH	Minimum Resistivity (ohm-cm)	Soluble Sulfate (mg/kg)	Soluble Chloride (mg/kg)
Cantua Creek B-3	0-5	7.6	270	2917.6	168.8
El Porvenir B-7	0-5	7.6	200	1548.6	22.6

The minimum electrical resistivity for both sites is generally representative of a very severely corrosive environment for buried unprotected metals.

Corrosion is dependent upon a complex variety of conditions (e.g., pH, soluble ions, redox, microbes, and area cathodic protection), which are beyond the geotechnical practice. Consequently, a qualified corrosion engineer/specialist should be consulted for specific recommendations on the need for any mitigation or protection of the pipeline.

The soluble sulfate content test results suggest that moderate to severe levels are present in on-site soils. Type V cement should be used in foundation concrete. The water-cement ratio

for concrete in contact with foundation soils should not exceed 0.45. The soluble chlorides test results suggest that a relatively low level are present in on-site soils. Normal reinforcement cover should be adequate in foundation concrete that comes in contact with the foundation soils.

6.5 SITE DRAINAGE

It is important that drainage away from the improvements be provided and maintained to prevent ponding and/or saturation of the soils in the vicinity of foundations or concrete slabs-on-grade. Proper drainage requires a partnering between the design and construction of the facility and the ultimate maintenance personnel.

The development should incorporate the basis for good drainage. This includes:

- Sufficient pad height to allow for proper drainage.
- Defined drainage gradients away from the structures to points of conveyance, such as drainage swales and/or area drains and discharge pipe.
- Roof downspouts connected to proper areas of discharge.

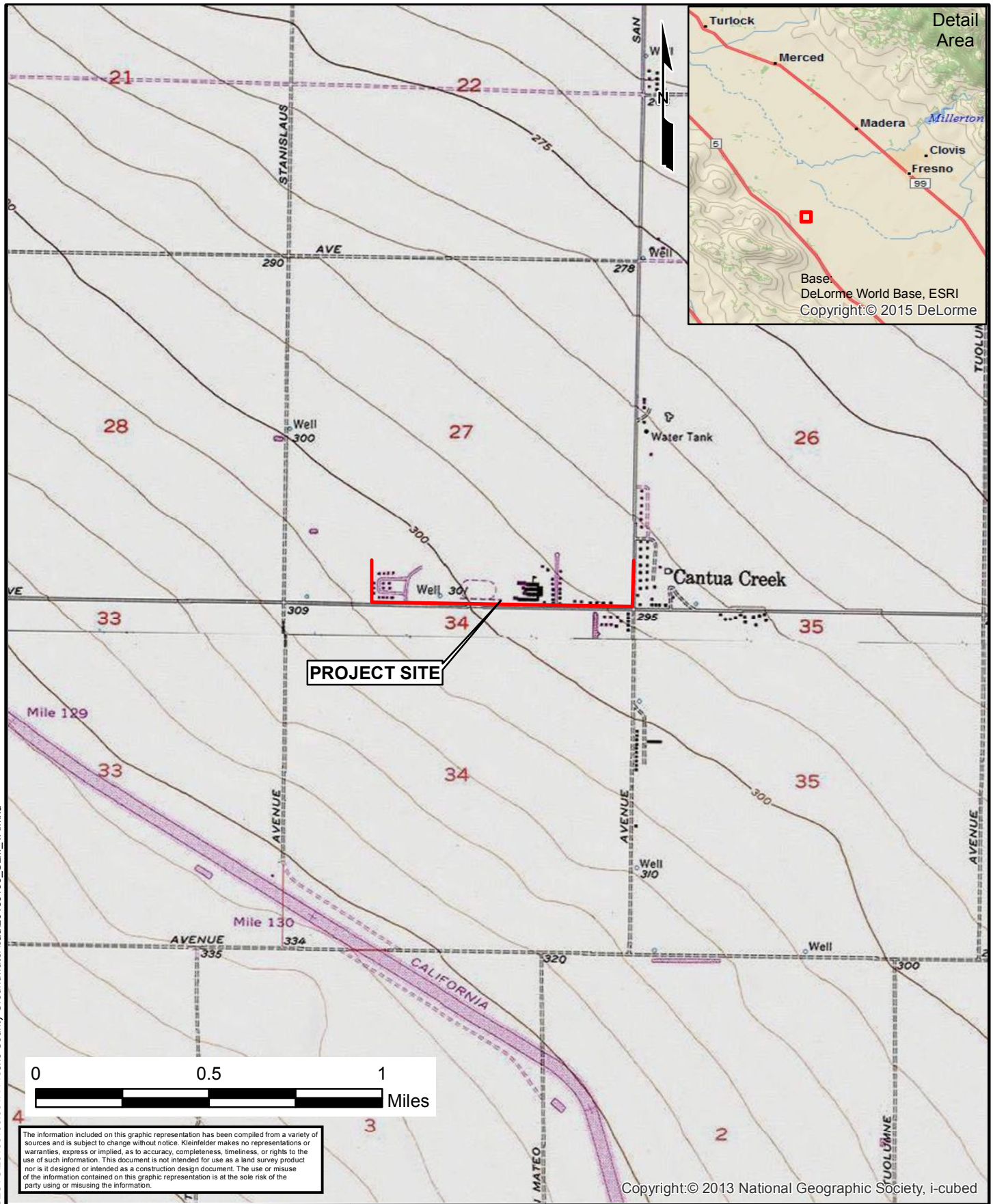
The maintenance personnel for the property must maintain the established site drainage by not blocking or obstructing gradients away from the foundations and structure. If the site is landscaped, the landscape personnel are also the only persons who can avoid over watering. If planted areas adjacent to the structure are desired, it is suggested that care be taken not to over irrigate and to maintain a leak-free sprinkler piping system. Well-maintained low volume emitter irrigation systems are best suited for planters adjacent to structures. Watering practices should strive to use only sufficient water to sustain and promote plant growth. All site irrigation should promote a soil moisture condition that is relatively uniform year round.

7. LIMITATIONS

Recommendations contained in this report are based on the field observations and subsurface explorations, laboratory tests, and present knowledge of the proposed construction. It is possible that soil conditions could vary between or beyond the points explored. If soil conditions are encountered during construction that differ from those described herein, Kleinfelder should be notified immediately in order that a review may be made and any supplemental recommendations provided. If the scope of the proposed construction, changes from that described in this report, the recommendations provided should also be reviewed.

This report has been prepared in substantial accordance with the generally accepted geotechnical engineering practice, as it exists in the general area at the time of the study. No warranty is expressed or implied. The recommendations provided in this report are based on the assumption that Kleinfelder will conduct an adequate program of tests and observations during the construction phase in order to evaluate compliance with the recommendations.

This report may be used only by Provost and Pritchard Consulting Group, other project consultants and reviewing regulatory agencies, and only for the purposes stated within a reasonable time from its issuance. Land use, site conditions or other factors may change over time, and additional work may be required with the passage of time. Any other party who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party.



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SITE VICINITY MAP
CANTUA CREEK

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
1

LEGEND

Approximate Boring Location

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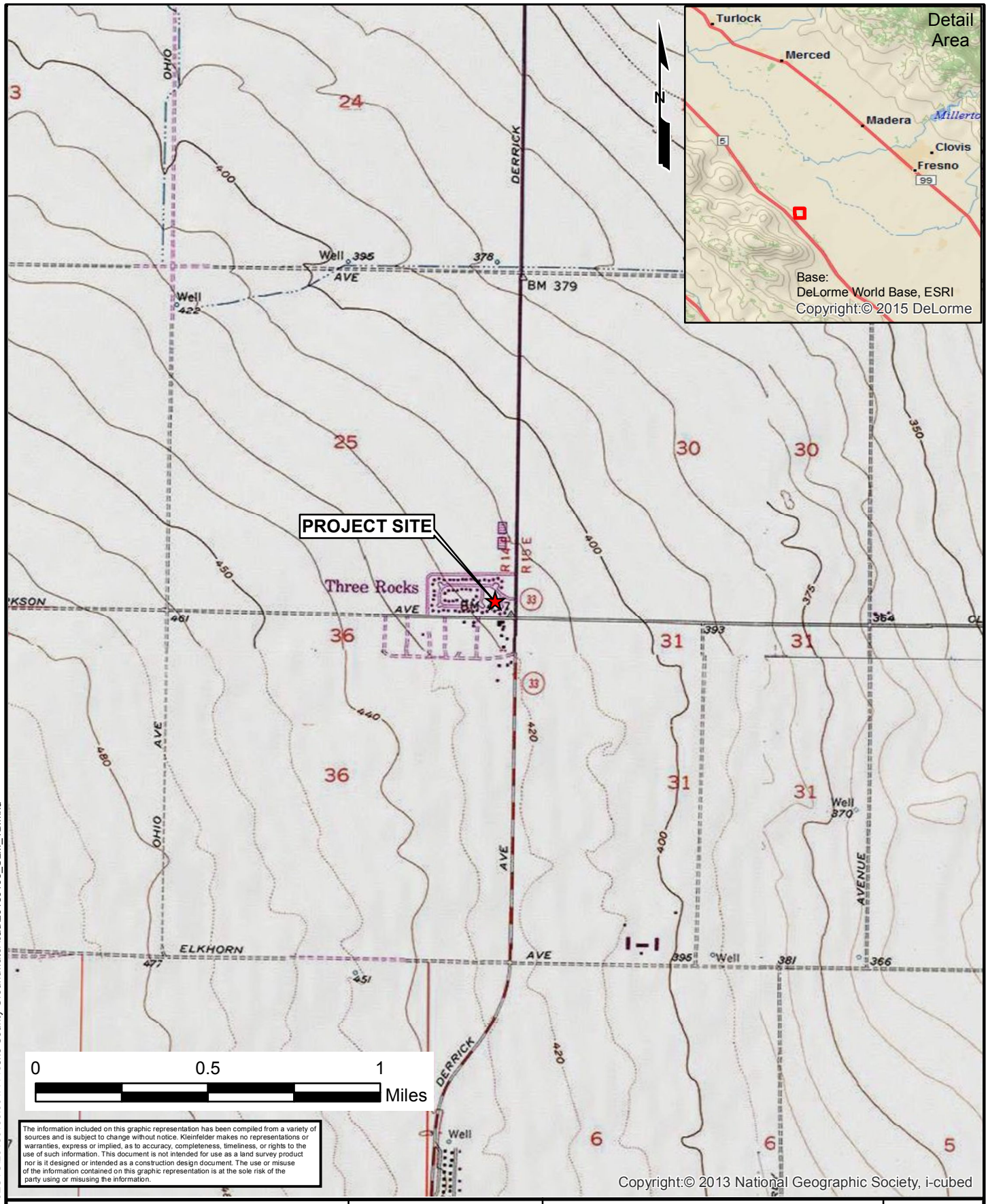
BORING LOCATION MAP
CANTUA CREEK

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
2

CAD FILE: K:\2017_PROJECTS\20180195.001A-Fresno County Groundwater\cad\ LAYOUT: CANTUA
PLOTTED: 15 May 2017, 9:28am, DRoss



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SITE VICINITY MAP
EL PORVENIR

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
3

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BORING LOCATION MAP
EL PORVENIR

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
4

SAMPLE/SAMPLER TYPE GRAPHICS

BULK SAMPLE

CALIFORNIA SAMPLER
(3 in. (76.2 mm.) outer diameter)

STANDARD PENETRATION SPLIT SPOON SAMPLER
(2 in. (50.8 mm.) outer diameter and 1-3/8 in. (34.9 mm.) inner diameter)

GROUND WATER GRAPHICS

WATER LEVEL (level where first observed)

WATER LEVEL (level after exploration completion)

WATER LEVEL (additional levels after exploration)

OBSERVED SEEPAGE

NOTES

- The report and graphics key are an integral part of these logs. All data and interpretations in this log are subject to the explanations and limitations stated in the report.
- Lines separating strata on the logs represent approximate boundaries only. Actual transitions may be gradual or differ from those shown.
- No warranty is provided as to the continuity of soil or rock conditions between individual sample locations.
- Logs represent general soil or rock conditions observed at the point of exploration on the date indicated.
- In general, Unified Soil Classification System designations presented on the logs were based on visual classification in the field and were modified where appropriate based on gradation and index property testing.
- Fine grained soils that plot within the hatched area on the Plasticity Chart, and coarse grained soils with between 5% and 12% passing the No. 200 sieve require dual USCS symbols, ie., GW-GM, GP-GM, GW-GC, GP-GC, GC-GM, SW-SM, SP-SM, SW-SC, SP-SC, SC-SM.
- If sampler is not able to be driven at least 6 inches then 50/X indicates number of blows required to drive the identified sampler X inches with a 140 pound hammer falling 30 inches.

ABBREVIATIONS
WOH - Weight of Hammer
WOR - Weight of Rod

UNIFIED SOIL CLASSIFICATION SYSTEM (ASTM D 2487)

COARSE GRAINED SOILS (More than half of material is larger than the #200 sieve)	**GRAVELS** (More than half of coarse fraction is larger than the #4 sieve)	CLEAN GRAVEL WITH <5% FINES	Cu ≥4 and 1≤ Cc≤3		**GW**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			Cu <4 and/ or 1>Cc >3		**GP**	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		GRAVELS WITH 5% TO 12% FINES	Cu ≥4 and 1≤ Cc≤3		**GW-GM**	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
					GW-GC	WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
			Cu <4 and/ or 1>Cc >3		**GP-GM**	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE FINES
					GP-GC	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES WITH LITTLE CLAY FINES
		GRAVELS WITH > 12% FINES			**GM**	SILTY GRAVELS, GRAVEL-SILT-SAND MIXTURES
					GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
					GC-GM	CLAYEY GRAVELS, GRAVEL-SAND-CLAY-SILT MIXTURES
	SANDS (More than half of coarse fraction is smaller than the #4 sieve)	CLEAN SANDS WITH <5% FINES	Cu ≥6 and 1≤ Cc≤3		**SW**	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
			Cu <6 and/ or 1>Cc >3		**SP**	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE OR NO FINES
		SANDS WITH 5% TO 12% FINES	Cu ≥6 and 1≤ Cc≤3		**SW-SM**	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
					SW-SC	WELL-GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
			Cu <6 and/ or 1>Cc >3		**SP-SM**	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE FINES
					SP-SC	POORLY GRADED SANDS, SAND-GRAVEL MIXTURES WITH LITTLE CLAY FINES
		SANDS WITH > 12% FINES			**SM**	SILTY SANDS, SAND-GRAVEL-SILT MIXTURES
					SC	CLAYEY SANDS, SAND-GRAVEL-CLAY MIXTURES
					SC-SM	CLAYEY SANDS, SAND-SILT-CLAY MIXTURES

FINE GRAINED SOILS (More than half of material is smaller than the #200 sieve)	SILTS AND CLAYS (Liquid Limit less than 50)	**ML**	INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS, SILTS WITH SLIGHT PLASTICITY
		CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		CL-ML	INORGANIC CLAYS-SILTS OF LOW PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
		OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS (Liquid Limit greater than 50)	**MH**	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILT
		CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
		OH	ORGANIC CLAYS & ORGANIC SILTS OF MEDIUM-TO-HIGH PLASTICITY

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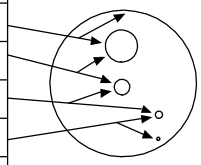
GRAPHICS KEY

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

1

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		>12 in. (304.8 mm.)	>12 in. (304.8 mm.)	Larger than basketball-sized
Cobbles		3 - 12 in. (76.2 - 304.8 mm.)	3 - 12 in. (76.2 - 304.8 mm.)	Fist-sized to basketball-sized
Gravel	coarse	3/4 -3 in. (19 - 76.2 mm.)	3/4 -3 in. (19 - 76.2 mm.)	Thumb-sized to fist-sized
	fine	#4 - 3/4 in. (#4 - 19 mm.)	0.19 - 0.75 in. (4.8 - 19 mm.)	Pea-sized to thumb-sized
Sand	coarse	#10 - #4	0.079 - 0.19 in. (2 - 4.9 mm.)	Rock salt-sized to pea-sized
	medium	#40 - #10	0.017 - 0.079 in. (0.43 - 2 mm.)	Sugar-sized to rock salt-sized
	fine	#200 - #40	0.0029 - 0.017 in. (0.07 - 0.43 mm.)	Flour-sized to sugar-sized
Fines		Passing #200	<0.0029 in. (<0.07 mm.)	Flour-sized and smaller



SECONDARY CONSTITUENT

	AMOUNT	
Term of Use	Secondary Constituent is Fine Grained	Secondary Constituent is Coarse Grained
Trace	<5%	<15%
With	≥5 to <15%	≥15 to <30%
Modifier	≥15%	≥30%

MOISTURE CONTENT

DESCRIPTION	FIELD TEST
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil is below water table

CEMENTATION

DESCRIPTION	FIELD TEST
Weakly	Crumbles or breaks with handling or slight finger pressure
Moderately	Crumbles or breaks with considerable finger pressure
Strongly	Will not crumble or break with finger pressure

CONSISTENCY - FINE-GRAINED SOIL

CONSISTENCY	SPT - N_{60} (# blows / ft)	Pocket Pen (tsf)	UNCONFINED COMPRESSIVE STRENGTH (Q_u)(psf)	VISUAL / MANUAL CRITERIA
Very Soft	<2	PP < 0.25	<500	Thumb will penetrate more than 1 inch (25 mm). Extrudes between fingers when squeezed.
Soft	2 - 4	0.25≤ PP <0.5	500 - 1000	Thumb will penetrate soil about 1 inch (25 mm). Remolded by light finger pressure.
Medium Stiff	4 - 8	0.5≤ PP <1	1000 - 2000	Thumb will penetrate soil about 1/4 inch (6 mm). Remolded by strong finger pressure.
Stiff	8 - 15	1≤ PP <2	2000 - 4000	Can be imprinted with considerable pressure from thumb.
Very Stiff	15 - 30	2≤ PP <4	4000 - 8000	Thumb will not indent soil but readily indented with thumbnail.
Hard	>30	4≤ PP	>8000	Thumbnail will not indent soil.

FROM TERZAGHI AND PECK, 1948; LAMBE AND WHITMAN, 1969; FHWA, 2002; AND ASTM D2488

REACTION WITH HYDROCHLORIC ACID

DESCRIPTION	FIELD TEST
None	No visible reaction
Weak	Some reaction, with bubbles forming slowly
Strong	Violent reaction, with bubbles forming immediately

APPARENT / RELATIVE DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPT-N_{60} (# blows/ft)	MODIFIED CA SAMPLER (# blows/ft)	CALIFORNIA SAMPLER (# blows/ft)	RELATIVE DENSITY (%)
Very Loose	<4	<4	<5	0 - 15
Loose	4 - 10	5 - 12	5 - 15	15 - 35
Medium Dense	10 - 30	12 - 35	15 - 40	35 - 65
Dense	30 - 50	35 - 60	40 - 70	65 - 85
Very Dense	>50	>60	>70	85 - 100

FROM TERZAGHI AND PECK, 1948

PLASTICITY

DESCRIPTION	LL	FIELD TEST
Non-plastic	NP	A 1/8-in. (3 mm.) thread cannot be rolled at any water content.
Low (L)	< 30	The thread can barely be rolled and the lump or thread cannot be formed when drier than the plastic limit.
Medium (M)	30 - 50	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump or thread crumbles when drier than the plastic limit.
High (H)	> 50	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 or thread can be formed without crumbling when drier than the plastic limit.

STRUCTURE

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 1/4-in. thick, note thickness.
Laminated	Alternating layers of varying material or color with the layer less than 1/4-in. thick, note thickness.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness.

ANGULARITY

DESCRIPTION	CRITERIA
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

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SOIL DESCRIPTION KEY

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EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-2

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-1**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	70°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		FIELD EXPLORATION — Surface Condition: Bare Earth				LABORATORY RESULTS							
0		**Fat CLAY with Sand (CH)**: fine-grained, high plasticity, light olive gray, moist, medium stiff				CH				73	60	41	**ASTM D1557 Method A=** Max. Dry Unit Wt.: 112.6 pcf Opt. Water Content: 14.8%
				BC=6 8 9			22.3	89.1					
5		calcium present		BC=5 7 6			22.5	89.4					
10		mica present		BC=4 3 5									
15		trace fine to medium grained sands		BC=5 8 11			25.2	91.8					
		Clayey SAND (SC): fine to medium-grained, low plasticity, dark olive, moist, medium dense											
20				BC=4 4 4						41			
		Silty SAND with Clay (SM): fine to medium-grained, non-plastic to low plasticity, dark olive brown, moist, medium dense											
25				BC=5 10 13			11.1	90.4					
30				BC=2 4 6									
		Lean CLAY (CL): fine-grained, low to medium plasticity, olive gray, moist, medium stiff											

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BORING LOG B-1

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-3

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-1**
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel	
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:** 140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger	
Weather:	70°/Sunny	**Bore Diameter:**	8 in. O.D.	

Depth (feet)	Graphical Log	Surface Condition: Bare Earth / Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		FIELD EXPLORATION				LABORATORY RESULTS							
▽		**Clayey SAND (SC)**: fine to coarse-grained, non-plastic to low plasticity, light olive brown, wet, medium dense		BC=7 10 13									
40		The boring was terminated at approximately 36.5 ft. below ground surface. The boring was backfilled with auger cuttings on May 01, 2017.											
45													
50													
55													
60													
65													

GROUNDWATER LEVEL INFORMATION:
▽ Groundwater was observed at approximately 35.5 ft. below ground surface during drilling.
GENERAL NOTES:

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BORING LOG B-1

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-3

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-2**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	70°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	Surface Condition: Bare Earth Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		FIELD EXPLORATION				LABORATORY RESULTS							
		Fat CLAY (CH): fine-grained, medium to high plasticity, light olive gray, moist, medium stiff											
		stiff, calcium present		BC=8 10 10			31.7	87.9					**Consolidation**
5		increase in calcium, trace fine sand		BC=5 9 15			31.0	83.1					**Direct Shear=** Peak Cohesion: 453 psf Peak Friction Angle: 20.3°
10				BC=5 8 9			25.2	94.8					
15		medium stiff, top 2 in. include fine sand		BC=2 3 3									
		Clayey SAND (SC): fine to medium-grained, low plasticity, light olive brown, moist, medium dense											
20				BC=4 7 11			18.5	99.2					
		Silty SAND with Clay (SM): fine to medium-grained, non-plastic to low plasticity, light olive gray, moist, medium dense											
25				BC=4 4 5									
		Clayey SAND (SC): fine-grained, low plasticity, light olive gray, moist, medium stiff											
30				BC=5 7 8			20.2	93.1					

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BORING LOG B-2

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FRESNO COUNTY, CALIFORNIA

FIGURE
A-4

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-2**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	70°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	FIELD EXPLORATION: Surface Condition: Bare Earth / Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	LABORATORY RESULTS: USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		Sandy Lean CLAY (CL): fine-grained, low to medium plasticity, light olive gray, moist, stiff		BC=5 6 8									

The boring was terminated at approximately 36.5 ft. below ground surface. The boring was backfilled with auger cuttings on May 01, 2017.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:

40
45
50
55
60
65

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BORING LOG B-2

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-4

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-3**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	70°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	Surface Condition: Bare Earth / Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		FIELD EXPLORATION				LABORATORY RESULTS							
0		**Sandy Fat CLAY (CH)**: fine-grained, medium plasticity, light olive gray, moist, medium stiff											
5		medium to high plasticity, dark olive, stiff, decrease in sands		BC=6 9 13			20.2	92.7					
10		calcium present		BC=4 4 5									
15				BC=7 12 12									
20													
25													
30													

The boring was terminated at approximately 16.5 ft. below ground surface. The boring was backfilled with auger cuttings on May 01, 2017.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:

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BORING LOG B-3

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-5

PAGE: 1 of 1

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-4**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	75°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	Surface Condition: Bare Earth Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		FIELD EXPLORATION				LABORATORY RESULTS							
0		**Sandy Fat CLAY (CH)**: fine-grained, medium to high plasticity, light olive gray, moist, medium stiff											
5		high plasticity, decrease in sands		BC=4 6 5									
10				BC=4 8 10			14.8	95.6					
		Clayey SAND (SC): fine-grained, low to medium plasticity, light olive gray, moist, medium dense											
15		**Lean CLAY (CL)**: fine-grained, medium plasticity, light olive gray, moist, stiff		BC=3 6 9									
20													
25													
30													

The boring was terminated at approximately 16.5 ft. below ground surface. The boring was backfilled with auger cuttings on May 01, 2017.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:

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BORING LOG B-4

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-6

PAGE: 1 of 1

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-5**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	75°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	Surface Condition: Bare Earth / Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		FIELD EXPLORATION				LABORATORY RESULTS							
0		**Fat CLAY (CH)**: fine-grained, medium to high plasticity, light olive brown, moist, medium stiff, trace fine subangular gravel up to 1 in.											
5		high plasticity, stiff, calcium present		BC=6 8 8			20.0	93.8					
10		trace fine to medium sands		BC=4 6 5									
15		increase in sands, trace fine subrounded gravel up to 1/4 in.		BC=7 9 15									
20													
25													
30													

The boring was terminated at approximately 16.5 ft. below ground surface. The boring was backfilled with auger cuttings on May 01, 2017.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:

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BORING LOG B-5

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-7

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-6**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	75°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	Surface Condition: Bare Earth / Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		FIELD EXPLORATION				LABORATORY RESULTS							
0		**Sandy Fat CLAY (CH)**: fine-grained, medium to high plasticity, light olive brown, moist, medium stiff											**ASTM D1557 Method A=** Max. Dry Unit Wt.: 113.2 pcf Opt. Water Content: 14.5%
5		calcium present		BC=4 4 4						68			
10		stiff, trace fine sand		BC=9 10 11			16.3	92.3					
15		decrease in fine sand		BC=4 6 7									
20													
25													
30													

The boring was terminated at approximately 16.5 ft. below ground surface. The boring was backfilled with auger cuttings on May 01, 2017.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:

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BORING LOG B-6

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-8

PAGE: 1 of 1

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-7**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	75°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	Surface Condition: Bare Earth and Grass Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		FIELD EXPLORATION				LABORATORY RESULTS							
		Clayey SAND (SC): fine-grained, olive, moist, medium dense				CL				50	36	20	**ASTM D1557 Method A=** Max. Dry Unit Wt.: 118.1 pcf Opt. Water Content: 13.0%
5				BC=13 14 12			10.2	88.7					**Direct Shear=** Peak Cohesion: 140 psf Peak Friction Angle: 29.7°
		Lean CLAY (CL): fine-grained, low to medium plasticity, olive, moist, medium stiff, calcium present											
		Sandy Lean CLAY (CL): fine-grained, low to medium plasticity, olive, moist, medium stiff											
10				BC=4 5 6									
15				BC=7 10 14			5.1	101.5					
		Poorly graded SAND (SP): fine to coarse-grained, non-plastic, light brownish gray, moist, medium dense											
		Clayey SAND (SC): fine to medium-grained, low plasticity, olive, moist, medium dense											
20				BC=6 9 7									
25		dense, increase in calcium		BC=8 16 25			18.1	100.6					
30		medium dense		BC=7 13 13									

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BORING LOG B-7

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-9

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-7**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	75°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	FIELD EXPLORATION Surface Condition: Bare Earth and Grass Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	LABORATORY RESULTS USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		Poorly graded SAND with Clay (SP-SC): fine to coarse-grained, non-plastic to low plasticity, olive, moist, dense		BC=15 18 23			15.6	97.8					
		Lean CLAY (CL): fine-grained, low to medium plasticity, olive, moist, stiff											
40		The boring was terminated at approximately 36.5 ft. below ground surface. The boring was backfilled with auger cuttings on May 01, 2017.											
45													
50													
55													
60													
65													

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:

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BORING LOG B-7

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-9
PAGE: 2 of 2

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-8**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	80°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	Surface Condition: Bare Earth / Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		FIELD EXPLORATION				LABORATORY RESULTS							
0		**Clayey SAND (SC)**: fine-grained, low to medium plasticity, olive yellow, moist, medium dense								23			
5		3 in. pocket poorly graded sand (SP), light brownish gray, fine to medium grained, medium dense, non-plastic		BC=9 10 7									
10		fine to medium-grained, low plasticity		BC=4 8 6									
15				BC=5 5 7									
20													
25													
30													

The boring was terminated at approximately 16.5 ft. below ground surface. The boring was backfilled with auger cuttings on May 01, 2017.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:

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BORING LOG B-8

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-10

Date Begin - End:	5/01/2017	**Drilling Company:**	AWA	**BORING LOG B-9**	
Logged By:	V. Tinoco	**Drill Crew:**	Miguel/Angel		
Hor.-Vert. Datum:	Not Available	**Drilling Equipment:**	CME-75	**Hammer Type - Drop:**	140 lb. Auto - 30 in.
Plunge:	-90 degrees	**Drilling Method:**	Hollow Stem Auger		
Weather:	80°/Sunny	**Bore Diameter:**	8 in. O.D.		

Depth (feet)	Graphical Log	Surface Condition: Asphalt Lithologic Description	Sample Type	Blow Counts(BC)= Uncorr. Blows/6 in.	Recovery (NR=No Recovery)	USCS Symbol	Water Content (%)	Dry Unit Wt. (pcf)	Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plasticity Index (NP=NonPlastic)	Additional Tests/ Remarks
		FIELD EXPLORATION				LABORATORY RESULTS							
0		**Clayey SAND (SC)**: fine to medium-grained, low plasticity, olive, moist, medium dense											
5		calcium present		BC=5 7 5			6.1	95.9					
		Sandy Lean CLAY (CL): fine-grained, medium plasticity, olive yellow, moist, medium stiff, mica present											
10				BC=5 4 3									
15		**Clayey SAND (SC)**: fine to medium-grained, non-plastic to low plasticity, olive gray, moist, medium dense		BC=5 6 8									
20													
25													
30													

The boring was terminated at approximately 16.5 ft. below ground surface. The boring was backfilled with auger cuttings and patched at surface on May 01, 2017.

GROUNDWATER LEVEL INFORMATION:
Groundwater was not observed during drilling or after completion.
GENERAL NOTES:

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BORING LOG B-9

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
A-11

Exploration ID	Depth (ft.)	Sample Description	Water Content (%)	Dry Unit Wt. (pcf)	Sieve Analysis (%)			Atterberg Limits			Additional Tests
					Passing 3/4"	Passing #4	Passing #200	Liquid Limit	Plastic Limit	Plasticity Index	
B-1	0.0	FAT CLAY WITH SAND (CH)					73	60	19	41	**ASTM D1557 Method A=**
											Maximum Dry Unit Weight: 112.6 pcf
											Optimum Water Content: 14.8%
B-1	2.5		22.3	89.1							
B-1	5.0		22.5	89.4							
B-1	15.0		25.2	91.8							
B-1	20.0	CLAYEY SAND (SC)					41				
B-1	25.0		11.1	90.4							
B-2	2.5	FAT CLAY (CH)	31.7	87.9							**Consolidation**
B-2	5.0	FAT CLAY (CH)	31.0	83.1							**Direct Shear=**
											Peak Cohesion: 453 psf
											Peak Friction Angle: 20.3°
B-2	10.0		25.2	94.8							
B-2	20.0		18.5	99.2							
B-2	30.0		20.2	93.1							
B-3	5.0		20.2	92.7							
B-4	10.0		14.8	95.6							
B-5	5.0		20.0	93.8							
B-6	0.0	SANDY FAT CLAY (CH)									**ASTM D1557 Method A=**
											Maximum Dry Unit Weight: 113.2 pcf
											Optimum Water Content: 14.5%
B-6	5.0	SANDY FAT CLAY (CH)					68				
B-6	10.0		16.3	92.3							
B-7	0.0	CLAYEY SAND (SC)					50	36	16	20	**ASTM D1557 Method A=**
											Maximum Dry Unit Weight: 118.1 pcf
											Optimum Water Content: 13.0%

Refer to the Geotechnical Evaluation Report or the supplemental plates for the method used for the testing performed above.
NP = NonPlastic

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LABORATORY TEST RESULT SUMMARY

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
B-1

Exploration ID	Depth (ft.)	Sample Description	Water Content (%)	Dry Unit Wt. (pcf)	Sieve Analysis (%)			Atterberg Limits			Additional Tests
					Passing 3/4"	Passing #4	Passing #200	Liquid Limit	Plastic Limit	Plasticity Index	
B-7	5.0	CLAYEY SAND (SC)	10.2	88.7							**Direct Shear=**
											Peak Cohesion: 140 psf
											Peak Friction Angle: 29.7°
B-7	15.0		5.1	101.5							
B-7	25.0		18.1	100.6							
B-7	35.0		15.6	97.8							
B-8	0.0	CLAYEY SAND (SC)					23				
B-9	5.0		6.1	95.9							

Refer to the Geotechnical Evaluation Report or the supplemental plates for the method used for the testing performed above.
NP = NonPlastic

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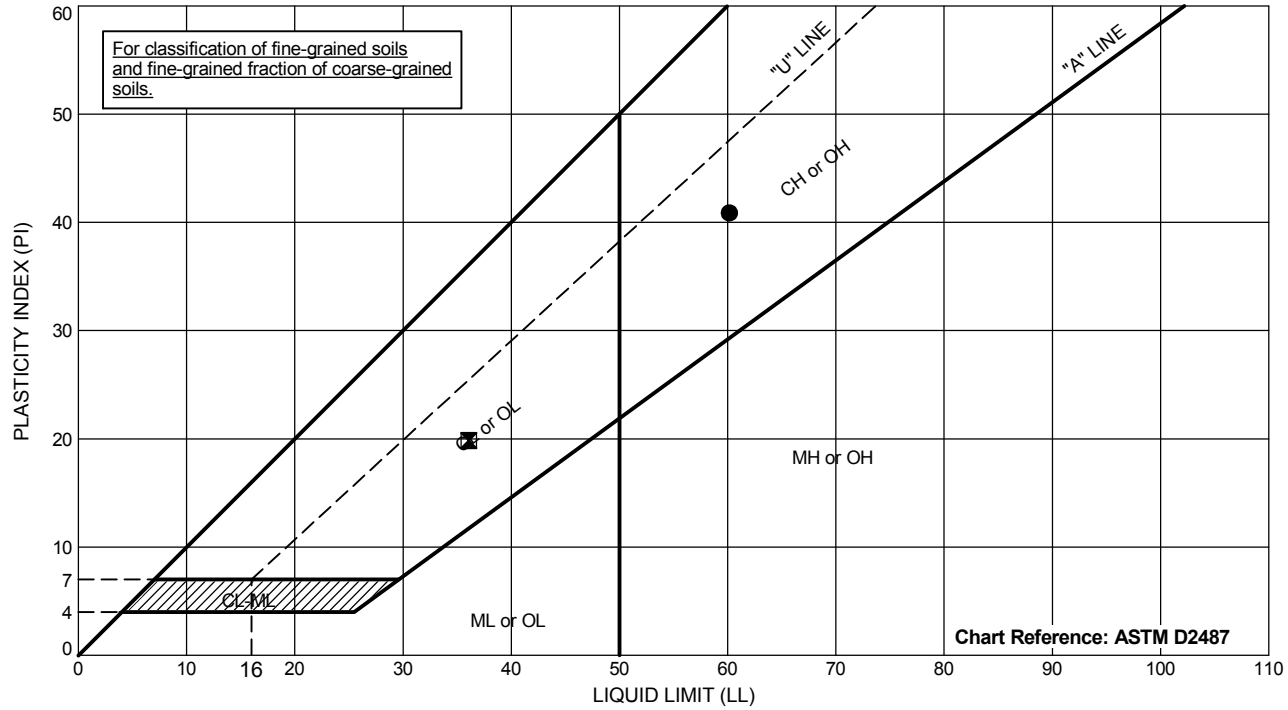
LABORATORY TEST RESULT SUMMARY

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
B-2



Exploration ID		Depth (ft.)	Sample Description	Passing #200	LL	PL	PI
●	B-1	0 - 5	FAT CLAY WITH SAND (CH)	73	60	19	41
⊠	B-7	0 - 5	CLAYEY SAND (SC)	50	36	16	20

Testing perfomed in general accordance with ASTM D4318.
NP = Nonplastic
NM = Not Measured

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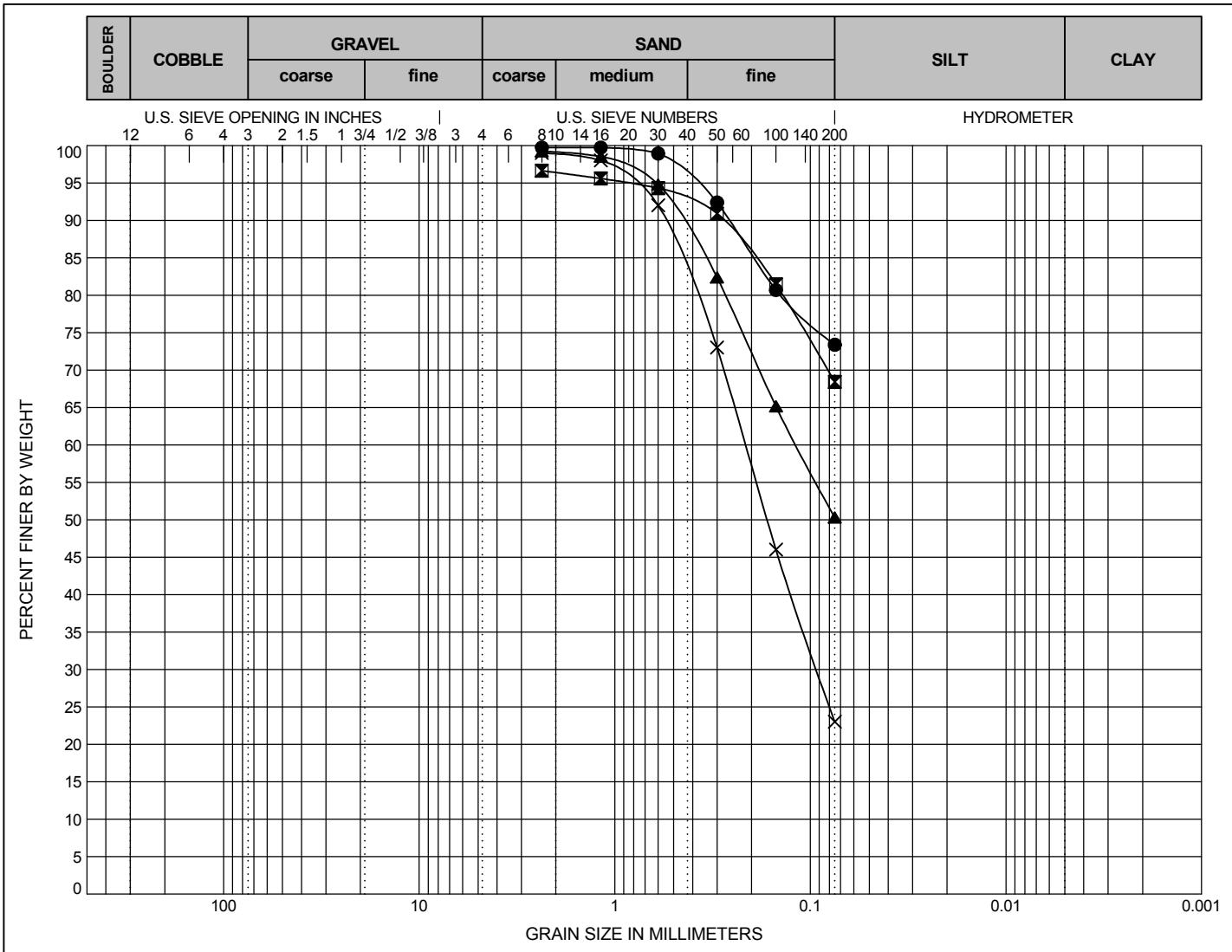
ATTERBERG LIMITS

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
B-3



Exploration ID		Depth (ft.)	Sample Description	LL	PL	PI
●	B-1	0 - 5	FAT CLAY WITH SAND (CH)	60	19	41
⊠	B-6	5	SANDY FAT CLAY (CH)	NM	NM	NM
▲	B-7	0 - 5	CLAYEY SAND (SC)	36	16	20
×	B-8	0 - 5	CLAYEY SAND (SC)	NM	NM	NM

Exploration ID		Depth (ft.)	D_{100}	D_{60}	D_{30}	D_{10}	Cc	Cu	Passing 3/4"	Passing #4	Passing #200	%Silt	%Clay
●	B-1	0 - 5	2.36	NM	NM	NM	NM	NM			73	NM	NM
⊠	B-6	5	2.36	NM	NM	NM	NM	NM			68	NM	NM
▲	B-7	0 - 5	2.36	0.118	NM	NM	NM	NM			50	NM	NM
×	B-8	0 - 5	2.36	0.215	0.093	NM	NM	NM			23	NM	NM

Sieve Analysis and Hydrometer Analysis testing performed in general accordance with ASTM D422.
NP = Nonplastic
NM = Not Measured

Coefficients of Uniformity - $C_u = D_{60} / D_{10}$
Coefficients of Curvature - $C_C = (D_{30})^2 / D_{60}\, D_{10}$
D_{60} = Grain diameter at 60% passing
D_{30} = Grain diameter at 30% passing
D_{10} = Grain diameter at 10% passing

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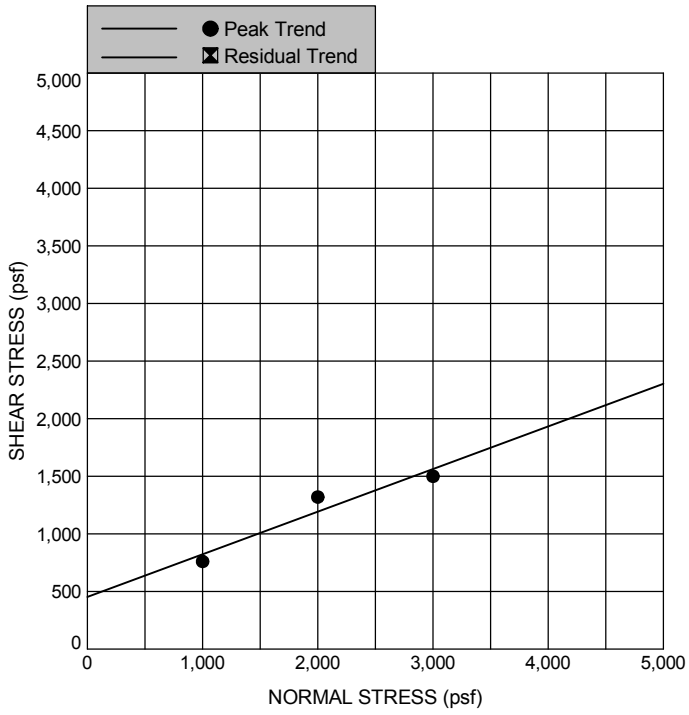
SIEVE ANALYSIS

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
B-4



Exploration ID	Depth (ft.)	Sample Description
B-2	5	FAT CLAY (CH)

Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plastic Limit	Plasticity Index	Specific Gravity
NM	NM	NM	NM	NM	

	Specimen No.	Water Content (%)	Dry Unit Weight (pcf)	Saturation (%)	Void Ratio	Area (in^2)	Height (in)
Initial	1	30.6	81.0	78.1	1.040	4.60	0.96
	2	31.2	83.4	83.9	0.983	4.60	0.96
	3	31.2	84.8	87.0	0.950	4.60	0.96
At Test	Specimen No.	Water Content (%)	Dry Unit Weight (pcf)	Saturation (%)	Void Ratio	Area (in^2)	Height (in)
	1	41.5	81.8		1.022	4.60	0.95
	2	41.7	85.1		0.944	4.60	0.94
	3	39.9	86.4		0.911	4.60	0.94

Specimen No.	Peak Shear Stress (psf)	Residual Shear Stress (psf)	Horizontal Displacement (in)	Normal Stress (psf)	Strain Rate (in/min)
1	760		0.0700	1000	0.001
2	1320		0.0500	2000	0.001
3	1500		0.0400	3000	0.001

Results	Cohesion (psf)	Friction ϕ (deg)	Tan ϕ (deg)
Peak	453	20.3	
Residual			

Testing perfomed in general accordance with ASTM D3080.
NP = Nonplastic
NM = Not Measured

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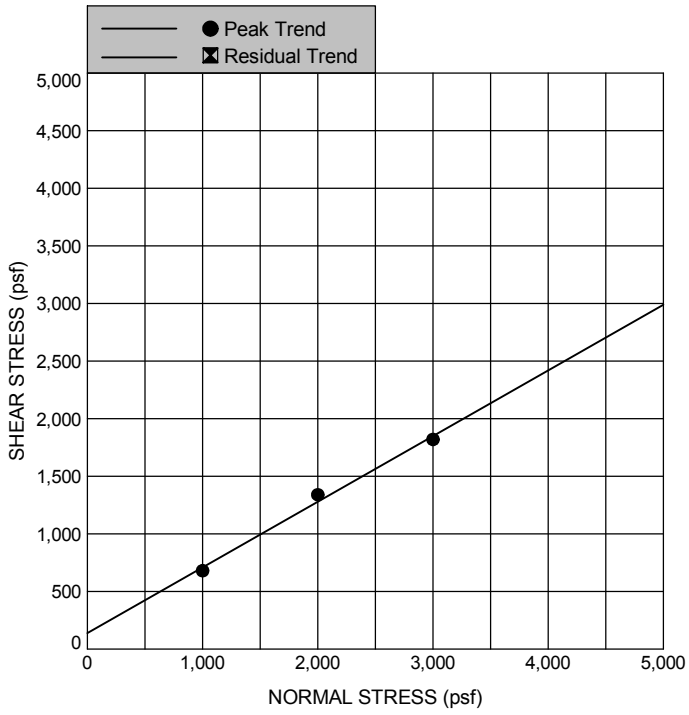
DIRECT SHEAR

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
B-5



Exploration ID	Depth (ft.)	Sample Description
B-7	5	CLAYEY SAND (SC)

Passing #4 (%)	Passing #200 (%)	Liquid Limit	Plastic Limit	Plasticity Index	Specific Gravity
NM	NM	NM	NM	NM	

	Specimen No.	Water Content (%)	Dry Unit Weight (pcf)	Saturation (%)	Void Ratio	Area (in^2)	Height (in)
Initial	1	8.4	94.8	30.0	0.745	4.60	0.96
	2	9.2	88.7	28.3	0.865	4.60	0.96
	3	12.9	82.5	34.0	1.004	4.60	0.96
At Test	Specimen No.	Water Content (%)	Dry Unit Weight (pcf)	Saturation (%)	Void Ratio	Area (in^2)	Height (in)
	1	22.9	100.2		0.745	4.60	0.96
	2	38.0	96.1		0.865	4.60	0.96
	3	41.4	91.8		1.004	4.60	0.96

Specimen No.	Peak Shear Stress (psf)	Residual Shear Stress (psf)	Horizontal Displacement (in)	Normal Stress (psf)	Strain Rate (in/min)
1	680		0.1400	1000	0.001
2	1340		0.1400	2000	0.001
3	1820		0.1400	3000	0.001

Results	Cohesion (psf)	Friction ϕ (deg)	Tan ϕ (deg)
Peak	140	29.68	
Residual			

Testing perfomed in general accordance with ASTM D3080.
NP = Nonplastic
NM = Not Measured

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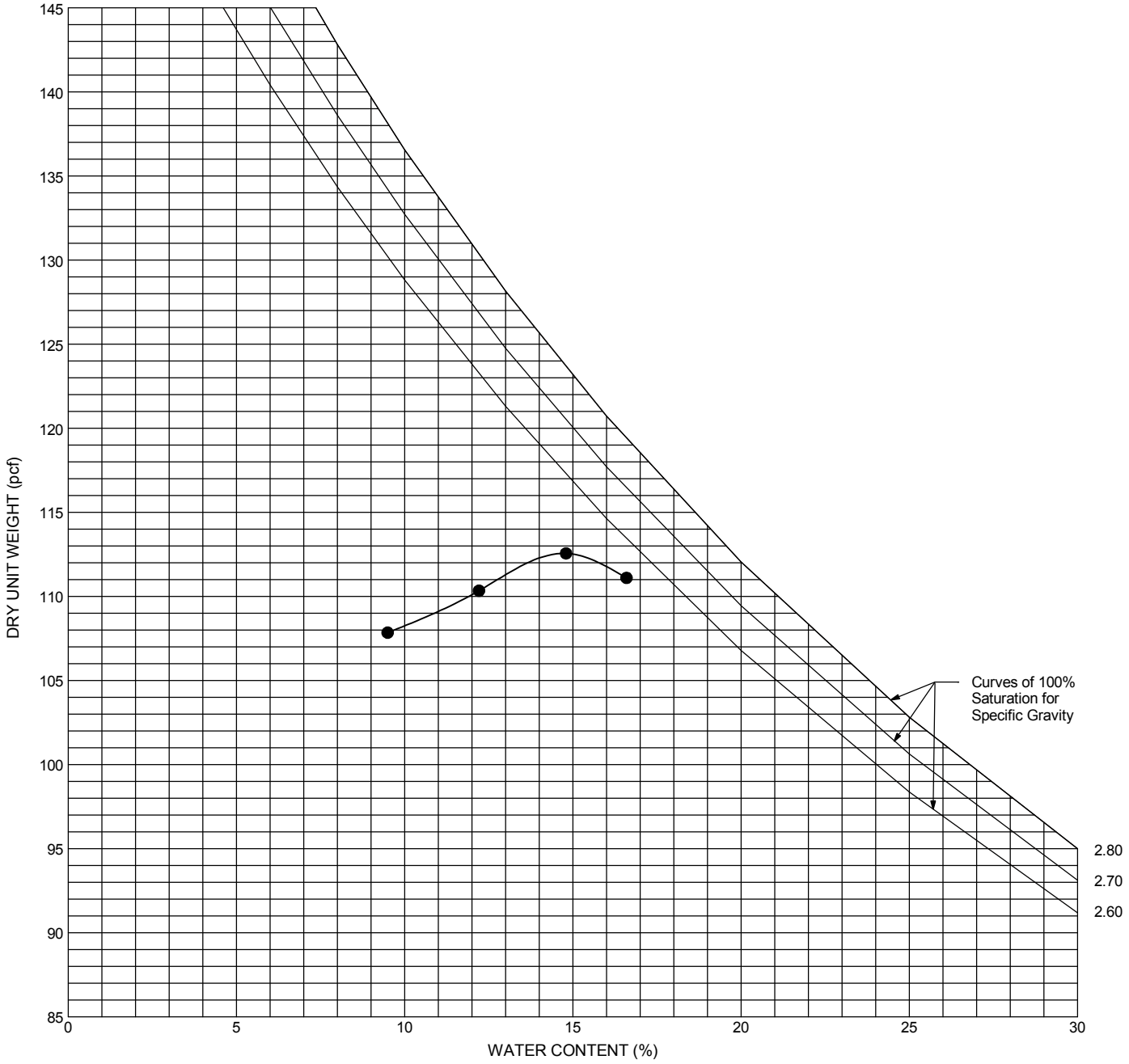
DIRECT SHEAR

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE
B-6



Exploration ID	Depth (ft.)	Sample Description
● B-1	0 - 5	FAT CLAY WITH SAND (CH)

Passing 3/4"	Passing #4	Passing #200	LL	PL	PI	Maximum Dry Unit Weight (pcf)	Optimum Water Content (%)
NM	NM	73	60	19	41	112.6	14.8

Testing performed in general accordance with ASTM D1557 Method A.
NP = Nonplastic
NM = Not Measured

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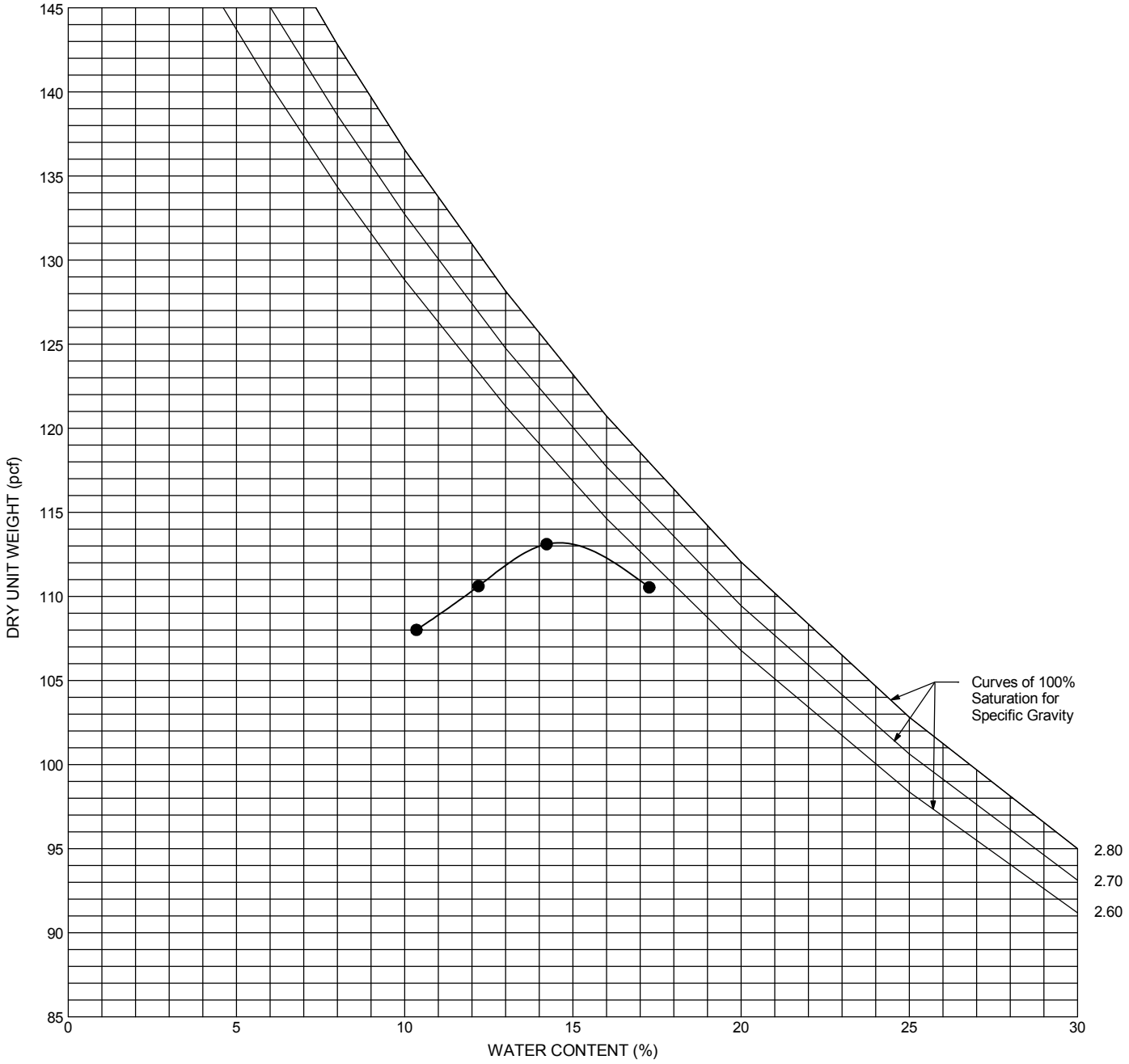
COMPACTION CURVE

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE

B-7



Exploration ID	Depth (ft.)	Sample Description
● B-6	0 - 5	SANDY FAT CLAY (CH)

Passing 3/4"	Passing #4	Passing #200	LL	PL	PI	Maximum Dry Unit Weight (pcf)	Optimum Water Content (%)
NM	NM	NM	NM	NM	NM	113.2	14.5

Testing performed in general accordance with ASTM D1557 Method A.
NP = Nonplastic
NM = Not Measured

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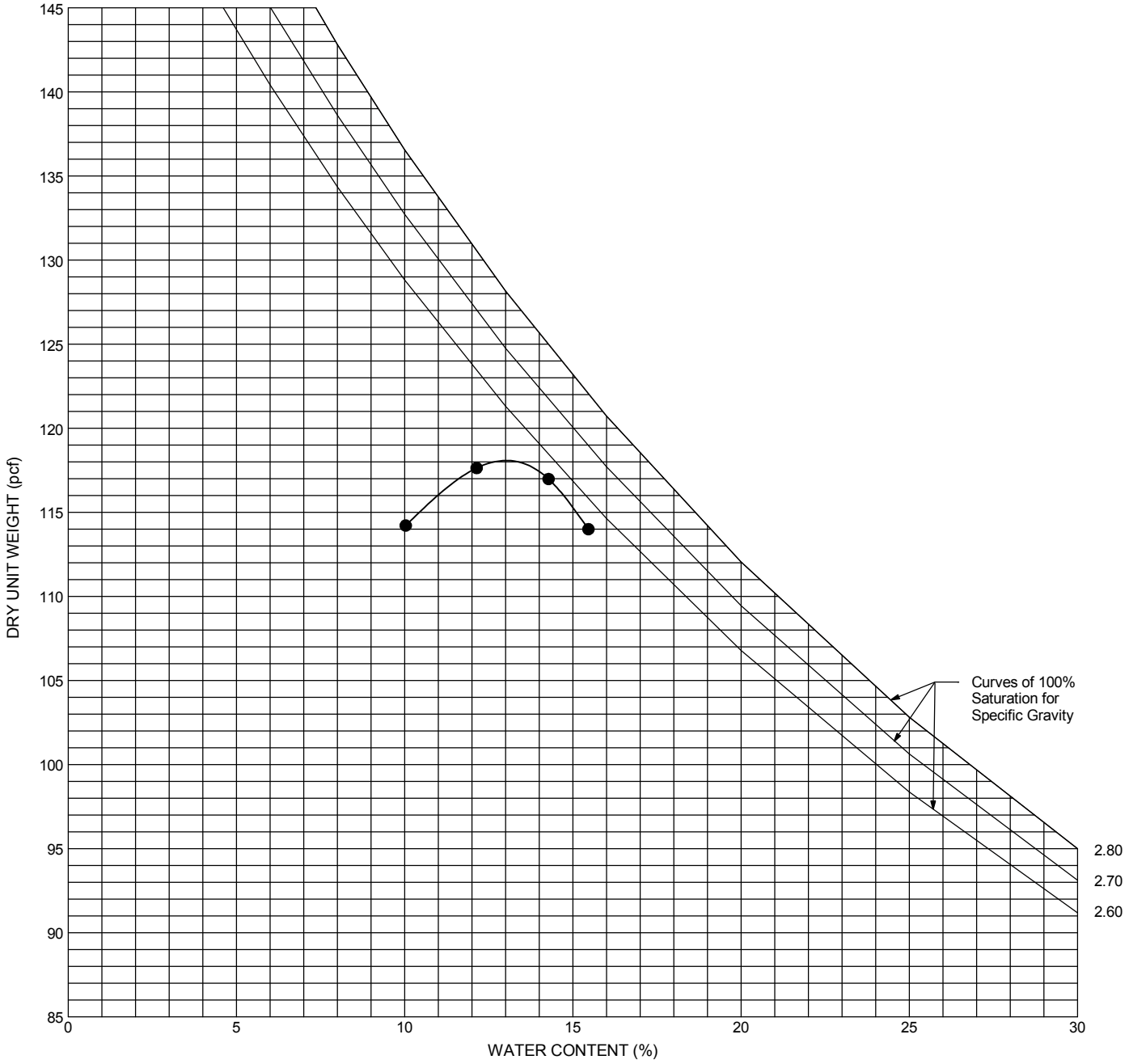
COMPACTION CURVE

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE

B-8



Exploration ID	Depth (ft.)	Sample Description
● B-7	0 - 5	CLAYEY SAND (SC)

Passing 3/4"	Passing #4	Passing #200	LL	PL	PI	Maximum Dry Unit Weight (pcf)	Optimum Water Content (%)
NM	NM	50	36	16	20	118.1	13.0

Testing performed in general accordance with ASTM D1557 Method A.
NP = Nonplastic
NM = Not Measured

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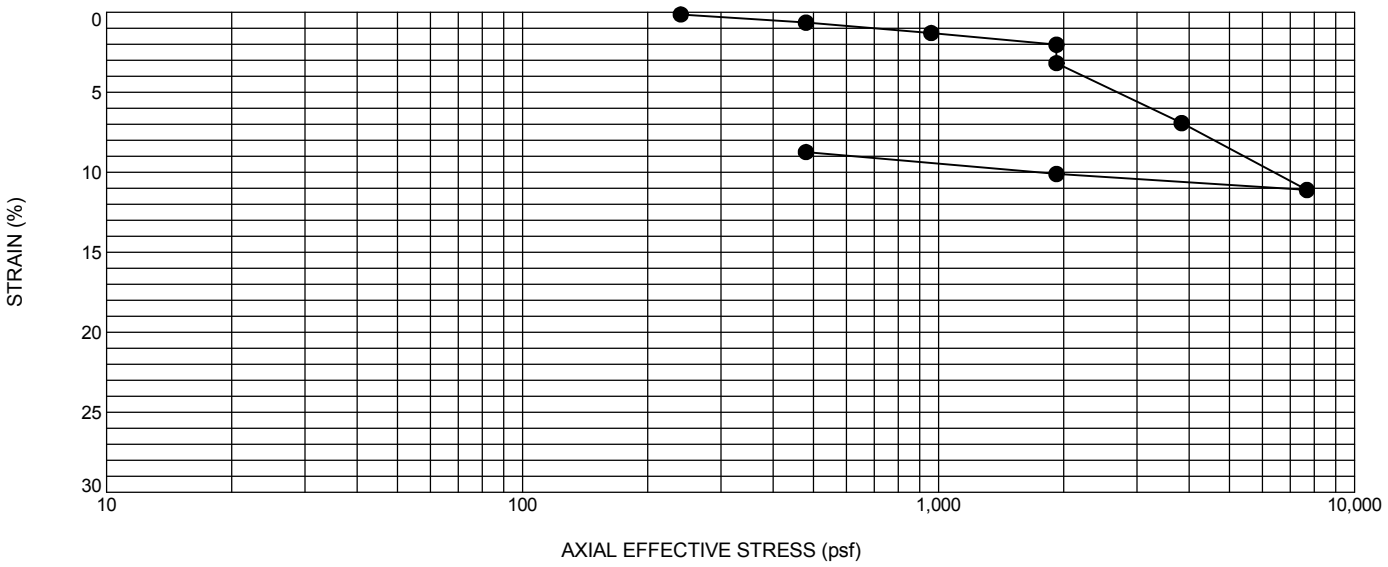
COMPACTION CURVE

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE

B-9



Exploration ID	Depth (ft.)	Sample Description
B-2	2.5 - 3	FAT CLAY (CH)

	Sample Condition Type	Sample Diameter (mm)	Height (mm)	Water Content (%)	Dry Unit Wt. (pcf)	Wet Unit Wt. (pcf)	Saturation (%)	Void Ratio	Specific Gravity	Passing #200	LL	PL	PI
Initial		61.5	25.4	31.7	106.2	139.9	NM	NM	NM	NM	NM	NM	NM
Final		61.5	23.2	33.7	106.3	142.1	NM	NM	NM				

Testing perfomed in general accordance with ASTM D2435 Method A.
NP = Nonplastic
NM = Not Measured

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ONE DIMENSIONAL CONSOLIDATION TEST

FRESNO COUNTY GROUNDWATER PROJECT
EL PORVENIR & CANTUA CREEK
FRESNO COUNTY, CALIFORNIA

FIGURE

B-10

PAGE: 1 of 2