APPENDIX D – PRELIMINARY LIMITED GEOTECHNICAL DESIGN REPORT

Geotechnical Engineering ● Engineering Geology

Preliminary Limited Geotechnical Design Report

LA PUENTE CITY PARK
STORMWATER STORAGE & INFILTRATION FACILITIES
15538-15598 E Temple Avenue
La Puente, California

Prepared for:

City of Industry
P.O. Box 3366
15625 E. Stafford, Suite 100
City of Industry, CA 91744

Prepared by:

Tetra Tech
1360 Valley Vista Drive
Diamond Bar, California 91765

March 20, 2018
Project No. TET 17-136E

TETRA TECH

Project No. TET 17-136E
March 20, 2018

Ms. Kristen Weger
City of Industry Project Manager
City of Industry
P.O. Box 3366
15625 E. Stafford, Suite 100
City of Industry, CA 91744

Subject: **PRELIMINARY LIMITED GEOTECHNICAL DESIGN REPORT**
LA PUENTE CITY PARK
STORMWATER STORAGE & INFILTRATION FACILITIES
15338-15598 E Temple Avenue
La Puente, California

Dear Mr. Philips:

Presented herein is Tetra Tech's preliminary limited geotechnical design report for the proposed stormwater infiltration/storage facilities at La Puente City Park located at 15338-15598 E Temple Avenue in the City of La Puente, California. This report summarizes the results of our geotechnical investigation to characterize the soils at the site and provides geotechnical considerations for the preliminary design of the proposed infiltration facilities. The appendices of the report include logs of borings from the previous and current investigations, results of laboratory and infiltration tests, and liquefaction analyses.

We appreciate the opportunity to provide our professional services on this project. If you have any questions regarding this report or if we can be of further service, please do not hesitate to contact the undersigned.

Respectfully submitted,
Tetra Tech

Fernando Cuenca, Ph.D., P.E.
Senior Project Engineer

REGISTERED PROFESSIONAL ENGINEER FERNANDO AUGUSTO CUENCA 50097 CIVIL STATE OF CALIFORNIA

Andrew McLarty, M. Sc., C.E.G.
Senior Engineering Geologist

CERTIFIED ENGINEERING ANDREW HARRISON McLARTY No. 2630 GEOLOGIST STATE OF CALIFORNIA

Peter Skopek, Ph.D., G.E.
Principal

REGISTERED PROFESSIONAL ENGINEER PETER SKOPEK GE 2635 GEOTECHNICAL STATE OF CALIFORNIA

Distribution: Addressee (pdf by email kweger@cityofindustry.org)
Oliver Galang (pdf by email Oliver.Galang@tetratech.com)

Filename: 2018-01-30 La Puente Geotechnical Report RPT.docx

TABLE OF CONTENTS

Page

Figures

Appendices

1. INTRODUCTION

This report presents the results of Tetra Tech's preliminary limited geotechnical engineering evaluation for the proposed stormwater capture, infiltration, and conveyance facilities at the La Puente City Park (see Figure 1) located at 15338-15598 E Temple Avenue in the City of La Puente, California.

The purpose of this study was to evaluate the subsurface conditions at the site and to provide considerations for the preliminary design of the proposed facilities. The area considered in this investigation is located immediately west of St. Joseph High School and the tennis court facilities located along Temple Avenue shown on Figure 2. This report summarizes the collected data and presents our findings, conclusions, and preliminary geotechnical design considerations.

2. SCOPE OF WORK

Tetra Tech's scope of services for this project consisted of the following tasks:

- Review of readily available background data, including in-house geotechnical data from our soil explorations in the vicinity of the proposed facilities.

- Perform a reconnaissance site visit to observe ground conditions and mark boring locations.

- Coordinate with City of Industry personnel, park staff, and Underground Service Alert (USA) for access and clearance of buried utilities prior to drilling.

- Conduct a subsurface investigation within the area where infiltration facilities could be located, including excavating, logging, and geotechnical sampling of 1 soil exploratory boring to a depth of 31.5 feet.

- Install 2 Double Ring Infiltrometers (DRIs) within the area where infiltration facilities could be located and perform infiltration tests in general accordance with County of Los Angeles guidelines GS200.2 (2017).

- Perform laboratory testing of selected samples recovered from the borings to evaluate geotechnical engineering properties of the on-site soils.

- Conduct an evaluation of the geotechnical data to develop preliminary limited geotechnical considerations for the design and construction of the proposed structures including the following items:

    - An evaluation of general subsurface conditions and description of types, distribution, and engineering characteristics of subsurface materials.
    - An evaluation of the liquefaction potential and dynamic settlement of the on-site materials.
    - An evaluation of the suitability of on-site soils for infiltration;
    - Determination of seismic design parameters in accordance with the 2016 California Building Code.
    - An evaluation of the corrosion potential of the on-site soils to buried concrete.

- Prepare this written report documenting the work performed, physical data acquired, and preliminary geotechnical considerations.

3. PROJECT BACKGROUND AND DESCRIPTION

The Upper San Gabriel River Enhanced Watershed Management Group (USGREWMG) was formed on October 24, 2013 and is comprised of the County of Los Angeles, the Los Angeles County Flood Control District (LACFCD), and the cities of Baldwin Park, Covina, Glendora, City of Industry, La Puente, and West Covina (the Cities). The group completed the development of an Enhanced Watershed Management Program (EWMP) and obtained approval from the Los Angeles Regional Quality Control Board on April 11, 2016.

The USGREWM Group was formed in response to provisions of National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit Order No. R4-2012-0175 (Permit). The USGREWM Group, through a cooperative and collaborative process, developed an EWMP to demonstrate compliance with water quality standards.

The EWMP identified a suite of watershed control measures and structural Best Management Practices (BMPs), and identified priority projects including the subject La Puente City Park. As required by the EWMP, a screening geotechnical investigation was conducted at the site (Ninyo and Moore, 2015). The County, the LACFD and the Cities are now taking the next step in implementing the EWMP by developing this Preliminary Geotechnical Design Report. The City of Industry represents the USGREWMG and is the lead agency for this effort.

La Puente City Park was considered a high priority site for a regional stormwater capture project due to its proximity to a 39-inch diameter reinforced concrete stormdrain pipe running in the east-west under Temple Avenue and then turning afterwards in the south-north direction under Glendora Avenue. The area considered in this investigation encompasses the area of the park immediately west of St. Joseph High School and the tennis court facilities located along Temple Avenue as shown in Figure 2.

At this moment no specific information regarding the location, depth, and size of the proposed diversion structures, pre-treatment units, and pump station is available. Therefore, the designer should verify with the Geotechnical Engineer the applicability of the considerations contained herein once the design configuration is decided. For infiltration a large scale spreading basin is being considered. It is estimated that the invert of the infiltration facility will be located at a maximum depth of about 5 feet.

4. SUBSURFACE EXPLORATIONS

A screening subsurface investigation was conducted at the southernmost area of the site by Ninyo and Moore (2015) at the location indicated on Figure 2. Ninyo and Moore's exploration consisted in drilling one soil boring to a depth of 101.5 feet. The log of this exploration is included in Appendix A.

For the Preliminary Design subject of this document the subsurface soil and groundwater conditions beneath the site were explored on November 29, 2017 and included the drilling, logging, and sampling of 1 hollow stem auger exploratory boring LP-101.

Prior to starting the field exploration program, a field reconnaissance was conducted to observe surface conditions and to mark the locations of the planned boreholes in agreement with the City of Industry and the park staff. A drilling permit was obtained from the Los Angeles County Department of Public Health (LACDPH) for the subsurface explorations. Underground Service Alert and the park staff were also notified of the drilling schedule at least 48 hours prior to drilling.

The hollow stem auger boring was excavated using a CME-75 truck-mounted drill rig equipped with an 8-inch diameter auger at the approximate location indicated on Figure 2 – Site Layout and Boring Location Map. Boring LP-101 was advanced to a depth of 31.5 feet. Subsequently, 2 shallow pits were excavated to a depth of 1 foot in the park area for infiltration testing. DRI tests DRI-102 and DRI-103 were conducted as described in the section "Field Infiltration Testing."

The approximate coordinates of the current soil exploration locations, the approximate elevations, and depths are included in Table 1.

Table 1
Borehole and DRI Information

Exploration Number	Northing	Easting	Approximate Depth (ft)	Approximate Top of Borehole/DRI test Elevation (ft)*
LP-101	34.02766	-117.95188	31.5	345
DRI-102	34.027750	-117.952452	1	340
DRI-103	34.028391	-117.952539	1	337
*Estimated from Google Earth				

Bulk, driven ring-type, and small bag samples were retrieved at selected depths during drilling of the exploratory boring. Standard Penetration Testing (SPT) was performed using an SPT sampler driven by an automatic 140-pound hammer with a drop of 30 inches in general accordance with ASTM D1586. The hammer calibration record indicated an energy transfer ratio of 80 percent. Ring-type samples were collected utilizing a California-type sampler driven by the same equipment used for the SPTs. Sampling between the depths of 2.5 and 10 feet was carried out at 2.5-foot intervals. Otherwise sampling was carried out at 5-foot intervals.

The soil boring was surface-logged by a California Professional Geologist in general accordance with the visual-manual procedure for description and identification of soils, ASTM D2488. The Geologist prepared the recovered samples for subsequent reference and laboratory testing. The soil boring log is presented in Appendix B.

At the completion of drilling, the exploratory boring was backfilled with a bentonite cement grout in accordance with LACDPH requirements. The excavated soils from the borehole were disposed of by park personnel.

5. LABORATORY TESTING

Laboratory tests were performed on selected samples recovered from the soil boring to aid in the classification of soils and to evaluate pertinent engineering properties. The following tests were performed:

- Moisture Content of Soil, ASTM D2216;
- Density of Soil Specimens, ASTM D7263;
- Particle Size Analysis of Soils, ASTM D6913 and ASTM D7928;
- Atterberg Limits, ASTM D4318;
- Percent Passing #200 Sieve, ASTM D1140;
- Swell and Collapse Test, ASTM D4546;
- Corrosion Testing of Soils:
    - pH, ASTM G51;
    - Resistivity, ASTM G187;
    - Sulfates, ASTM D516;
    - Chlorides, ASTM D512;
    - Redox, ASTM G200;
    - Sulfides, SM-4500-S2;
    - Ammonia, SM 4500-NH_3; and
    - Nitrate SM 4500-NO_3.

Results of all laboratory tests are presented in Appendix C. For ease of referral to the soil profile, most of the laboratory results have also been included on the boring logs in Appendix B.

6. SUBSURFACE CONDITIONS

6.1. Regional Geology

The subject site is located within the eastern portions of the greater Los Angeles Basin. The Los Angeles Basin is located within Peninsular Ranges geomorphic province which is characterized as a low-lying plain that rises gently inland to the surrounding mountains and hills including the Santa Monica and San Gabriel Mountains to the north, Puente Hills to the northeast, the Santa Ana Mountains to the Southeast, and the San Joaquin hills and Palos Verdes Peninsula to the south. The Peninsular Range is characterized by northwest-southeast trending structural blocks separated by northwest-southeast trending strike-slip faults. The site is nearby and to the south of the San Gabriel Mountains surrounded by locally characteristic steep mountains, low foothills, and relatively flat valleys. Local mountains are characterized by crystalline plutonic rock of Cretaceous age to Precambrian gneisses. Foothills are locally characterized by Miocene aged units of andesitic volcanic units of the Glendora Volcanics and sandstones of the Topanga Formation (Harden, 2004). Valleys are filled with intermediate and young alluvium formations consisting of locally derived surficial sands and gravels (Dibblee, 2002). Older alluvial gravels outcrop in uplifted remnants, and coarser gravels outcrops are younger and present in active stream channels within the valley floor.

6.2. Site Geology

Based on a review of the geologic maps of El Monte and Baldwin Park quadrangles the subject site is underlain by Quaternary alluvial gravel and sand (Dibblee, 1999). Geologic units encountered during our reconnaissance and subsurface exploration of the project site included relatively thin fill soils that mantle alluvium. The alluvium was encountered to the maximum explored depth of 31.5 feet. Additional descriptions are provided on the boring log in Appendix B. A geologic map of the region is presented on Figure 3. Generalized descriptions of the encountered units are provided in the subsequent sections.

6.2.1. Fill

Fill materials were encountered in our boring LP-101 extending from the ground surface to a depth of approximately 1 foot. As observed, the fill materials generally consisted of dark brown, moist, medium dense, silty sand. Scattered roots and grass were encountered in the fill materials.

6.2.2. Native Alluvium

Native alluvium was encountered in our boring LP-101 underlying the fill materials and was observed to extend to the total depth explored of 31.5 feet below existing grade. As observed during our subsurface exploration, the alluvial materials generally consisted of brown to yellowish brown, damp to moist, stiff to very stiff silts and lean clays, and dark yellowish brown to olive brown, medium dense, silty and clayey sands and poorly graded sands. The previous exploration by Ninyo and Moore (2015) encountered the same material types within the alluvium, and it also encountered them in a very stratified manner throughout the explored depth of 101.5 feet.

6.3. Groundwater

Groundwater was not encountered neither in the Ninyo and Moore's exploration (2015) to a depth of 101.5 feet nor in the Tetra Tech exploratory boring to a depth of 31.5 feet. According to the State of California Seismic Hazard Zone Report for the Baldwin Park 7.5-minute Quadrangle (CDMG, 1998), the historic high groundwater level near the site has been mapped at a depth of about 18 feet (Figure 4 – Historic High Groundwater Map). However, it is recognized that the CDMG groundwater contours are based on early last century water well logs (Mendenhall, 1905, Conkling, 1927) and also include water measurements from wells from the Central Basin Investigation (State Water Resources Board, 1952), Department of Water Resources (circa 1940's) which reflect conditions prior to massive infrastructure and urban development that has taken place in the last 50 years which modified the drainage and infiltration patterns and therefore they may not correspond or apply to current conditions and circumstances.

Well data from the Los Angeles County Department of Public Works (LACDPW) database (http://dpw.lacounty.gov/general/wells/) and from the database from Geotracker (http://geotracker.waterboards.ca.gov/map/) for nearby wells indicate groundwater depths as summarized in Table 4.

Table 4
Groundwater Wells in the Vicinity of the Site

Well Identification	Monitoring Period	Approximate location relative to the site	Shallowest groundwater depth
LACDPW Well ID 3048E State # 2S10W08G02	March 1971 to October 2017	0.97 miles to the southwest	10.7 feet on March 1986
LACDPW Well ID 3026E State # 1S10W31P06	November 1979 to May 2011	1.33 miles to the northwest	43 feet on November 1983
LACDPW Well ID 3036 State # 1S10W31P06	March 1928 to September 2009	1.33 miles to the northwest	4.2 feet on May 1942 and 46 on March 1969 (within the last 50 years)
Geotracker well cluster T0603791308, MW-1 though MW-3	November 2001	0.31 miles to the south	13.2 feet on November 2001
Geotracker well cluster T0603704226, B-8 though B-23	January 2006 to April 2009	0.4 miles to the southwest	12.9 feet on November 2001

Based on the assessment of the local stratigraphy and local topography, it is our opinion that the LACDPW and the Geotracker wells can be utilized for interpretation of the project groundwater conditions. Considering also the current soil exploration, it is our conclusion that the groundwater at the site has been deeper than about 11 feet within the last 50 years.

Based on the research and observed conditions, groundwater is not expected to impact the design or the construction of the proposed development if infiltration takes place near the ground surface. The historic high groundwater of 18 feet can be used for the design. It is noted that the County guidelines establish that a minimum distance of 10 feet must be kept between the proposed invert of the infiltration BMP and the groundwater, so facilities with an invert depth of up to 8 feet could be considered in principle. Fluctuations of the groundwater level, localized zones of perched water, and increased soil moisture content should be anticipated during and following the rainy season. Irrigation of landscaped areas on or adjacent to the site can also cause a fluctuation of local groundwater levels. Evaluation of such factors is beyond the scope of our services.

7. FIELD INFILTRATION TESTING

Tetra Tech performed 2 DRI tests denoted DRI-102 and DRI-103 located in the park area using the test procedure described in the LACDPW GS200.2 guidelines (2017) and in general accordance with ASTM D3385. Both, DRI-102 and DRI-103, were installed to a depth of about 1 foot. At both locations the ground surface was prepared by trimming loose soil to expose undisturbed alluvium and create a generally flat and level surface. The double ring assembly consisted of concentrically arranged 12- and 24-inch diameter rings (inner and outer rings, respectively). The assembly was placed on the prepared surface and the rings embedded approximately 4 to 6 inches into the ground. The approximate coordinates of the 2 DRI tests, the test depth and elevations are included in Table 1.

The DRI locations were presoaked for at least 2 hours before the test. For the DRI testing a constant water level of about 6 inches was maintained above the bottom of the test. Mariotte tubes with a 3- and 10-liter capacity were used to maintain a constant water level in both the inner and outer rings, respectively. The readings to determine the flow rate were taken every 30 minutes until a stabilized drop rate was obtained (per GS 200.2 a stabilized rate is obtained when the highest and lowest readings are within 10 percent from each other for 3 consecutive readings), however testing was not completed until a 4-hour minimum testing period was completed. Immediately following testing and removal of the ring assembly, a vertical trench was excavated at each test location along a mid-line through both rings. Soil samples were recovered from the surface down to a depth of 1.1 feet at vertical intervals of 0.3 feet. Recovered samples were sealed in plastic bags and transported to the laboratory for moisture determinations. Logs of DRI testing are included in Appendix D. After conclusion of the DRI testing, the pits were backfilled with tamped soil cuttings.

The field vertical hydraulic conductivity expressed in inches per hour was adjusted as explained below and on the percolation logs. A testing method reduction factor RF_t of 2 was applied as required by the guidelines to account for the direction of flow during the test and the reliability of the method. To account for effects related to site subsurface variability and the limited number of tests, a reduction factor RF_v of 2 was used (typical range between 1 and 3) reflecting that although the tests were relatively consistent, some degree of variation in stratigraphy was observed throughout the site. Lastly, to account for long-term siltation, and plugging, a reduction factor RF_s of 2 was considered (typical range between 1 and 3). The results of the DRI testing and calculation of the adjusted hydraulic conductivity are summarized in Table 2.

The DRI results from this exploration indicate that the adjusted hydraulic conductivity ranges between 0.0026 and 0.0004 inches/hour. These hydraulic conductivities are much smaller than the minimum infiltration rate of 0.3 inches/hour required by the LACDPW guidelines and corresponds to soils with very poor permeability and very poor drainage characteristics. These rates are also consistent with the soil descriptions for the surficial soils at the site (up to a depth of 80 inches) obtained from the USDA web soil survey (https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx) which indicate the presence of silty loam and clay loam belonging to Hydrologic Group C with water transmission through the soil being somewhat restricted. The soil boring from this exploration indicates that the subsurface materials to the maximum explored depth of 31.5 feet consists of interspersed layers of clayey sands, silts, clays, and sandy clays.

Table 2
Adjusted Hydraulic Conductivities

Boring Percolation Test No.	DRI Test Depth (ft)	Adjusted Hydraulic Conductivity (inches/hour)
DRI-102	1	0.026
DRI-103	1	0.0004

The Ninyo and Moore (2015) soil exploration also indicates that the subsurface materials consist of interspersed layers of silts, silty and clayey sands, and clays. The adjusted hydraulic conductivities indicate that effective infiltration is not feasible at this site. Furthermore, the boring logs also indicate that the subsurface materials would likely not be suitable for the installation of underground infiltration galleries or dry wells.

8. ESTIMATED SATURATED HYDRAULIC CONDUCTIVITY

In order to further estimate the magnitude of the hydraulic conductivity of the coarser-grained materials below the invert of the proposed infiltration facilities, the following analyses were performed. It should be noted that the estimates given with empirical formulas should be viewed as "order-of magnitude" estimates and field data should always be considered more reliable. An estimate of the saturated soil field hydraulic conductivity for a soil samples taken at about 5 feet below the planned invert depth was made from the grain size distributions using the approximation based on Chapuis (2004) formula:

$$K_{sat} = 2.4622 \left[{D_{10}}^{2} \frac{e^{3}}{(1+e)} \right]^{0.7825}$$

where:

K_{sat} is the saturated hydraulic conductivity in cm/s
D_{10} is the grain size in mm for which 10% of the sample is finer
e is the void ratio

Although this formula is applicable to coarse-grained soils, it was here used to compute the permeability of a soil with a high percentage of fines (49%), so the results may not be reliable. This sample was selected because it would yield the best scenario possible in terms of infiltration. To compare the hydraulic conductivity estimated above with the hydraulic conductivity from the DRI testing described in the previous section, the saturated hydraulic conductivities calculated using the equation above were further adjusted using the same reduction factors as for the calculation of the adjusted hydraulic conductivities, i.e., a reduction factor for testing method RF_t of 2, a site subsurface variability factor RF_v of 2, and a long-term siltation factor RF_s of 2. The resulting infiltration-equivalent computed hydraulic conductivities are shown on Table 3.

Table 3
Computed Hydraulic Conductivities from Grain Size Distributions

Boring and Sample No.	USCS Classification	Sample Depth (ft)	Applicable Depth Interval (ft)	Infiltration-Equivalent Computed Hydraulic Conductivity (inches/hour)
LP-101 SPT-3	SC	7.5-9	7.5-10	0.0002

The computed hydraulic conductivity using Chapuis formula matches well the DRI measured and adjusted hydraulic conductivities.

TETRA TECH

9. ENGINEERING SEISMOLOGY AND GEOLOGIC HAZARDS

9.1. General Seismic Setting

The Southern California region is known to be seismically active. Earthquakes occurring within approximately 60 miles of the site are generally capable of generating ground shaking of engineering significance to the proposed construction. The project area is located in the general proximity of several active and potentially active faults, as shown on Figure 5 – Regional Faults and Seismicity Map. Active faults are defined as those that have experienced surface displacement within the Holocene period (approximately the last 11,000 years).

Known faults within approximately 13 miles of the project site include:

- the Walnut Creek fault located approximately within the northwest corner of the site (approximately 0.1 miles northwest of the proposed site of the BMP);
- the San Jose fault approximately 3.8 miles east of the site;
- the Whittier zone approximately 3.9 miles southwest of the site;
- the Indian Hill fault approximately 5.4 miles northeast of the site;
- the East Montebello fault approximately 7.1 miles west of the site;
- the Sierra Madre fault zone located approximately 7.4 miles to the north of the site;
- the Raymond fault located approximately 9.6 miles northwest of the site;
- the Clamshell-Sawpit fault approximately 10.4 miles north of the site; and
- the Chino/Central Avenue fault approximately 12.5 miles east east of the site.

The San Andreas Fault is located about 28 miles to the northeast of the site.

Table 5 lists selected principal known active faults that may affect the subject site and the maximum moment magnitude (M_{max}) as published by Cao et al. (2003) for the California Geological Survey (CGS). The approximate distance to the site were calculated from Jennings (2010).

Superimposed on the area map in Figure 5 are earthquake epicenters recorded by the USGS between 1900 to present day. A large amount of seismic activity and associated events with their epicenters have been recorded surrounding the project site. Notable historic earthquakes in Southern California of significance to the project are listed in Table 6.

Table 5
Main Active Faults

Fault Name	Approximate Fault Distance to Site[1] (miles)	Maximum Moment Magnitude[2] (M_{max})
San Jose	3.8	6.4
Whittier	3.9	6.8
East Montebello	7.1	7.2
Sierra Madre	7.4	7.2
Puente Hills Blind Thrust	7.8	7.1
Raymond	9.6	6.5
Clamshell-Sawpit	10.4	6.5
Chino/Central Avenue	12.5	6.7
Hollywood	14.7	6.4
San Gabriel	15.1	7.2
Los Alamitos	16.3	6.2
Verdugo	17.5	6.9
Cucamonga	17.8	6.9
Newport-Inglewood	19.8	7.1
Palos Verdes	25.9	7.3
Santa Monica	26.8	6.6
Malibu Coast	40.1	6.7

Notes:
[1] per Jennings, 2010
[2] per Cao, et al., 2003

TETRA TECH

Table 6
Historic Earthquakes in Southern California

Earthquake Name	Year	Fault and Fault Type	Earthquake Magnitude*	Epicenter	
				Latitude	Longitude
Chino Hills	2008	Whittier fault (left-lateral thrust)	5.5 M_w	33.95°N	117.76°W
Northridge	1994	Northridge Thrust (blind thrust)	6.7 M_w	34.21°N	118.54°W
Sierra Madre	1991	Clamshell-Sawpit Canyon fault (reverse)	5.8 M_L	34.20°N	118.14°W
Upland	1990	San Jose fault (left-lateral strike-slip)	5.4 M_L	34.13°N	117.70°W
Pasadena	1988	Raymond fault (left-lateral strike-slip)	5.0 M_w	34.14°N	118.13°W
Whittier Narrows	1987	Puente Hills Fault (blind thrust)	5.9 M_L	34.06°N	118.08°W
San Fernando	1971	San Fernando fault (thrust)	6.5-6.7 M_w	34.42°N	118.37°W
Lytle Creek	1970	Lytle Creek fault (right-reverse)	5.2 M_L	34.27°N	117.54°W
Torrance-Gardena	1941	Palos Verdes fault (right-reverse)	4.8 M_L	33.82°N	118.22°W
Long Beach	1933	Newport-Inglewood fault (right-lateral strike-slip)	6.4 M_w	33.63°N	118.00°W
San Jacinto	1923	San Jacinto fault (right-lateral strike-slip)	6.3 M_L	34.00°N	117.24°W
San Jacinto	1918	San Jacinto fault (right-lateral strike-slip)	6.7 M_w	33.65°N	117.43°W
Elsinore	1910	Elsinore fault (right-lateral strike-slip)	6 M_L	33.75°N	117.45°W
Fort Tejon	1857	San Andreas fault (right-lateral strike-slip)	7.9 M_w	35.43°N	120.19°W

*M_w refers to Moment Magnitude scale
M_L refers to Local Magnitude scale

Potential seismic sources of significance to the project include active faults previously described and faults that are not known to break the ground surface but are considered active. This latter group of faults includes buried or "blind" thrust faults. Current tectonic models for the Los Angeles basin include the presence of buried thrust faults, several of which are considered partly responsible for the north-to-south compression of the basin. Although these faults are not currently zoned by the State of California for surface rupture hazards (Earthquake Fault Zones), many are considered capable of generating seismic shaking of significance to structures.

Of these buried active faults the closest to the site is the Puente Hills Trust Fault (PHTF). The PHTF is currently defined as 3 separate but juxtaposed, generally east-west trending and north-dipping, fault surfaces underlying Downtown Los Angeles to Brea. From west to east these include the Los Angeles, Santa Fe Springs, and Coyote Hills segments. Based upon recent studies by several researchers, including Shaw et al., (2002), Olsen and Cooke (2005), and Leon et al. (2007), the three fault surfaces are interpreted to extend from depths in excess of 9 miles on the north side of the Los Angeles Basin to less than 1.2 miles at the southerly limits of the fault surfaces in the central portion of the basin. Fault surface geometries are interpreted from historical petroleum exploration data, limited geotechnical subsurface exploration data, and limited seismicity (i.e.; the 1987 magnitude 5.9 Whittier Narrows earthquake).

Leon et al. (2007) estimates that upwards of 60 percent of the total Los Angeles Basin compression may be attributed to strain along the PHTF. Although ground rupture has not been officially attributed to the fault, the presence of youthful hills (e.g., Coyote Hills) and shallow folding at depth in the upper portion of the interpreted thrust ramp suggests recent activity. The PHTF is considered capable of generating earthquake magnitudes up to about M_w 7.0.

9.2. Surface Fault Rupture

Official Maps of Earthquake Fault Zones were reviewed to evaluate the location of the project site relative to active fault zones. Earthquake Fault Zones (known as Special Studies Zones prior to 1994) have been established in accordance with the Alquist-Priolo Special Studies Zones Act enacted in 1972. The Act directs the State Geologist to delineate the regulatory zones that encompass surface traces of active faults that have a potential for future surface fault rupture. The purpose of the Alquist-Priolo Act is to regulate development near active faults in order to mitigate the hazard of surface fault rupture.

The site is not located within a designated Earthquake Fault Zone for fault surface rupture hazard. Based on a review of State of California Earthquake Fault Zone maps, the closest zoned fault for surface rupture is the Elsinore Fault Zone, Whittier section located approximately 4 miles southwest of the site and is mapped within the La Habra Quadrangle (1999).

No surface traces of any active or potentially active faults are known to pass directly through or project towards the site. Neither our field exploration nor literature review disclosed an active fault trace projecting to the ground surface in the project area. Therefore, the potential for surface rupture due to faulting occurring beneath the site during the design life of the proposed development is considered low.

9.3. Seismic Hazard Zones

Maps of seismic hazard zones are issued by the California Geological Survey (CGS, formerly California Department of Conservation, Division of Mines and Geology (CDMG)) in accordance with the Seismic Hazards Mapping Act enacted in April 1997. The intent of the Seismic Hazards Mapping Act is to provide for a statewide seismic hazard mapping and technical advisory program to assist cities and counties in developing compliance requirements to protect the public health and safety from the effects of strong ground shaking, liquefaction, landslides, or other ground failure and other seismic hazards caused by earthquakes.

Based on the review of the Baldwin Park Quadrangle Official Map of Seismic Hazard Zones issued March 25, 1999 (see Figure 6), the proposed development is not located within an area identified by the State of California as subject to the hazard of liquefaction. However, as of 2013 CBC the seismic demand for assessment of liquefaction has increased from an earthquake event with 10% probability of exceedance in 50 years to a Maximum Considered Earthquake generally taken as geometric mean near ground motion for an earthquake probability of exceedance of about 2% in 50 years. Therefore, further analysis are needed even when a site is not located within a designated seismic hazard zone for liquefaction. Consequently, presented below is an associated site-specific assessment.

9.4. Liquefaction Potential, Dynamic Settlement, and Cyclic Softening

Liquefaction of soils can be caused by ground shaking during earthquakes. Research and historical data indicate that loose, relatively clean granular soils and low plasticity silts are susceptible to liquefaction and dynamic settlement, whereas the stability of the majority of clayey silts, silty clays and clays are not typically adversely affected by ground shaking. Liquefaction is generally known to occur in saturated or near-saturated cohesionless soils at depths shallower than about 50 feet. However, cyclic mobility and seismically induced strength softening with effects similar to liquefaction can occur also in fine-grained soils. Since the historic high groundwater level near the site has been mapped at a depth of about 10 feet, a more rigorous liquefaction hazard analysis per 2016 CBC is included in the following sections.

9.4.1. Soil Description

Evaluation of liquefaction potential for the on-site materials was performed based on soil stratigraphy encountered in the field explorations. The encountered soil materials generally consisted of alluvial deposits made up of interspersed layers of very stiff sandy silt and lean clay, medium dense clayey sand, and medium dense silty sand.

Materials that are above the groundwater table are not considered susceptible to liquefaction. Thus, the focus of this investigation was aimed at evaluating the liquefaction potential of soils encountered at a depth between 10 and 50 feet. Fine-grained soils can also undergo severe strength loss during ground shaking, and thus an evaluation of their sensitivity was also performed.

9.4.2. Groundwater Level for Liquefaction Analysis

Groundwater was not encountered during the field explorations. According to the State of California Seismic Hazard Zone Report for the Baldwin Park 7.5-minute Quadrangle (CDMG, 1998), the historic high groundwater level near the site has been mapped at a depth of about 18 feet. Therefore, although not considered as a design groundwater level for the project, for the purposes of liquefaction evaluation and consistent with SPT 117 (CDCDMG, 2008) a groundwater depth of 18 feet was assumed for evaluation of liquefaction potential at the site.

9.4.3. Liquefaction Seismic Demand

Based on the USGS U.S. Seismic Design Maps website application (http://earthquake.usgs.gov/designmaps/us/application.php), for the subject site at coordinates 34.02792^{o} N, -117.952265^{o} W, the mapped geometric mean Peak ground acceleration (PGA_M) was estimated to be approximately 0.78g for a site class D (assumed v_s = 260 m/s), for a ground motion corresponding to the Maximum Considered Earthquake (MCE). From the Seismic Hazard Interactive Deaggregation website (https://earthquake.usgs.gov/hazards/interactive/) and using the 2008 Dynamic Conterminous U.S. v3.3.1 edition, the ground motion for a return period of 2,475 years (2% in 50 years) corresponds approximately to a modal earthquake magnitude of M_w 6.9 located at a distance of approximately 7.4 km (4.6 miles). These ground motion parameters provided above were used in the liquefaction analyses.

9.4.4. Evaluation of Liquefaction Potential and Sensitivity Analyses

The liquefaction potential of cohesionless (sandy) soils was evaluated based on the SPT blowcounts and laboratory test results utilizing procedure published by Boulanger and Idriss (2014) and generally as recommended in the County of Los Angeles Administrative Manual, Liquefaction/Lateral Spreading/GS045.0 dated October 6, 2014. Cohesive soils with a Plasticity Index less than 7 were considered to behave as cohesionless materials and therefore be susceptible to liquefaction.

The analyses based on standard penetration test (SPT) considered the energy ratio correction factor C_E of 1.3. This ratio is based on a calibrated average hammer efficiency of approximately 80 percent as supplied by the drilling contractor. The blowcounts recorded for soils driven with the 3-inch O.D. California Sampler with brass rings were converted to an equivalent SPT blowcounts using a reduction factor of 0.66. Borehole diameter correction factor C_B of 1 based on the internal diameter of the hollow stem auger system used for the drilling was utilized in the liquefaction evaluation.

Results of liquefaction analyses of granular soils are summarized in Table 7 in the next section of this report and the analysis details are presented in Appendix E. The analyses based on SPT and Modified California data indicated that the majority of the on-site granular soils are not susceptible to liquefaction.

Seismic sensitivity of fine-grained soils (clays and silts) was further evaluated per County of Los Angeles Administrative Manual GS045.0 with modifications proposed by Idriss and Boulanger (2008) and the fine-grained soils were classified in the following 3 categories:

1. Soils with Plasticity Index < 7 and below groundwater are classified as fine-grained soils susceptible to liquefaction (typically includes silts);

2. Soils with Plasticity Index > 18 and a degree of sensitivity S_t > 6 are classified as fine-grained soils potentially susceptible to significant loss of strength during seismic shaking and require additional evaluation. The sensitivity of the on-site fine-grained soils is evaluated based on the water content, Atterberg limits, and effective vertical stresses using the procedures suggested by Holtz and Kovacs (1981) and Terzaghi, Peck and Mesri (1996).

3. Fine-grained soils falling outside the two categories above are considered to behave like clays, and are not considered susceptible to liquefaction or seismic sensitivity.

The results from the sensitivity analyses indicated that the fine-grained materials at the site below groundwater are not considered susceptible to liquefaction or seismic sensitivity (see Appendix E).

9.4.5. Dynamic Settlement

Dynamic settlement can occur in saturated sands due to liquefaction or in dry sands due to densification of the soil matrix. The anticipated dynamic settlement of the saturated soils at the site was estimated using SPT data from the current exploration using procedures outlined by Yoshimine et al (2006). The estimated settlements by Yoshimine et al (2006) were further adjusted by a calibration factor of 0.9 recommended by Cetin (2009) to better match observed settlements. The potential for dry dynamic settlement using SPT data was calculated according to the procedure outlined in Pradel (1998a and 1998b).

Table 7 presents the results of the liquefaction analyses and it includes liquefaction settlement of saturated sands and the seismically-induced settlement of unsaturated materials above the groundwater table. As shown in Table 7, the combined dynamic settlement at the ground surface estimated from the SPT data is about 0.6 inches. It is noted that although the magnitude of the estimated dynamic settlements corresponds to a mean estimated settlement and can vary on the order of +/- 50 percent, the standard of practice uses the mean estimated values in developing guidelines and evaluating potential damage to structures. Differential settlements per GS045.0 are assumed to be about half of the total settlements i.e., about 0.3 inches over a span of 30 feet. Therefore, structural mitigation is acceptable at this site, and the Structural Engineer should account for this differential settlement in the design of the foundation and the structure.

Table 7
Results of Liquefaction and Dry Dynamic Settlement Analyses

Boring No.	Assumed Groundwater Depth (feet)	Liquefiable Zone Depth Interval (feet)	FS_{liq}	Liquefaction Settlement (inches)[1]	Settlement of Dry Sands (inches)[1]	Combined Dynamic Settlement (inches)[1]
LP-101 Tetra Tech	18	25-27.5	0.5	0.5	0.1	0.6
B-10 Ninyo and Moore		33-36	1	0.2	0.3	0.5
[1]Estimated settlements are mean values which can vary within +/-50 percent.						

9.5. Earthquake-Induced Landslides

The site is not located in an Earthquake-Induced Landslide Hazard Zone on the State of California Seismic Hazard Zones Map (see Figure 6). No evidence of landsliding was observed on or in the immediate vicinity of the site. Therefore an occurrence of an earthquake-induced landslide is not considered to be a hazard to the site.

TETRA TECH

9.6. Subsidence

Land subsidence is the lowering of the ground surface due to extraction or lowering of water levels or other fluids within the subsurface soil pores, or due to seismic activity. The fluid withdrawal causes the alluvial sediments in the basin to compact. Damage caused by subsidence can be visible cracks, fissures, or surface depression.

The site is not located in an area mapped by the USGS (https://ca.water.usgs.gov/land_subsidence/california-subsidence-areas.html) where either historical or current subsidence has been recorded. Therefore, subsidence is not considered a hazard for this site.

10. PRELIMINARY DESIGN CONSIDERATIONS

10.1. General

Based on the results of the field exploration and engineering analyses, it is Tetra Tech's opinion that the proposed construction of the infiltration BMP is not feasible from the geotechnical standpoint given the low hydraulic conductivity properties of the subsurface materials.

If a capture/storage facility is considered viable, then it is expected that conventional foundation and construction methods will be suitable for the proposed improvements.

Laboratory tests indicate that the on-site soils are not considered to be susceptible to collapse (less than 1 percent volume change per ASTM D4546 at 1,200 psf) as assessed by Jennings and Knight (1975). Consequently, infiltration is not likely to trigger detrimental collapse or swelling of the underlying soils.

Observations and laboratory tests indicate that the on-site soils have negligible levels of water-soluble sulfates, therefore, the soils are not expected to cause injurious sulfate attack on concrete with a minimum 28-day compressive strength of 2,500 psi.

Once the preferred BMP type for the site is selected, as well as the final location and depth, then more specific geotechnical recommendations for the project design phase should be developed. The key geotechnical design items that will need to be addressed:

- Site Preparation;
- Excavation and shoring design;
- Foundation design of at-grade and subterranean structures;
- Lateral earth pressures on underground structures;
- Conveyance pipelines; and
- Grading recommendations.

For the preliminary design, presented below are the updated seismic design parameters and assessment of the corrosion potential of the onsite soils.

10.2. Seismic Design Parameters

The seismic design coefficients provided below in Table 8 are based on Chapter 16 of the 2016 CBC and on the information provided by the USGS website (https://earthquake.usgs.gov/designmaps/us/application.php?).

Table 8
Site Categorization and 2016 CBC Site Coefficients
Site coordinates 34.02792º N, -117.952265º W

Parameter	Design Value
Site Class (Table 20.3-1 ASCE 7)	D*
Short Period Spectral Acceleration Parameter S_s	2.137**
1-sec. Period Spectral Acceleration Parameter S_1	0.755**
Short Period Design Spectral Acceleration Parameter S_{DS}	1.425**
1-sec. Period Design Spectral Acceleration Parameter S_{D1}	0.755**

* Soil profile based on estimated v_{s30} of 260 m/s
** Values from USGS Earthquake Hazards Program website based on the ASCE7-10 with March 2013 errata and 2015 International Building Code.

10.3. Soil Corrosion

The corrosion potential of the on-site materials to buried steel and concrete was evaluated based on laboratory testing on a representative soil sample from this investigation and a sample from Ninyo and Moore's investigation (2015). Table 9 below presents the results of the corrosivity testing.

Table 9
Corrosivity Test Results

Boring	Sample ID	Depth (feet)	pH	Minimum Resistivity (ohm-cm)	Chlorides (ppm/%)	Soluble Sulfate Content in Soil (ppm/%)	Nitrate (mg/kg)	Sulfide (mg/kg)	Ammonia (mg/kg)	Redox (mV)
LP-101 Tetra Tech	SPT-1	2.5-4	7.9	1,340	36/0.0036	90/0.0090 Category S0 per 2016 CBC	21	ND	ND	220
B-10 Ninyo and Moore	N/A	0-3	7.0	640	490/0.049	100/0.010 Category S0 per 2016 CBC	Not measured			

Per 2016 CBC/ 2015 IBC, Section 1904.1, concrete subject to exposure to sulfates shall comply with the requirements set forth in ACI 318, Section 19.3. Based on the measured water soluble sulfate results the exposure of buried concrete to sulfate attack should be considered "not applicable", i.e., exposure class S0 per ACI 318, Table 19.3.1.1. Consequently, injurious sulfate attack is not anticipated for concrete with a minimum 28-day compressive strength of 2,500 psi.

Per 2016 CBC, Section 1904.1, concrete shall conform to durability requirements established in ACI 318 Sections 19.3.2 and 26.4 including protection for corrosion and exposure to chlorides. Reinforcement should be protected from corrosion in accordance with ACI 318 Section 20.6.

The evaluation of potential for corrosion of buried metals was based on the minimum resistivity and our experience with similar soils. The on-site soils are anticipated to be “moderately corrosive” to “corrosive” to buried metals as defined by the NACE (1984).

A corrosion specialist should be consulted regarding suitable types of piping and necessary protection for underground metal conduits. The corrosion potential of the on-site soils should be verified during construction for each encountered soil type. Imported fill materials should be tested prior to placement to confirm that their corrosion potential is not more severe than the one assumed for the project.

11. LIMITATIONS

This report presents preliminary design considerations for the proposed infiltration BMP at La Puente City Park. It is not intended to be the geotechnical document suitable for final design of the proposed development as the extent and scope of the performed field and laboratory testing and engineering analyses was not developed for the anticipated relatively complex specific configuration of the proposed development. Consequently, additional field and laboratory investigation and engineering analyses will be required once the scope and configuration of the project are determined.

The recommendations and opinions expressed in this report are based on Tetra Tech's review of background documents and on information obtained from the current geotechnical investigation. It should be noted that this study did not evaluate the possible presence of hazardous materials on any portion of the site.

Due to the limited nature of the field explorations, conditions not observed and described in this report may be present on the site. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation and laboratory testing can be performed upon request. It should be understood that conditions different from those anticipated in this report may be encountered during grading operations, for example, the extent of unsuitable soil and the associated additional effort required to mitigate them.

Site conditions, including groundwater level, can change with time as a result of natural processes or the activities of man at the subject site or at nearby sites. Changes to the applicable laws, regulations, codes, and standards of practice may occur as a result of government action or the broadening of knowledge. The findings of this document may, therefore, be invalidated over time, in part or in whole, by changes over which Tetra Tech has no control. Therefore, this report should reviewed and recertified if it were to be used for a project design commencing more than 1 year after the date of issuance of this report.

Tetra Tech's recommendations for this site are dependent upon verification of the actual encountered field conditions, appropriate quality control of grading operations including overexcavation, processing, and replacement of the on-site materials, shoring, and foundation construction. Accordingly, the recommendations are made contingent upon the opportunity for Tetra Tech to observe all aspects of subgrade preparation for the proposed construction. If parties other than Tetra Tech are engaged to provide such services, such parties are assuming complete responsibility as the Geotechnical Engineer of Record for the geotechnical phase of the project and implicitly concur with the recommendations provided in this report or may provide alternative recommendations.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Tetra Tech should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document. Reliance by others on the data presented herein or for purposes other than those stated in the text is authorized only if so permitted in writing by Tetra Tech. It should be understood that such an authorization may incur additional expenses and charges.

Tetra Tech has endeavored to perform its evaluation using the degree of care and skill ordinarily exercised under similar circumstances by reputable geotechnical professionals with experience in this area in similar soil conditions. No other warranty, either expressed or implied, is made as to the conclusions and recommendations contained in this report.

12. SELECTED REFERENCES

American Concrete Institute, 2014. 318-14: Building Code Requirements for Structural Concrete and Commentary on Building Code Requirements for Structural Concrete.

California Building Standards Commission, 2016 California Building Code, California Code of Regulations Title 24, Based on the 2015 International Building Code, July 2016.

California Department of Conservation, Division of Mines and Geology, 2008, Guidelines for Evaluation and Mitigation of Seismic Hazards in California: Special Publication 117.

California Department of Conservation, Division of Mines and Geology, 1998, Seismic Hazard Zone Report for the Baldwin Park 7.5-Minute Quadrangle, Los Angeles County, California: Seismic Hazard Zone Report 022.

California Department of Transportation (CALTRANS), 2011, Trenching and Shoring Manual. County of Los Angeles, Department of Public Works, Geotechnical and Materials Engineering Division, 2009. Review of Geotechnical Reports addressing Liquefaction. GME-3 (February 4).

California Department of Transportation (CALTRANS), 2012. Corrosion Guidelines, Version 2. November 2012.

California Geological Survey (CGS), 1999, Seismic Hazard Zones for the Baldwin Park Quadrangle 7.5-Minute Quadrangle, Revised Official Map, Los Angeles County.

Cao, T., Bryant, W. A., Rowshandel B., Branum D., and Wills C. J., 2003, The Revised 2002 California Probabilistic Seismic Hazard Maps June 2003.

Dibblee, T.W., and Ehrenspeck, H.E., 1999, Geologic map of the El Monte and Baldwin Park quadrangles, Los Angeles County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-69, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., 2001, Geologic map of the Whittier and La Habra quadrangles (western Puente Hills) Los Angeles and Orange Counties, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-74, scale 1:24,000.

Dibblee, T.W., and Ehrenspeck, H.E., 2001, Geologic map of the Yorba Linda and Prado Dam quadrangles (eastern Puente Hills), Los Angeles, Orange, San Bernardino and Riverside Counties, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-75, scale 1:24,000.

Dibblee, T.W., and Minch, J.A., 2002, Geologic map of the Baldwin Park quadrangle, Los Angeles County, California: Dibblee Geological Foundation, Dibblee Foundation Map DF-89, scale 1:24,000.

Ebeling, R., 1993, The Seismic Design of Waterfront Retaining Structures, NCEL Technical Report R-939, January 1993.

Harden, D.R., 2004, California Geology, Second Edition, Pearson Education Inc.

Idriss, I.M., and Boulanger, R.W., 2008. Soil Liquefaction during Earthquakes. Earthquake Engineering Research Institute.

Idriss, I.M., and Boulanger, R.W., 2015. "2nd Ishihara Lecture: SPT- and CPT-based relationships for the residual shear strength of liquefied soil." Soil Dynamics and Earthquake Engineering, 68, 57-68, 10.1016/j.soildyn.2014.09.010.

International Code Council, Inc., 2015. International Building Code, May 2014.

International Code Council, Inc., 2017. County of Los Angeles Building Code – Amendments only.

Jennings, C. W., and Bryant, W. A., 2010, Fault Activity Map of California, California Geological Survey, Data Map No. 6, Map scale 1:750,000.

Jennings, J. E., and K. Knight, 1975. A Guide to Construction on or With Material Exhibiting Additional Settlement due to Collapse of Grain Structure," Journal of Soil Mechanics and Foundation Engineering, 6th Regional Conference for Africa on Soil Mechanics and Foundation Engineering, Durban, South Africa, pp. 99-105.

National Association of Corrosion Engineers (NACE), 1984. Corrosion Basics, An Introduction, LS Van Delinder, ed., Houston, TX.

Naval Facilities Engineering Command (NAVFAC), 1982. Soil Mechanics, Foundations and Earth Structures. Design Manuals 7.01 and 7.02.

Ninyo & Moore, 2015, Geotechnical Services, La Puente City Park, Upper San Gabriel River EWMP, Los Angeles County, California, Task Order No. T10503269-102669-OM, Project No. 107900001: dated June 3.

Leon, L. A., Christofferson, S. A., Dolan, J. F., Shaw, J. H., and Pratt, T. L., 2007, Earthquake-by-earthquake fold growth above the Puente Hills, blind thrust fault, Los Angeles, California: Implications for fold kinematics and seismic hazard, J. Geophys. Res., 112.

Mahoney W. Editor, 2015. 2015 Greenbook: Standard Specifications for Public Works Construction. BNI Publications.

Mikola, G. R., and Sitar, N., 2013. "Seismic Earth Pressures on Retaining Structures in Cohesionless Soils." Report submitted to the California Department of Transportation (Caltrans), Report No. UCB GT 13-01, March 2013.

Norris, R. M., and R. W. Webb, 1990, Geology of California, John Wiley & Sons, N.Y.

Olson, E.L. and Cooke, M.L., 2005, Application of Three Fault Growth Criteria to the Puente Hills Thrust System, Los Angeles, California, USA: Journal of Structural Geology 27(2005)1765-1777.

Poland and Piper, 1956, Ground-water geology of the coastal zone, Long Beach - Santa Ana area, California, USGS, Water-Supply Paper 1109, dated 1956

Pradel, D., 1998a, Procedure to Evaluate Earthquake-Induced Settlements in Dry Sandy Soils: Journal of Geotechnical and Geoenvironmental Engineering, dated April, pp. 364-368.

Pradel, D., 1998b, Erratum to Procedure to Evaluate Earthquake-Induced Settlements in Dry Sandy Soils: Journal of Geotechnical and Geoenvironmental Engineering, dated October, p. 1048.

Shaw, J., Plesch, A., Dolan, J. F., Pratt, T. L., Fiore, P., 2002, Puente Hills Blind-Thrust System, Los Angeles, California, Bulletin of the Seismological Society of America (Seismological Society of America) 92 (8): 2946–2960.

Southern California Earthquake Center, 1999. Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California, dated March.

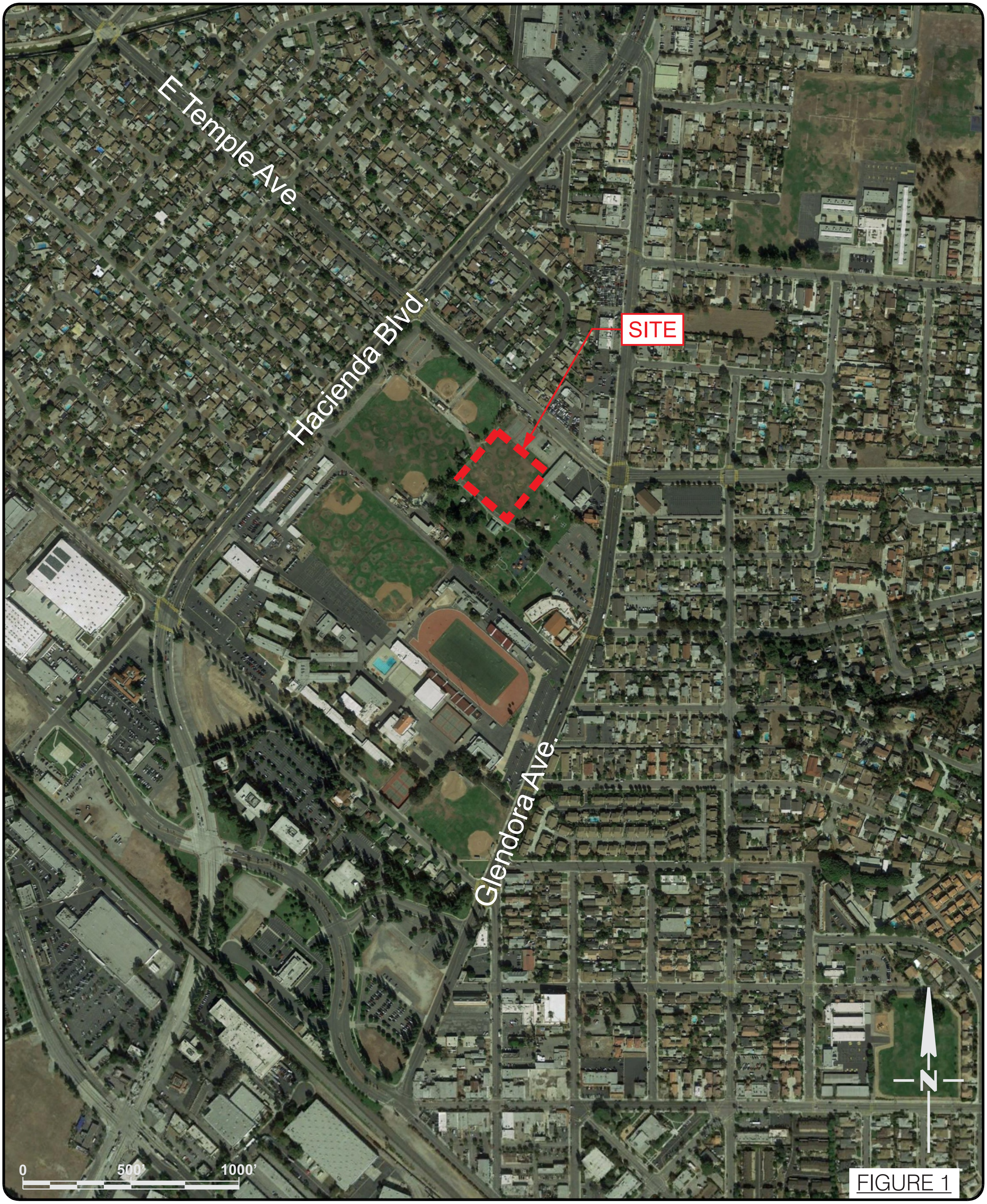
Taciroglu, E., Shamsabadi, A., and Shi-Yu X., 2013. Development of Improved Guidelines for Analysis and Design of Earth Retaining Structures. UCLA-SGEL Report 2013/02. Caltrans Final Report No. CA13-2270. July, 2013.

Terzaghi, K., Peck R., and Mesri G., (1996), Soil Mechanics in Engineering Practice, Third Edition, Published by Wiley-Interscience, February 7, 1996.

Youd, T.L., and Idriss, I.M. (eds.), 1998, Summary Report in Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils: National Center for Earthquake Engineering Research Technical Report NCEER-97-0022, pp. 1-40.

Youd, T.L. and Idriss, I.M., 2001, Liquefaction Resistance of Soils: Summary report of NCEER 1996 and 1998 NCEER/SF Workshops on Evaluation of Liquefaction Resistance of Soils: Journal of Geotechnical and Geoenvironmental Engineering, dated April, 2001.

Figures



TETRA TECH BAS
GEOSCIENCE
1360 Valley Vista Drive, Diamond Bar, CA 91765
TEL 909.860.7777 FAX 909.860.8017

LA PUENTE CITY PARK - LA PUENTE, CA

SITE LOCATION MAP

JOB NO.	TET 17-136E
DATE	DEC 2017
DRAWN BY	SCM
CHECKED BY	FC

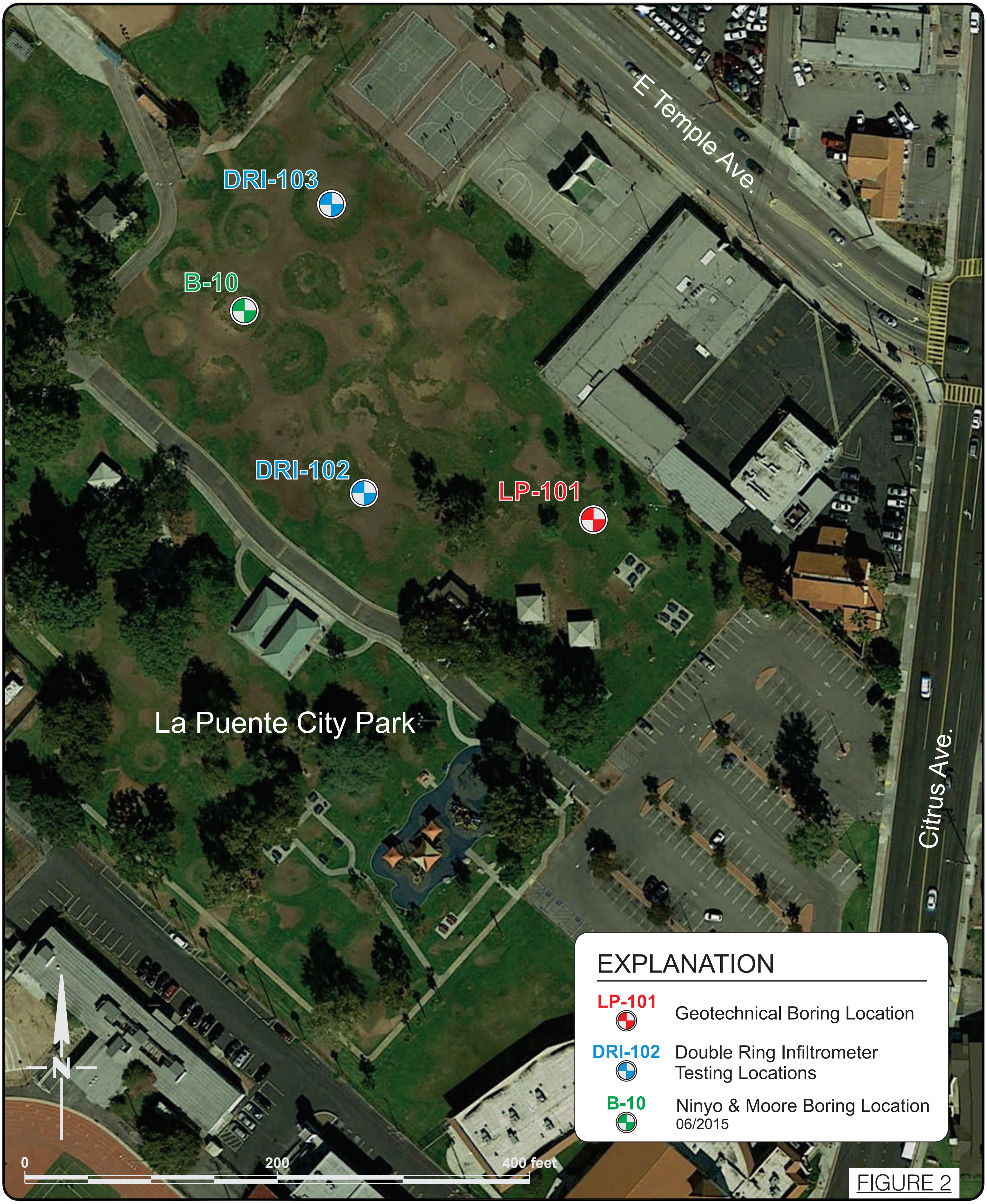


FIGURE 2

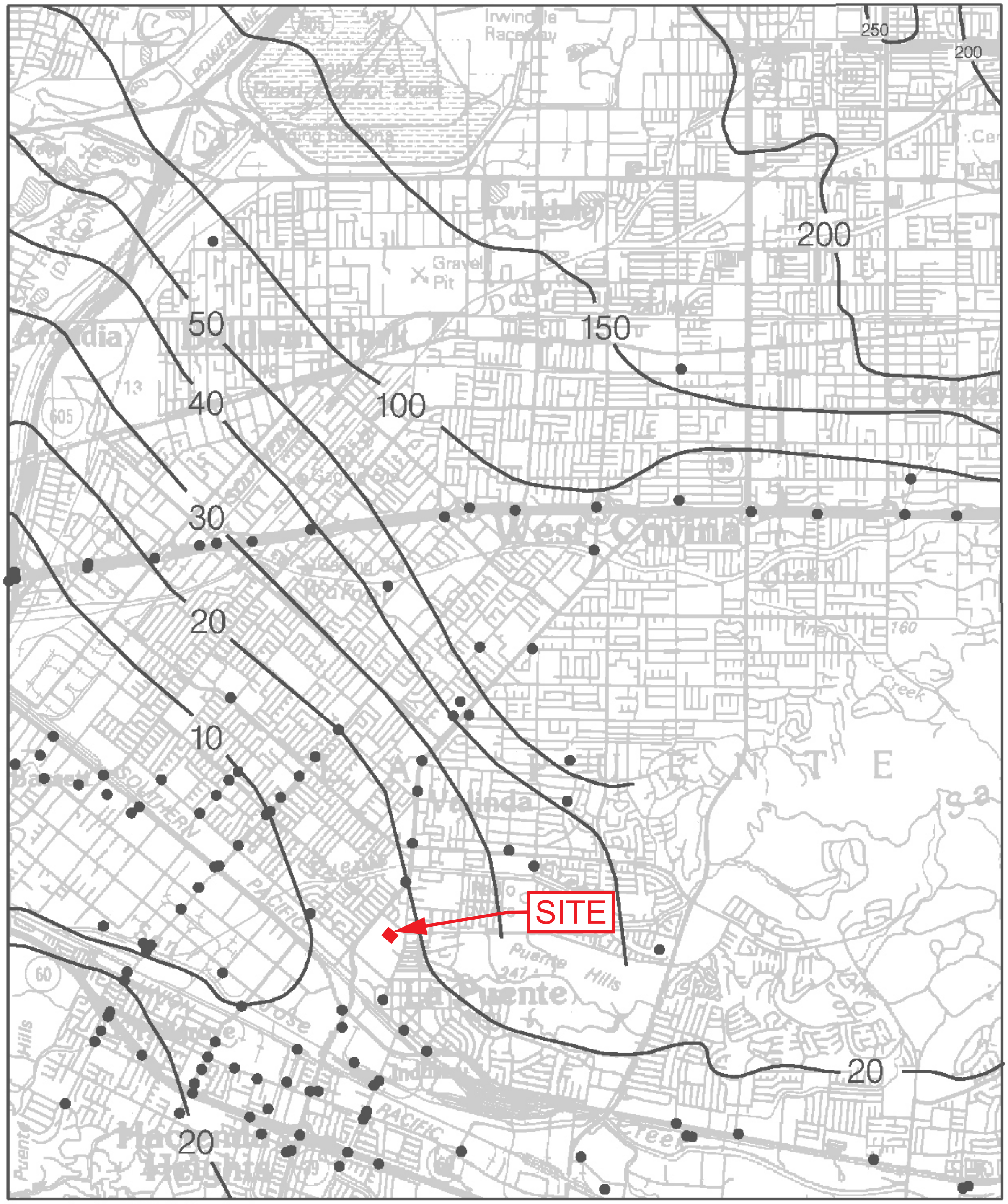
TETRA TECH BAS GEOSCIENCE 1360 Valley Vista Drive, Diamond Bar, CA 91765 TEL 909.860.7777 FAX 909.860.8017	LA PUENTE CITY PARK - LA PUENTE, CA SITE LAYOUT AND BORING LOCATION MAP	JOB NO. TET 17-136E DATE DEC 2017 DRAWN BY SCM CHECKED BY FC

PORTION OF THE
GEOLOGIC MAP OF THE EL MONTE & BALDWIN PARK QUADRANGLES, LOS ANGELES COUNTY, CALIFORNIA
By THOMAS W. DIBBLEE, JR., 1999

FIGURE 3

TETRA TECH BAS GEOSCIENCE 1360 Valley Vista Drive, Diamond Bar, CA 91765 TEL 909.860.7777 FAX 909.860.8017	LA PUENTE CITY PARK - LA PUENTE, CA	JOB NO. TET 17-136E
	GEOLOGIC MAP	DATE DEC 2017
		DRAWN BY SCM
		CHECKED BY FC

Open–File Report 98–13



Base map enlarged from U.S.G.S. 30 x 60–minute series

Plate 1.2 Historically Highest Ground Water Contours and Borehole Log Data Locations, Baldwin Park Quadrangle.

● Borehole Site — 30 — Depth to ground water in feet

ONE MILE

SCALE

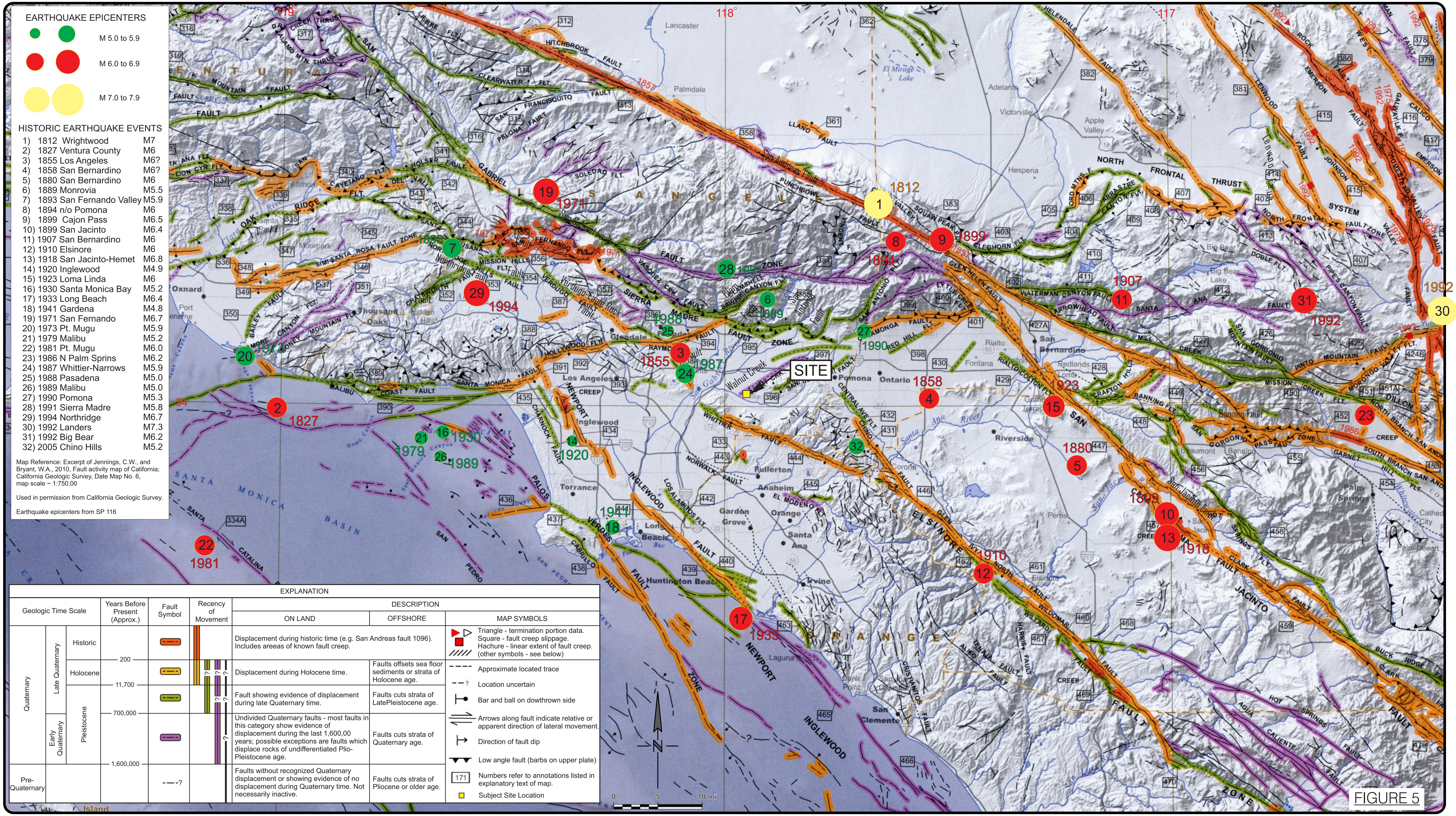
FIGURE 4

TETRA TECH BAS
GEOSCIENCE
1360 Valley Vista Drive, Diamond Bar, CA 91765
TEL 909.860.7777 FAX 909.860.8017

LA PUENTE CITY PARK - LA PUENTE, CA

HISTORIC HIGH GROUNDWATER MAP

JOB NO.	TET 17-136E
DATE	DEC 2017
DRAWN BY	SCM
CHECKED BY	FC



EXPLANATION

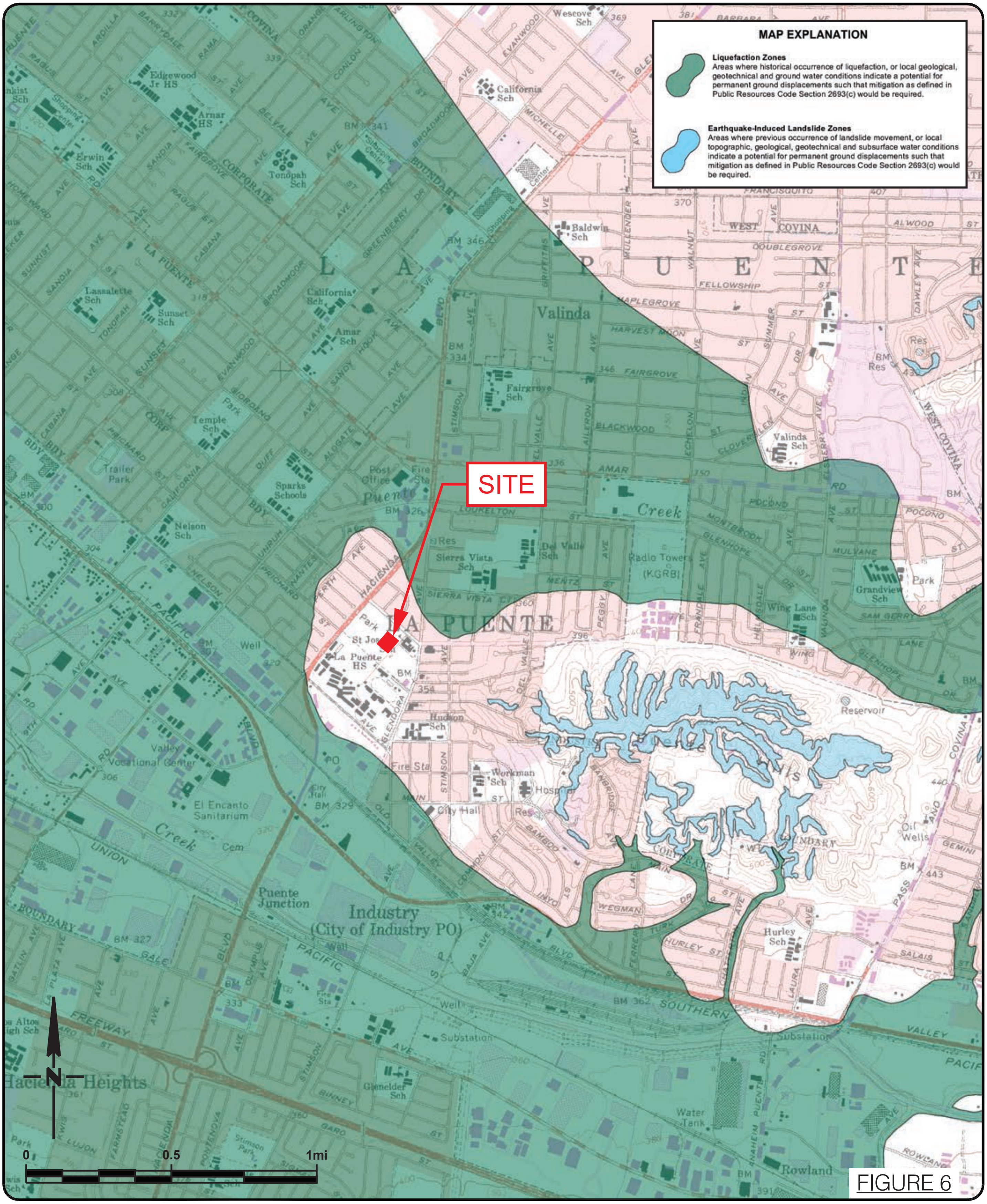
Geologic Time Scale			Years Before Present (Approx.)	Fault Symbol	Recency of Movement	DESCRIPTION: ON LAND	DESCRIPTION: OFFSHORE	MAP SYMBOLS
Quaternary	Late Quaternary	Historic	200			Displacement during historic time (e.g. San Andreas fault 1096). Includes areeas of known fault creep.		Triangle - termination portion data. Square - fault creep slippage. Hachure - linear extent of fault creep. (other symbols - see below)
		Holocene	11,700			Displacement during Holocene time.	Faults offsets sea floor sediments or strata of Holocene age.	Approximate located trace; Location uncertain
		Pleistocene	700,000			Fault showing evidence of displacement during late Quaternary time.	Faults cuts strata of LatePleistocene age.	Bar and ball on dowthrown side
	Early Quaternary		1,600,000			Undivided Quaternary faults - most faults in this category show evidence of displacement during the last 1,600,00 years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age.	Faults cuts strata of Quaternary age.	Arrows along fault indicate relative or apparent direction of lateral movement. Direction of fault dip. Low angle fault (barbs on upper plate)
Pre-Quaternary				---?		Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive.	Faults cuts strata of Pliocene or older age.	171 Numbers refer to annotations listed in explanatory text of map. Subject Site Location

TETRA TECH
1360 Valley Vista Drive, Diamond Bar, CA 91765
TEL 909.860.7777 FAX 909.860.8017

LA PUENTE CITY PARK - LA PUENTE, CA

REGIONAL FAULTS AND SEISMICITY MAP

JOB NO.	TET 17-136E
DATE	DEC 2017
DRAWN BY	SCM
CHECKED BY	FC



TETRA TECH BAS GEOSCIENCE 1360 Valley Vista Drive, Diamond Bar, CA 91765 TEL 909.860.7777 FAX 909.860.8017	LA PUENTE CITY PARK - LA PUENTE, CA	JOB NO. TET 17-136E
	SEISMIC HAZARD ZONES MAP	DATE DEC 2017
		DRAWN BY SCM
		CHECKED BY FC

Appendix A

Logs of Ninyo and Moore's Exploratory Boring

BORING LOG EXPLANATION SHEET

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0								Bulk sample.
								Modified split-barrel drive sampler.
								2-inch inner diameter split-barrel drive sampler.
								No recovery with modified split-barrel drive sampler, or 2-inch inner diameter split-barrel drive sampler.
								Sample retained by others.
5								Standard Penetration Test (SPT).
								No recovery with a SPT.
			XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
								No recovery with Shelby tube sampler.
								Continuous Push Sample.
10								Seepage.
								Groundwater encountered during drilling.
								Groundwater measured after drilling.
							SM	MAJOR MATERIAL TYPE (SOIL): Solid line denotes unit change.
							CL	Dashed line denotes material change.
								Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Shear Bedding Surface
15								
								The total depth line is a solid line that is drawn at the bottom of the boring.
20								

Ninyo & Moore

BORING LOG

Explanation of Boring Log Symbols

PROJECT NO.	DATE	FIGURE

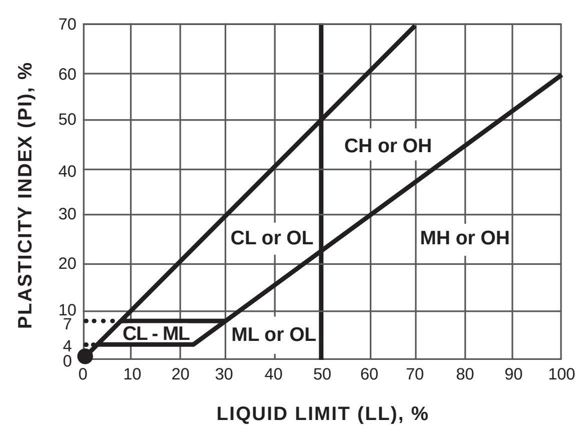
SOIL CLASSIFICATION CHART PER ASTM D 2488

PRIMARY DIVISIONS			SECONDARY DIVISIONS: GROUP SYMBOL	SECONDARY DIVISIONS: GROUP NAME
COARSE-GRAINED SOILS more than 50% retained on No. 200 sieve	GRAVEL more than 50% of coarse fraction retained on No. 4 sieve	CLEAN GRAVEL less than 5% fines	GW	well-graded GRAVEL
			GP	poorly graded GRAVEL
		GRAVEL with DUAL CLASSIFICATIONS 5% to 12% fines	GW-GM	well-graded GRAVEL with silt
			GP-GM	poorly graded GRAVEL with silt
			GW-GC	well-graded GRAVEL with clay
			GP-GC	poorly graded GRAVEL with clay
		GRAVEL with FINES more than 12% fines	GM	silty GRAVEL
			GC	clayey GRAVEL
			GC-GM	silty, clayey GRAVEL
	SAND 50% or more of coarse fraction passes No. 4 sieve	CLEAN SAND less than 5% fines	SW	well-graded SAND
			SP	poorly graded SAND
		SAND with DUAL CLASSIFICATIONS 5% to 12% fines	SW-SM	well-graded SAND with silt
			SP-SM	poorly graded SAND with silt
			SW-SC	well-graded SAND with clay
			SP-SC	poorly graded SAND with clay
		SAND with FINES more than 12% fines	SM	silty SAND
			SC	clayey SAND
			SC-SM	silty, clayey SAND
FINE-GRAINED SOILS 50% or more passes No. 200 sieve	SILT and CLAY liquid limit less than 50%	INORGANIC	CL	lean CLAY
			ML	SILT
			CL-ML	silty CLAY
		ORGANIC	OL (PI > 4)	organic CLAY
			OL (PI < 4)	organic SILT
	SILT and CLAY liquid limit 50% or more	INORGANIC	CH	fat CLAY
			MH	elastic SILT
		ORGANIC	OH (plots on or above "A"-line)	organic CLAY
			OH (plots below "A"-line)	organic SILT
	Highly Organic Soils		PT	Peat

GRAIN SIZE

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		> 12"	> 12"	Larger than basketball-sized
Cobbles		3 - 12"	3 - 12"	Fist-sized to basketball-sized
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb-sized to fist-sized
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea-sized to thumb-sized
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock-salt-sized to pea-sized
	Medium	#40 - #10	0.017 - 0.079"	Sugar-sized to rock-salt-sized
	Fine	#200 - #40	0.0029 - 0.017"	Flour-sized to sugar-sized
Fines		Passing #200	< 0.0029"	Flour-sized and smaller

PLASTICITY CHART



APPARENT DENSITY - COARSE-GRAINED SOIL

APPARENT DENSITY	SPOOLING CABLE OR CATHEAD: SPT (blows/foot)	SPOOLING CABLE OR CATHEAD: MODIFIED SPLIT BARREL (blows/foot)	AUTOMATIC TRIP HAMMER: SPT (blows/foot)	AUTOMATIC TRIP HAMMER: MODIFIED SPLIT BARREL (blows/foot)
Very Loose	≤ 4	≤ 8	≤ 3	≤ 5
Loose	5 - 10	9 - 21	4 - 7	6 - 14
Medium Dense	11 - 30	22 - 63	8 - 20	15 - 42
Dense	31 - 50	64 - 105	21 - 33	43 - 70
Very Dense	> 50	> 105	> 33	> 70

CONSISTENCY - FINE-GRAINED SOIL

CONSIS-TENCY	SPOOLING CABLE OR CATHEAD: SPT (blows/foot)	SPOOLING CABLE OR CATHEAD: MODIFIED SPLIT BARREL (blows/foot)	AUTOMATIC TRIP HAMMER: SPT (blows/foot)	AUTOMATIC TRIP HAMMER: MODIFIED SPLIT BARREL (blows/foot)
Very Soft	< 2	< 3	< 1	< 2
Soft	2 - 4	3 - 5	1 - 3	2 - 3
Firm	5 - 8	6 - 10	4 - 5	4 - 6
Stiff	9 - 15	11 - 20	6 - 10	7 - 13
Very Stiff	16 - 30	21 - 39	11 - 20	14 - 26
Hard	> 30	> 39	> 20	> 26

Ninyo & Moore

USCS METHOD OF SOIL CLASSIFICATION

Explanation of USCS Method of Soil Classification

PROJECT NO.	DATE	FIGURE

DATE DRILLED	3/17/15
BORING NO.	B-10
GROUND ELEVATION	320' ± (MSL)
SHEET	1 OF 3
METHOD OF DRILLING	8" Diameter Hollow-Stem Auger (CME 75) (Geoboden)
DRIVE WEIGHT	140 lbs. (Auto-Trip Hammer)
DROP	30"
SAMPLED BY	CAT
LOGGED BY	CAT
REVIEWED BY	GTF

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0	Bulk				ML	FILL: Brown, dry, medium dense, fine to medium sandy SILT; scattered roots and grass; trace fragments of asphalt.
					SM	ALLUVIUM: Light reddish brown, moist, dense, silty fine SAND; trace clay; trace medium sand; scattered pinhole voids.
	Driven	26	16.2			
10	Driven	45	10.7	121.4		Trace coarse sand and gravel up to 1-inch in diameter.
	Driven	35	5.6			Fine to coarse sand.
					SC	Brown, moist, dense, clayey fine to coarse SAND with gravel up to 1-inch in diameter.
20	Driven	24	10.8			
					ML	Reddish brown, moist, hard, clayey SILT; trace fine sand; scattered fine laminations.
					CL	Brown, moist, stiff, silty CLAY; some fine to medium sand; scattered black manganese deposits; slightly micaceous.
	Driven	9	21.1			
30	Driven	30	17.0	108.8		Mottled reddish brown and light brown; trace fine gravel.
					SC	Brown, moist, dense, clayey fine to SAND.
	Driven	21	16.6			
					CL	Brown, moist, hard, silty CLAY with fine to coarse sand and fine gravel.
40						

Ninyo & Moore

BORING LOG

LA PUENTE PARK - UPPER SAN GABRIEL RIVER EWMP
LOS ANGELES COUNTY, CALIFORNIA

PROJECT NO.	DATE	FIGURE
107900001	6/15	A-1

DATE DRILLED	3/17/15	BORING NO.	B-10
GROUND ELEVATION	320' ± (MSL)	SHEET	2 OF 3
METHOD OF DRILLING	8" Diameter Hollow-Stem Auger (CME 75) (Geoboden)		
DRIVE WEIGHT	140 lbs. (Auto-Trip Hammer)	DROP	30"
SAMPLED BY	CAT	LOGGED BY	CAT
REVIEWED BY	GTF		

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
40		X	13	16.0			ML	ALLUVIUM: (Continued) Reddish brown, moist, medium dense, fine sandy SILT; scattered black manganese deposits; resembles soil profile.
		X	16	24.3				
							SM	Brown, moist, dense, silty fine SAND; some yellowish brown mottling; micaceous.
50		X	50	15.1	111.6			
							CL	Mottled brown and grayish brown, moist, stiff, silty CLAY.
60		X	11	25.2				Trace fine sand.
							SM	Light grayish brown, moist, very dense, silty fine SAND; trace gravel up to 1/2-inch in diameter.
70		X	57	6.2				
							CL	Mottled brown and light grayish brown, moist, hard, fine sandy CLAY.
80								

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DATE DRILLED 3/17/15 BORING NO. B-10
								GROUND ELEVATION 320' ± (MSL) SHEET 3 OF 3
								METHOD OF DRILLING 8" Diameter Hollow-Stem Auger (CME 75) (Geoboden)
								DRIVE WEIGHT 140 lbs. (Auto-Trip Hammer) DROP 30"
								SAMPLED BY CAT LOGGED BY CAT REVIEWED BY GTF
								DESCRIPTION/INTERPRETATION
80		◣	28	16.5			CL	ALLUVIUM: (Continued) Mottled brown and light grayish brown, moist, hard, fine sandy CLAY.
							SC	Brown and light grayish brown, wet, dense, clayey fine to medium SAND; scattered clay up to 1/2-inch in diameter.
							ML	Mottled brown and light grayish brown, wet, hard, clayey SILT; scattered pockets of fine sand.
90		◣	22	18.0				
100		◣	33	17.7			CL	Brown, wet, hard, silty CLAY; scattered grayish and reddish brown mottling.
								Total Depth = 101.5 feet. Groundwater not encountered during drilling. Backfilled shortly after drilling on 3/17/15. Notes: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report. The ground elevation shown above is an estimation only. It is based on our interpretations of published maps and other documents reviewed for the purposes of this evaluation. It is not sufficiently accurate for preparing construction bids and design documents.
110								
120								

Appendix B

Logs of Tetra Tech's Exploratory Boring

L:\02 - PROJECTS\2017 Projects\TET 17-136E (4552-0136) Upper San Gabriel EWMP - City of Industry\03 Field & Lab\2017-11-29 & 30 La Puente City Park Drilling & DRI Testing\Boring Log Rev 2018-01-22.bg4[40-45 with 2 lab Tt LOGO w Lab Abb.tpl]

Project: **Upper San Gabriel EWMP - City of Industry**
Project Location: **La Puente City Park, La Puente, CA**
Project Number: **TET 17-136E**

Log of Boring LP-101

Date(s) Drilled **11/29/2017**	Logged By **JPG**	Checked By **FC**
Drilling Method **Hollow stem auger**	Drill Bit Size/Type **8-inch**	Total Depth of Borehole **31.5 feet**
Drill Rig Type **CME-75**	Drilling Contractor **2R Drilling, Inc.**	Approximate Surface Elevation **345 feet**
Groundwater Level and Date Measured **Not Encountered**	Sampling Method(s) **SPT, Rings**	Hammer Data **CME Auto trip; 140 pounds with 30-inch drop**
Borehole Backfill **Cement bentonite grout, tamped soil cuttings**	Location **Latitude: 34.02766° Longitude: -117.95188°**	

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
345	0				SM	[FILL] Artificial fill (af) Silty SAND, medium dense, dark brown (7.5YR 3/4), damp, rootlets			
					ML	[NATIVE] Alluvium (Qae) Sandy SILT, very stiff, brown (2.5Y 4/6), moist to wet			
		SPT	SPT-1	4-7-10					CORR
340	5	Ring	R-2	14-27-40		... hard, mottled to dark olive brown (2.5Y 3/3), moist	16.8	116	#200 = 66% LL/PL/PI = 27/25/2
		SPT	SPT-3	7-11-16	SC	Clayey SAND, medium dense, dark yellowish brown (10YR 4/4), moist, fine to medium grained			G/S/F = 0/51/49%
335	10	Ring	R-4	7-20-24	ML	SILT, very stiff, moist, clayey with fine sand	19.6	113	Swell/Collapse Test
330	15	SPT	SPT-5	7-11-12	SM	Silty SAND, medium dense, dark yellowish brown (10YR 4/4), fien to medium grained			#200 = 40%
					CL	Lean CLAY, very stiff, dark olive brown (2.5Y 3/3), moist			
325	20	Ring	R-6	8-16-16			23.4	102	
320	25	SPT	SPT-7	4-8-11	SP-SM	Poorly-graded SAND with Silt, medium dense, dark olive brown (2.5Y 3/3), moist, trace of white caliche laminations			#200 = 9%
					CL	Lean CLAY, hard, olive (2.5Y 4/3), moist, fine grained			
315	30	Ring	R-8	15-28-37			15.5	117	
						Bottom of boring at 31.5 feet below ground surface. - No groundwater encountered. Boring backfilled: 1-31.5 feet with cement bentonite grout, and 0-1 feet with tamped soil cuttings and grass plug.			
310	35								
305	40								

L:\02 - PROJECTS\2017 Projects\TET 17-136E (4552-0136) Upper San Gabriel EWMP - City of Industry\03 Field & Lab\2017-11-29 & 30 La Puente City Park Drilling & DRI Testing\Boring Log Rev 2018-01-22.bg4[40-45 with 2 lab Tt LOGO_w Lab Abb.tpl]

Project: **Upper San Gabriel EWMP - City of Industry**
Project Location: **La Puente City Park, La Puente, CA**
Project Number: **TET 17-136E**

Key to Log of Boring

Elevation (feet)	Depth (feet)	Sample Type	Sample Number	Sampling Resistance, blows/ft	Material Type	Graphic Log	MATERIAL DESCRIPTION	Water Content, %	Dry Unit Weight, pcf	REMARKS AND OTHER TESTS
1	2	3	4	5	6	7	8	9	10	11

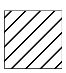
COLUMN DESCRIPTIONS

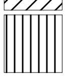
1 Elevation (feet): Elevation (MSL, feet).
2 Depth (feet): Depth in feet below the ground surface.
3 Sample Type: Type of soil sample collected at the depth interval shown.
4 Sample Number: Sample identification number.
5 Sampling Resistance, blows/ft: Number of blows to advance driven sampler one foot (or distance shown) beyond seating interval using the hammer identified on the boring log.
6 Material Type: Type of material encountered.
7 Graphic Log: Graphic depiction of the subsurface material encountered.
8 MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
9 Water Content, %: Water content of the soil sample, expressed as percentage of dry weight of sample.
10 Dry Unit Weight, pcf: Dry weight per unit volume of soil sample measured in laboratory, in pounds per cubic foot.
11 REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.

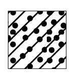
FIELD AND LABORATORY TEST ABBREVIATIONS

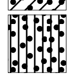
CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
DS: Direct Shear
EI: Expansion Index
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

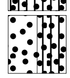
MATERIAL GRAPHIC SYMBOLS


Lean CLAY, CLAY w/SAND, SANDY CLAY (CL)


SILT, SILT w/SAND, SANDY SILT (ML)


Clayey SAND (SC)


Silty SAND (SM)


Poorly graded SAND with Silt (SP-SM)

TYPICAL SAMPLER GRAPHIC SYMBOLS


3.0-inch-OD Modified California w/ brass liners


2-inch-OD unlined split spoon (SPT)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

Figure B-1

TETRA TECH

Appendix C

Tetra Tech Laboratory Testing

TETRA TECH BAS GEOSCIENCE

MOISTURE CONTENT AND DENSITY

ASTM D2937

Job Name:	Upper san Gabriel EWMP	**Date Sampled:**	11/29/2017
Job Number:	197-4552-0136	**Date Completed:**	12/20/2017
Tested By:	MG	**Note:**	Page 1 of 3

Boring / Test Pit / Trench		**FB-101**	**FB-101**	**C-101**	**C-101**	**C-101**	**C-101**	**C-101**	**C-102**	**C-102**
Sample Number		**R-6**	**R-8**	**R-2**	**R-4**	**R-8**	**R-12**	**R-14**	**R-2**	**R-4**
Sample Depth	*feet*	**17.5-19**	**22.5-24**	**5-6.5**	**12.5-14**	**22.5-24**	**40-41.4**	**50-51.5**	**5-6.5**	**12.5-14**
USCS Soil Description		Brown Native (ML)	Greenish Black Native (SP)	Brown Native (SW)	Yellowish Brown Native (SW-SM)	Yellowish Brown Native (SW-SM)	Brown Native (SM)	Brown Native (ML)	Brown Native (SM)	Brown Native (SP)
Number of Rings		6	6	6	5	6	6	6	6	6
Total Weight Rings + Soil	*grams*	1248.90	1218.70	1026.10	907.40	1132.00	1142.90	1186.70	1077.20	1026.80
* Volume of Rings	*ft^3*	0.0159	0.0159	0.0159	0.0133	0.0159	0.0159	0.0159	0.0159	0.0159
* Weight of Rings	*grams*	277.80	277.80	277.80	231.50	277.80	277.80	277.80	277.80	277.80
* Weight of Soil	*grams*	971.10	940.90	748.30	675.90	854.20	865.10	908.90	799.40	749.00
* Wet Density	*pcf*	134.27	130.09	103.46	112.15	118.11	119.61	125.67	110.53	103.56
Container ID		PZ1	Z5	P4	VB-4	P88	P#2	Z18	Z9	Z24
Tare	*grams*	90	4	92.3	148.7	9.3	84	4	4	4
Wet Soil + Tare	*grams*	400.7	317.3	481.7	739.5	289.7	482.3	301	252.1	270
Dry Soil + Tare	*grams*	369.8	310.5	446.9	706.2	270.2	431.6	245.5	231.8	251.2
* Weight of Water	*grams*	30.9	6.8	34.8	33.3	19.5	50.7	55.5	20.3	18.8

*** Dry Density**	***pcf***	**120.9**	**127.3**	**94.2**	**105.8**	**109.9**	**104.4**	**102.2**	**101.5**	**96.2**
*** Moisture Content**	***%***	**11.0**	**2.2**	**9.8**	**6.0**	**7.5**	**14.6**	**23.0**	**8.9**	**7.6**

TETRA TECH BAS GEOSCIENCE

MOISTURE CONTENT AND DENSITY

ASTM D2937

Job Name:	Upper san Gabriel EWMP	**Date Sampled:**	11/29/2017
Job Number:	197-4552-0136	**Date Completed:**	12/20/2017
Tested By:	MG	**Note:**	Page 2 of 3

Boring / Test Pit / Trench		**C-102**	**B-101**	**B-101**	**B-101**	**LP-101**	**LP-101**	**LP-101**	**LPI-102**	**LPI-102**
Sample Number		**R-8**	**R-2**	**R-8**	**R-10**	**R-2**	**R-06**	**R-08**	**G-01**	**G-02**
Sample Depth	*feet*	**22.5-24**	**5-6.5**	**22.5-24**	**30-31.5**	**5-6.5**	**20-21.5**	**30-31.5**	**1.3**	**0-0.3**
USCS Soil Description		Brown Native (SW)	Black & White Native (SW-SM)	Black & White Native (SW-SM)	Yellowish Brown Native (SW-SM)	Yellowish Brown Native (CL)	Yellowish Brown Native (CL)	Yellowish Brown Native (SC)	Brown Native (SM)	Brown Native (SP)
Number of Rings		6	6	6	6	6	6	6		
Total Weight Rings + Soil	*grams*	1172.50	1102.10	1135.00	1185.70	1259.00	1185.90	1256.60		
* Volume of Rings	*ft^3*	0.0159	0.0159	0.0159	0.0159	0.0159	0.0159	0.0159		
* Weight of Rings	*grams*	277.80	277.80	277.80	277.80	277.80	277.80	277.80		
* Weight of Soil	*grams*	894.70	824.30	857.20	907.90	981.20	908.10	978.80		
* Wet Density	*pcf*	123.71	113.97	118.52	125.53	135.67	125.56	135.34		
Container ID		Z31	Z38	Z1	Z7	A2	Z15	Z37	Z39	Z36
Tare	*grams*	4	4	4	4	147.1	4	4	4	4
Wet Soil + Tare	*grams*	279.9	273.4	300.1	263.3	554.9	297.4	337.4	298	398.3
Dry Soil + Tare	*grams*	267.1	268.3	292.2	253.7	496.3	241.7	292.7	261.4	344.7
* Weight of Water	*grams*	12.8	5.1	7.9	9.6	58.6	55.7	44.7	36.6	53.6

*** Dry Density**	***pcf***	**118.0**	**111.8**	**115.4**	**120.9**	**116.2**	**101.7**	**117.2**		
*** Moisture Content**	***%***	**4.9**	**1.9**	**2.7**	**3.8**	**16.8**	**23.4**	**15.5**	**14.2**	**15.7**

MOISTURE CONTENT AND DENSITY

ASTM D2937

TETRA TECH BAS GEOSCIENCE

Job Name:	Upper san Gabriel EWMP	**Date Sampled:**	11/29/2017
Job Number:	197-4552-0136	**Date Completed:**	12/20/2017
Tested By:	MG	**Note:**	Page 3 of 3

Boring / Test Pit / Trench		**LPI-102**	**LPI-102**	**LPI-103**	**LPI-103**	**LPI-103**	**LPI-103**			
Sample Number		**G-03**	**G-04**	**G-01**	**G-02**	**G-03**	**G-04**			
Sample Depth	*feet*	**0.3-0.7**	**0.7-1.1**	**1.3**	**0-0.3**	**0.3-0.7**	**0.7-1.1**			
USCS Soil Description		Brown Native (SC)	Brown Native (SC)	Olive Brown Native (CL)	Red Gray (CL)	Olive Brown (CL)	Olive Brown (CL)			
Number of Rings										
Total Weight Rings + Soil	*grams*									
* Volume of Rings	*ft*^{3}									
* Weight of Rings	*grams*									
* Weight of Soil	*grams*									
* Wet Density	*pcf*									
Container ID		Z34	Z16	Z4	Z29	Z19	Z20			
Tare	*grams*	4	4	4	4	4	4			
Wet Soil + Tare	*grams*	300.2	282.4	226.1	270.9	290.2	282.2			
Dry Soil + Tare	*grams*	263.3	247.7	208	230.5	250.7	250.7			
* Weight of Water	*grams*	36.9	34.7	18.1	40.4	39.5	31.5			

*** Dry Density**	***pcf***									
*** Moisture Content**	***%***	**14.2**	**14.2**	**8.9**	**17.8**	**16.0**	**12.8**			

1360 Valley Vista Drive * Diamond Bar, CA 91765 * Tel.: (909) 860-7777

MOISTURE CONTENT AND DRY DENSITY OF RING SAMPLES

ASTM D2216 & ASTM D2937

HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

Client: TETRA TECH
Project Name: Uper San Gabriel EWMP - City of Industry
Project No.: 197-4552-0136

HAI Project No.: TRT-17-017
Performed by: KL
Checked by: MJ/MZ
Date: 12/7/2017

No.		1	2	3
Boring No.		**FB-101**	**B-101**	**LP-101**
Sample No.		**R-4**	**R-4**	**R-04**
Depth (ft)		**12.5-14**	**12.5-14**	**10-11.5**
Total wt of rings and soil	gr	403.10	355.75	625.12
Height of sample	in	2.00	2.01	3.00
Diameter of sample	in	2.416	2.416	2.416
Volume of sample	cu.ft	0.0053	0.0053	0.0080
Weight of rings	gr	92.60	93.28	138.90
Weight of soil	lbs.	0.68	0.58	1.07
Wet Density	pcf	129.01	108.62	134.68
Weight of cont.+ wet soil	gr	108.25	124.86	104.99
Weight of cont.+ dry soil	gr	100.40	121.98	88.59
Weight of container	gr	4.98	11.71	4.86
Weight of water	gr	7.85	2.88	16.40
Weight of dry soil	gr	95.42	110.27	83.73
Moisture Content	**%**	**8.2**	**2.6**	**19.6**
Dry Density	**pcf**	**119.2**	**105.9**	**112.6**

PERCENT PASSING # 200 SIEVE

ASTM D1140

Job Name:	Uper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:			
Date Sampled:	November 29, 2017		

Boring Number	Sample Number	Depth (ft)	Weight Before Wash - Dry (grams)	Weight After Wash - Dry (grams)	Percent Passing # 200 Sieve	USCS Classification
C-101	R-6	17.5-19	279.9	183.1	35%	SM
C-101	SPT-9	25-26.5	502.6	169.2	66%	ML
C-101	R-12	40-41.5	374.4	333.6	11%	SP-SM
C-102	SPT-5	15-16.5	346	140.5	59%	CL
C-102	R-10	30-31.5	408.9	184	55%	CL
LP-101	R-02	5-6.5	349.3	117.9	66%	CL
LP-101	SPT-05	15-16.5	314.8	188.8	40%	SM
LP-101	SPT-07	25-26.5	360.2	326.5	9%	SP-SM

HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

PERCENT PASSING # 200 SIEVE

ASTM D 1140

Client: TETRA TECH
Project Name: Uper San Gabriel EWMP - City of Industry
Project No.: 197-4552-0136

HAI Project No.: TRT-17-017
Performed by: GA
Checked by: KL/MJ
Date: 12/7/2017

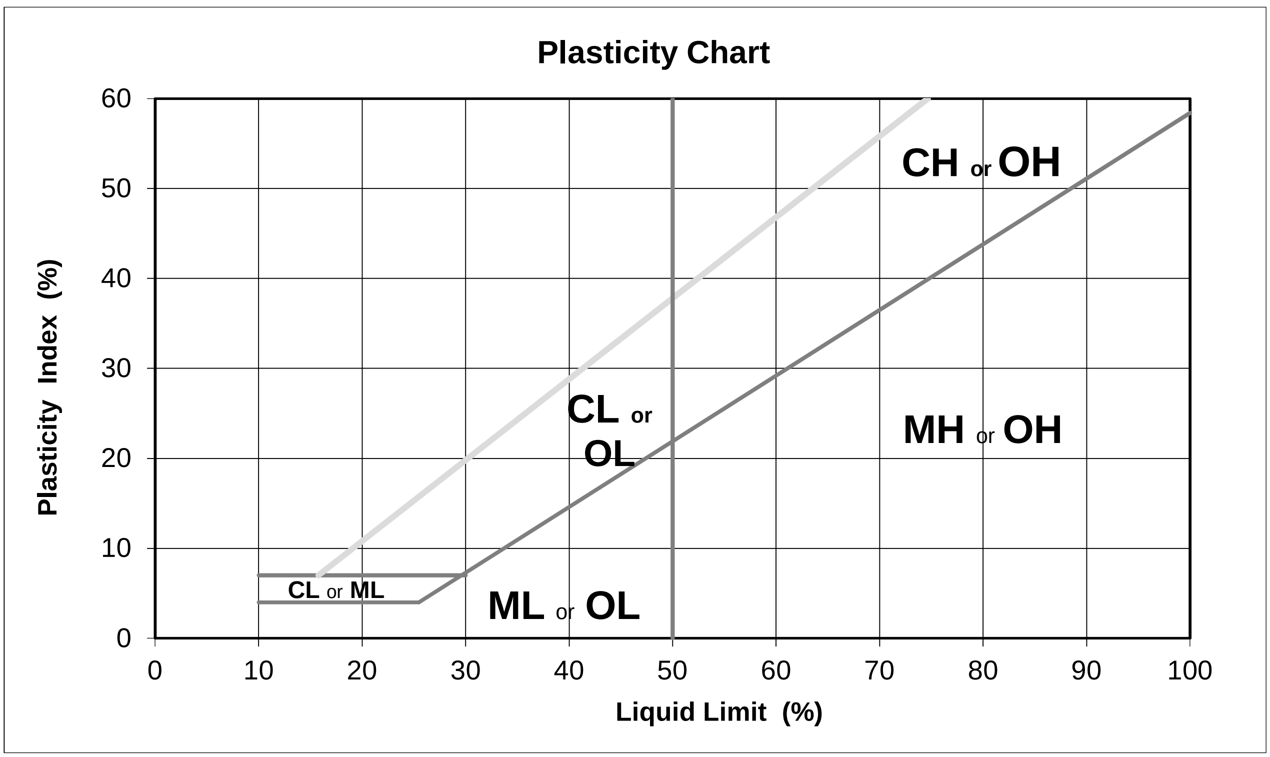
Boring No.	Sample No.	Depth	Soil Description	USCS	Wt of oven dry soil before wash + Wt of container gr	Wt of oven dry soil retained after #200 wash + Wt of container gr	Wt of Container gr	Wt of soil passing # 200 sieve gr	Initial wt of oven dry soil gr	Soil passing # 200 sieve %
C-101	**R-6**	**17.5-19**	Brown, Clayey Sand	**SC**	296.05	167.82	8.14	128.23	287.91	**44.5**

ATTERBERG LIMITS
ASTM D4318

TETRA TECH BAS GEOSCIENCE

Job Name:	Uper San Gabriel EWMP	**Date Sampled:**	11/29/2017
Job Number:	197-4552-0136	**Date Completed:**	12/24/2017
Tested By:	MG	**Sample Identification:**	C-101, SPT-9
Note:		**Sample Depth:**	25-26.5 ft
Sample Description:	Brown Native (ML)		

		PLASTIC LIMIT		LIQUID LIMIT			
Test No.		**1**	**2**	**1**	**2**	**3**	**4**
Number of Blows							
Container ID		NP	NP	NP	NP	NP	
Wet Weight of Soil + Cont.	*grams*						
Dry Weight of Soil + Cont.	*grams*						
Weight of Container	*grams*						
* Moisture Weight	*grams*						
* Weight of Dry Soil	*grams*						
*** Moisture Content**	*%*	**NP**	**NP**	**NP**	**NP**	**NP**	



Plastic Limit	**NP**
Liquid Limit	
Plasticity Index	

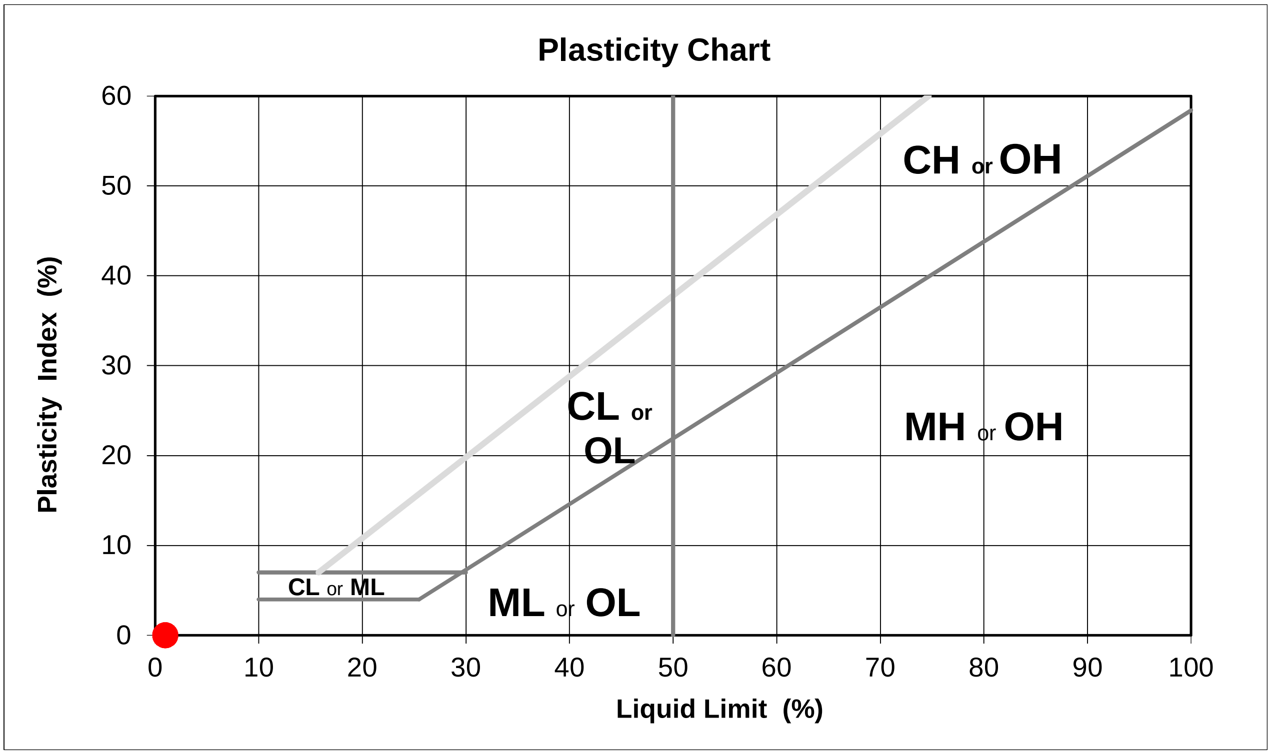
USCS Classification	**ML**

ATTERBERG LIMITS
ASTM D4318

TETRA TECH BAS GEOSCIENCE

Job Name:	Uper San Gabriel EWMP	**Date Sampled:**	11/29/2017
Job Number:	197-4552-0136	**Date Completed:**	12/24/2017
Tested By:	MG	**Sample Identification:**	C-101, SPT-11
Note:		**Sample Depth:**	35-36.5 ft
Sample Description:	Brown Native (ML)		

		PLASTIC LIMIT		LIQUID LIMIT			
Test No.		**1**	**2**	**1**	**2**	**3**	**4**
Number of Blows							
Container ID							
Wet Weight of Soil + Cont.	*grams*	NP	NP	NP	NP	NP	
Dry Weight of Soil + Cont.	*grams*						
Weight of Container	*grams*						
* Moisture Weight	*grams*	0.00	0.00	0.00	0.00	0.00	
* Weight of Dry Soil	*grams*	0.00	0.00	0.00	0.00	0.00	
*** Moisture Content**	*%*	**NP**	**NP**	**NP**	**NP**	**NP**	



Plastic Limit	**NP**
Liquid Limit	**NP**
Plasticity Inde	**NP**

USCS Classification	**ML**

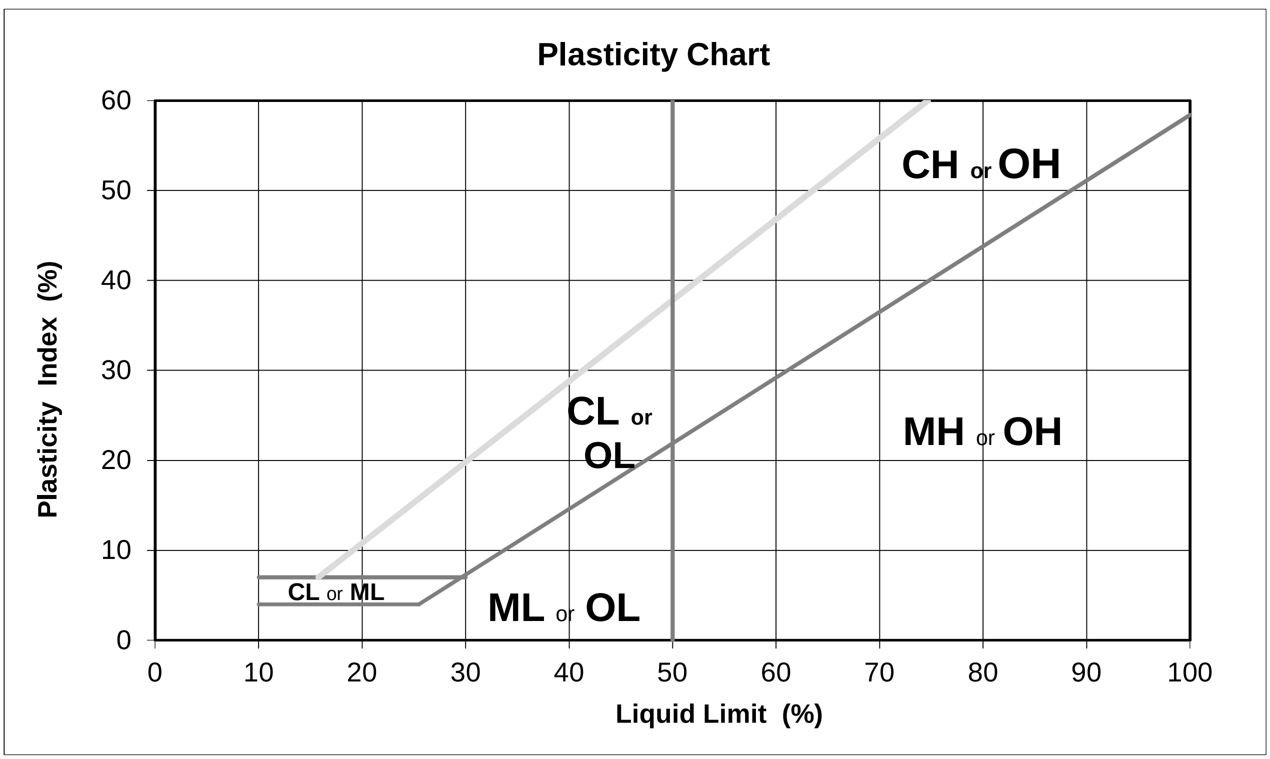
TETRA TECH BAS GEOSCIENCE

ATTERBERG LIMITS

ASTM D4318

Job Name:	Uper San Gabriel EWMP	**Date Sampled:**	11/29/2017
Job Number:	197-4552-0136	**Date Completed:**	12/24/2017
Tested By:	MG	**Sample Identification:**	FB-101, R-6
Note:		**Sample Depth:**	17.5-19 ft
Sample Description:	Brown Native (ML)		

		PLASTIC LIMIT		LIQUID LIMIT			
Test No.		**1**	**2**	**1**	**2**	**3**	**4**
Number of Blows							
Container ID		NP	NP	NP	NP	NP	
Wet Weight of Soil + Cont.	*grams*						
Dry Weight of Soil + Cont.	*grams*						
Weight of Container	*grams*						
* Moisture Weight	*grams*						
* Weight of Dry Soil	*grams*						
*** Moisture Content**	*%*	**NP**	**NP**	**NP**	**NP**	**NP**	



Plastic Limit	**NP**
Liquid Limit	
Plasticity Index	

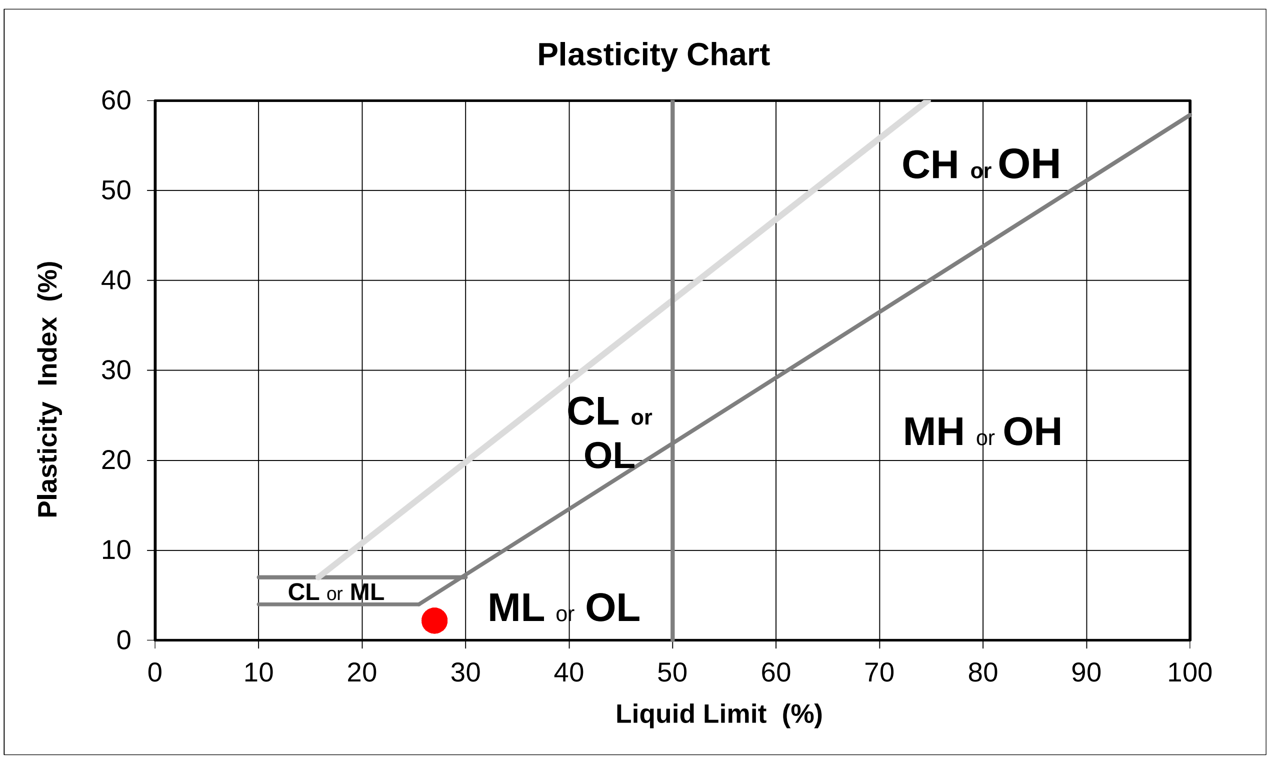
USCS Classification	**ML**

ATTERBERG LIMITS
ASTM D4318

TETRA TECH BAS GEOSCIENCE

Job Name:	Uper San Gabriel EWMP	**Date Sampled:**	11/29/2017
Job Number:	197-4552-0136	**Date Completed:**	12/24/2017
Tested By:	MG	**Sample Identification:**	LP-101, R-02
Note:		**Sample Depth:**	5-6.5 ft
Sample Description:	Yellowish Brown Native (ML)		

		PLASTIC LIMIT		LIQUID LIMIT			
Test No.		1	2	1	2	3	4
Number of Blows				36	24	16	
Container ID		P5	P11	T23	N10	M7	
Wet Weight of Soil + Cont.	*grams*	28.00	29.00	49.90	49.60	53.90	
Dry Weight of Soil + Cont.	*grams*	24.90	25.70	45.10	44.50	47.60	
Weight of Container	*grams*	12.40	12.40	26.00	25.60	26.00	
* Moisture Weight	*grams*	3.10	3.30	4.80	5.10	6.30	
* Weight of Dry Soil	*grams*	12.50	13.30	19.10	18.90	21.60	
*** Moisture Content**	*%*	**24.8**	**24.8**	**25.1**	**27.0**	**29.2**	



Plastic Limit	**25**
Liquid Limit	**27**
Plasticity Index	**2**

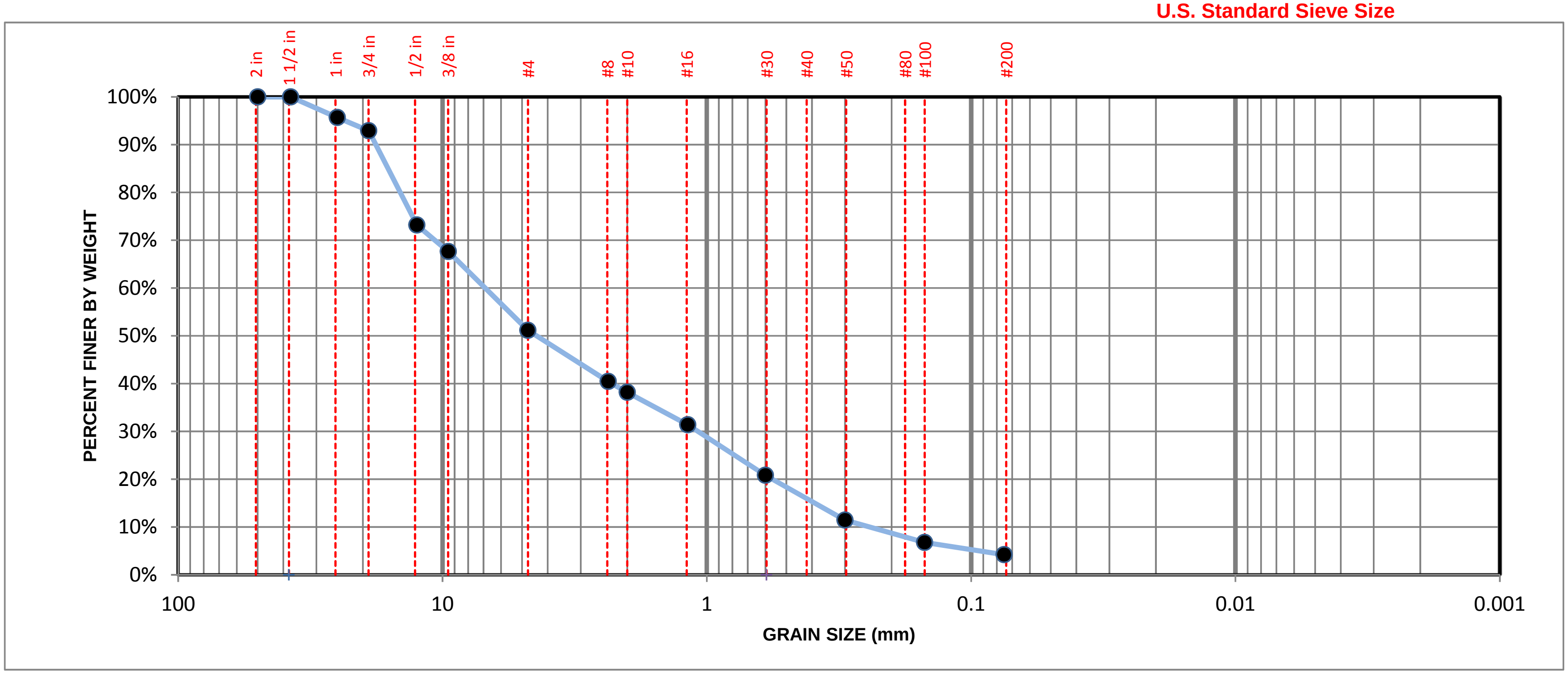
USCS Classification	**ML**

TETRA TECH BAS GEOSCIENCE

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	B-101, SPT-3
Date Sampled:	November 29, 2017		



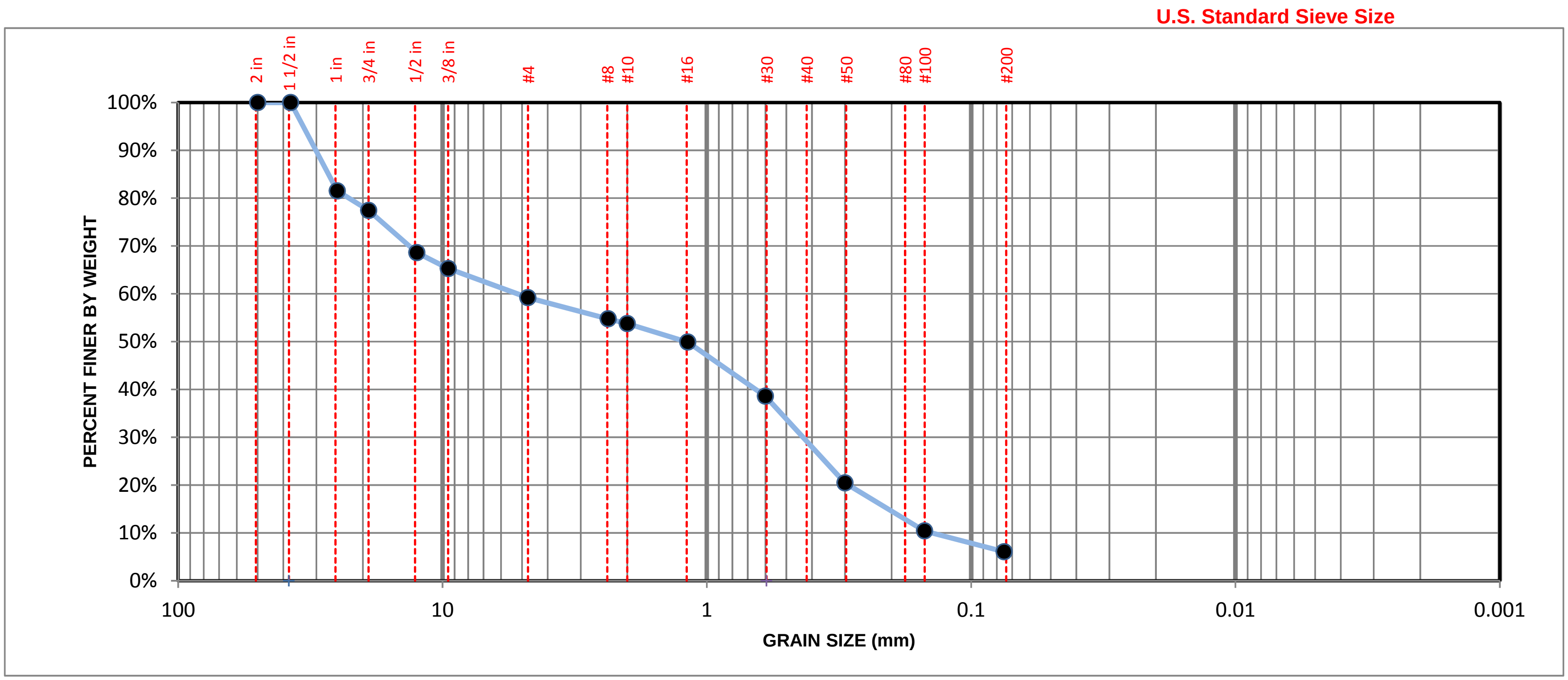
Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2µ
●	B-101	SPT-3	10'-11.5'	-	-	**GP**	**49%**	**47%**	**4%**	

1360 Valley Vista Drive * Diamond Bar, CA 91765 * Tel.: (909) 860-7777

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	B-101, SPT-5
Date Sampled:	November 29, 2017		



Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2µ
●	B-101	SPT-5	15'-16.5'	-	-	**SP-SM**	**41%**	**53%**	**6%**	

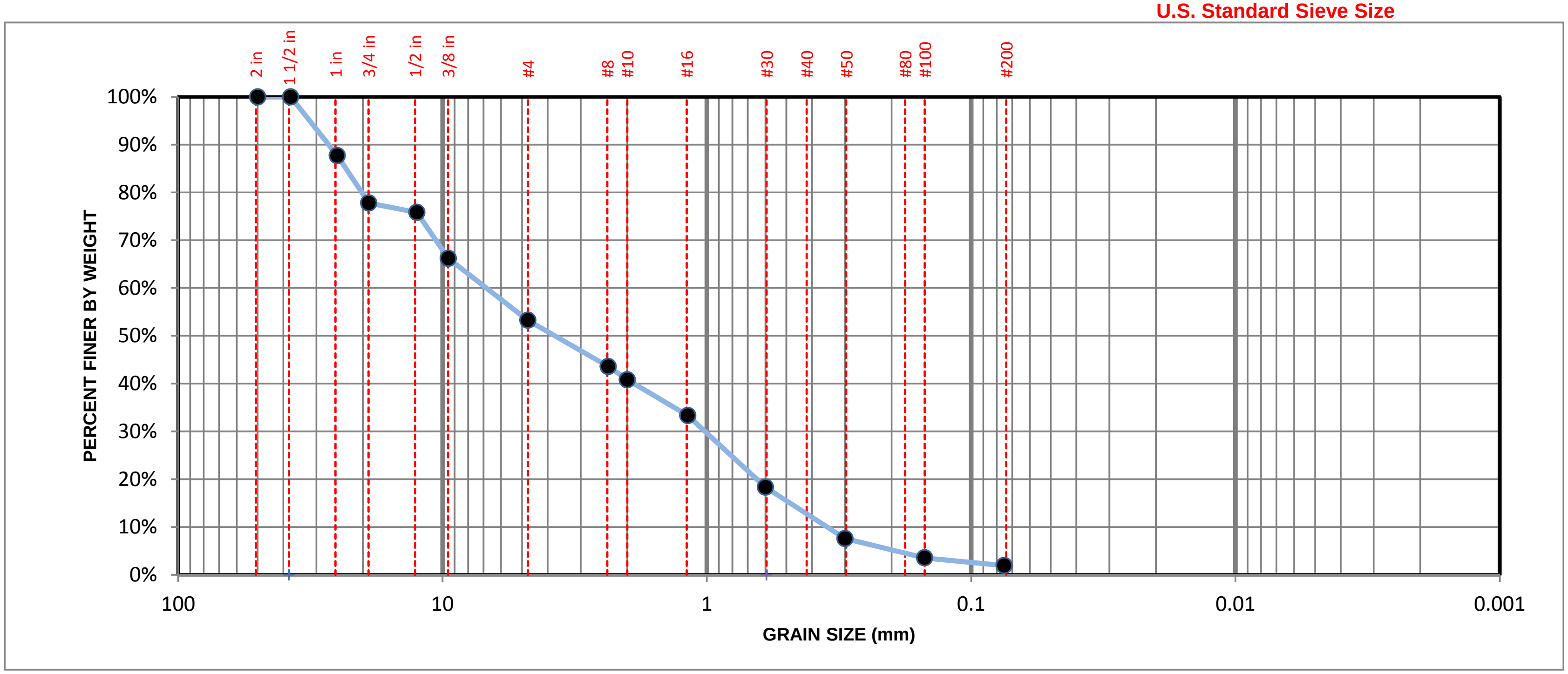
1360 Valley Vista Drive * Diamond Bar, CA 91765 * Tel.: (909) 860-7777

TETRA TECH BAS GEOSCIENCE

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	B-101, R-8
Date Sampled:	November 29, 2017		

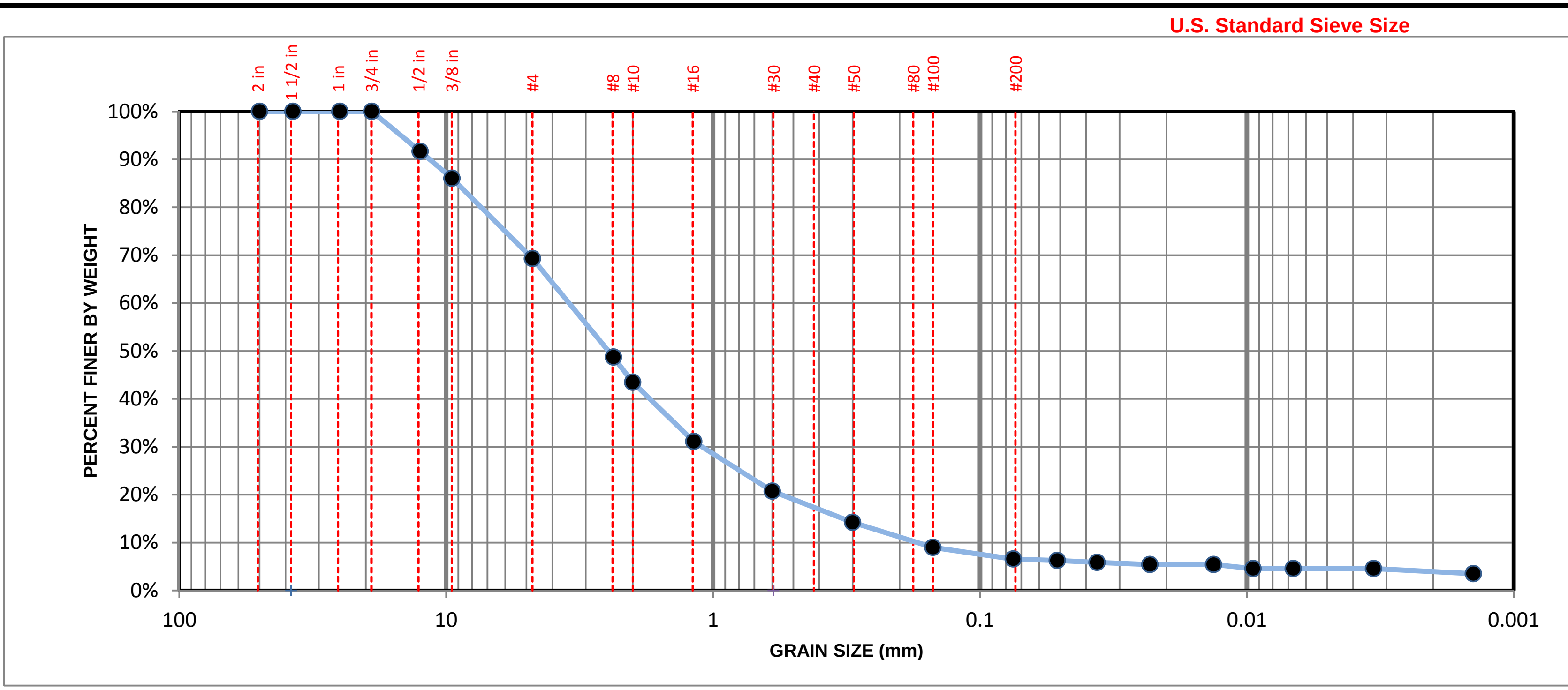


Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2µ
●	B-101	R-8	22.5'-24'	-	-	**SP**	**47%**	**51%**	**2%**	

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	C-101, R-4
Date Sampled:	November 29, 2017		



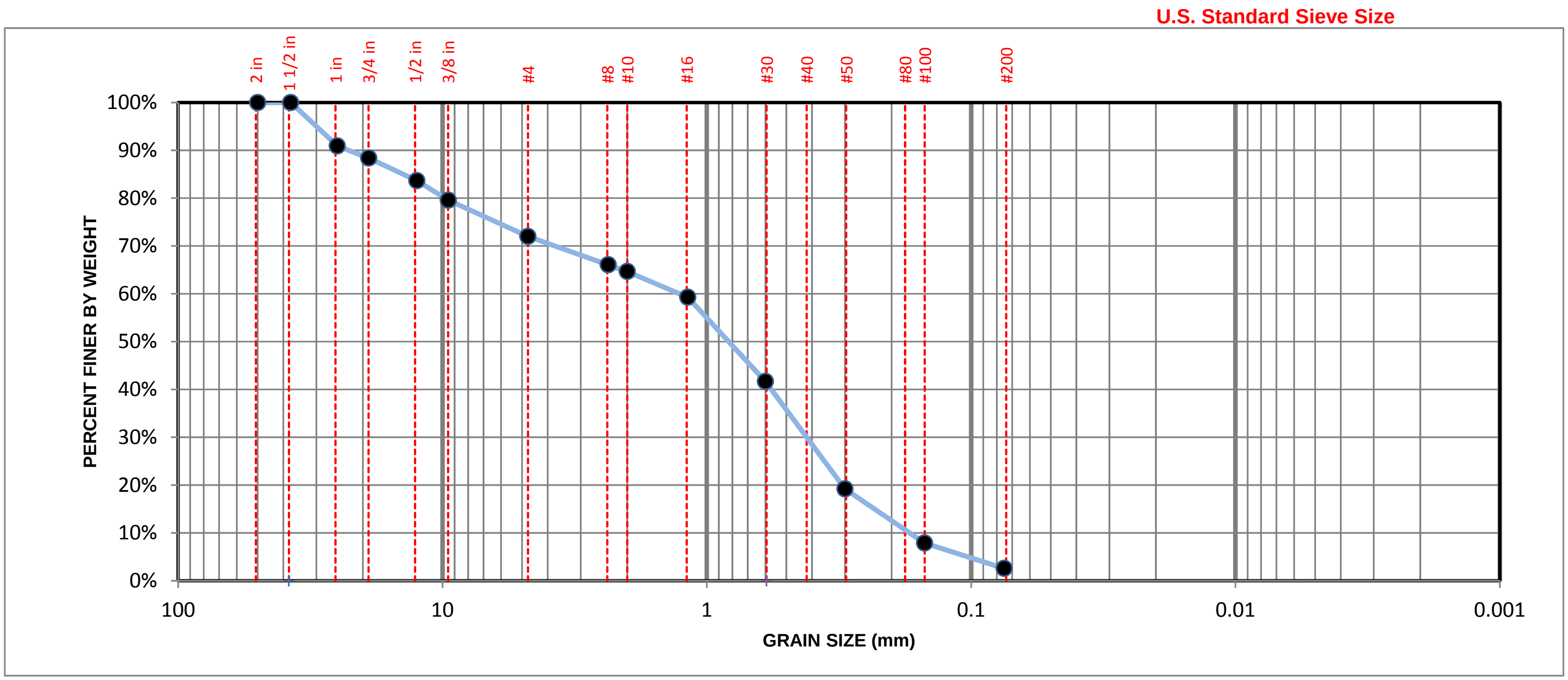
Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2µ
●	C-101	R-4	12.5'-14'	-	-	**SW-SM**	**31%**	**63%**	**7%**	**4%**

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

TETRA TECH BAS GEOSCIENCE

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	C-101, SPT-7
Date Sampled:	November 29, 2017		

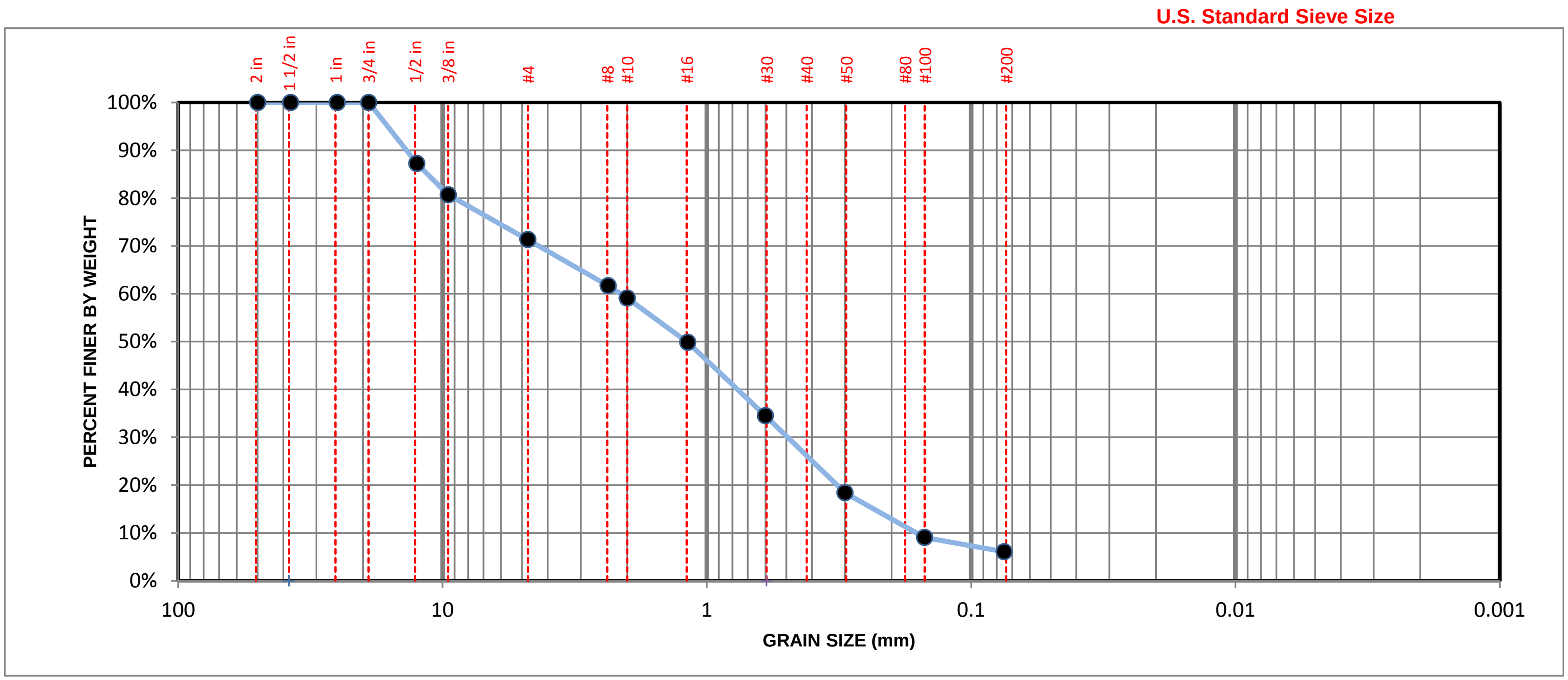


Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2μ
●	C-101	SPT-7	20'-21.5'	-	-	**SP**	**28%**	**69%**	**3%**	

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	C-101, R-8
Date Sampled:	November 29, 2017		



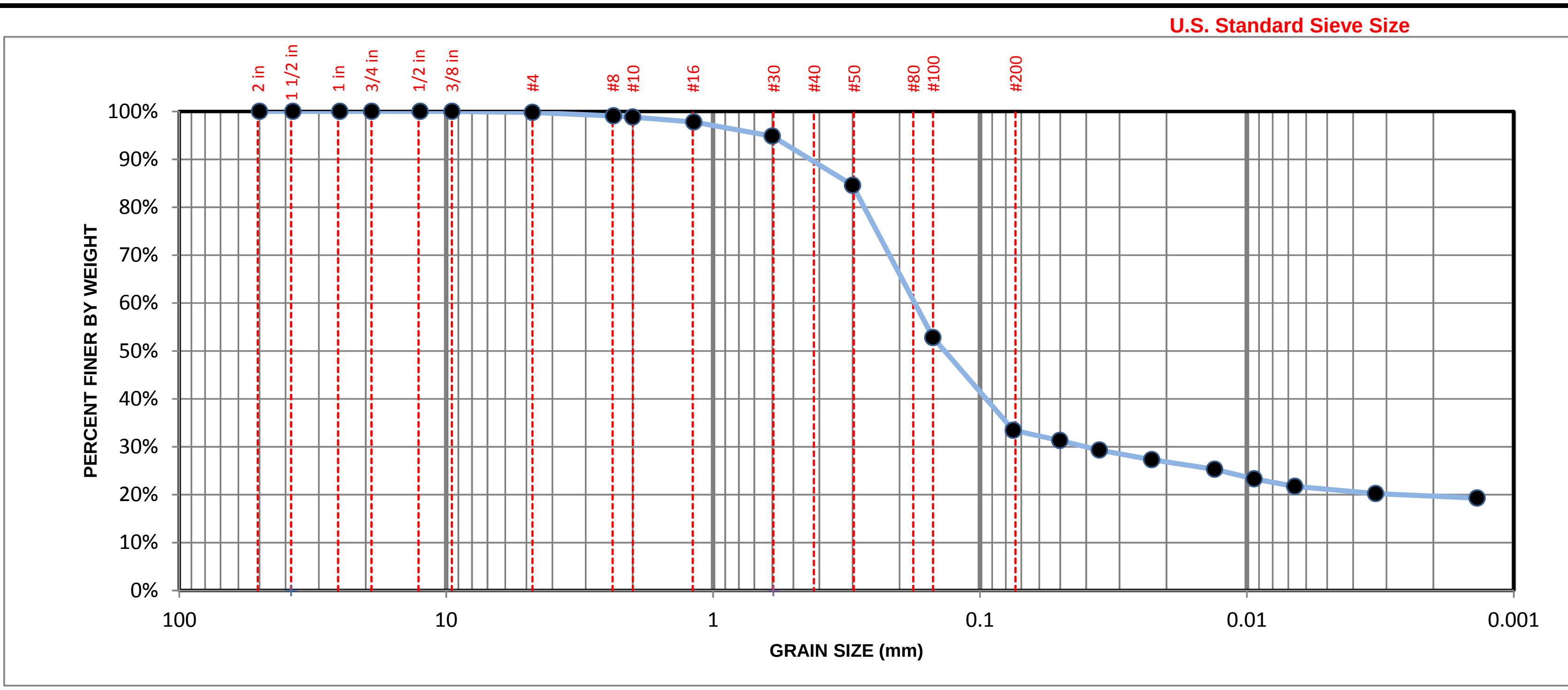
Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2μ
●	C-101	R-8	22.5'-24'	-	-	**SP-SM**	**29%**	**65%**	**6%**	

TETRA TECH BAS GEOSCIENCE

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	C-101, R-10
Date Sampled:	November 29, 2017		



Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2μ
●	C-101	R-10	30'-31.5'	-	-	**SM**	**0%**	**66%**	**33%**	**19%**

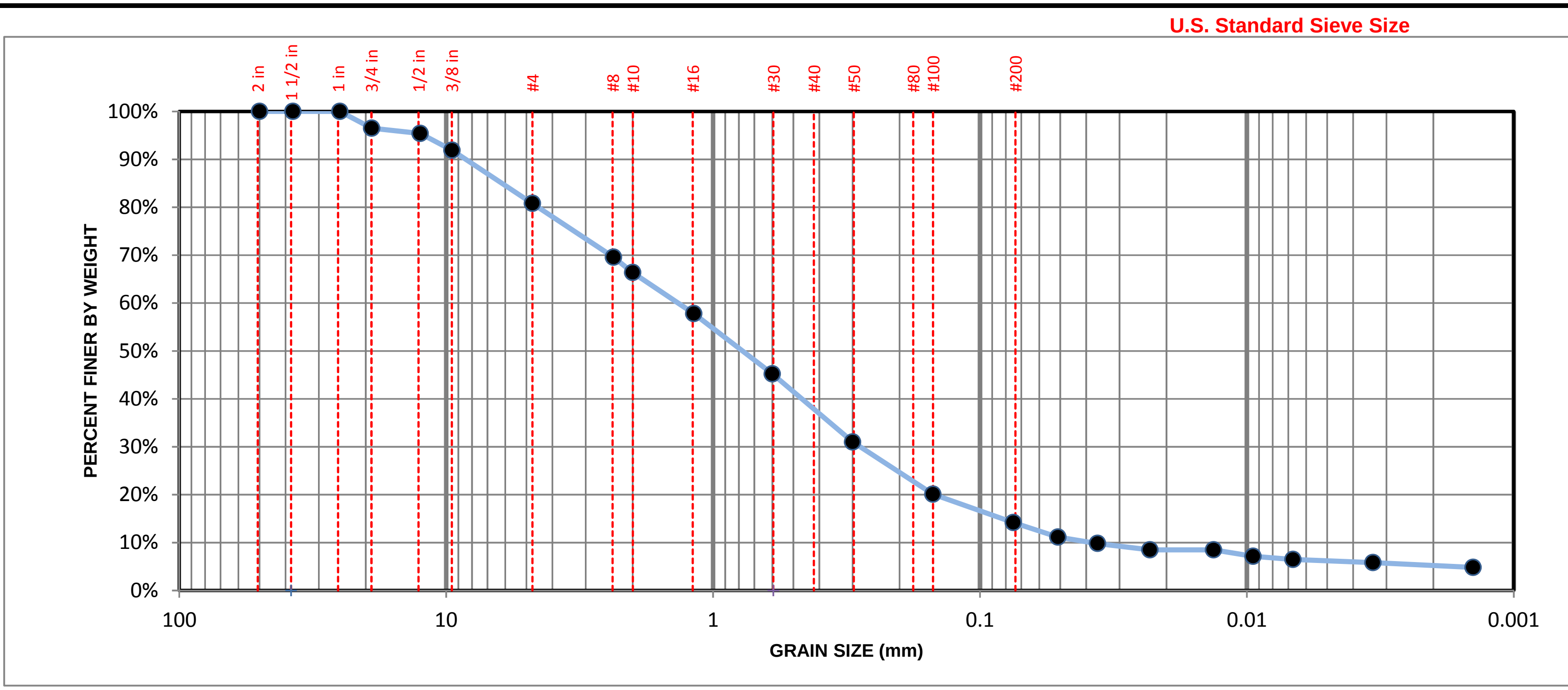
TETRA TECH BAS GEOSCIENCE

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name: Upper San Gabriel EWMP
Job Number: 197-4552-0136
Address:
Date Sampled: November 29, 2017

Tested By : MG
Date Completed: December 24, 2017
Sample Number: C-102, SPT-7



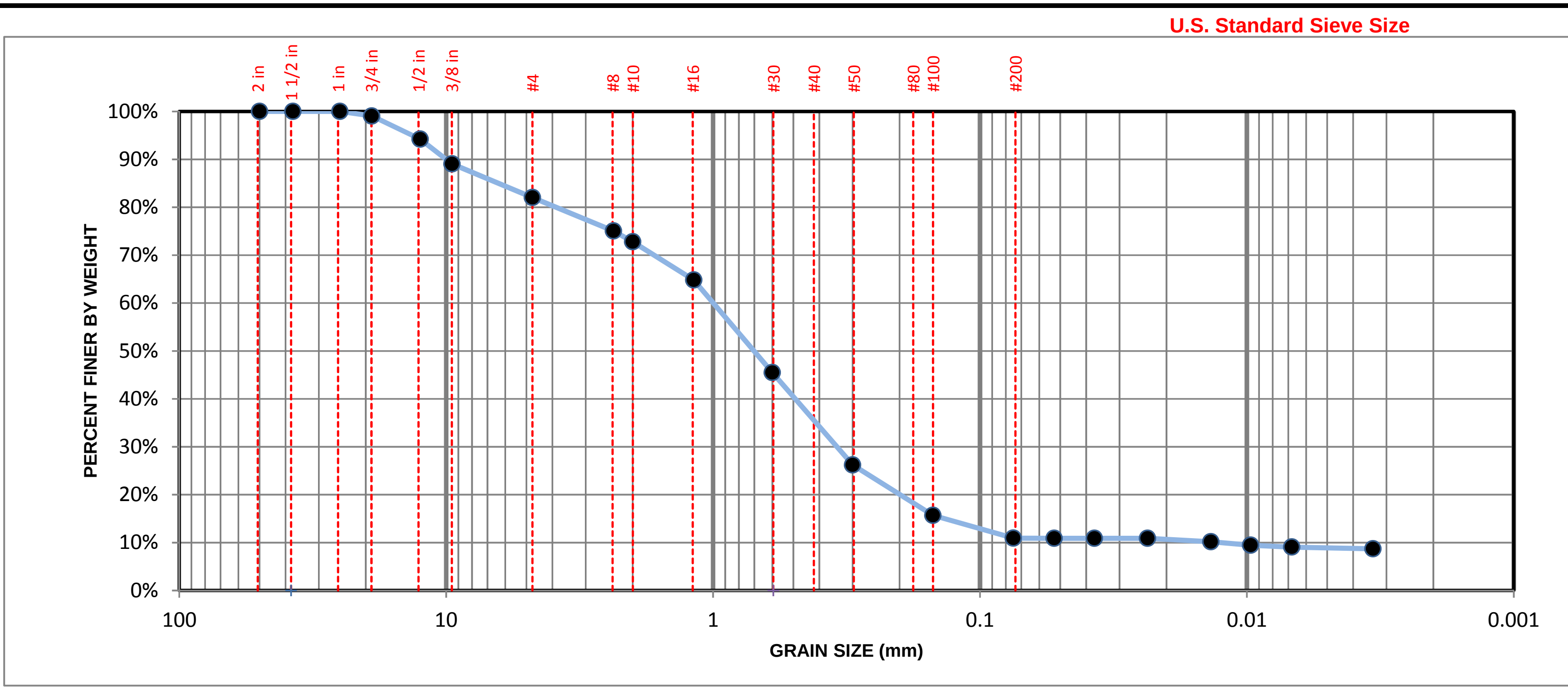
Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2µ
●	C-102	SPT-7	20'-21.5'	-	-	**SM**	**19%**	**67%**	**14%**	**5%**

TETRA TECH BAS GEOSCIENCE

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	C-102, SPT-9
Date Sampled:	November 29, 2017		

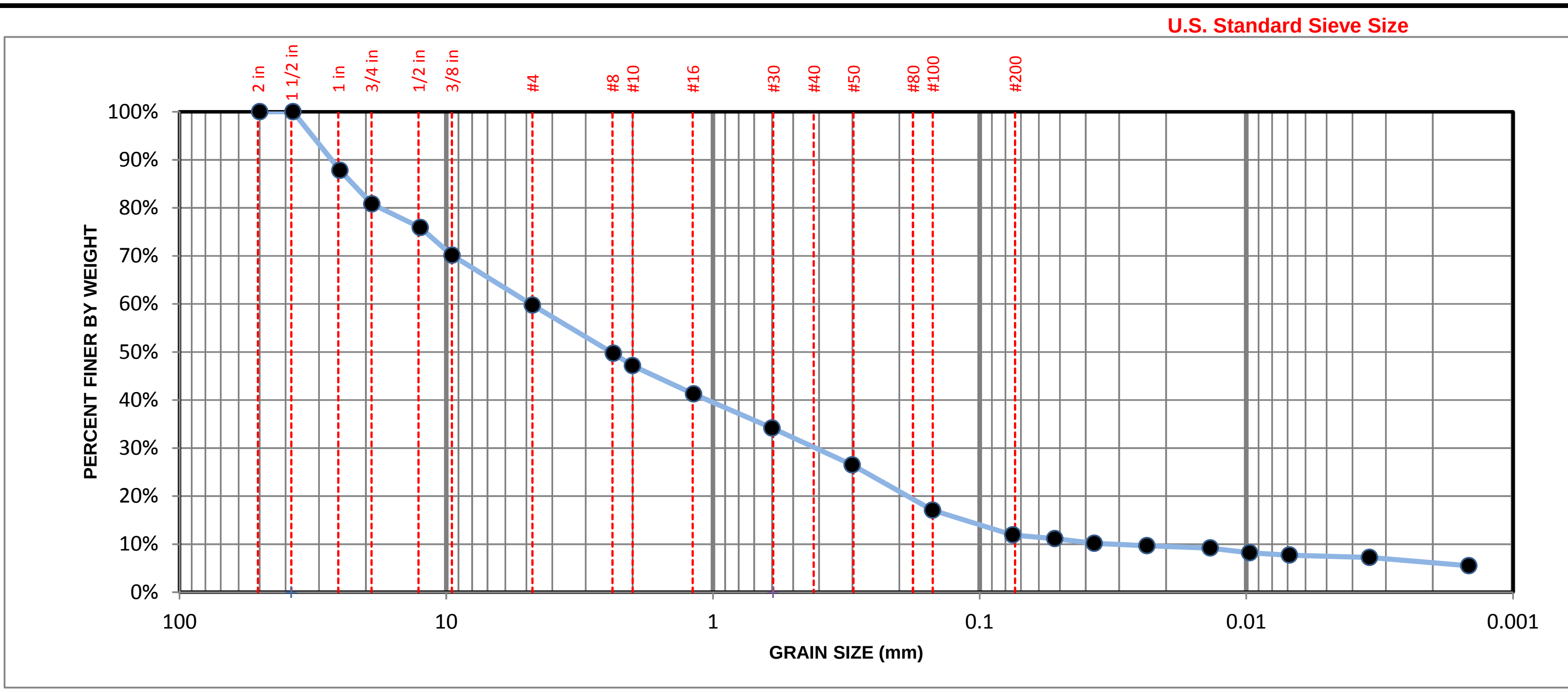


Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2μ
●	C-102	SPT-9	25'-26.5'	-	-	**SP-SM**	**18%**	**71%**	**11%**	**8%**

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	FB-101, SPT-7
Date Sampled:	November 29, 2017		



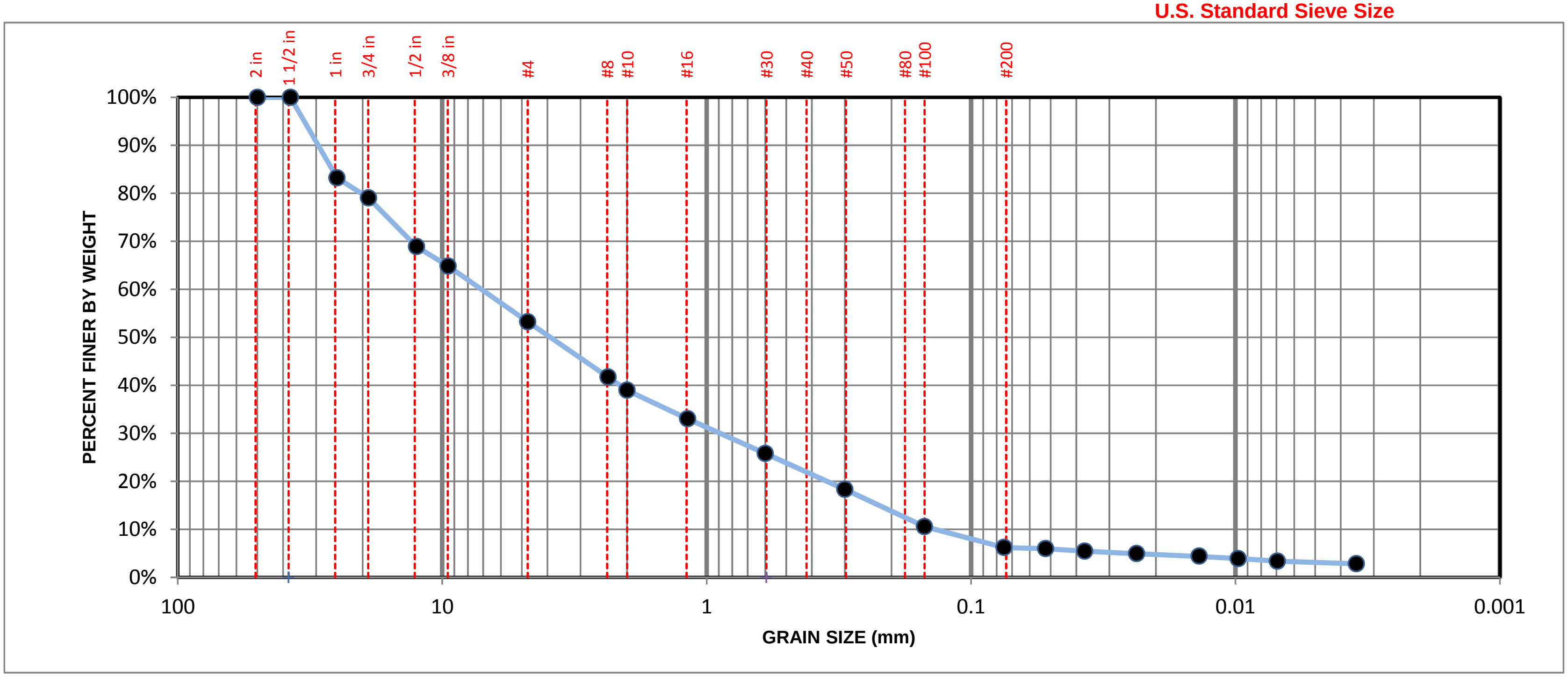
Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2µ
●	FB-101	SPT-7	20'-21.5'	-	-	**SP-SM**	**40%**	**48%**	**12%**	**6%**

1360 Valley Vista Drive * Diamond Bar, CA 91765 * Tel.: (909) 860-7777

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	FB-101, SPT-9
Date Sampled:	November 29, 2017		

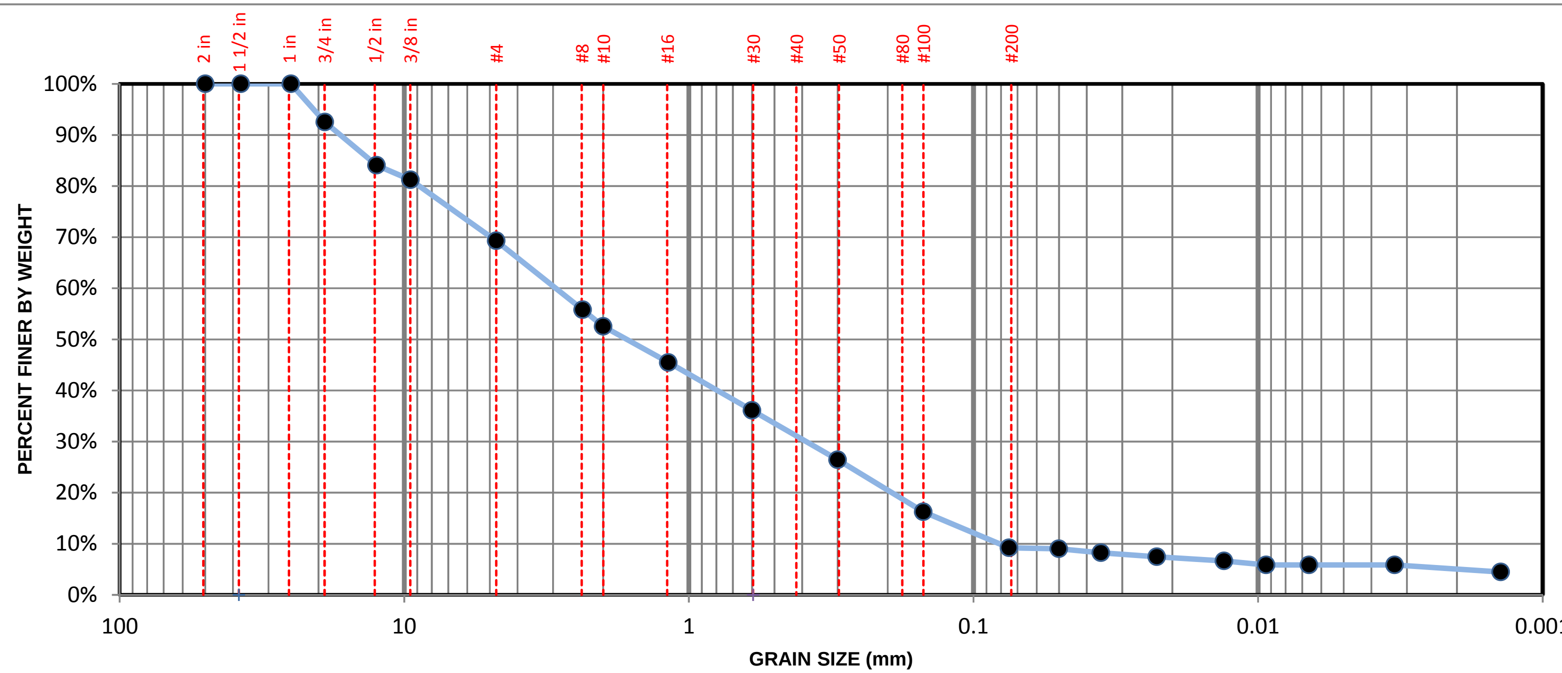


Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2µ
●	FB-101	SPT-9	25'-26.5'	-	-	**SP-SM**	**47%**	**47%**	**6%**	**2%**

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	FB-101, SPT-13
Date Sampled:	November 29, 2017		



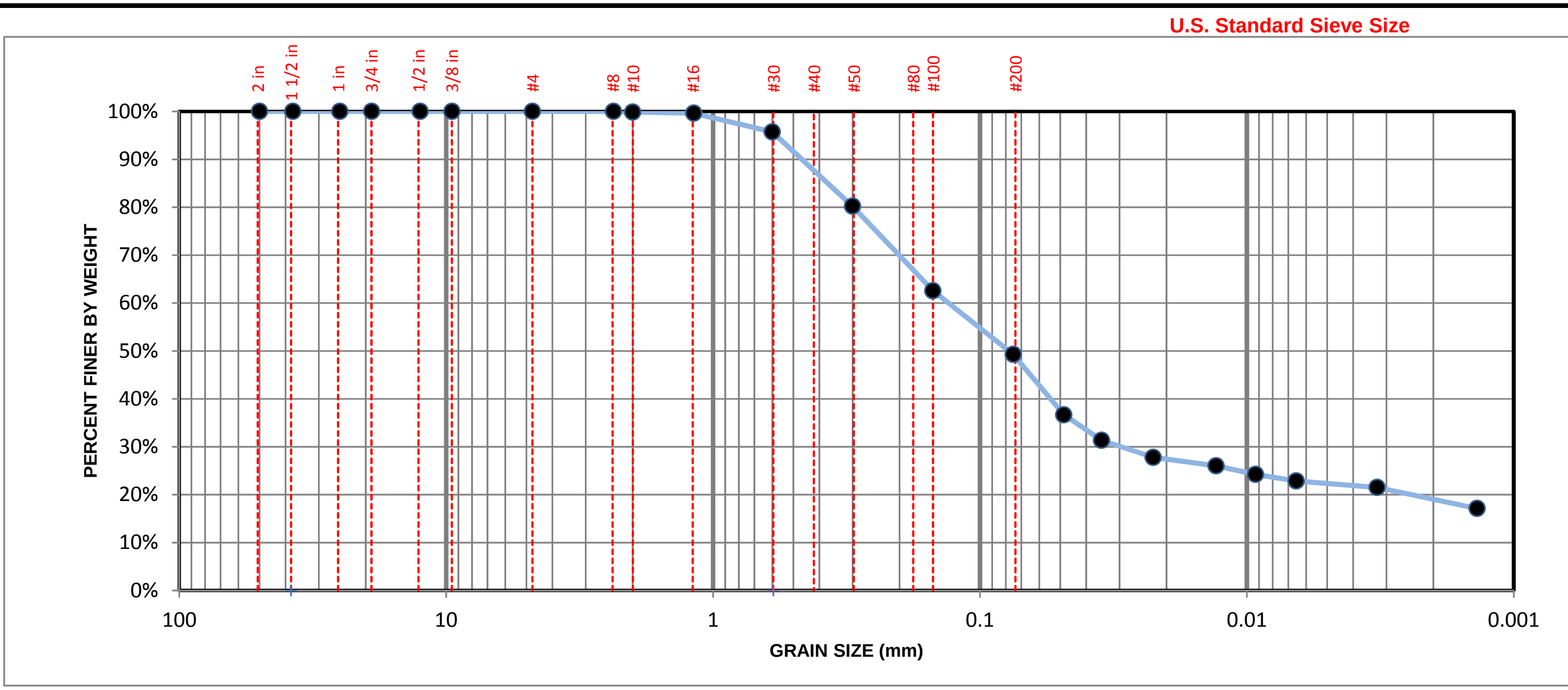
Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2μ
●	FB-101	SPT-13	45'-46.5'	-	-	**SP-SM**	**31%**	**60%**	**9%**	**5%**

1360 Valley Vista Drive * Diamond Bar, CA 91765 * Tel.: (909) 860-7777

GRAIN SIZE DISTRIBUTION ANALYSIS

ASTM C136/C117/D422

Job Name:	Upper San Gabriel EWMP	**Tested By :**	MG
Job Number:	197-4552-0136	**Date Completed:**	December 24, 2017
Address:		**Sample Number:**	LP-101, SPT-03
Date Sampled:	November 29, 2017		



Symbol	Boring No.	Sample #	Deph (feet)	LL	PI	USCS	Gravel	Sand	Fines	2μ
●	LP-101	SPT-3	7.5'-9'	-	-	**SC**	**0%**	**51%**	**49%**	**19%**

1360 Valley Vista Drive * Diamond Bar, CA 91765 * Tel.: (909) 860-7777

HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

DIRECT SHEAR TEST

ASTM D3080

HAI Pr No.: TRT-17-017

Client: TETRA TECH

Project Name: Uper San Gabriel EWMP - City of Industry

Project Number: 197-4552-0136

Boring No.: B-101

Sample No.: R-4

Sample type: Undisturbed Ring

Depth (ft): 12.5-14

Soil description: Gray, Poorly Graded Sand with Gravel (SP)

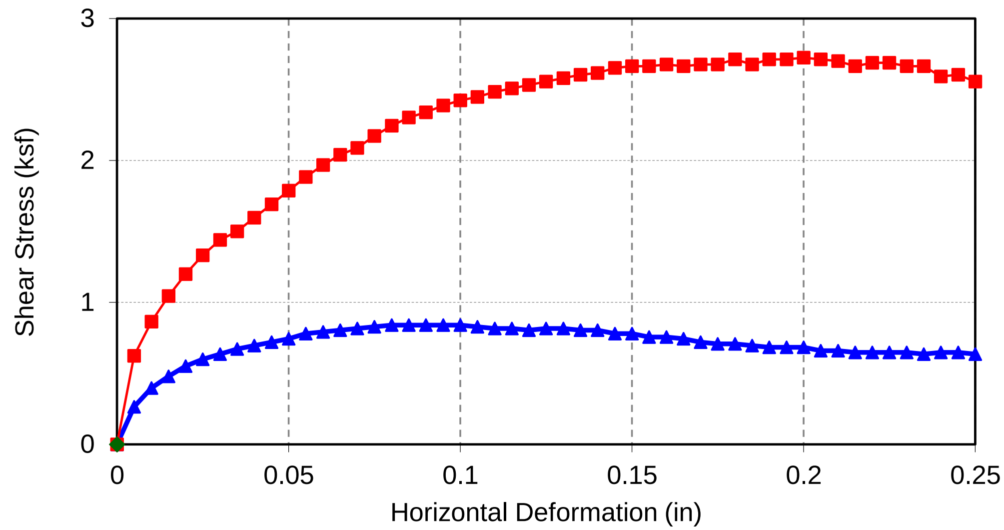
Tested by: KL

Checked by: MJ/MZ

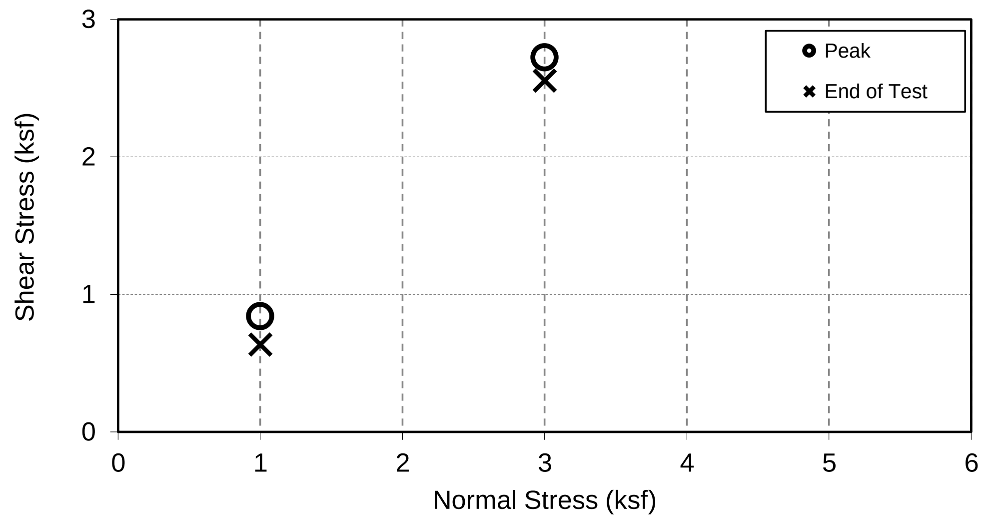
Date: 12/7/2017

Type of test: **Consolidated, Drained**

Test No.	1	2	3
Symbol	▲	■	◆
Normal Stress (ksf)	**1**	**3**	**-**
Deformation Rate (in/min)	**0.002**	**0.002**	**-**



Peak Shear Stress (ksf)	**O**	**0.84**	**2.72**	
Shear Stress @ End of Test (ksf)	**X**	**0.64**	**2.56**	



Initial Height of Sample (in)	1.005	1.003	
Height of Sample before Shear (in)	0.9980	0.9806	-
Diameter of Sample (in)	2.416	2.416	
Initial Moisture Content (%)	**2.6**	**2.6**	
Final Moisture Content (%)	**19.4**	**17.2**	**-**
Dry Density (pcf)	**103.7**	**107.9**	**-**

DIRECT SHEAR TEST

ASTM D3080

HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

HAI Pr No.: TRT-17-017

Tested by: KL

Checked by: KL/MJ

Date: 12/7/2017

Client: TETRA TECH

Project Name: Uper San Gabriel EWMP - City of Industry

Project Number: 197-4552-0136

Boring No.: FB-101

Sample No.: R-2

Sample type: Undisturbed Ring

Depth (ft): 5-6.5

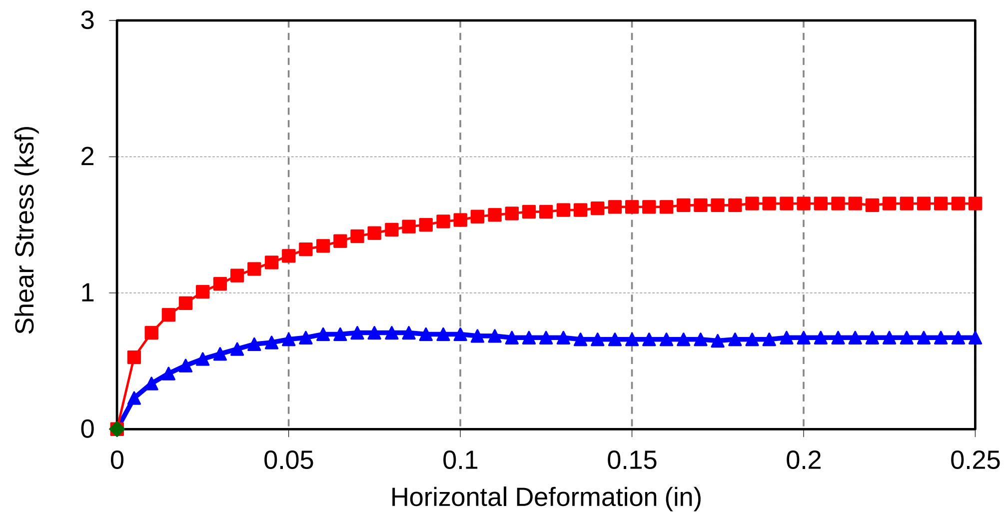
Soil description: Brown, Silty Sand with Gravel (SM)

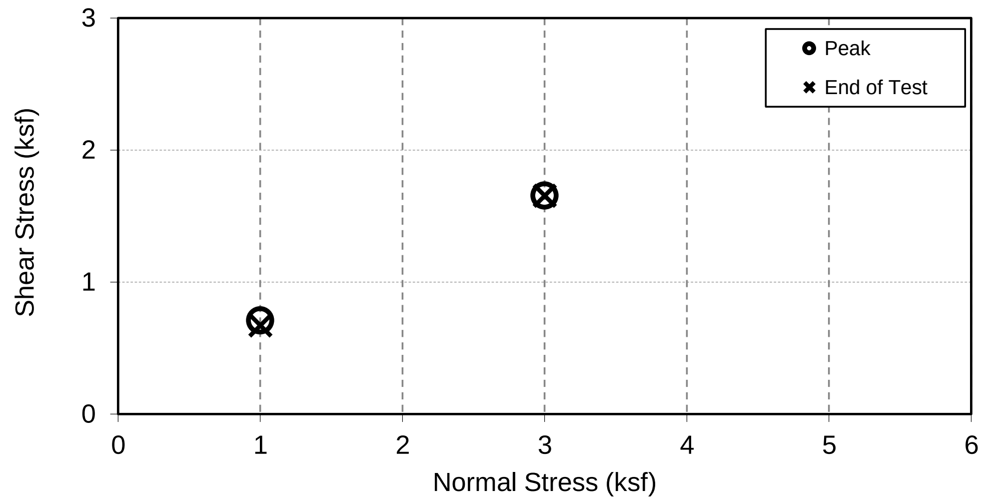
Type of test: **Consolidated, Drained**

Test No.	1	2	3
Symbol	▲	■	◆
Normal Stress (ksf)	**1**	**3**	**-**
Deformation Rate (in/min)	**0.002**	**0.002**	**-**

Peak Shear Stress (ksf)	**O**	**0.71**	**1.66**	
Shear Stress @ End of Test (ksf)	**X**	**0.67**	**1.66**	

Initial Height of Sample (in)	1.024	1.009	
Height of Sample before Shear (in)	1.0160	0.9842	-
Diameter of Sample (in)	2.416	2.416	
Initial Moisture Content (%)	**6.6**	**6.6**	
Final Moisture Content (%)	**18.6**	**17.8**	**-**
Dry Density (pcf)	**108.3**	**109.1**	**-**





SWELL / COLLAPSE TEST
ASTM D4546

Client :	TETRA TECH	***HAI Project No.:***	TRT-17-017
Project Name:	Uper San Gabriel EWMP - City of Industry	***Tested by:***	KL
Project No.:	197-4552-0136	***Checked by:***	KL/MJ
Boring No.:	B-101	***Date:***	12/07/17
Sample No.:	R-6		
Type of Sample:	Undisturbed Ring		
Depth (ft):	17.5-19		
Soil Description:	Light Brown, Poorly Graded Sand (SP)		

Initial Total Weight (g)	Final Total Weight (g)	Final Dry Weight (g)
143.30	146.99	121.24

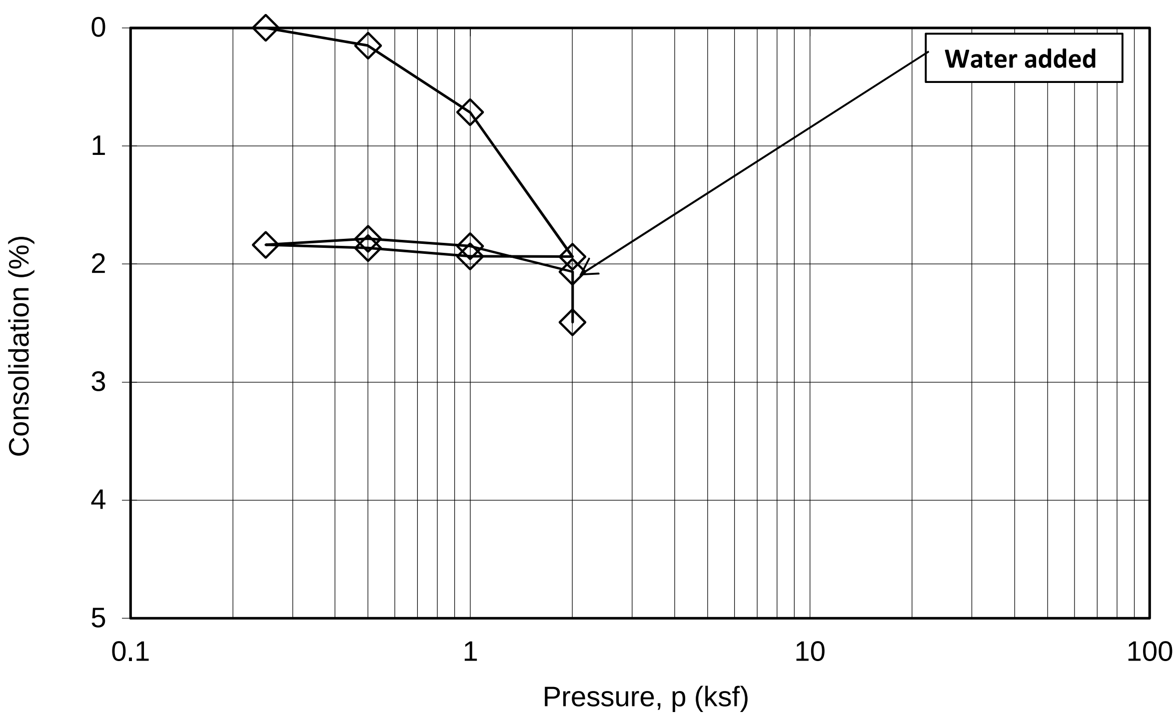
			Initial Conditions	Final Conditions
Height	H	(in)	1.015	0.990
Height of Solids	Hs	(in)	0.602	0.602
Height of Water	Hw	(in)	0.294	0.343
Height of Air	Ha	(in)	0.119	0.045
Dry Density		**(pcf)**	**99.2**	**102.8**
Water Content		**(%)**	**18.2**	**21.2**
Saturation		**(%)**	**71.1**	**88.5**

* Saturation is calcualted based on Gs=2.68

Load (ksf)	δH (in)	H (in)	Voids (in)	e	Consol. (%)	a_v (ksf^{-1})	M_v (ksf^{-1})	Comment
0.01	-------	1.0150	0.413	0.686	0			
0.25	0.0000	1.0150	0.413	0.686	0.0	0.0E+00	0.0E+00	
0.5	0.0015	1.0135	0.411	0.683	0.2	1.0E-02	6.1E-03	
1	0.0073	1.0077	0.406	0.673	0.7	1.9E-02	1.1E-02	
2	0.0197	0.9953	0.393	0.653	1.9	2.1E-02	1.2E-02	
1	0.0197	0.9953	0.393	0.653	1.9		Unloaded	
0.5	0.0189	0.9961	0.394	0.654	1.9			
0.25	0.0187	0.9964	0.394	0.655	1.8			
0.5	0.0181	0.9969	0.395	0.655	1.8	-3.4E-03	-2.1E-03	
1	0.0188	0.9962	0.394	0.654	1.8	2.1E-03	1.3E-03	
2	0.0210	0.9940	0.392	0.651	2.1	3.7E-03	2.2E-03	
2	0.0253	0.9897	0.388	0.644	2.5		Water Added	

SWELL / COLLAPSE TEST
ASTM D4546

Client:	TETRA TECH	***HAI Project No.:***	TRT-17-017
Project Name:	Uper San Gabriel EWMP - City of Industry	***Tested by:***	KL
Project No.:	197-4552-0136	***Checked by:***	KL/MJ
Boring No.:	B-101	***Date:***	12/07/17
Sample No.:	R-6		
Type of Sample:	Undisturbed Ring		
Depth (ft):	17.5-19		
Soil Description:	Light Brown, Poorly Graded Sand (SP)		

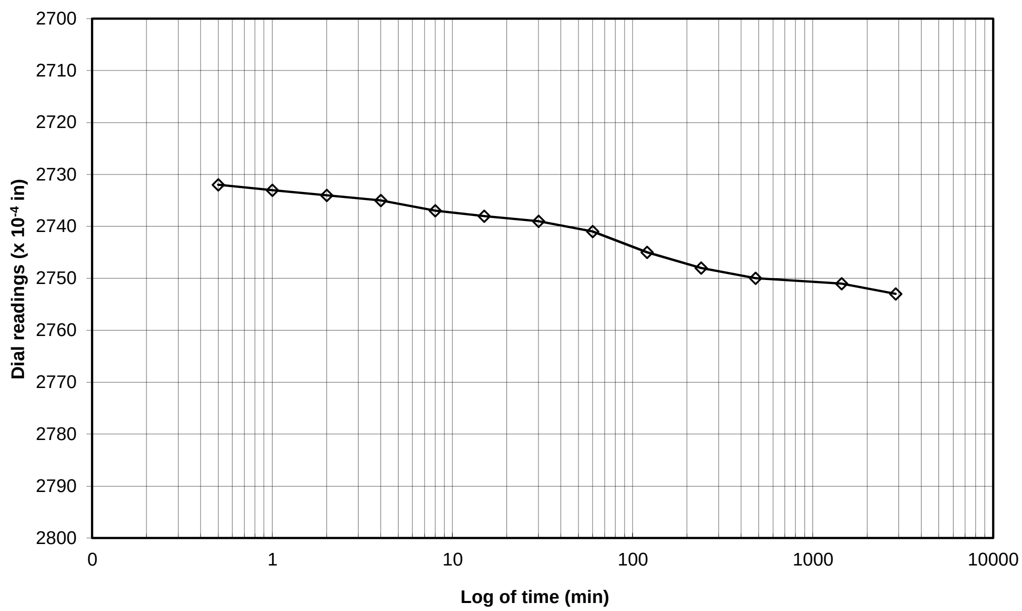


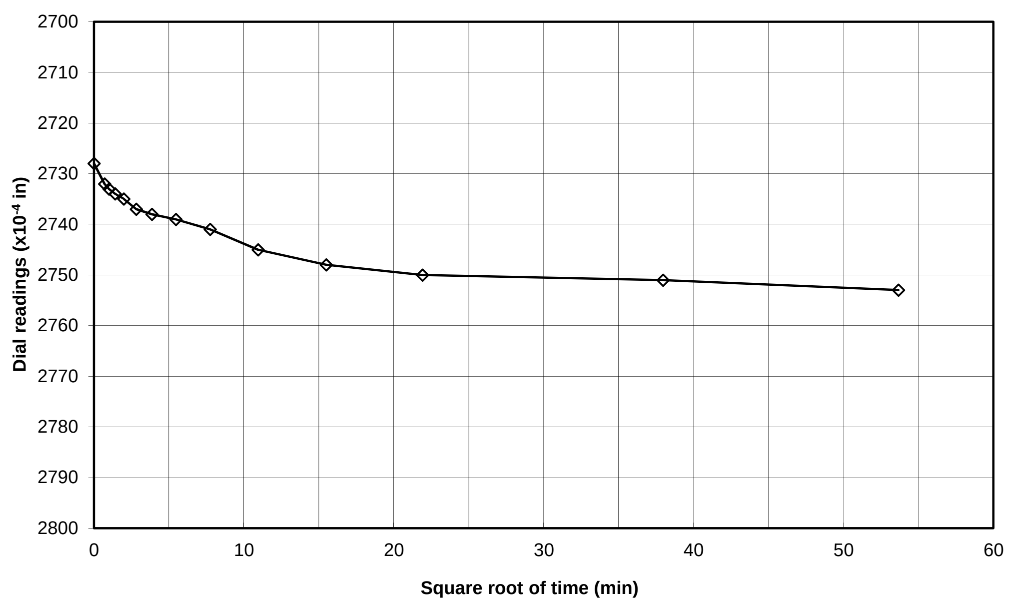
HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

SWELL / COLLAPSE TEST
ASTM D4546

Client:	TETRA TECH
Project Name:	Uper San Gabriel EWMP - City of Industry
Project No.:	197-4552-0136
Boring No.:	B-101
Sample No.:	R-6
Soil Description:	Light Brown, Poorly Graded Sand (SP)
Type of Sample:	Undisturbed Ring

Load: <u>2 (ksf)</u>





SWELL / COLLAPSE TEST
ASTM D4546

Client :	TETRA TECH	***HAI Project No.:***	TRT-17-017
Project Name:	Uper San Gabriel EWMP - City of Industry	***Tested by:***	KL
Project No.:	197-4552-0136	***Checked by:***	KL/MJ
Boring No.:	C-101	***Date:***	12/07/17
Sample No.:	R-6		
Type of Sample:	Undisturbed Ring		
Depth (ft):	17.5-19		
Soil Description:	Brown, Clayey Sand (SC)		

Initial Total Weight (g)	Final Total Weight (g)	Final Dry Weight (g)
156.98	156.34	129.38

			Initial Conditions	Final Conditions
Height	H	(in)	1.020	0.991
Height of Solids	Hs	(in)	0.643	0.643
Height of Water	Hw	(in)	0.367	0.359
Height of Air	Ha	(in)	0.010	0.000
Dry Density		**(pcf)**	**105.4**	**109.3**
Water Content		**(%)**	**21.3**	**20.8**
Saturation		**(%)**	**97.3**	**100.0**

* Saturation is calcualted based on Gs=2.68

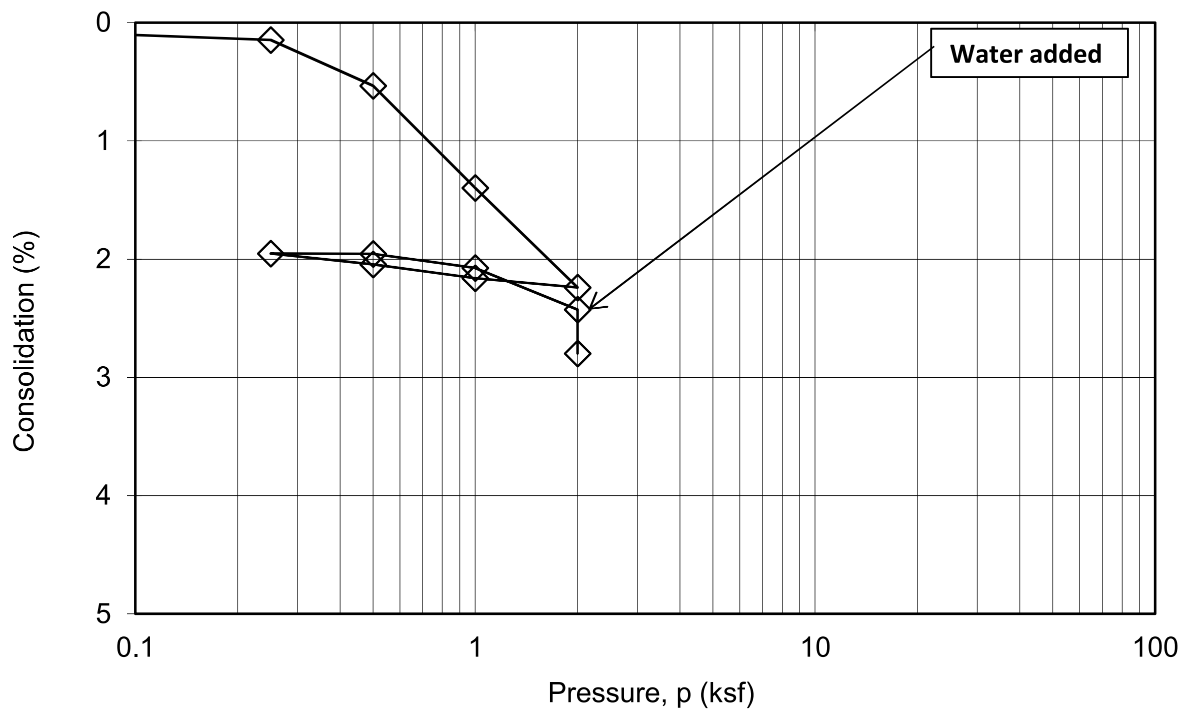
Load (ksf)	δH (in)	H (in)	Voids (in)	e	Consol. (%)	a_v (ksf^{-1})	M_v (ksf^{-1})	Comment
0.01	-------	1.0200	0.377	0.587	0			
0.25	0.0015	1.0185	0.376	0.585	0.1	9.7E-03	6.1E-03	
0.5	0.0055	1.0146	0.372	0.579	0.5	2.5E-02	1.6E-02	
1	0.0143	1.0058	0.363	0.565	1.4	2.7E-02	1.7E-02	
2	0.0228	0.9972	0.355	0.552	2.2	1.3E-02	8.6E-03	
1	0.0221	0.9980	0.355	0.553	2.2	Unloaded		
0.5	0.0209	0.9992	0.357	0.555	2.0			
0.25	0.0199	1.0001	0.357	0.556	2.0			
0.5	0.0200	1.0001	0.357	0.556	2.0	3.1E-04	2.0E-04	
1	0.0212	0.9989	0.356	0.554	2.1	3.7E-03	2.4E-03	
2	0.0247	0.9953	0.353	0.549	2.4	5.6E-03	3.6E-03	
2	0.0285	0.9915	0.349	0.543	2.8	Water Added		

SWELL / COLLAPSE TEST

ASTM D4546

HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

Client:	TETRA TECH	***HAI Project No.:***	TRT-17-017
Project Name:	Uper San Gabriel EWMP - City of Industry	***Tested by:***	KL
Project No.:	197-4552-0136	***Checked by:***	KL/MJ
Boring No.:	C-101	***Date:***	12/07/17
Sample No.:	R-6		
Type of Sample:	Undisturbed Ring		
Depth (ft):	17.5-19		
Soil Description:	Brown, Clayey Sand (SC)		

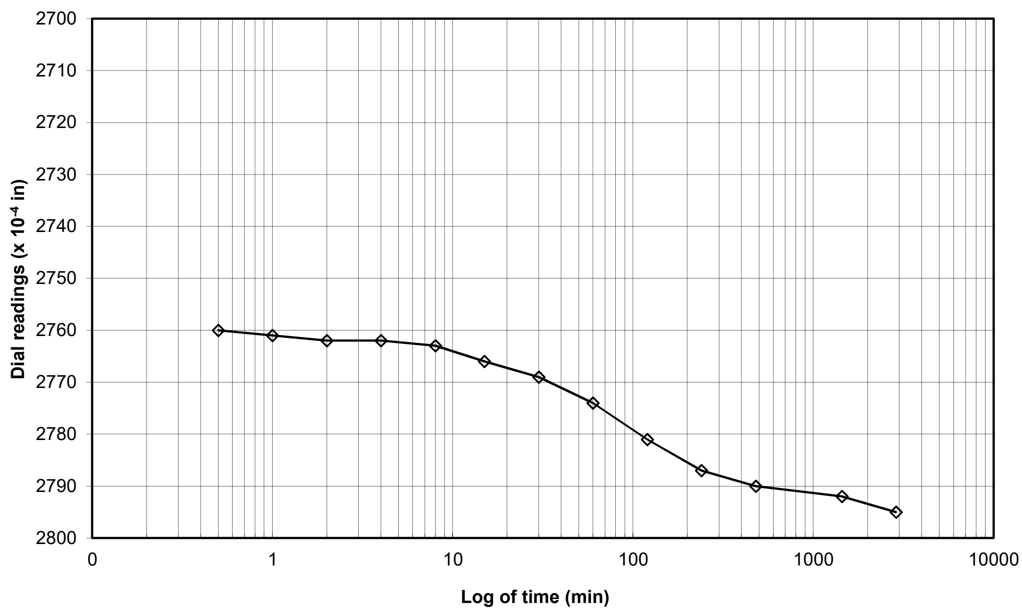


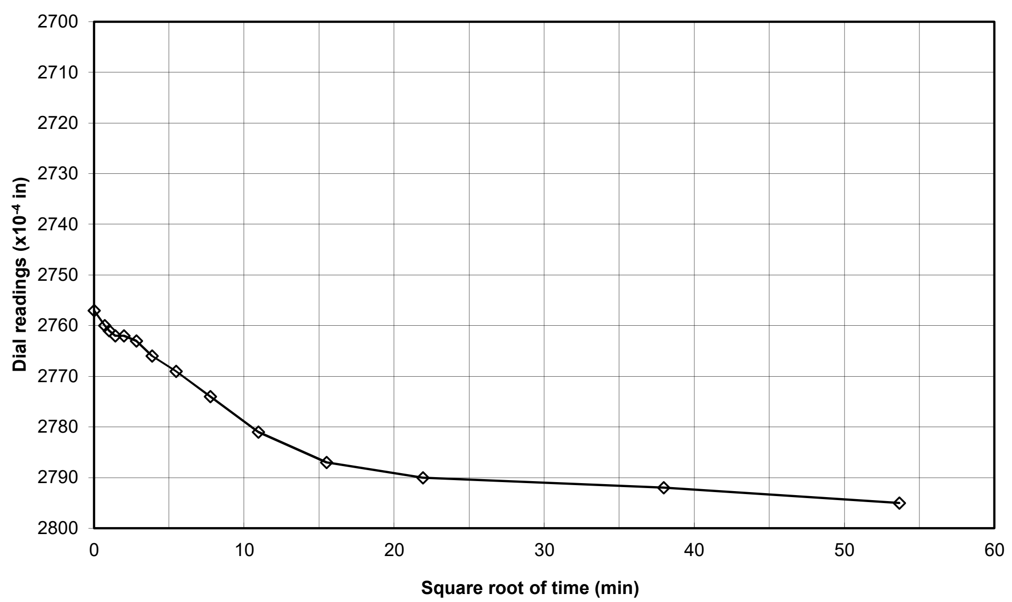
SWELL / COLLAPSE TEST
ASTM D4546

HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

Client: TETRA TECH
Project Name: Uper San Gabriel EWMP - City of Industry
Project No.: 197-4552-0136
Boring No.: C-101
Sample No.: R-6
Soil Description: Brown, Clayey Sand (SC)
Type of Sample: Undisturbed Ring

Load: **<u>2 (ksf)</u>**





SWELL / COLLAPSE TEST
ASTM D4546

HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

Client :	TETRA TECH	***HAI Project No.:***	TRT-17-017
Project Name:	Uper San Gabriel EWMP - City of Industry	***Tested by:***	KL
Project No.:	197-4552-0136	***Checked by:***	KL/MJ
Boring No.:	FB-101	***Date:***	12/07/17
Sample No.:	R-4		
Type of Sample:	Undisturbed Ring		
Depth (ft):	12.5-14		
Soil Description:	Brown, Silty Sand with Gravel (SM)		

Initial Total Weight (g)	Final Total Weight (g)	Final Dry Weight (g)
159.27	165.08	145.40

			Initial Conditions	Final Conditions
Height	H	(in)	1.028	1.008
Height of Solids	Hs	(in)	0.728	0.728
Height of Water	Hw	(in)	0.185	0.262
Height of Air	Ha	(in)	0.116	0.018
Dry Density		**(pcf)**	**117.5**	**119.0**
Water Content		**(%)**	**9.5**	**13.5**
Saturation		**(%)**	**61.5**	**93.6**

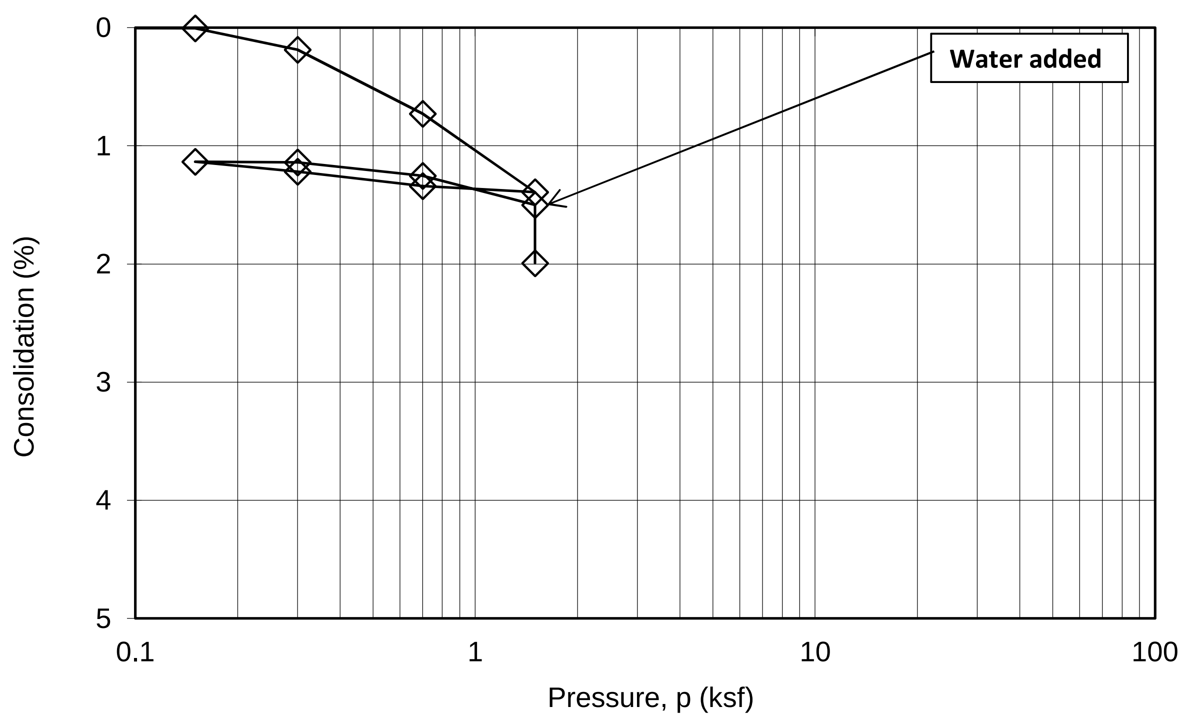
* Saturation is calcualted based on Gs=2.68

Load (ksf)	**δH (in)**	**H (in)**	**Voids (in)**	**e**	**Consol. (%)**	**a_v (ksf^{-1})**	**M_v (ksf^{-1})**	**Comment**
0.01	-------	1.0280	0.300	0.413	0			
0.15	0.0000	1.0280	0.300	0.413	0.0	4.9E-04	3.5E-04	
0.3	0.0019	1.0261	0.298	0.410	0.2	1.7E-02	1.2E-02	
0.7	0.0075	1.0205	0.293	0.403	0.7	1.9E-02	1.4E-02	
1.5	0.0143	1.0137	0.286	0.393	1.4	1.2E-02	8.4E-03	
0.7	0.0138	1.0142	0.287	0.394	1.3			
0.3	0.0125	1.0155	0.288	0.396	1.2		Unloaded	
0.15	0.0117	1.0164	0.289	0.397	1.1			
0.3	0.0117	1.0163	0.289	0.397	1.1	6.9E-04	4.9E-04	
0.7	0.0129	1.0151	0.288	0.395	1.3	4.0E-03	2.8E-03	
1.5	0.0154	1.0126	0.285	0.392	1.5	4.4E-03	3.1E-03	
1.5	0.0205	1.0075	0.280	0.385	2.0		Water Added	

SWELL / COLLAPSE TEST

ASTM D4546

Client:	TETRA TECH	***HAI Project No.:***	TRT-17-017
Project Name:	Uper San Gabriel EWMP - City of Industry	***Tested by:***	KL
Project No.:	197-4552-0136	***Checked by:***	KL/MJ
Boring No.:	FB-101	***Date:***	12/07/17
Sample No.:	R-4		
Type of Sample:	Undisturbed Ring		
Depth (ft):	12.5-14		
Soil Description:	Brown, Silty Sand with Gravel (SM)		

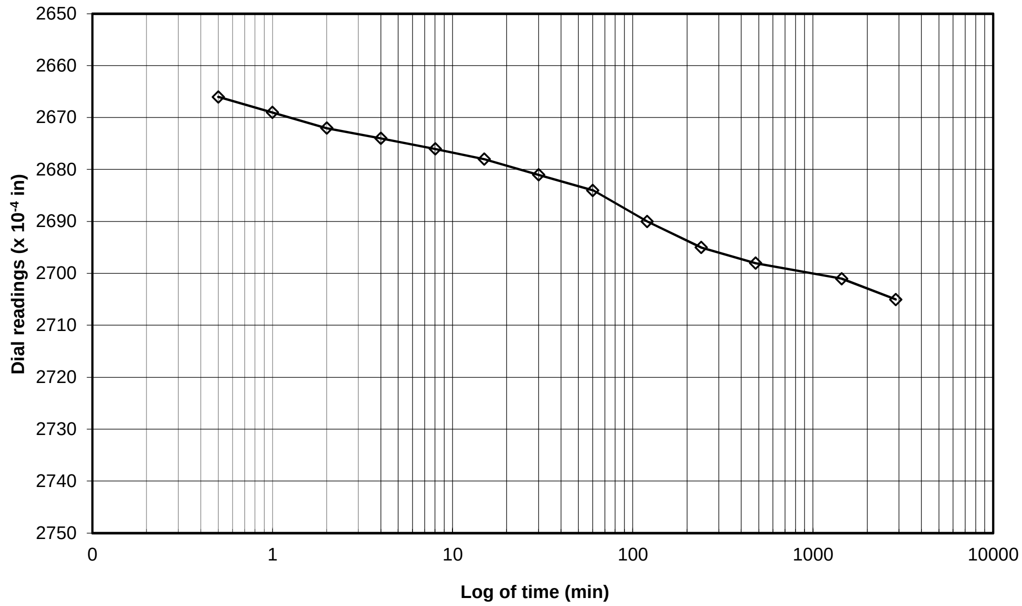


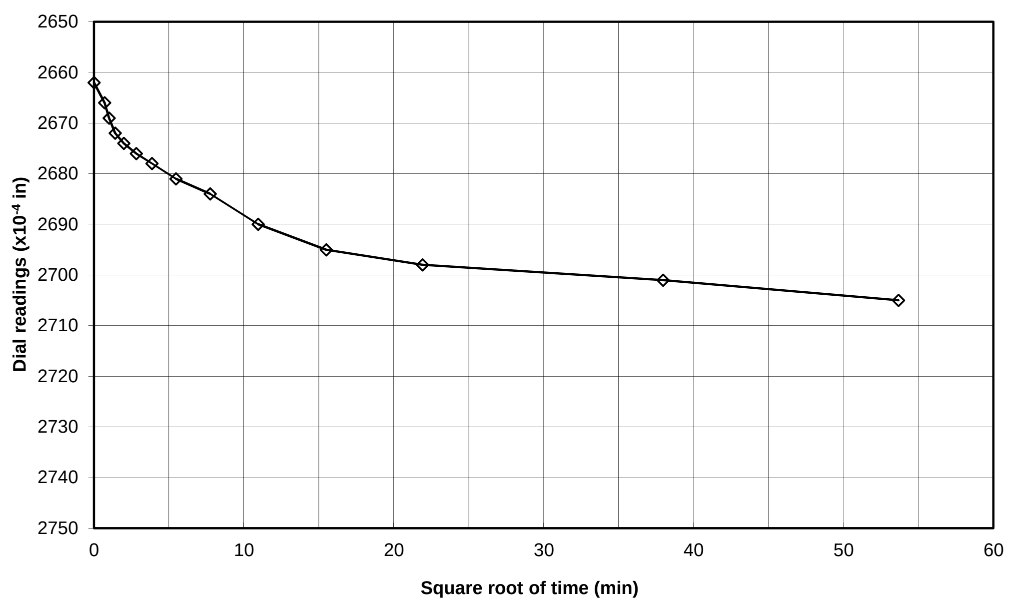
SWELL / COLLAPSE TEST
ASTM D4546

HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

Client: TETRA TECH
Project Name: Uper San Gabriel EWMP - City of Industry
Project No.: 197-4552-0136
Boring No.: FB-101
Sample No.: R-4
Soil Description: Brown, Silty Sand with Gravel (SM)
Type of Sample: Undisturbed Ring

Load: 1.5 (ksf)





SWELL / COLLAPSE TEST
ASTM D4546

Client :	TETRA TECH	***HAI Project No.:***	TRT-17-017
Project Name:	Uper San Gabriel EWMP - City of Industry	***Tested by:***	KL
Project No.:	197-4552-0136	***Checked by:***	KL/MJ
Boring No.:	LP-101	***Date:***	12/07/17
Sample No.:	R-04		
Type of Sample:	Undisturbed Ring		
Depth (ft):	10-11.5		
Soil Description:	Brown, Clayey Sand (SC)		

Initial Total Weight (g)	Final Total Weight (g)	Final Dry Weight (g)
161.28	163.16	137.71

			Initial Conditions	Final Conditions
Height	H	(in)	1.016	1.006
Height of Solids	Hs	(in)	0.684	0.684
Height of Water	Hw	(in)	0.314	0.339
Height of Air	Ha	(in)	0.018	0.000
Dry Density		**(pcf)**	**112.6**	**112.9**
Water Content		**(%)**	**17.1**	**18.5**
Saturation		**(%)**	**94.5**	**100.0**

* Saturation is calcualted based on Gs=2.68

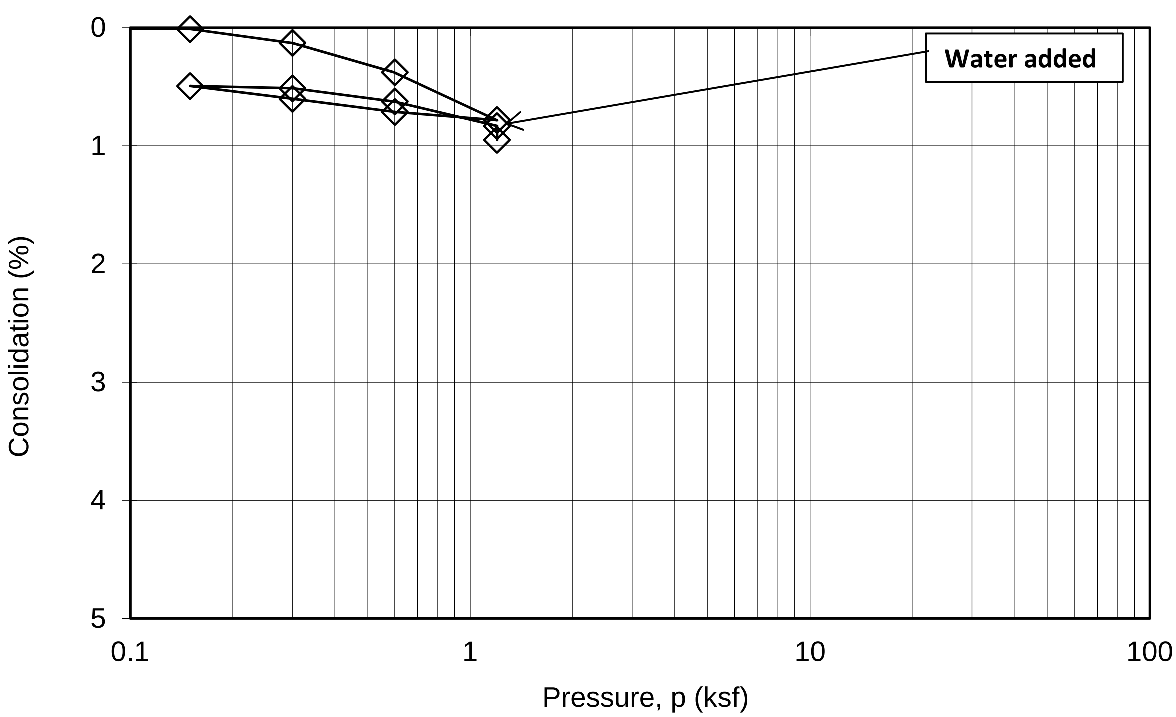
Load (ksf)	δH (in)	H (in)	Voids (in)	e	Consol. (%)	a_v (ksf^{-1})	M_v (ksf^{-1})	Comment
0.01	-------	1.0160	0.332	0.485	0			
0.15	0.0001	1.0159	0.332	0.485	0.0	1.4E-03	9.7E-04	
0.3	0.0013	1.0147	0.331	0.483	0.1	1.2E-02	7.8E-03	
0.6	0.0039	1.0121	0.328	0.480	0.4	1.2E-02	8.4E-03	
1.2	0.0080	1.0080	0.324	0.474	0.8	1.0E-02	6.8E-03	
0.6	0.0073	1.0087	0.325	0.475	0.7			
0.3	0.0061	1.0099	0.326	0.476	0.6		Unloaded	
0.15	0.0050	1.0110	0.327	0.478	0.5			
0.3	0.0052	1.0108	0.327	0.478	0.5	1.8E-03	1.2E-03	
0.6	0.0064	1.0096	0.326	0.476	0.6	5.5E-03	3.8E-03	
1.2	0.0085	1.0075	0.324	0.473	0.8	5.1E-03	3.5E-03	
1.2	0.0097	1.0063	0.322	0.471	1.0		Water Added	

HUSHMAND ASSOCIATES, INC.
Geotechnical and Earthquake Engineers

SWELL / COLLAPSE TEST

ASTM D4546

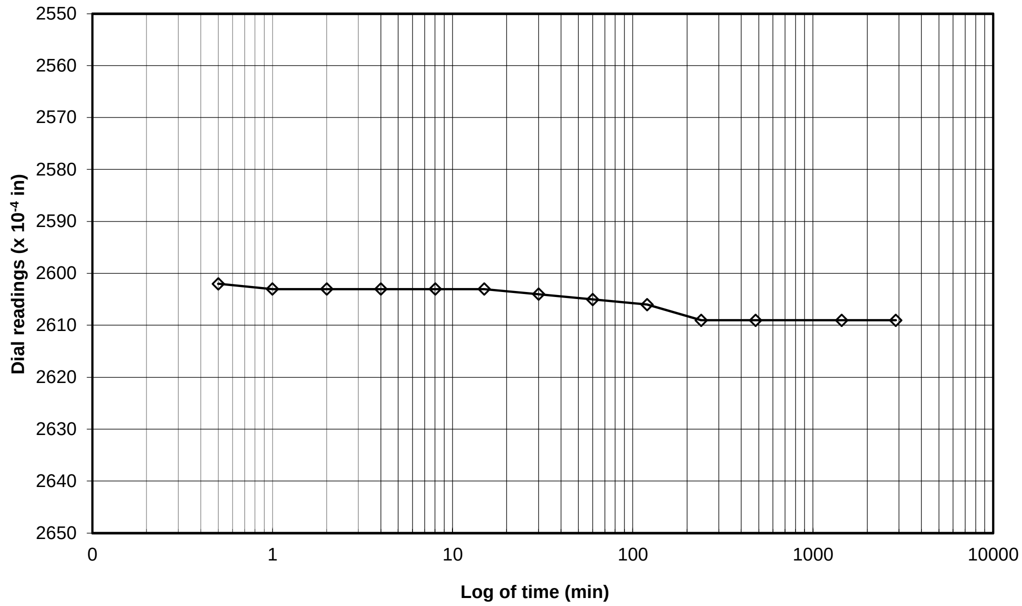
Client:	TETRA TECH	***HAI Project No.:***	TRT-17-017
Project Name:	Uper San Gabriel EWMP - City of Industry	***Tested by:***	KL
Project No.:	197-4552-0136	***Checked by:***	KL/MJ
Boring No.:	LP-101	***Date:***	12/07/17
Sample No.:	R-04		
Type of Sample:	Undisturbed Ring		
Depth (ft):	10-11.5		
Soil Description:	Brown, Clayey Sand (SC)		

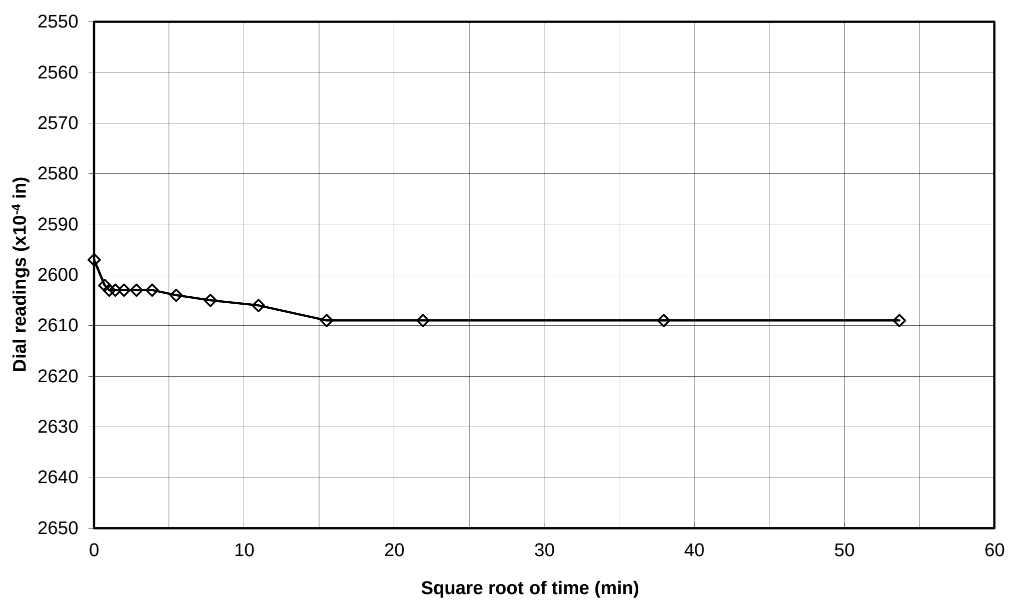


SWELL / COLLAPSE TEST
ASTM D4546

Client: TETRA TECH
Project Name: Uper San Gabriel EWMP - City of Industry
Project No.: 197-4552-0136
Boring No.: LP-101
Sample No.: R-04
Soil Description: Brown, Clayey Sand (SC)
Type of Sample: Undisturbed Ring

Load: 1.2 (ksf)





Soil Analysis Lab Results

Client: HAI
Job Name: Upper San Gabriel EWMP - City of Industry
Client Job Number: TRT-17-017 (197-4552-0136)
Project X Job Number: S171211A
December 14, 2017

	Method	ASTM G187		ASTM D516		ASTM D512B		SM 4500-E	SM 4500-C	SM 4500-D	ASTM G200	ASTM G51
Bore# / Description	**Depth**	**Resistivity** As Rec'd	Minimum	**Sulfates**		**Chlorides**		**Nitrate**	**Ammonia**	**Sulfide**	**Redox**	**pH**
	(ft)	(Ohm-cm)	(Ohm-cm)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(mg/kg)	(mg/kg)	(mg/kg)	(mV)	
FB-101, SPT-1	2.5-4.0	32,160	5,092	18	0.0018	54	0.0054	ND	12.0	0.72	222	7.66
C-101, SPT-1	2.5-4.0	1,407	1,407	150	0.0150	503	0.0503	150	69.0	7.65	207	8.14
B-101, SPT-1	2.5-4.0	274,700	23,450	21	0.0021	12	0.0012	ND	2.8	0.15	223	7.74
LP-101, SPT-01	2.5-4.0	1,876	1,340	90	0.0090	36	0.0036	21	ND	ND	220	7.91

Unk = Unknown
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
mg/L = milligrams per liter of liquid volume
Chemical Analysis performed on 1:3 Soil-To-Water extract

Please call if you have any questions.

Prepared by,

Ernesto Padilla, BSME
Field Engineer

Respectfully Submitted,

Eddie Hernandez, M.Sc., P.E.
Sr. Corrosion Consultant
NACE Corrosion Technologist #16592
Professional Engineer
California No. M37102
ehernandez@projectxcorrosion.com

Appendix D

Field Infiltration Testing Results

TETRA TECH BAS GEOSCIENCE

Double Ring Infiltrometer

ASTM D-3385

Project Name:	La Puente City Park, La Puente - Upper San Gabriel EWMP	**Date Start:**	November 30, 2017
Project No:	TET 17-136E	**Date Finished:**	November 30, 2017
Test Number:	**DRI-102** (Lat: 34.027750°, Long: -117.952452°; elev. *~341 ft ground, ~340 ft test)	**Enter By:**	SCM
Preformed By:	**JPG**	**Reviewed By:**	FC

Note:*Elevation from GoogleEarth

Clayey SAND, medium dense, dark yellowish brown (10YR 4/4), moist

		INNER RING	**OUTER RING**
Diameter of Ring	**d, cm**	30.5	61.0
Area of Ring,	**A**	729.7	2192.8
Height of water above soil surface	**H_z cm**	15.0	15.0
Depth of wetted front	**D_w, cm**	18.288	18.288
Soil suction	**cm**	1	1

Coefficient of Permeability

$L = H_z + D_w + Suction$

$k = Q*D_w/(L*A*t)$

Trial No.	Date	Time Reading hr:min:sec	Time t (sec)	Inner Flow Readings: Inner Ring, cm	Inner Marriotte Reading (ml)	Flow Rate Q/t (cm^3/sec)	Outer Flow Readings: Outer Ring, cm	Outer Marriotte Reading (ml)	Flow Rate Q/t (cm^3/sec)	Temp. (C)	Infiltration Rate, Inner (cm/sec)	Hydraulic Conductivity k (cm/sec)	Comments
1	11/30/2017	10:41:00		15.0			15.0						
		11:11:00	1800	15.0	475	2.64E-01	15.0	1688	9.38E-01	18.2	3.62E-04	2.03E-04	clear, ~22C; ground 14.6C
2	11/30/2017	11:18:00		15.6			15.0						
		11:48:00	1800	15.6	575	3.19E-01	15.0	200	1.11E-01	18.4	4.38E-04	2.45E-04	ground 14.6C
3	11/30/2017	11:54:00		15.8			15.0						
		12:24:00	1800	15.8	565	3.14E-01	15.0	1125	6.25E-01	18.8	4.30E-04	2.41E-04	ground 15.3C
4	11/30/2017	12:24:00		16.3			15.1						
		12:54:00	1800	16.3	415	2.31E-01	15.1	975	5.42E-01	19.7	3.16E-04	1.73E-04	ground 15.2C
5	11/30/2017	12:54:00		16.6			15.2						
		13:24:00	1800	16.6	320	1.78E-01	15.2	650	3.61E-01	20.1	2.44E-04	1.30E-04	ground 15.5C
6	11/30/2017	13:29:00		17.0			15.1						
		13:59:00	1800	17.0	450	2.50E-01	15.1	600	3.33E-01	19.7	3.43E-04	1.87E-04	ground 16.0C
7	11/30/2017	13:59:00		17.4			15.2						
		14:29:00	1800	17.4	365	2.03E-01	15.2	525	2.92E-01	20.1	2.78E-04	1.48E-04	ground 16.4C
8	11/30/2017	14:29:00		17.5			15.2						
		14:59:00	1800	17.5	260	1.44E-01	15.2	625	3.47E-01	20.1	1.98E-04	1.06E-04	ground 16.7C
										AVERAGE =	**2.7E-04**	**1.5E-04**	

Notes:

1) Permeant levels maintained using: [X] 2 Marriotte Tubes [ ] Float Valve [ ] Other

2) Water Source: 55 gal drum

3) Depth to water table: Unknown

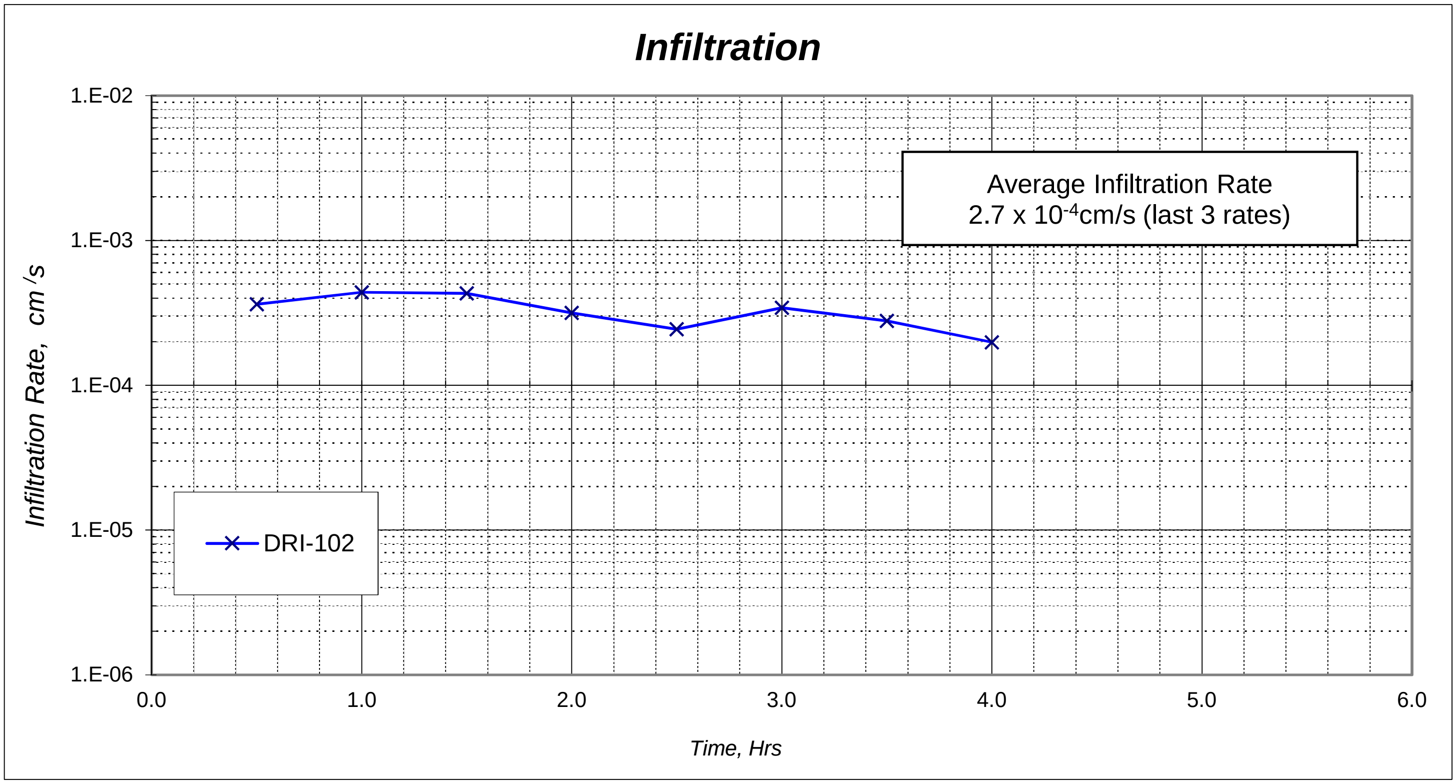
4) Annular Space Ring Marriotte Tube Voulme = 10, 000 ml Inner Ring Marriotte Tube Volume = 3,000 ml

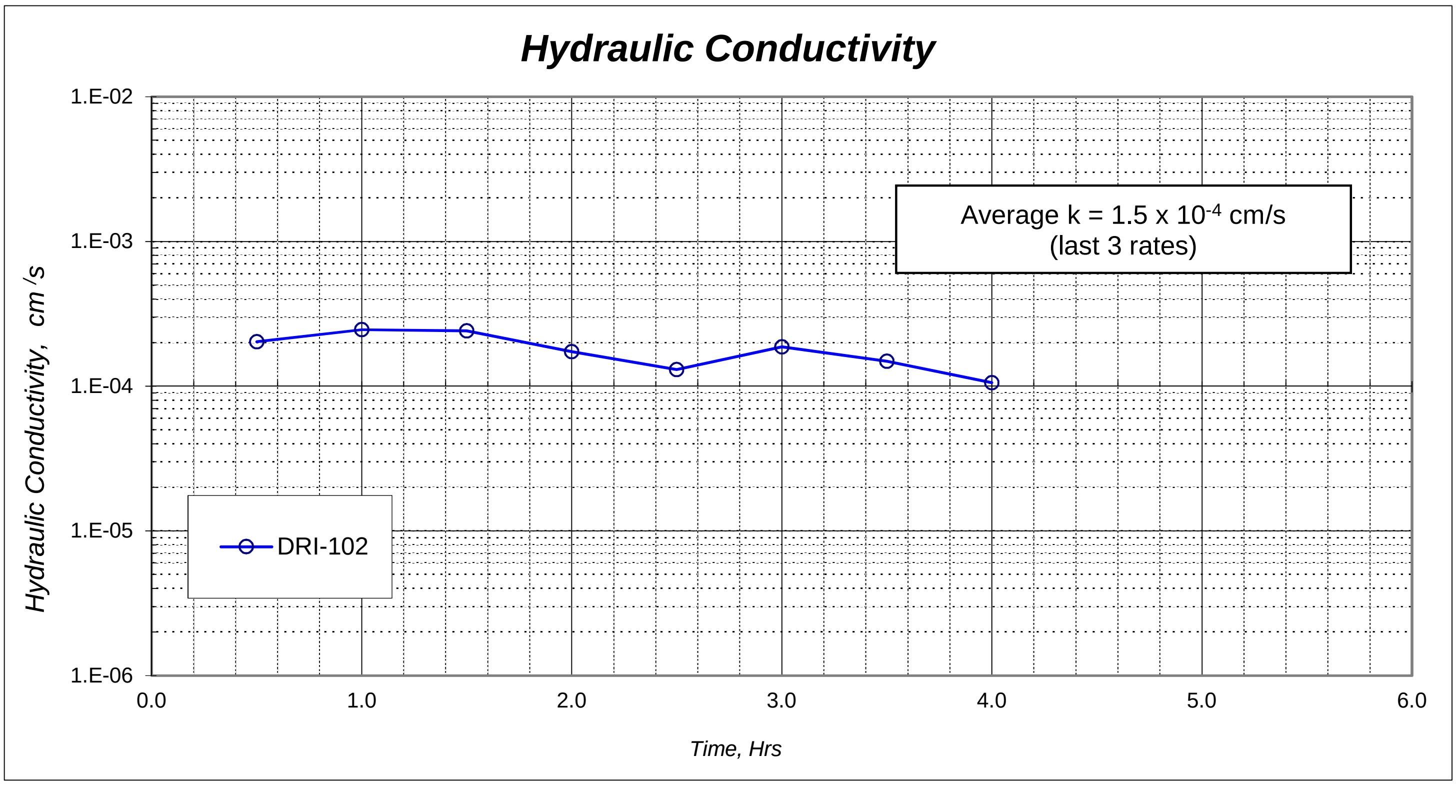
HYDRAULIC CONDUCTIVITY

DOUBLE RING INFILTRATION TEST

ASTM D-3385

Client / Project Name: La Puente City Park, La Puente - Upper San Gabriel EWMP	Project No: TET 17-136E	Test By: JPG
Test No. / Location: DRI-102 (el.~340')		Report Date: November 30, 2017





Print Date: 12/13/17	Entered By: DML	Reviewed By: PS

TETRA TECH BAS GEOSCIENCE

Double Ring Infiltrometer

ASTM D-3385

Project Name: La Puente City Park, La Puente - Upper San Gabriel EWMP
Date Start: November 30, 2017
Project No: TET 17-136E
Date Finished: November 30, 2017
Test Number: **DRI-103** (Lat: 34.028391°,Long: -117.952539°; elev. *~338 ft ground, ~337 ft test)
Enter By: SCM
Preformed By: **SCM**
Reviewed By: FC

Note:*Elevation from GoogleEarth

Lean CLAY, very stiff, brown (2.5Y 4/6), moist to wet

		INNER RING	**OUTER RING**
Diameter of Ring	**d, cm**	30.5	61.0
Area of Ring,	**A**	729.7	2192.8
Height of water above soil surface	**H_z cm**	16.0	16.0
Depth of wetted front-	**D_w, cm**	6.096	6.096
Soil suction	**cm**	1	1

Coefficient of Permeability
$L = H_z + D_w + Suction$
$k = Q*D_w/(L*A*t)$

Trial No.	Date	Time Reading hr:min:sec	Time t (sec)	Inner Flow Readings: Inner Ring, cm	Inner Marriotte Reading (ml)	Flow Rate Q/t (cm^3/sec)	Outer Flow Readings: Outer Ring, cm	Outer Marriotte Reading (ml)	Flow Rate Q/t (cm^3/sec)	Temp. (C)	Infiltration Rate, Inner (cm/sec)	Hydraulic Conductivity k (cm/sec)	Comments
1	11/30/2017	11:00:00		16.0			16.0						
		11:30:00	1800	16.0	0	0.00E+00	16.0	63	3.47E-02	19.3	0.00E+00	0.00E+00	clear, ~22C; ground 16.3C
2	11/30/2017	11:30:00		16.0			16.0						
		12:00:00	1800	16.0	25	1.39E-02	16.0	100	5.56E-02	19.5	1.90E-05	5.15E-06	ground 16.4C
3	11/30/2017	12:00:00		16.0			16.0						
		12:30:00	1800	16.0	25	1.39E-02	16.0	75	4.17E-02	19.5	1.90E-05	5.15E-06	ground 16.5C
4	11/30/2017	12:30:00		16.0			16.0						
		13:00:00	1800	16.0	20	1.11E-02	16.0	75	4.17E-02	20.1	1.52E-05	4.02E-06	ground 16.5C
5	11/30/2017	13:00:00		16.0			16.0						
		13:30:00	1800	16.0	15	8.33E-03	16.0	75	4.17E-02	20.2	1.14E-05	3.02E-06	ground 16.8C
6	11/30/2017	13:30:00		16.0			16.0						
		14:00:00	1800	16.0	15	8.33E-03	16.0	63	3.47E-02	20.2	1.14E-05	3.02E-06	ground 16.9C
7	11/30/2017	14:00:00		16.0			16.0						
		14:30:00	1800	16.0	10	5.56E-03	16.0	63	3.47E-02	20.2	7.61E-06	2.01E-06	ground 16.9C
8	11/30/2017	14:30:00		16.0			16.0						
		15:00:00	1800	16.0	10	5.56E-03	16.0	63	3.47E-02	20.2	7.61E-06	2.01E-06	ground 17.0C
										AVERAGE =	**8.9E-06**	**2.3E-06**	

Notes:
1) Permeant levels maintained using: [X] 2 Marriotte Tubes [ ] Float Valve [ ] Other
2) Water Source: 55 gal drum
3) Depth to water table: Unknown
4) Annular Space Ring Marriotte Tube Voulme = 10, 000 ml   Inner Ring Marriotte Tube Volume = 3,000 ml

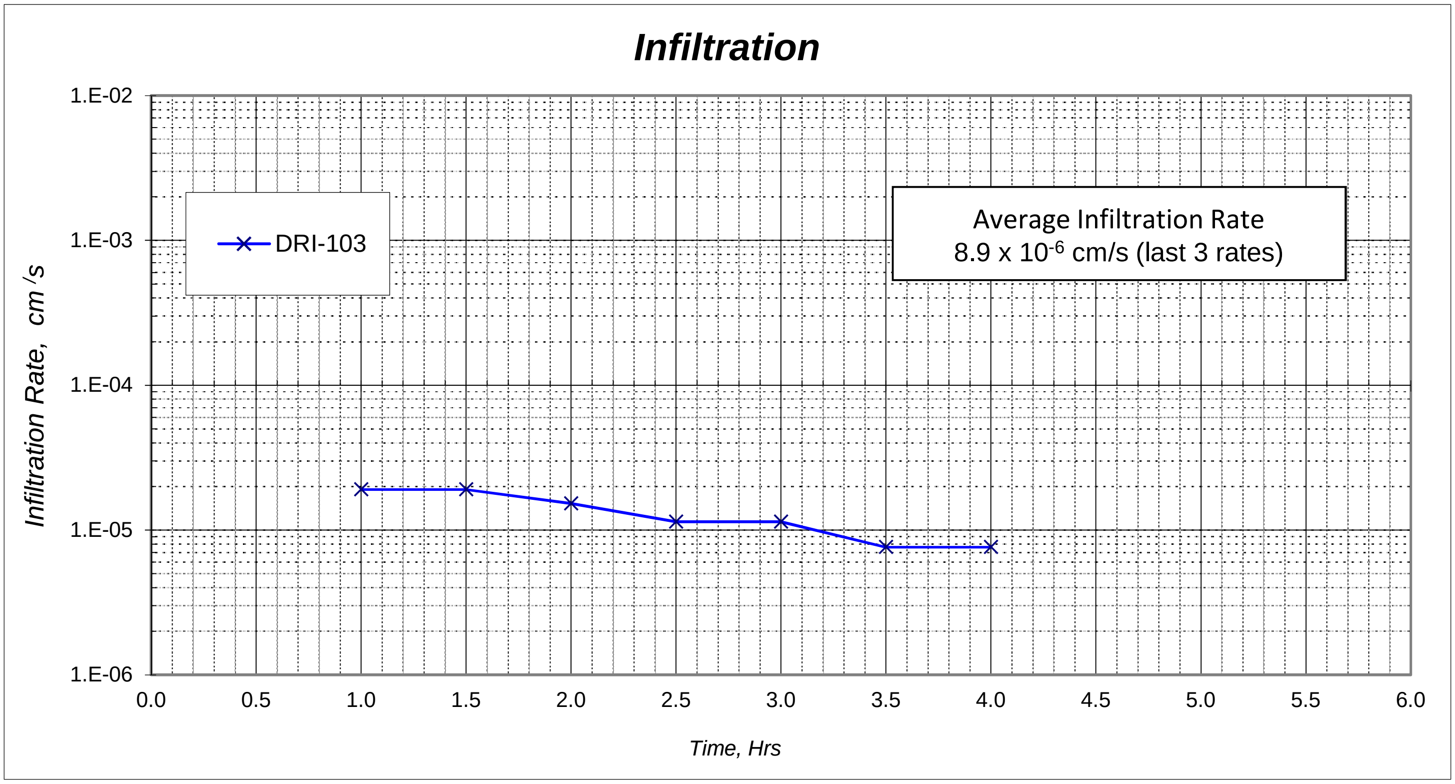
HYDRAULIC CONDUCTIVITY

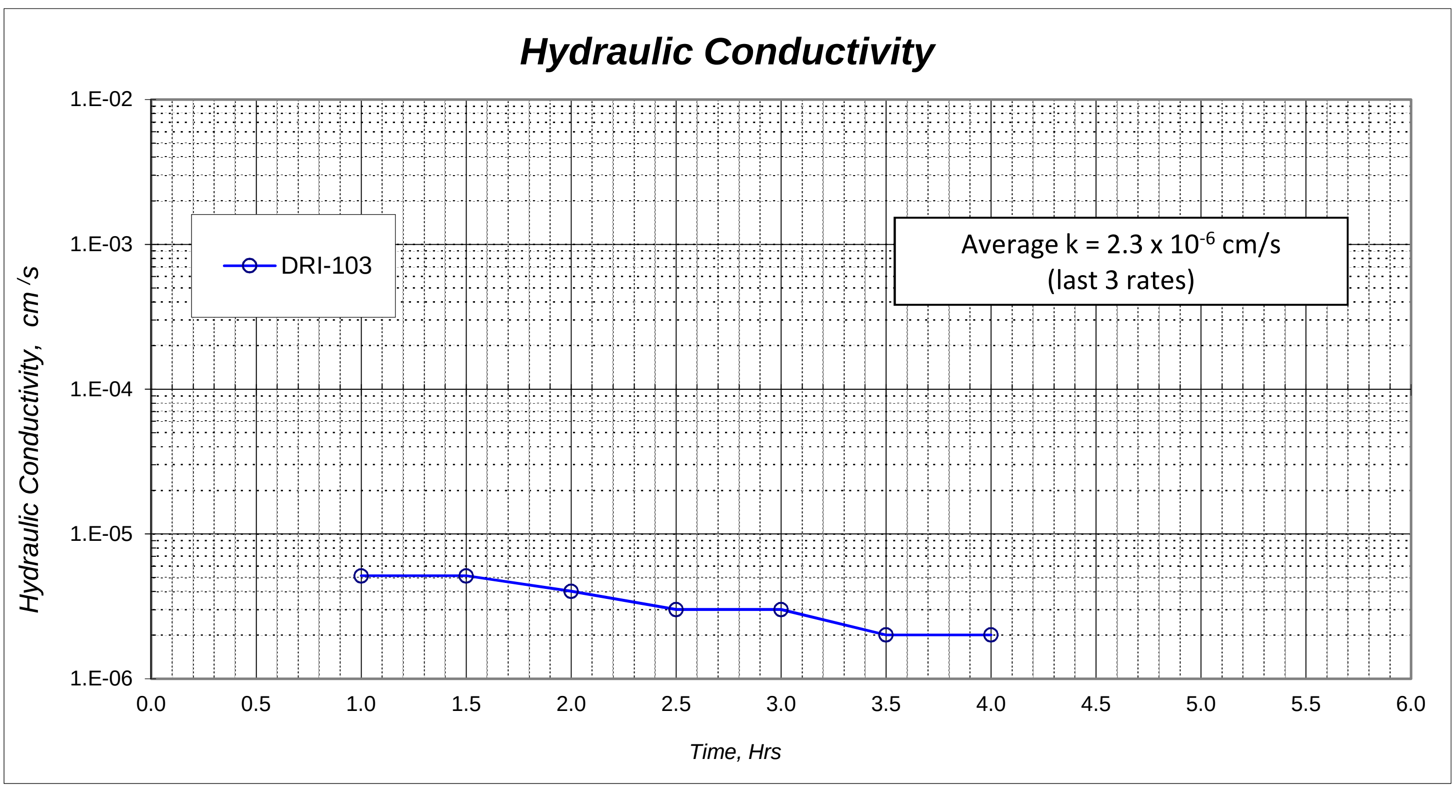
DOUBLE RING INFILTRATION TEST

ASTM D-3385

Client / Project Name:	Project No:	Test By:
La Puente City Park, La Puente - Upper San Gabriel EWMP	**TET 17-136E**	**SCM**

Test No. / Location:		Report Date:
DRI-103	**(el.~337')**	**November 30, 2017**





Print Date:	Entered By:	Reviewed By:
12/13/17	DML	PS

DEPTH OF WETTED FRONT

DOUBLE RING INFILTRATION TEST

ASTM D-3385

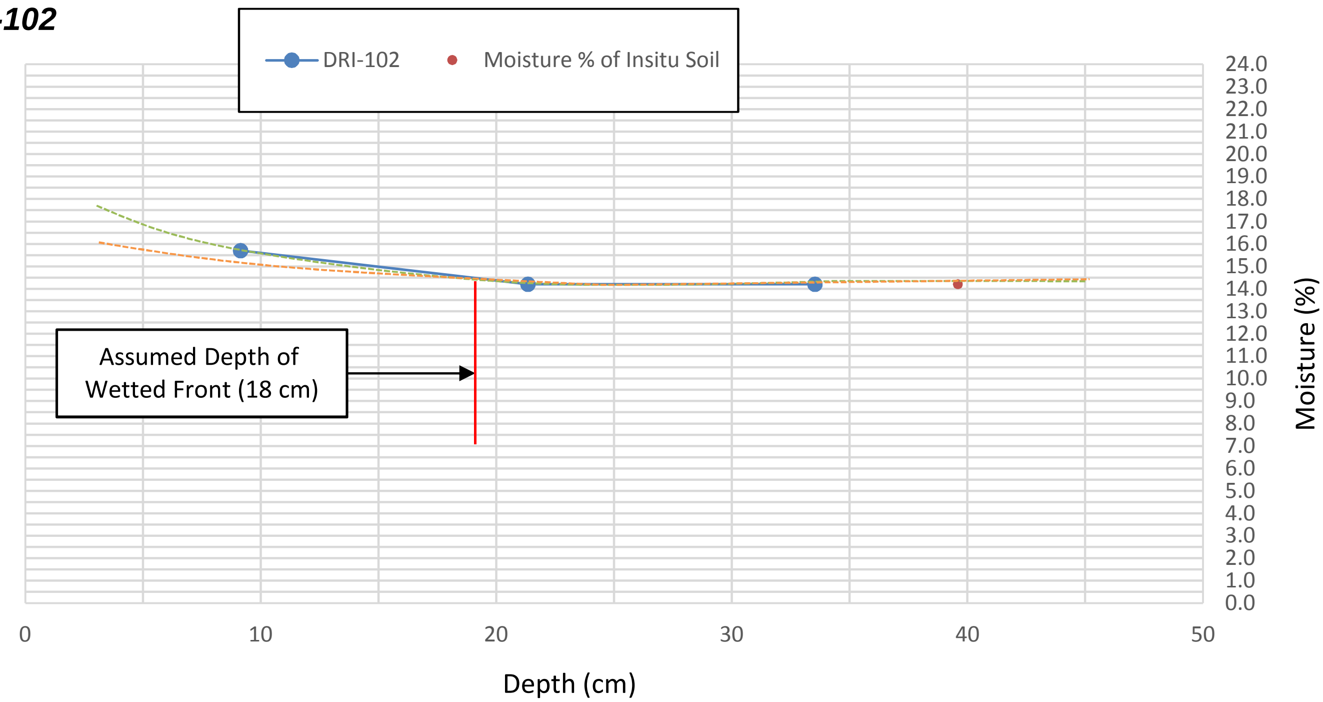
TETRA TECH BAS GEOSCIENCE

Client / Project Name:	Project No:	Tested By:
La Puente City Park, La Puente - Upper San Gabriel EWMP	TET 17-136E	SCM/JPG

Report Date: **January 30, 2018**

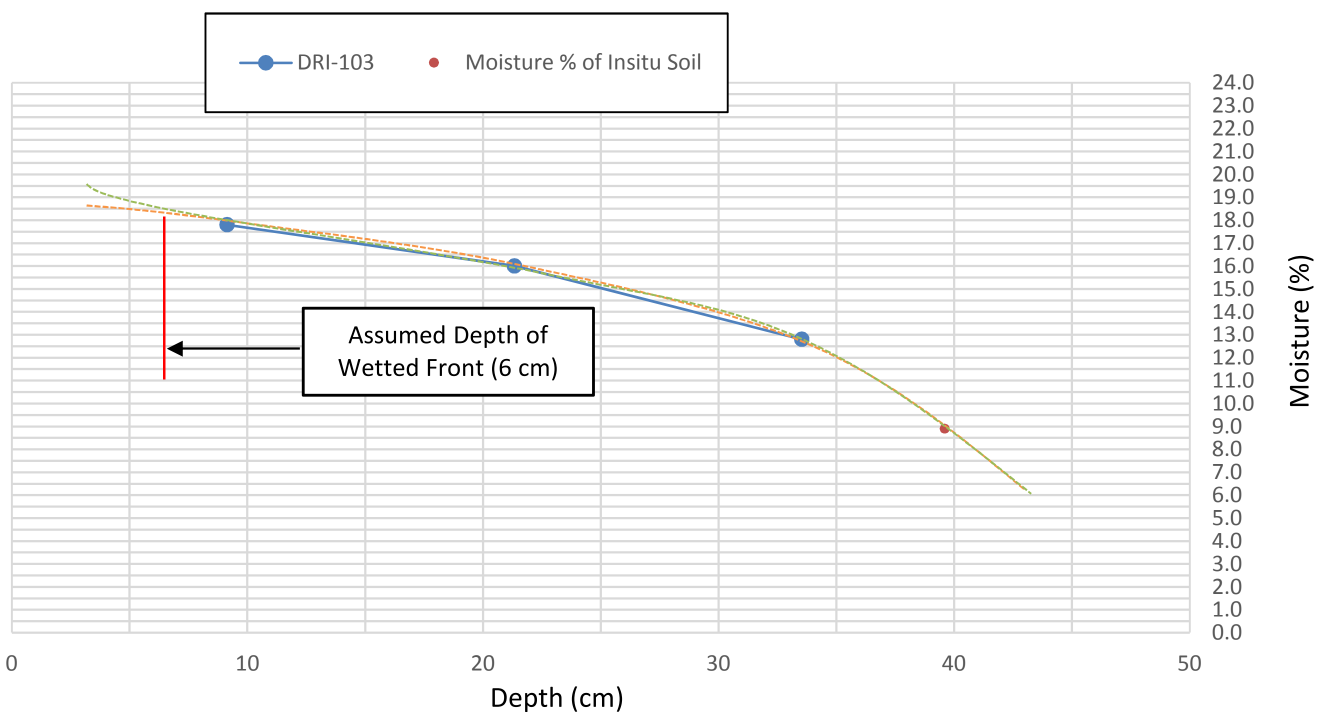
Test No. / Location:

DRI-102



Test No. / Location:

DRI-103



Print Date:	Entered By:	Reviewed By:
01/30/18	SCM	PS

Appendix E

Liquefaction Analyses

Summary of Liquefaction and Earthquale-Induced Settlement Analysis

Project:	TET 17-136E Upper San Gabriel EWMP - La Puente Park	Boring:	**B-10**	Engineer:	FC	Date:	1/19/2018

Liquefaction Evaluation Method

Correction for fines content	Idriss & Boulang. 2008, 2014
Correction for overburden C_N	Idriss & Boulang. 2014 (N1)60cs
Cyclic resistance ratio of soil CRR_{CS}	Idriss & Boulang. 2004, 2014
Correction for overburden Kσ	Idriss & Boulang. 2008, 2014
Stress reduction factor r_D	Idriss 1999, I&B 2008,2014
Magnitude scaling factor MSF	Idriss & Boulang. 2014
Liquefaction settlement	Yoshimine et al., 2006 – no adjustment
Dry settlement	Pradel, 1998a,b

Liquefaction Analysis Statistics

Total thickness of evaluated profile	50	feet
Profile thickness susceptible to liquefaction	3	feet
Number of evaluated intervals	11	
Number of potentially liquefiable intervals	2	
Average Factor of Safety of sandy intervals	**2.1**	
Dry sand settlement	0.25	inches
Liquefaction settlement	0.24	inches
Total earthquake-induced settlement	**0.49**	**inches**

Plasticity Index sand behavior threshold 7

Calculate settlement only for layers with less than 50 % of fines

Depth to Layer Top	Layer Thickness	Total Unit Weight In-situ	Total Unit Weight Design	Fines %	Plasticity Index	Considered Blowcounts SPT-N	N1,60	N1,60,cs	Liquefaction Factor of Safety	Liquefaction potential rationale	Layer Settlement	Cumulative Settlement
feet	feet	pcf	pcf	%	–	bpf	bpf	bpf	–	–	in	in
0	3	127.53	121.0	65	10	20.0	39.8	45.4	Not liquefiable	- no groundwater	0.00	0.49
3	7	140.36	125.0	35	n/plastic	26.0	38.6	44.1	Not liquefiable	- no groundwater	0.11	0.49
10	6	134.31	125.0	35	n/plastic	29.7	34.5	40.0	Not liquefiable	- no groundwater	0.14	0.38
16	2	120.99	125.0	35	10	24.0	34.6	40.1	Not liquefiable	- no groundwater	0.00	0.24
18	3	120.99	125.0	35	10	24.0	33.3	38.8	Not liquefiable	- clay-like behaviour	0.00	0.24
21	4	120.99	125.0	65	10	24.0	31.7	37.3	Not liquefiable	- clay-like behaviour	0.00	0.24
25	8	131.89	125.0	65	12	9.0	10.0	15.6	Not liquefiable	- clay-like behaviour	0.00	0.24
33	3	127.53	125.0	35	n/plastic	21.0	24.8	30.3	1.02	- liquefieable - FS < 1.3	0.24	0.24
36	4	127.53	125.0	65	15	21.0	23.9	29.4	Not liquefiable	- clay-like behaviour	0.00	0.00
40	8	126.44	125.0	65	10	13.0	12.8	18.4	Not liquefiable	- clay-like behaviour	0.00	0.00
48	2	115.248	125.0	30	n/plastic	33.0	29.8	35.2	2.19	- too dense – (N1)60,CS > 32	0.00	0.00
250.00	50.00	1393.81	1371.00	530.00	77.00	244.70	313.77	374.61	3.21		0.49	2.56

Profile

In-Situ Groundwater depth	no GW	feet
DESIGN Groundwater depth	18.00	feet
DESIGN Excavation depth	0.00	feet
DESIGN Surcharge (fill)	0.00	feet

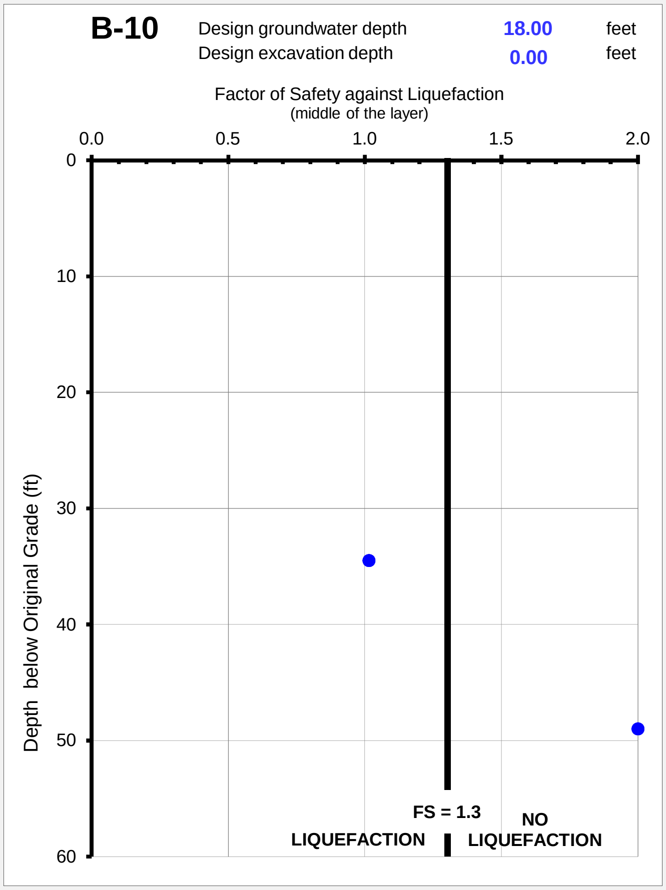
Earthquake loading

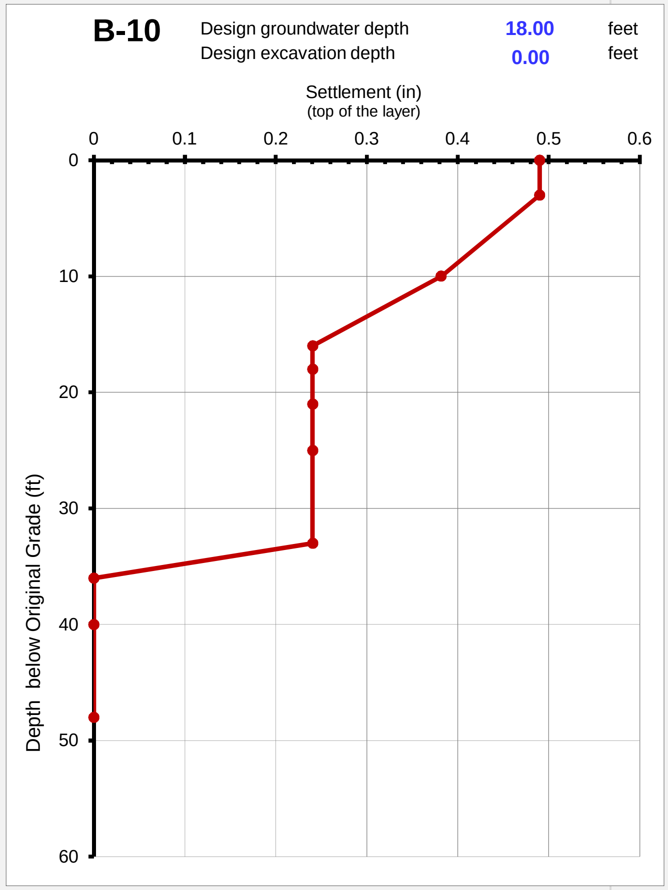
M	6.91
PGA	0.775

Checks

Groundwater depth check	OK
Design groundwater/excavation depth check	OK
Fines correction method compatibility	OK
Idris & Boulanger, 2004 method for C_N	not used
Cetin 2009 settlement method	not used

Version v1c 2018-01


B-10
Design groundwater depth 18.00 feet
Design excavation depth 0.00 feet
Factor of Safety against Liquefaction
(middle of the layer)
0.0
0.5
1.0
1.5
2.0
0
10
20
30
40
50
60
Depth below Original Grade (ft)
FS = 1.3
LIQUEFACTION
NO
LIQUEFACTION


B-10
Design groundwater depth 18.00 feet
Design excavation depth 0.00 feet
Settlement (in)
(top of the layer)
0
0.1
0.2
0.3
0.4
0.5
0.6
0
10
20
30
40
50
60
Depth below Original Grade (ft)

Summary of Liquefaction and Earthquale-Induced Settlement Analysis

Project:	TET 17-136E Upper San Gabriel EWMP - La Puente Park	Boring:	LP-101	Engineer:	FC	Date:	1/19/2018

Liquefaction Evaluation Method

Correction for fines content	Idriss & Boulang. 2008, 2014
Correction for overburden C_N	Idriss & Boulang. 2014 (N1)60cs
Cyclic resistance ratio of soil CRR_{CS}	Idriss & Boulang. 2004, 2014
Correction for overburden Kσ	Idriss & Boulang. 2008, 2014
Stress reduction factor r_D	Idriss 1999, I&B 2008,2014
Magnitude scaling factor MSF	Idriss & Boulang. 2014
Liquefaction settlement	Yoshimine et al., 2006 – no adjustment
Dry settlement	Pradel, 1998a,b

Liquefaction Analysis Statistics

Total thickness of evaluated profile	31.5 feet
Profile thickness susceptible to liquefaction	2.5 feet
Number of evaluated intervals	9
Number of potentially liquefiable intervals	1
Average Factor of Safety of sandy intervals	**0.5**
Dry sand settlement	0.14 inches
Liquefaction settlement	0.60 inches
Total earthquake-induced settlement	**0.74 inches**

Plasticity Index sand behavior threshold 7

Calculate settlement only for layers with less than 50 % of fines

Depth to Layer Top	Layer Thickness	Total Unit Weight In-situ	Total Unit Weight Design	Fines %	Plasticity Index	Considered Blowcounts SPT-N	N1,60	N1,60,cs	Liquefaction Factor of Safety	Liquefaction potential rationale	Layer Settlement	Cumulative Settlement
feet	feet	pcf	pcf	%	–	bpf	bpf	bpf	–	–	in	in
0	5	135.72	121.0	66	2	17.0	33.8	39.4	Not liquefiable	- no groundwater	0.00	0.74
5	3	135.72	125.0	66	2	44.2	51.4	57.0	Not liquefiable	- no groundwater	0.00	0.74
8	2	126.5	125.0	49	n/plastic	27.0	36.9	42.5	Not liquefiable	- no groundwater	0.04	0.74
10	5	135.6	125.0	65	2	29.0	34.3	39.9	Not liquefiable	- no groundwater	0.00	0.70
15	3	120.75	125.0	40	n/plastic	23.0	30.0	35.6	Not liquefiable	- no groundwater	0.10	0.70
18	2	135.6	125.0	65	12	21.1	24.4	30.0	Not liquefiable	- clay-like behaviour	0.00	0.60
20	5	125.46	125.0	65	12	21.1	22.9	28.5	Not liquefiable	- clay-like behaviour	0.00	0.60
25	2.5	120.75	125.0	9	n/plastic	19.0	23.0	23.7	0.54	- liquefieable - FS < 1.3	0.60	0.60
27.5	4	135.72	125.0	65	12	42.9	46.0	51.5	Not liquefiable	- clay-like behaviour	0.00	0.00
128.50	31.50	1171.82	1121.00	490.00	42.00	244.40	302.53	347.97	0.54		0.74	5.41

Profile

In-Situ Groundwater depth	no GW	feet
DESIGN Groundwater depth	18.00	feet
DESIGN Excavation depth	0.00	feet
DESIGN Surcharge (fill)	0.00	feet

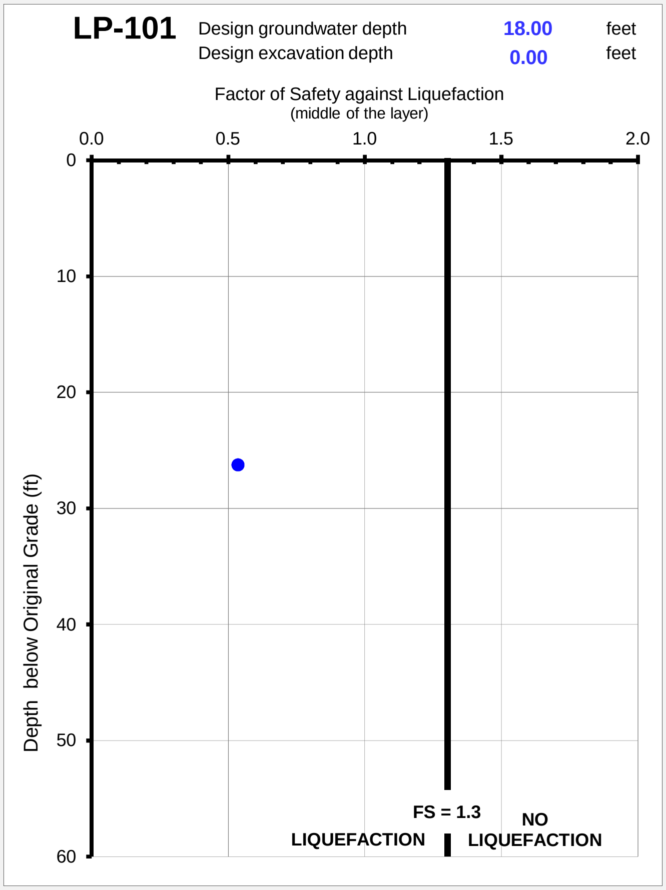
Earthquake loading

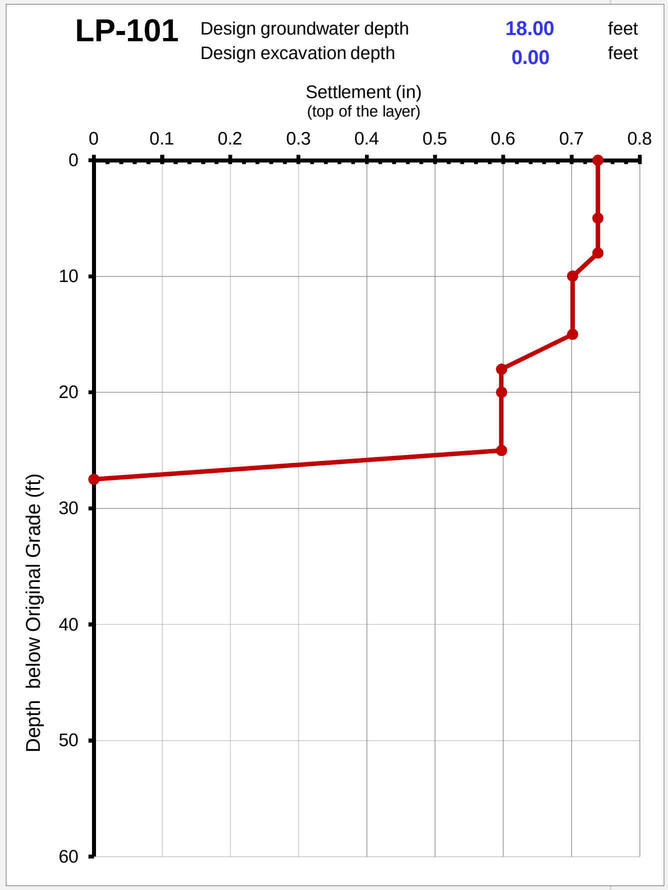
M	6.91
PGA	0.775

Checks

Groundwater depth check	OK
Design groundwater/excavation depth check	OK
Fines correction method compatibility	OK
Idris & Boulanger, 2004 method for C_N	not used
Cetin 2009 settlement method	not used

Version v1c 2018-01


LP-101
Design groundwater depth 18.00 feet
Design excavation depth 0.00 feet
Factor of Safety against Liquefaction
(middle of the layer)
0.0
0.5
1.0
1.5
2.0
0
10
20
30
40
50
60
Depth below Original Grade (ft)
FS = 1.3
LIQUEFACTION
NO
LIQUEFACTION


LP-101
Design groundwater depth 18.00 feet
Design excavation depth 0.00 feet
Settlement (in)
(top of the layer)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0
10
20
30
40
50
60
Depth below Original Grade (ft)