

# Geotechnical Evaluation Lynwood City Park Stormwater Capture Project 11301 Bullis Road Lynwood, California

Craftwater Engineering, Inc.

45 South Arroyo Parkway, B6 | Pasadena, California 91105

March 17, 2023 | Project No. 212102001



Geotechnical | Environmental | Construction Inspection & Testing | Forensic Engineering & Expert Witness

Geophysics | Engineering Geology | Laboratory Testing | Industrial Hygiene | Occupational Safety | Air Quality | GIS

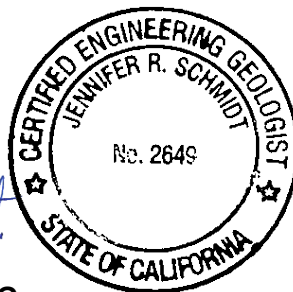
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Lynwood City Park Stormwater Capture  
Project  
11301 Bullis Road  
Lynwood, California

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# 1 INTRODUCTION

In accordance with your request and authorization, we have performed a geotechnical evaluation for the Lynwood City Park Stormwater Capture Project located at 11301 Bullis Road in Lynwood, California (Figure 1). We understand that the project will generally consist of the installation of a regional stormwater capture and infiltration facility within Lynwood City Park that will provide improved flood control, water treatment, infiltration of groundwater, and improved flood management for water from a 955-acre drainage area. The purpose of our study was to evaluate the subsurface soil and geologic conditions at the park, including the infiltration rates of the on-site soils, in order to provide geotechnical recommendations for the design and construction of the proposed improvements. Our evaluation was performed in general accordance with our referenced proposal dated July 11, 2022. This report presents our findings, conclusions, and geotechnical recommendations for the project.

## 2 SCOPE OF SERVICES

Our scope of services included the following:

- Project coordination and planning with subcontractors and personnel from Craftwater Engineering, Inc. and the City of Lynwood.
- Review of readily available background materials, including published topographic maps, geologic maps, fault and seismic hazard maps, groundwater data, stereoscopic aerial photographs, in-house geotechnical information, and other reports provided by the client.
- Acquisition of a Los Angeles County Environmental Health Department (LACEHD) permit for drilling deeper than 10 feet below the ground surface.
- Field reconnaissance to observe and document the site conditions, mark-out proposed hollow-stem-auger (HSA) boring and cone penetration test (CPT) sounding locations for underground utility clearance by Underground Service Alert.
- Subsurface exploration consisting of the drilling, sampling, and logging of seven HSA borings, ranging in depths from approximately 6½ feet to 101½ feet, and two CPTs ranging in depths from approximately 60 feet to 100 feet.
- Field percolation testing in four of the HSA borings in general accordance with the 2021 County of Los Angeles Department of Public Work's (CLADPW) Guidelines for Geotechnical Investigation and Reporting Low Impact Development Stormwater Infiltration.
- Geotechnical laboratory testing of representative soil samples to evaluate in-situ moisture content and dry density, percentage of particles finer than the No. 200 sieve, Atterberg limits, consolidation, direct shear strength, and soil corrosivity.
- Data compilation and engineering analysis of the information obtained from our background review, subsurface evaluation, percolation testing, and laboratory testing.
- Preparation of this geotechnical report presenting our findings, conclusions, and recommendations pertaining to the design and construction of the proposed improvements.

### 3 SITE DESCRIPTION

Lynwood City Park is situated in a mixed residential and commercial neighborhood in the City of Lynwood, approximately ½ mile northeast of Interstate 105 (I-105) and approximately 1½ miles west of I-710 (Figure 1). The park consists of a rectangular-shaped lot situated on the west side of the Lynwood Community Center. The park is bounded by Cesar Chavez Lane and Martin Luther King Boulevard on the north, Birch Street on the west, Spruce Street and administration buildings on the south, and the community center and Bullis Road on the east (Figures 2 and 3). The park is a relatively flat area ranging from approximately 85 to 90 feet above mean sea level with a gentle slope toward the south (United States Geological Survey, 2018). The park generally consists of various grass-covered fields, including four baseball fields on the west approximate half of the park and three soccer fields on the east approximate half of the park. Other park improvements include a snack shack/restroom structure between the baseball fields, tennis courts and an asphalt-concrete (AC) paved parking lot on the south, a playground area and greenbelt area on the north, and Portland cement concrete (PCC) walkways. The east side of the park includes the community center building, basketball courts, skate park, maintenance and restroom building, and AC-paved parking lots adjacent to the buildings (Figures 2 and 3). According to Craftwood (2020), two storm drains associated with East Compton Creek are located within Bullis Road and Birch Street.

### 4 PROJECT DESCRIPTION AND PROPOSED CONSTRUCTION

Based on our review of the City of Lynwood request for proposal, dated June 23, 2022, we understand that the project generally consists of the installation of regional stormwater capture, infiltration, and treatment facility (Best Management Practice [BMP]) within the Lynwood City Park to improve the water quality within the Lower Los Angeles River Watershed. The facility will provide improved flood control, water treatment and groundwater replenishment by diverting wet-weather flow from the two storm drains located in Bullis Road and Birch Street to the park. Two new diversion structures, one in Bullis Road (20 cubic feet per second [20cfs]) and one in Birch Street (40cfs), will be constructed to divert water to the park through new pipelines to a new pre-cast concrete infiltration gallery. The gallery will have a storage capacity of approximately 11.2-acre-feet (3.6 million gallons) and has a conceptual footprint of approximately 120 feet by 440 feet (Craft Water, 2020). It is anticipated that the gallery structure will have an invert depth of approximately 20 feet below the existing ground surface. New actuated valves and pretreatment hydrodynamic separators will be installed in-line prior to the structure. A second pipeline and valve will be installed to allow the treated water to return the storm drain within Bullis Road. Other site BMPs and park improvements include the installation of an ephemeral stream to the butterfly garden along the north side of the park. We understand that previously proposed permeable

pavements and bioswales in the community center parking lot have been removed from the project.

## **5 PREVIOUS SITE EVALUATION**

As part of our evaluation, we reviewed a preliminary infiltration study report for the subject project prepared by Albus-Keefe & Associates (Albus-Keefe, 2017). Their study was performed to evaluate the feasibility of using dry wells at the site for on-site stormwater infiltration. Their study included three exploratory borings (B-1, B-2, and B-3) to depths of approximately 51½, 12, and 12 feet, respectively, and percolation testing in the two shallower borings. Their borings and percolation testing were performed near the western end of the proposed underground structure as shown on Figures 2 and 3. We used their borings and percolation test data to supplement our report. Data from their report is included in our discussions below. A copy of their report, including their boring logs, is provided in Appendix A.

## **6 SUBSURFACE EVALUATION AND LABORATORY TESTING**

Our subsurface evaluation was conducted on January 30, January 31, and February 1, 2023, and consisted of the drilling, logging, and sampling of seven HSA borings (B-1, B-2, B-3, and P-1 through P-4) and two CPT soundings (CPT-1 and CPT-2). The borings were drilled using a truck-mounted drill rig with 8-inch diameter augers. Borings B-1, B-3, and P-1 through P-4 were drilled to proposed depths of approximately 31.5, 31.5, 6.5, 21.5, 21.5, and 21.5 feet, respectively. Boring B-2 was drilled to a depth of 101.5 as requested by the City. The borings were logged in the field by a representative of Ninyo & Moore and representative bulk and relatively undisturbed soil samples were collected from the borings at selected depths for laboratory testing. Logs of the exploratory borings are provided in Appendix B. Percolation testing was performed in borings P-1 through P-4 as further discussed in Section 8 of this report. CPT soundings CPT-1 and CPT-2 were performed using a 30-ton CPT rig to depths of approximately 60.3 and 100.2 feet, respectively. Continuous soil profiles, including cone tip resistance and sleeve friction, were recorded during the soundings. Pore water dissipation test measurements were recorded from both CPT soundings and shear wave testing was performed in CPT-2. Logs of the CPT soundings, including the results of the dissipation and shear wave tests, are provided in Appendix C. The approximate locations of the borings and CPTs are presented on Figures 2 and 3. The borings and CPTs were backfilled with cement-bentonite grout upon completion of the drilling and percolation testing in general accordance with the requirements of LACEHD.

Geotechnical laboratory testing of representative soil samples included tests to evaluate in-situ moisture content and dry density, percentage of particles finer than the No. 200 sieve Atterberg

limits, consolidation potential, direct shear strength, and soil corrosivity. Moisture and density test results are presented on the boring logs in Appendix B. The remaining test results are presented in Appendix D.

Soil cuttings from the borings and CPTs were placed in 55-gallon drums, and composite soil samples of the drummed soil were collected in 8-ounce jars for waste characterization. The samples were stored in a chilled cooler and delivered to a laboratory for analytical testing under chain-of-custody protocol. The samples were tested for total petroleum hydrocarbons (gas and diesel range) per United States Environmental Protection Agency (EPA) Test Method 8015B, Title 22 metals per EPA Test Methods 6010B/7470/7471, and volatile organic compounds per EPA Test Method 8260B. Based on the characterization test results, the drums were disposed at an approved landfill by a licensed transportation subcontractor as non-hazardous material. The waste characterization test results are provided in Appendix E.

## **7 GEOLOGIC AND SUBSURFACE CONDITIONS**

The project site is located within the Los Angeles Basin of the Peninsular Ranges Geomorphic Province (Norris and Webb, 1990). The basin has been divided into four blocks, the northeastern, northwestern, southwestern, and central blocks that are separated by prominent fault systems. The project site is located within the central block, which is underlain by up to approximately 35,000 feet of Cretaceous to Pleistocene-age marine and non-marine sedimentary rock. The sedimentary rock is overlain by late Pleistocene to Holocene-age alluvial deposits associated with the ancestral Los Angeles and San Gabriel Rivers. According to Saucedo, et al. (2016), the project site is generally underlain by Holocene to late Pleistocene-age young alluvium consisting of poorly consolidated, poorly sorted, permeable floodplain deposits of soft, clay and silt, and loose to moderately dense, sand and silty sand (Figure 4). The California Department of Mines and Geology (CDMG, 1998) has also mapped the site as being underlain by young alluvium deposits consisting of loose to medium dense, very coarse- to very fine-grained sand, gravel, and silt that interfinger and grade laterally into each other. Various fills are anticipated at the site associated with past earthwork, including building construction and underground utility installation.

Materials encountered during our subsurface exploration generally consisted of undocumented fill underlain by young alluvium. Undocumented fill was encountered in our borings B-2 and P-1 to depths ranging from approximately ½ and 1 foot, respectively. The undocumented fill generally consists of brown, moist, medium dense, silty gravel with sand and silty sand with few gravel. Documentation regarding the limits of fill or the placement and compaction of the fill soils was not available for our review. Young alluvium was encountered beneath the undocumented fill in borings B-2 and P-1 and at the ground surface in the remaining borings to the total depths

explored of up to approximately 100 feet. The young alluvium generally consists of approximately 4 to 10 feet of light brown, moist, loose to medium dense, silty sand underlain by predominantly fine deposits to depths of approximately 28 to 40 feet. The fine deposits generally consist of light brown, brown, dark brown, grayish brown, olive gray, and gray, moist, loose to very dense and stiff to hard, silt with variable amounts of sand with interbeds of dark brown, moist, very stiff, clay. Below depths of approximately 28 to 40 feet, the alluvium generally consists of interbedded light brown and gray, moist to wet, medium dense to very dense, silty sand and silt with variable amounts of sand with occasional thin clay layers. Similar alluvial deposits were encountered in the previous borings by Albus-Keefe (2017). More detailed descriptions of the subsurface materials encountered during our subsurface exploration are presented on the boring logs and CPT soundings in Appendices B and C, respectively.

## **8 GROUNDWATER**

During our subsurface exploration, groundwater was encountered in boring B-2 at a depth of approximately 44.3 feet and in our CPT-1 and CPT-2 at depths of approximately 43.4 and 55.5 feet, respectively. Albus-Keefe (2017) encountered groundwater at a depth of approximately 43 feet in their boring B-1. The historic high depth to groundwater is mapped at approximately 8 feet by CDMG, (1998). As part of our evaluation, we reviewed depth to groundwater data available on the State of California Water Resources Control Board's GeoTracker website (2023) for three sites located approximately ½ mile west, ½ mile southwest, and 1 mile east of the site. Similar depths to groundwater were recorded in numerous groundwater monitoring wells at each site. In general, the groundwater depths ranged from approximately 16 to 40 feet between approximately 1988 to 2019. Fluctuations in the level of groundwater will occur due to variations in ground surface topography, subsurface stratification, rainfall, irrigation practices, groundwater pumping, and other factors that were not evident at the time of our field evaluation.

## **9 FIELD PERCOLATION TESTING**

Percolation testing was performed in our borings P-1 through P-4 in general accordance with the 2021 CLADPW Guidelines for Geotechnical Investigation and Reporting Low Impact Development Stormwater Infiltration. The testing was performed to evaluate the infiltration rates of the on-site soils for use in design of project BMPs. Boring P-1 was drilled to a depth of approximately 6½ feet and borings P-2, P-3, and P-4 were drilled to depths of approximately 21½ feet. The purpose of borings P-2, P-3, and P-4 was to evaluate the infiltration rate at the approximate invert depth of the proposed infiltration gallery and the purpose of boring P-1 was to evaluate the infiltration rate of shallower soils in the event that additional BMPs, such as

bioswales, permeable pavements, etc., are added to the project. The approximate locations of the percolation test borings are shown on Figures 2 and 3.

Preparation of each boring for percolation testing included the installation of a 2-inch-diameter slotted polyvinyl chloride (PVC) pipe in each boring and backfilling the bottom approximately 5 feet of annular space between the borehole wall and pipe with clean gravel. The infiltration zones were pre-soaked with water for at least one hour prior to performing percolation testing. After the borings were pre-soaked, falling-head percolation testing was performed in the borings.

The falling-head test method involved placing clean water into the PVC pipe to establish a head of water and measuring the rate at which the water level dropped in the pipe at consecutive time intervals (approximately 30 minutes). The test was repeated until three consecutive tests provided similar results and a stabilized rate was obtained. The field percolation rate was calculated by measuring the total volume of water infiltrated during the time interval and dividing by the surface area of the tested zone of the boring. The measured field percolation rates are presented in Table 1. The Albus-Keefe (2017) percolation test results, which were performed using the Well Permeameter test method USBR-7300-89, are also provided in Table 1 for informative purposes regarding materials above the tank's proposed invert depth.

The 2021 CLADPW guidelines indicate that the measured field percolation rates should be reduced to account for the long-term performance of the proposed BMPs by dividing the field rates by the "Total Reduction Factor (RF)." They define the RF as the sum of the "test-specific" reduction factor ( $RF_t$ ), the "site variability" reduction factor ( $RF_v$ ), and the "long-term siltation, plugging, and maintenance" reduction factor ( $RF_s$ ) (i.e.,  $RF = RF_t + RF_v + RF_s$ ). The guidelines (CLADPW, 2021) indicate that the  $RF_t$  is applied to account for variations in the direction of flow during the test and the reliability of the different test methods and ranges from 1 to 3. We recommend using an  $RF_t$  value of 2 for the small diameter boring test method used in this evaluation. The  $RF_v$  value is applied to account for site variability, number of tests, and thoroughness of the subsurface investigation and ranges from 1 to 3. Based on our explorations and relative consistency of materials encountered between borings and CPTs, we recommend using an  $RF_v$  value of 1. The long-term siltation, plugging, and maintenance value ( $RF_s$ ) also ranges from 1 to 3 and will generally vary on the level of pre-treatment performed prior to infiltration and the level of future maintenance of the system. For the purposes of this evaluation, we have assumed an  $RF_s$  value of 1; however, the  $RF_s$  value should be provided by the BMP designer. The  $RF_t$ ,  $RF_v$ ,  $RF_s$ , and resulting RF values used in our analysis are presented in Table 1. The adjusted percolation rates based on these values are also presented in Table 1.

**Table 1 – Percolation Test Results**

| Test Boring | Test Type        | Approximate Depth of Tested Zone (feet) | Field Percolation Rate (inches/hour) | Reduction Factor |                 |                 |    | Adjusted Percolation Rate (inches/hour) |
|-------------|------------------|-----------------------------------------|--------------------------------------|------------------|-----------------|-----------------|----|-----------------------------------------|
|             |                  |                                         |                                      | RF <sub>t</sub>  | RF <sub>v</sub> | RF <sub>s</sub> | RF |                                         |
| P-1         | Falling Head     | 3 – 5                                   | 2.45                                 | 2                | 1               | 1               | 4  | 0.61                                    |
| P-2         | Falling Head     | 15 – 20                                 | 0.04                                 | 2                | 1               | 1               | 4  | 0.01                                    |
| P-3         | Falling Head     | 15 – 20                                 | 1.27                                 | 2                | 1               | 1               | 4  | 0.32                                    |
| P-4         | Falling Head     | 15 – 20                                 | 1.34                                 | 2                | 1               | 1               | 4  | 0.34                                    |
| P-1 (AK)    | Well Permeameter | 7-12                                    | 0.83                                 | -                | -               | -               | -  | -                                       |
| P-2 (AK)    | Well Permeameter | 7-12                                    | 1.03                                 | -                | -               | -               | -  | -                                       |

**Notes:**RF<sub>t</sub> – Test Specific Reduction FactorRF<sub>v</sub> – Site Variability Reduction FactorRF<sub>s</sub> – Long-Term Siltation, Plugging, and Maintenance Reduction Factor (To be adjusted by the BMP designer)

RF – Total Reduction Factor

Based on our evaluation and the presence of clay layers at the proposed invert depth of the gallery, we recommend that an adjusted percolation rate of 0.01 inch per hour, following adjustments by the BMP designer for RF<sub>s</sub>, be used for design of the infiltration gallery. A preliminary design value of 0.6 inch per hour can be used for shallower site BMPs, such as bioswales. If shallow BMPs are added to the project, additional shallow percolation tests may be warranted for the design of shallow BMPs.

In addition, we recommend that new or existing buildings be set-back from the proposed infiltration gallery a minimum of 15 feet or a distance where the bottom of the lowest foundation element of the structure is at least 10 horizontal feet outside of an imaginary 1:1 (horizontal to vertical) plane projected downward and outward from the zone of infiltration.

## 10 FLOOD HAZARDS

Based on our review of flood insurance rate maps for the project area (Federal Emergency Management Agency [FEMA], 2008), the project site is not located in the 100-year Flood Hazard Area. The site is located within “Other Flood Areas – Zone X,” which includes areas potentially subject to 500-year floods, areas of 100-year floods with average depths of less than one foot, and areas protected by levees.

## 11 FAULTING AND SEISMICITY

The site is in a seismically active area, as is the majority of southern California, and the potential for strong ground motion in the project area is considered significant during the design life of the proposed project. Figure 5 shows the approximate site location relative to the major faults in the region. The site is not located within a State of California Earthquake Fault Zone (EFZ) (formerly known as an Alquist-Priolo Special Studies Zone) (California Geological Survey [CGS], 2018).

The nearest mapped active fault to the site is the Newport Inglewood fault located approximately 3.7 miles southwest of the site (Jennings and Bryant, 2010) (Figure 5).

The principal seismic hazards evaluated at the subject site are surface fault rupture, ground motion, and liquefaction. A brief description of these principal seismic hazards is discussed in the following sections.

## 11.1 Surface Fault Rupture

Surface fault rupture is the offset or rupturing of the ground surface by relative displacement across a fault during an earthquake. Based on our review of referenced geologic and fault hazard data, the project site is not transected by known active faults. Therefore, the potential for surface rupture is relatively low. However, lurching or cracking of the ground surface as a result of nearby seismic events is possible.

## 11.2 Ground Motion

Considering the proximity of the site to active faults capable of producing a maximum moment magnitude of 6.0 or more, the project area has a high potential for experiencing strong ground motion. The 2022 California Building Code (CBC) specifies that the risk-targeted maximum considered earthquake ( $MCE_R$ ) ground motion response accelerations be used to evaluate seismic loads for design of buildings and other structures. Based on the shear wave velocity measurements performed at CPT-2, we calculated that the average shear wave velocity in the upper 100 feet (30 meters) of the subsurface profile ( $V_{s30}$ ) is approximately 850 feet per second (259 meters per second). In accordance with Chapter 20 of the American Society of Civil Engineers (ASCE) Publication 7-16 (2016) for the Minimum Design Loads and Associated Criteria for Building and Other Structures, the site classification is Site Class D.

In accordance with ASCE 7-16, the mapped  $MCE_R$  ground motion response accelerations were determined using the 2023 Applied Technology Council (ATC) seismic design tool (web-based). The  $MCE_R$  ground motion response accelerations are based on the spectral response accelerations for 5 percent damping in the direction of maximum horizontal response and incorporate a target risk for structural collapse equivalent to 1 percent in 50 years with deterministic limits. Spectral response acceleration parameters, consistent with the 2022 CBC, are provided in Section 13.3 for the evaluation of seismic loads on buildings and other structures.

ASCE 7-16 specifies that the potential for liquefaction and soil strength loss be evaluated, where applicable, for the maximum considered earthquake geometric mean ( $MCE_G$ ) peak ground acceleration adjusted for site effects ( $PGA_M$ ). The  $PGA_M$  is based on the geometric mean peak

ground acceleration with a 2 percent probability of exceedance in 50 years. The  $PGA_M$  was calculated as 0.878g using the 2023 ATC seismic design tool.

### 11.3 Liquefaction

Liquefaction is the phenomenon in which loosely deposited granular soils with silt and clay contents of less than approximately 35 percent and non-plastic silts located below the water table undergo rapid loss of shear strength when subjected to strong earthquake-induced ground shaking. Ground shaking of sufficient duration results in the loss of grain-to-grain contact due to a rapid rise in pore water pressure and causes the soil to behave as a fluid for a brief period of time. Liquefaction is known generally to occur in saturated or near saturated cohesionless soils at depths shallower than 50 feet. Factors known to influence liquefaction potential include composition and thickness of soil layers, grain size, relative density, groundwater level, degree of saturation, and both intensity and duration of ground shaking.

The State of California Hazard Zones map (CDMG, 1999) indicates that the subject site is located in an area mapped as being potentially susceptible to liquefaction (Figure 6). Accordingly, we evaluated the liquefaction potential of the subsurface soils at the site. Our analysis was performed using the CPT data collected from CPT-1 and CPT-2. The liquefaction analysis was based on the National Center for Earthquake Engineering Research procedure (Youd, et al., 2001) using the computer program LiquefyPro (CivilTech Corporation, 2008). A historic high depth to groundwater of 8 feet below the existing ground surface, a  $PGA_m$  of 0.878g, and a design earthquake magnitude of 7.3 were used in our analyses. Our analysis indicates that the granular soil layers occurring below the historic high groundwater level of 8 feet, in the event that the groundwater was to rise from its current depth of approximately 50 feet, are susceptible to liquefaction during the design seismic event.

### 11.4 Dynamic Settlement

As a result of liquefaction, the proposed improvements may be subject to liquefaction-induced settlement. In order to estimate the amount of dynamic settlement of saturated soils, the method proposed Ishihara and Yoshimine (1992) was used. Based on our analysis, post-earthquake settlements of up to approximately 4½ inches were calculated at both CPT locations. Based on the guidelines presented in CGS Special Publication 117A (2008) and assuming relatively uniform subsurface stratigraphy across the site, we estimate a differential dynamic settlement on the order of 2 inches over a horizontal distance of about 60 feet.

## 12 CONCLUSIONS

Based on the results of our evaluation, it is our opinion that the proposed project and associated improvements at Lynwood City Park are feasible from a geotechnical standpoint, provided the recommendations presented in this report are incorporated into the design and construction of the project. In general, the following conclusions were made:

- The subject site is generally underlain by up to approximately 1 foot of undocumented fill. The fill is underlain by young alluvial deposits consisting of interbedded moist, loose to very dense, poorly graded sand with silt, silty sand, and silt with variable amounts of sand, and stiff to very stiff, silt and sandy lean clay.
- Our percolation testing indicates that the on-site soils at the approximate invert depth of the infiltration gallery (approximately 20 feet) have an adjusted percolation rate of 0.01 inch per hour. We recommend using this value for design of the gallery; however, this rate should be adjusted as needed in accordance with the 2021 CLADPW guidelines. For planning purposes, shallow infiltration BMPs, if included with the project, can be designed using an adjusted percolation rate of ½ inch per hour.
- In general, excavations and drilling in the existing fill soil and young alluvium should be feasible with earthmoving equipment in good working condition.
- We anticipate that the on-site excavated materials should be suitable for re-use as engineered fill and trench backfill provided, they are free of trash, debris, roots, contamination, deleterious materials, and cobbles or hard lumps of material in excess of 4 inches in diameter. Processing of the materials to bring them near the laboratory optimum moisture content (i.e., drying and/or wetting) prior to use as fill should be planned by the contractor. In-situ moisture contents of collected soil samples ranged from approximately 8.6 to 36.3 percent.
- The on-site soils should be considered as Type C soils in accordance with United States Department of Labor Occupational Safety and Health Administration (OSHA) regulations. Accordingly, temporary excavations deeper than 4 feet in depth should be shored or laid back at inclinations of 1½ to 1 (horizontal to vertical) or flatter.
- Where excavations cannot be laid back, temporary shoring is anticipated. Shoring should be designed by the contractor to support the excavation sidewalls and to reduce the potential for settlement of adjacent structures, roadways and other site improvements. Shoring should be designed in accordance with OSHA regulations.
- Groundwater was encountered in one of our exploratory borings at a depth of approximately 43.3 and in our CPTs at depths of approximately 43.4 and 55.5 feet. These depths are similar to groundwater monitoring data reviewed from three other sites within approximately 1 mile of the project site. The historic high depth to groundwater is mapped as being approximately 8 feet (CDMG, 1998). Fluctuations in the level of groundwater will occur due to variations in ground surface topography, subsurface stratification, rainfall, irrigation practices, groundwater pumping, and other factors that were not evident at the time of our field evaluation.
- The site is located within a mapped Seismic Hazards Zone considered susceptible to liquefaction (CDMG, 1999). Based on our liquefaction analysis, the site is considered to be potentially liquefiable during a seismic event. A total dynamic settlement of approximately 4½ inches was calculated for the site. In addition, we estimated the differential dynamic settlement is approximately 2 inches over a horizontal span of 60 feet.

- The site is not located within an EFZ with the potential for fault rupture as defined by the Alquist-Priolo Earthquake Fault Zoning Act (CGS, 2018). The probability of surface fault rupture at the site is considered to be low.
- Based on the results of our laboratory testing, hydro-collapse of the on-site soils resulting from on-site infiltration is not considered a design issue.
- The site is not located within a designated flood inundation zone from the 100-year flood event (FEMA, 2008).
- Based on our laboratory corrosion testing, the on-site soil can be classified as corrosive per the 2021 Caltrans Corrosion Guidelines.

## 13 RECOMMENDATIONS

The following sections present our geotechnical recommendations for design and construction of the project. This project is in preliminary design phase and some aspects of the design will be subject to change. Ninyo & Moore should review the final plans and develop additional geotechnical recommendations as appropriate. These recommendations are based on our evaluation of the site geotechnical conditions, our understanding of the planned construction, and experience in the vicinity of the project. The work should be performed in conformance with the recommendations presented in this report, project specifications, and appropriate agency standards.

### 13.1 Earthwork

We anticipate that earthwork at the site will consist of cuts and fills associated with the construction of the proposed BMP gallery and associated improvements, including the diversion structures, actuated valves, hydrodynamic separators, pump station, and pre-cast concrete subsurface structure, , and trenching and backfilling of underground utilities and pipelines. Based on our understanding of the project, we anticipate that excavations for the proposed BMP gallery and associated improvements/pipelines will have an invert dept of approximately 20 feet below the ground surface. Earthwork operations should be performed in accordance with the requirements of applicable governing agencies and the recommendations presented in the following sections.

#### 13.1.1 Pre-Construction Conference

We recommend that grading and foundation plans be submitted to Ninyo & Moore for review to check for conformance to the recommendations provided in this report. We further recommend that a pre-construction conference be held to discuss the grading recommendations presented in this report. The owner and/or their representative, the governing agencies' representatives, the civil engineer, Ninyo & Moore, and the contractor

should be in attendance to discuss the work plan, project schedule, and earthwork requirements.

### **13.1.2 Clearing and Site Preparation**

Prior to performing excavations or other earthwork, the site should be cleared of existing site improvements and foundations, gravel, debris, vegetation, and loose or otherwise unsuitable soils. Materials generated from the clearing/demolition operations should be removed from the project site and disposed of at a legal dump site. Existing utilities to remain in-place should be located and protected from damage by construction activities. Excavations resulting from the removal of foundations, underground utilities, and/or other underground improvements, should be backfilled with compacted fill in general accordance with the fill and compaction recommendations presented below.

### **13.1.3 Excavation Characteristics**

We anticipate that excavations in the undocumented fill and young alluvium should be feasible with earthmoving equipment in good working order. The undocumented fill and young alluvial materials generally consisted of moist, loose to very dense, poorly graded sand with silt, silty sand, and silt with variable amounts of sand, and stiff to very stiff, silt and sandy lean clay. Oversize material is not considered suitable for use as backfill. In the event that oversize material, including cobbles and/or construction debris is encountered during excavation operations, the oversized material should be disposed of off-site. Processing of the excavated materials to bring them near the laboratory optimum moisture content (i.e., drying and/or wetting) prior to use as fill should be planned by the contractor. In-situ moisture contents of on-site soils ranged from approximately 8.6 to 36.3 percent. Contractors should make their own independent evaluation of the excavatability of the on-site materials prior to submitting their bids, including allowances for processing the soils.

### **13.1.4 Subgrade Preparation for the Infiltration Gallery**

Based on our exploratory borings and CPTs, alluvial deposits are anticipated to be encountered at the bottom of the planned infiltration gallery that should be suitable for support of the gallery and compacted fill placed to bury the gallery. The excavation bottom should be evaluated by our representative during the excavation work. In the event that unsuitable material is encountered along the bottom of the excavation, including undocumented fill, the unsuitable material should be removed and replaced with loosely packed clean sand or gravel, such as drainage rock. The actual recommendations for removal and replacement should be based on our field observations. We recommend that minimal compaction be performed on the exposed subgrade, materials used to replace unsuitable materials (if

needed), and/or rock blanket placed beneath the gallery. Compaction of the subgrade could potentially reduce the infiltration rate of the gallery. If the subgrade of the infiltration gallery is compacted, we recommend that additional percolation testing be performed. If a rock blanket is used beneath the gallery, we recommend that it consist of ¾-inch to 1½-inch diameter, open-graded gravel underlain by filter fabric consisting of Mirafi 140N or equivalent.

If foundations are to be installed along the bottom of the gallery, such as strip footings, the upper approximately 8 inches of subgrade, only beneath the foundations, should be scarified, moisture-conditioned to near optimum moisture content, and recompact to a relative compaction of 90 percent as evaluated by ASTM International (ASTM) test method D 1557. If unsuitable materials, including undocumented fill, loose/soft, and/or wet materials, are encountered along the excavation bottom that extend beneath the proposed footings, specific recommendations for removal and replacement of these materials, if warranted, will be provided by our firm based on field observations. The excavation bottoms should be evaluated by our representative during the excavation work.

#### **13.1.5 Treatment of Near-Surface Soils for Buried and At-Grade Structures and Site Pavements**

In order to provide suitable support and reduce the potential for settlement of proposed buried structures (i.e., the diversion structures, hydro-dynamic separators, valves, etc.) and at-grade structures, if any, we recommend that the existing undocumented fill and upper loose alluvial deposits be removed and recompact from beneath the footprints of these structures. The excavations should extend deep enough to provide 2 feet or more of newly compacted fill material beneath the proposed foundations. The overexcavation should expose relatively dense alluvial deposits. Additional overexcavation of loose, soft, and/or wet areas may be appropriate. The excavation bottoms should be evaluated by our representative during the excavation work and additional recommendations, if needed, will be based on field observations. The limits of removal should extend approximately 2 feet beyond the footprint of the foundations for the buried structures and 5 feet for the at-grade structures, or a distance equal to the depth of the overexcavations beneath the foundations, whichever is farther. If drainage rock is placed beneath the foundations for the buried structures, the rock can be considered part of the 2-foot-thick layer of compacted fill beneath the foundations. Prior to placing compacted fill and/or drainage rock, the upper approximately 8 inches of the exposed bottom should be scarified, moisture-conditioned to near optimum moisture content, and recompact to a relative compaction of 90 percent as evaluated by ASTM D 1557.

In order to provide suitable support and reduce the potential settlements of hardscape (i.e., sidewalks, curbs and gutters, ribbon drains, etc.), we recommend that the subgrade materials beneath the proposed hardscape areas be scarified to a depth of approximately 1 foot, moisture-conditioned to near optimum moisture content, and recompact. The limits of the scarification should extend laterally 2 feet beyond the outside edge of hardscape. The exposed subgrade should be evaluated by our representative during the excavation work. Loose, soft, and/or wet areas may need to be overexcavated, depending on our observations during construction. Prior to placing new compacted fill in areas that are overexcavated and/or in areas where the existing subgrade will be raised with new fill, the exposed bottom should be scarified, moisture-conditioned, and recompact to a depth of approximately 8 inches.

### **13.1.6 Temporary Excavations**

We recommend that excavations be designed and constructed in accordance with OSHA regulations. These regulations provide shoring design parameters for excavations and trenches up to 20 feet deep based on the soil types encountered. Trenches over 20 feet deep should be designed by the contractor's engineer based on site-specific geotechnical analyses. For planning purposes, we recommend that the undocumented fill and alluvial soils be considered as OSHA Type C soil.

For trench or other excavations, OSHA requirements regarding personnel safety should be met by using appropriate shoring or by laying back the slopes no steeper than 1½:1 (horizontal to vertical). Temporary excavations that encounter seepage may need shoring or may be mitigated by placing sandbags or gravel along the base of the seepage zone. Excavations encountering seepage should be evaluated on a case-by-case basis. On-site safety of personnel is the responsibility of the contractor.

Care should be taken by the contractor to avoid undermining adjacent existing foundations and improvements. New excavations should not extend within the "zone of influence" of existing foundations, which is defined as a 1:1 (horizontal to vertical) plane projecting out from the bottom outside edge of the foundations. In the event that excavations will extend within the "zone of influence" of existing foundations, our office should be notified, and appropriate recommendations provided, such as temporary underpinning of impacted foundations and/or temporary shoring.

### 13.1.7 Shoring

Where temporary slopes are not possible, shoring will be appropriate. The design of the shoring system should consider the excavation characteristics of the onsite soil, temporary excavation stability, and the impact of construction on existing structures.

Shoring systems will be constructed through fill and alluvial deposits. We anticipate that braced driven sheet pile shoring systems will be appropriate for the project to depths up to approximately 30 feet. Cantilevered shoring systems (if used) should be limited to heights of up to about 10 feet. Braced and cantilevered shoring systems should be designed using the lateral earth pressure values presented on Figures 7 and 8, respectively. The recommended design pressures are based on the assumptions that the shoring system is constructed without raising the ground surface elevation behind the shoring wall, that there are no surcharge loads, such as soil stockpiles and construction materials, and that no loads act above a 1:1 (horizontal to vertical) plane extending up and back from the base of the shoring system. For shoring walls subjected to the above-mentioned surcharge loads, the contractor should include the effect of these loads on the lateral pressures against the shoring system. The shoring systems planned for the project should be reviewed by our office to evaluate the design considerations and geotechnical parameters used. Ground settlement may occur behind the shoring system wall during excavation. The amount of settlement depends on the type of shoring system, the contractor's workmanship, and soil conditions. We recommend that structures/improvements in the vicinity of the planned shoring installation be reviewed with regard to foundation support and tolerance to settlement. To reduce the potential for distress to adjacent structures, we recommend that the shoring system be designed to limit the ground settlement behind the shoring system to  $\frac{1}{2}$  inch or less, which would equal approximately  $\frac{1}{2}$  inch of deflection. Potential causes of settlement that should be addressed include settlement during installation of the shoring, excavation for structure construction, construction vibrations, and removal of the support system. The vibrations from the driving of sheet piles, if used, may result in some dynamic settlement of granular soils that may affect the adjacent structures. We recommend that shoring installation be evaluated carefully by the contractor prior to construction and that ground vibration and settlement monitoring be performed during construction. Vibration and settlement monitoring should be performed during sheet pile driving, if used. If settlement is detected or peak particle velocities of approximately 0.4 inch per second (ips) or more are measured adjacent to existing improvements, the sheet pile driving should be stopped and evaluated. The evaluation may include changing the hammer vibration frequency and monitoring for settlement and vibrations. To reduce the potential for settlement associated with sheet pile removal, sheet

piles may be left in place. In the event excessive settlement or other damage occurs associated with the pile driving operations, it may be appropriate to perform grouting beneath nearby structure(s) to mitigate the pile driving effects. We recommend that shoring installation be evaluated carefully by the contractor prior to construction.

The contractor should retain a licensed, qualified and experienced engineer to design the shoring system. The shoring parameters presented in this report are minimum requirements, and the contractor should evaluate the adequacy of these parameters and make the modifications as needed for their design. We recommend that the contractor take appropriate measures to protect workers. OSHA requirements pertaining to worker safety should be observed.

#### **13.1.8 Fill Material**

In general, the on-site soils should be suitable for reuse as fill materials, provided they are free of trash, debris, oversize material, or other deleterious materials. Fill should generally be free of rocks or lumps of material in excess of 4 inches in diameter. Rocks or hard lumps larger than approximately 4 inches in diameter should be broken into smaller pieces or should be removed from the site.

Fill used as backfill against the gallery structure and other buried structures should consist of free-draining, granular, non-expansive soil that conforms with the latest edition of Greenbook for structure backfill. “Non-expansive” can be defined as soil having an expansion index (EI) of 20 or less in accordance with ASTM Test Method D 4829 (CBC, 2022).

Imported fill material should consist of clean, non-expansive, granular material which also conforms to the latest addition of Greenbook for structure backfill. The soil should also be tested for corrosive properties prior to importing. We recommend that the imported materials meet the 2021 Caltrans criteria for non-corrosive soils (i.e., soils having a chloride concentration of 500 parts per million [ppm] or less, a soluble sulfate content of approximately 0.15 percent (1,500 ppm) or less, a pH value of 5.5 or higher, or an electrical resistivity of 1,500 ohm-centimeters or more). Materials for use as fill should be evaluated by Ninyo & Moore prior to importing. The contractor should be responsible for the uniformity of import material brought to the site.

#### **13.1.9 Fill Placement and Compaction**

Fill should be placed and compacted in accordance with project specifications, the requirements of the City of Lynwood, and sound construction practices. Fill materials should

be moisture conditioned to slightly above the optimum laboratory moisture content. The lift thickness for fill soils will vary depending on the type of compaction equipment used, but should generally be placed in horizontal lifts not exceeding 8 inches in loose thickness. Fill materials should be compacted to a relative compaction of 90 percent as evaluated by ASTM D 1557. The upper 12 inches of pavement subgrade materials should be compacted to a relative compaction of 95 percent as evaluated by ASTM D 1557. Special care should be taken to avoid pipe damage when compacting trench backfill above pipes. Fill should be tested for specified compaction level by Ninyo & Moore.

## **13.2 Underground Utilities**

We anticipate that underground pipelines will be supported on native alluvial deposits. Based on our understanding of the project, pipeline inverts may be on the order of 20 feet in depth.

### **13.2.1 Pipe Bedding**

We recommend that pipes be supported on 6 inches or more of granular bedding material, such as sand, with a sand equivalent (SE) value of 30 or more. Bedding material should be placed around the pipe and 12 inches or more above the top of the pipe in accordance with the current Greenbook. Special care should be taken not to allow voids beneath the pipe. Compaction of the bedding material and backfill should proceed up both sides of the pipe. Trench backfill, including bedding material, should be placed in accordance with the recommendations presented in the Earthwork section of this report.

### **13.2.2 Trench Backfill**

Based on our subsurface evaluation, the on-site soils should generally be suitable for re-use as trench backfill provided, they are free of organic material, clay lumps, debris, and rocks more than approximately 4 inches in diameter. We recommend that trench backfilling be in general conformance with the Greenbook standard specifications for structure backfill. Fill should be moisture-conditioned to at or slightly above the laboratory optimum. Wet soils should be allowed to dry to a moisture content near the optimum prior to their placement as trench backfill. Trench backfill should be compacted to a relative compaction of 90 percent or more as evaluated by ASTM D 1557. Lift thickness for trench backfill will depend on the type of compaction equipment utilized but should generally be placed in horizontal lifts not exceeding 8 inches in loose thickness. Special care should be exercised to avoid damaging the pipelines during compaction of the backfill.

### 13.2.3 Modulus of Soil Reaction for Pipe Design

The modulus of soil reaction is used to characterize the stiffness of soil backfill placed along the sides of buried flexible pipelines for the purpose of evaluating deflection caused by the weight of the backfill above the pipe. We recommend that a modulus of soil reaction of 1,000 pounds per square inch be used for design, provided that granular bedding material is placed adjacent to the pipe, as recommended in the previous section.

## 13.3 Seismic Design Considerations

Design of the proposed improvements should be performed in accordance with the requirements of governing jurisdictions and applicable building codes. Table 2 presents the spectral response acceleration parameters in accordance with the CBC (2022) guidelines.

| Table 2 – 2022 California Building Code Seismic Design Criteria                            |        |
|--------------------------------------------------------------------------------------------|--------|
| Site Coefficients and Spectral Response Acceleration Parameters                            | Values |
| Site Class                                                                                 | D      |
| Mapped Spectral Response Acceleration at 0.2-second Period, $S_s$                          | 1.713  |
| Mapped Spectral Response Acceleration at 1.0-second Period, $S_1$                          | 0.611  |
| Spectral Response Acceleration at 0.2-second Period, $S_{MS}$                              | 2.056  |
| Spectral Response Acceleration at 1.0-second Period, $S_{M1}$                              | 1.039  |
| Design Spectral Response Acceleration at 0.2-second Period, $S_{DS}$                       | 1.371  |
| Design Spectral Response Acceleration at 1.0-second Period, $S_{D1}$                       | 0.692  |
| Maximum Considered Earthquake Geometric Mean ( $MCE_G$ ) Peak Ground Acceleration, $PGA_M$ | 0.878g |

## 13.4 Foundations

Our evaluation indicated a liquefaction-induced total settlement up to 4½ inches and a liquefaction-induced differential settlement of 2 inches over a horizontal span of about 60 feet are anticipated on-site during the design seismic event. Based on the differential settlement threshold provided in ASCE 7-16 Table 12.13-3 (ASCE, 2016) for a Risk Category III single-story structure such as the proposed improvements, the threshold differential settlement is 2.4 inches over a horizontal distance of 40 feet. Accordingly, it is our opinion that the proposed infiltration gallery may be supported on spread footings (i.e., strip footings) and that other underground structures (i.e., diversion structures, pre-treatment unit, etc.) may be supported on mat foundations. The following are our recommendations for project foundations:

### 13.4.1 Spread Footing

Spread footings for the infiltration gallery (i.e., strip footings) should be placed directly on low expansion alluvial materials and/or compacted fill in accordance with the recommendations presented in the Earthwork section of this report. Continuous and isolated footings should have a width of 24 inches or more. Continuous footings should be reinforced with two No. 4 steel reinforcing bars, one placed near the top and one placed near the bottom of the footings, and further detailed in accordance with the recommendations of the structural engineer.

Footings, as described above and bearing on dense alluvial materials or compacted fill, may be designed using a net allowable bearing capacity of 3,000 pounds per square foot (psf). Total and differential settlements for footings designed in accordance with the above recommendations are estimated to be less than approximately 1 inch and ½ inch over a horizontal span of 40 feet, respectively.

Footings bearing on dense alluvial materials or compacted fill may be designed using a coefficient of friction of 0.35, where the total frictional resistance equals the coefficient of friction times the dead load. Footings may be designed using a passive resistance value of 350 psf per foot of depth, with a maximum value of 3,500 psf. The allowable lateral resistance can be taken as the sum of the frictional resistance and passive resistance, provided the passive resistance does not exceed one-half of the total allowable resistance. The passive resistance (including the maximum value) may be increased by one-third when considering loads of short duration such as wind or seismic forces.

#### **13.4.2 Mat Foundation**

Mat foundations for other underground structures (i.e., diversion structure, hydro-dynamic separator, pump station, valves, filtration unit, etc.) may be supported on compacted fill in accordance with the recommendations presented in the Earthwork section of this report. Foundations should be designed in accordance with the structural considerations and the following recommendations. In addition, requirements of the appropriate governing jurisdictions and applicable building codes should be considered in the design of the structures.

The mat foundations may be designed using a net allowable bearing capacity of 2,500 psf. The total and differential settlement corresponding to this allowable bearing load are estimated to be less than approximately 1 inch and ½ inch over a horizontal span of 40 feet, respectively.

Mat foundations typically experience some deflection due to loads placed on the mat and the reaction of the soils directly underlying the mat. A design modulus of subgrade reaction (K) of 100 tons per cubic foot may be used for the compacted subgrade soils in evaluating such deflections.

### **13.5 Lateral Earth Pressures for Underground Structures**

Walls for below-grade structures when constructed as recommended above may be designed for lateral earth pressures represented by the earth pressure diagram on Figure 9. To reduce the potential for pipe-to-wall differential settlement caused by dynamic loading, which could cause

pipe shearing, we recommend that a flexible pipe joint be located close to the exterior of the wall. The type of joint should be such that minor relative movement can be accommodated without distress. The pipe connections should be sufficiently flexible to withstand differential settlement of approximately 2 inches.

### **13.6 Exterior Flatwork**

We recommend that new exterior concrete sidewalks and flatwork (hardscape) have a thickness of 4 inches. The hardscape should be underlain by 4 inches of clean sand and installed with crack-control joints at an appropriate spacing as designed by the structural engineer to reduce the potential for shrinkage cracking. Positive drainage should be established and maintained adjacent to flatwork. To reduce the potential for differential offset, joints between the new hardscape and adjacent curbs, existing hardscape, building walls, and/or other structures, and between sections of new hardscape, should be doweled.

### **13.7 Corrosivity**

Laboratory testing was performed on two representative soil samples collected from boring B-1 at a depth of approximately 4½ to 5 feet and from boring B-2 at a depth of approximately 8 to 9½ feet to evaluate soil pH, electrical resistivity, water-soluble chloride content, and water-soluble sulfate content. The soil pH and electrical resistivity tests were performed in general accordance with CT 643. Chloride content tests were performed in general accordance with CT 422. Sulfate testing was performed in general accordance with CT 417.

The soil pH of the samples tested from borings B-1 and B-2 was measured to be 7.4 and 7.3 and the electrical resistivity was measured to be 8,745 and 580 ohm-centimeters, respectively. The chloride content of the samples was measured to be 60 and 650 ppm. The sulfate content of the samples was measured to be 0.007 and 0.018 percent by weight (i.e., 70 and 180 ppm). Based on the laboratory test results and 2021 Caltrans corrosion criteria, the soils at the project site can be classified as corrosive, which is defined as having earth materials with more than 500 ppm chlorides, more than 0.15 percent sulfates (i.e., 1,500 ppm), a pH of 5.5 or less, or an electrical resistivity of 1,500 ohm-cm or less. The corrosivity test results are presented in Appendix D.

### **13.8 Concrete Placement**

Concrete in contact with soil or water that contains high concentrations of water-soluble sulfates can be subject to premature chemical and/or physical deterioration. Based on the CBC (2022), the potential for sulfate attack is negligible for water-soluble sulfate contents in soil ranging from 0.00 to 0.10 percent by weight, moderate for water-soluble sulfate contents ranging from 0.10 to 0.20 percent by weight, severe for water-soluble sulfate contents ranging from 0.20 to

2.00 percent by weight, and very severe for water-soluble sulfate contents over 2.00 percent by weight. The soil samples tested for this evaluation, using CT 417, indicate water-soluble sulfate contents of approximately 0.007 and 0.018 percent by weight (i.e., 70 and 180 ppm). Accordingly, the on-site soils are considered to have a negligible to moderate potential for sulfate attack. Per ACI (2019b), Type II cement is appropriate for the site improvements. However, due to the potential variability of the soils on site, consideration should be given to using Type II/V cement for the project.

To reduce the potential for shrinkage cracks in the concrete during curing, we recommend that the concrete for the proposed improvements be placed with a slump of 4 inches based on ASTM C 143. The slump should be checked periodically at the site prior to concrete placement. We further recommend that concrete cover over reinforcing steel for foundations be provided in accordance with CBC (2022). The structural engineer should be consulted for additional concrete specifications.

### **13.9 Stormwater Infiltration Gallery**

Based on our subsurface evaluation, the park is generally underlain by undocumented fill over young alluvial deposits consisting of interbedded sandy silt, silt with sand, and clay in the upper approximately 19 to 38 feet and silty sand with interbeds of silt and clay below these depths. Since the gallery invert is located within the upper zone of finer deposits, we recommend that an infiltration rate of 0.01 inch per hour, following adjustments by the BMP designer for  $RF_s$ , be used for design at Lynwood City Park for the infiltration gallery. We recommend that the bottom of the infiltration gallery be further evaluated during construction.

Based on our evaluation, the potential for hydro-collapse settlement associated with infiltration is generally low due to the proposed depth of infiltration. However, we generally recommend a setback of 15 feet or more between settlement sensitive structures and proposed infiltration areas.

### **13.10 Drainage**

Appropriate surface drainage is imperative for satisfactory site performance. Positive drainage should be provided and maintained to direct surface water away from existing foundations. Positive drainage is defined as a slope of 2 percent or more for a distance of 5 feet or more away from foundations and tops of slopes. Runoff should then be directed by the use of swales or pipes into a collective drainage system. Area drains for landscaped and paved areas are recommended. Surface waters should not be allowed to pond adjacent to footings. We recommend that above-ground structures, if constructed, have roof drains and downspouts installed to collect runoff.

### 13.11 Landscaping

Project landscaping should consist of drought tolerant plants. Landscape irrigation should be kept to a level just sufficient to maintain plant vigor. Overwatering should not be permitted.

## 14 CONSTRUCTION MONITORING PROGRAM

We recommend that pre-construction condition surveys be performed on structures and improvements within approximately 50 feet of the proposed excavations prior to construction. This distance should be extended to 100 feet adjacent to proposed excavations if driven and/or vibratory sheet or soldier piles are installed. This survey should include locating existing cracks and measuring widths of cracks, in combination with videotape documentation of existing conditions. In addition, interviews should be conducted with utility owners so that existing knowledge about the age, type, and maintenance history of affected utilities is available prior to construction.

### 14.1 Construction Vibrations

People can perceive vibrations from construction activities at significantly lower levels than might cause cosmetic damage to structures. Jones & Stokes (2004) indicate that transient vibrations, such as from pile driving or construction activities, may be noticeable, and therefore may result in complaints, at peak particle velocities as low as 0.02 to 0.06 inch per second (ips). The vibrations may be disturbing and result in complaints and/or damage claims at peak particle velocities as low as 0.2 to 0.4 ips. However, these vibration levels are well below the level considered to cause cosmetic damage to residential construction.

There is also the possibility of settlement of the soil during construction activities due to vibrations. This settlement may result in damage to structures. If the construction vibrations can be maintained below a peak particle velocity of 0.2 ips, it is anticipated the settlement can be limited to acceptable levels based on past projects in similar conditions.

For the above stated reasons, we recommend that seismographs be used in the early stages of construction to monitor the vibrations. Seismographs should be located near structures and improvements next to the construction activities. Additional seismographs should be located at various structures and improvements farther from construction activities to monitor vibrations as a function of distance from the sites. Periodic vibration monitoring is recommended during other construction activities. After review of the data obtained, the number of seismographs may be reduced at the discretion of the client and the geotechnical consultant.

## 14.2 Ground Surface Settlement

We recommend that arrays of ground surface settlement points be installed around the proposed excavations and trenchless pipeline sections. The contractor should submit a monitoring plan showing the proposed locations of settlement points for review and approval by the project engineer. We recommend that the contractor be responsible for maintaining total settlement at any survey point to less than ½ inch. If the settlements reach this limit, we recommend that a further review of construction methodologies be performed and appropriate changes be made.

## 14.3 Lateral Movement for Shoring Support System

We recommend that survey points be established behind excavations located in areas where existing structures are located above a 1:1 (horizontal to vertical) plane projected from the bottom of the proposed excavations to the ground surface. The survey points should be monitored and evaluated daily during excavation activities to provide an advanced warning system of potential problems. As discussed previously, we recommend that the shoring system be designed to limit the ground settlement behind the shoring system to ½ inch or less to reduce the potential for distress to adjacent structures and improvements. If settlement values reach ¼ inch, we recommend that a review of the contractor's methods be performed and appropriate changes be made, if needed.

## 15 CONSTRUCTION OBSERVATION

The recommendations provided in this report are based on our understanding of the proposed project and our evaluation of the data collected based on subsurface conditions disclosed by widely spaced exploratory borings. It is imperative that the geotechnical consultant checks the interpolated subsurface conditions during construction. We recommend that Ninyo & Moore review the project plans and specifications prior to construction. It should be noted that, upon review of these documents, some recommendations presented in this report may be revised or modified.

During construction we recommend that the duties of the geotechnical consultant include, but not be limited to:

- Observing site clearing, grubbing, and removals.
- Observing excavation bottoms, including the bottom of the proposed infiltration gallery.
- Observing preparation of pavement and foundation subgrades.
- Observing placement and compaction of fill, including trench backfill.
- Evaluating imported materials prior to their use as fill (if used).

- Performing field tests to evaluate fill compaction.
- Observing foundation excavations for bearing materials and cleaning prior to placement of reinforcing steel or concrete.
- Performing material testing services including concrete compressive strength and steel tensile strength tests and inspections.

The recommendations provided in this report assume that Ninyo & Moore will be retained as the geotechnical consultant during the construction phase of this project. If another geotechnical consultant is selected, we request that the selected consultant indicate to the owner and to our firm in writing that our recommendations are understood and that they are in full agreement with our recommendations.

## 16 LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analysis presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

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. Ninyo & Moore should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified, and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

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# FIGURES



**Ninyo & Moore**  
Geotechnical & Environmental Sciences Consultants

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# LEGEND

**B-3**  
TD=31.5

BORING;  
TD=TOTAL DEPTH IN FEET

**CPT-2**  
TD=100.2

CONE PENETRATION TEST;  
TD=TOTAL DEPTH IN FEET

**P-4**  
TD=21.5

PERCOLATION TEST;  
TD=TOTAL DEPTH IN FEET

**B-1**  
TD=51.5

BORING (ALBUS-KEEFE, 2017);  
TD=TOTAL DEPTH IN FEET

**B-3/P-2**  
TD=12.0

BORING/PERCOLATION TEST  
(ALBUS-KEEFE, 2017);  
TD=TOTAL DEPTH IN FEET

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. | REFERENCE: CRAFTWATER ENGINEERING, 2020.



**Parking Lot: Permeable  
Pavement and Bioswales**



**Pre-Cast Subsurface  
Infiltration Facility**

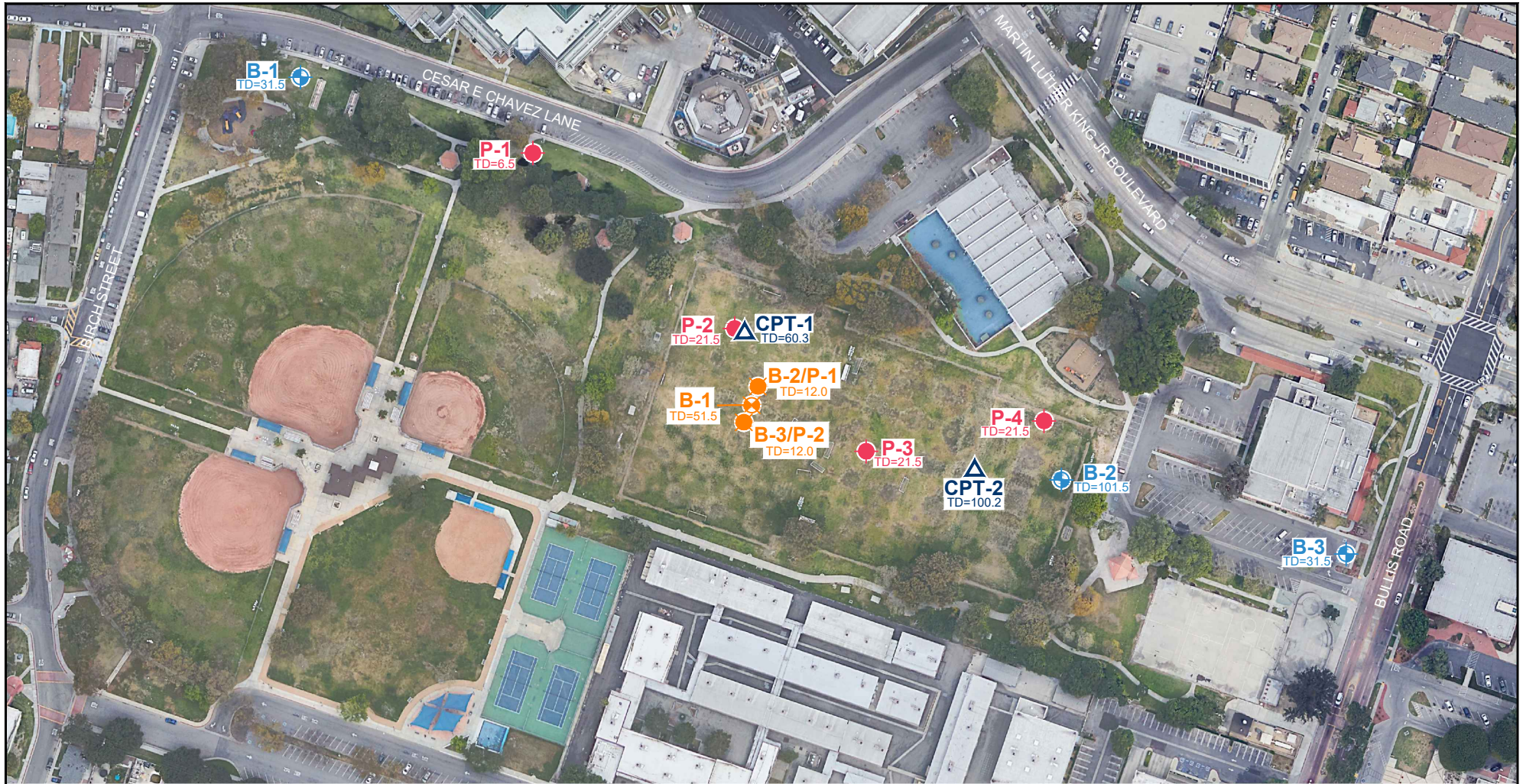


**Ephemeral Stream to butterfly**

**FIGURE 2**

## SITE PLAN

LYNWOOD CITY PARK STORMWATER CAPTURE PROJECT  
LYNWOOD, CALIFORNIA



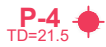
# LEGEND



**B-3**  
TD=31.5 BORING;  
TD=TOTAL DEPTH IN FEET



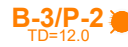
**CPT-2**  
TD=100.2 CONE PENETRATION TEST;  
TD=TOTAL DEPTH IN FEET



**P-4**  
TD=21.5 PERCOLATION TEST;  
TD=TOTAL DEPTH IN FEET



**B-1**  
TD=51.5 BORING (ALBUS-KEEFE, 2017);  
TD=TOTAL DEPTH IN FEET



**B-3/P-2**  
TD=12.0 BORING/PERCOLATION TEST  
(ALBUS-KEEFE, 2017);  
TD=TOTAL DEPTH IN FEET

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. | REFERENCE: GOOGLE EARTH, 2023.

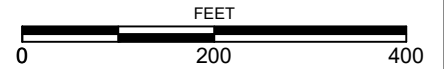
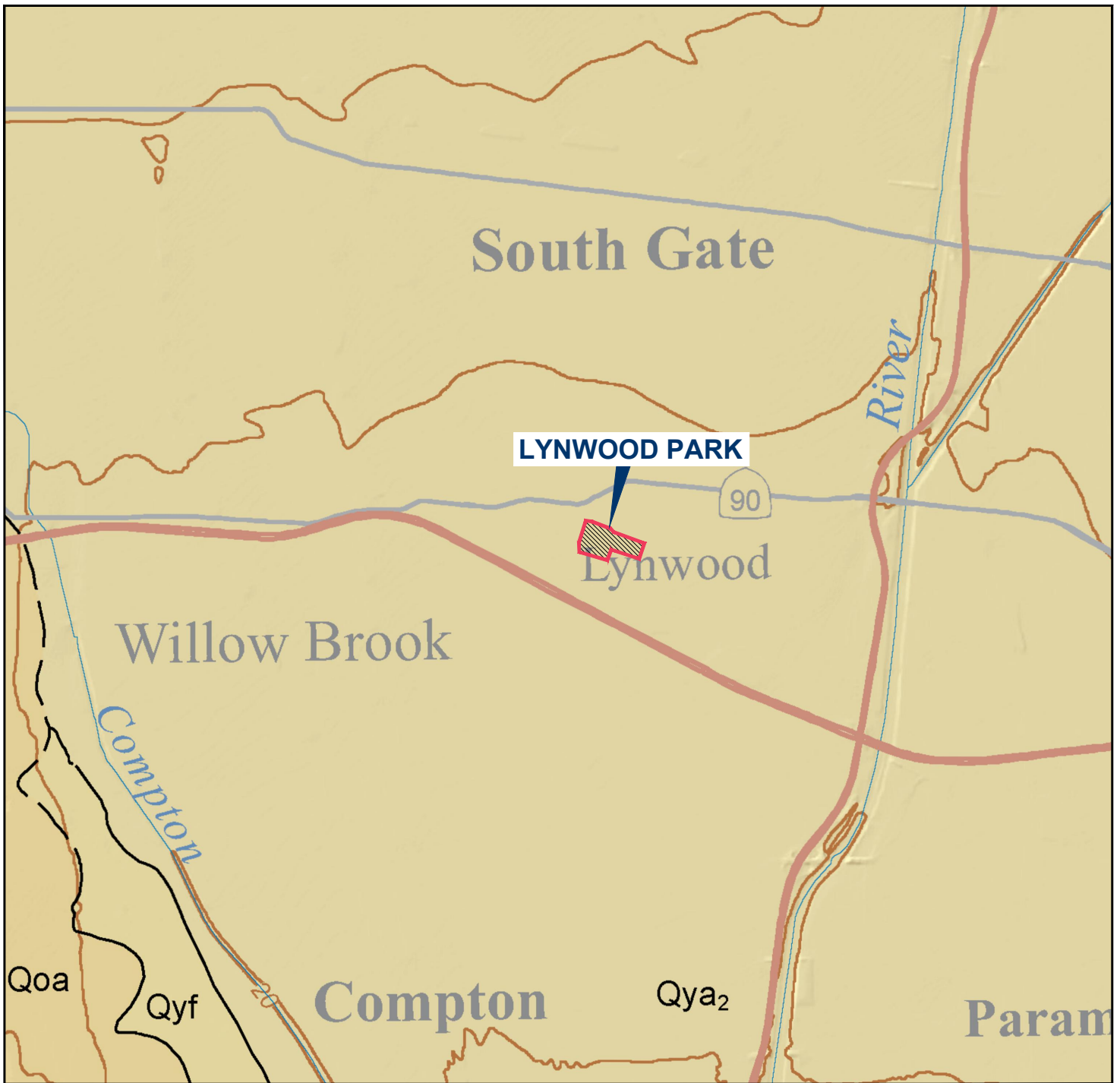


FIGURE 3

## BORING, CPT, AND PERCOLATION TEST LOCATIONS

LYNWOOD CITY PARK STORMWATER CAPTURE PROJECT  
LYNWOOD, CALIFORNIA



#### LEGEND

|                        |                             |            |                  |
|------------------------|-----------------------------|------------|------------------|
| <b>Qya<sub>2</sub></b> | YOUNG ALLUVIUM              | <b>Qoa</b> | OLD ALLUVIUM     |
| <b>Qyf</b>             | YOUNG ALLUVIAL FAN DEPOSITS |            | GEOLOGIC CONTACT |

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. | REFERENCE: SAUCEDO, ET AL., 2016.

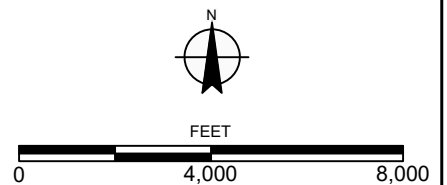
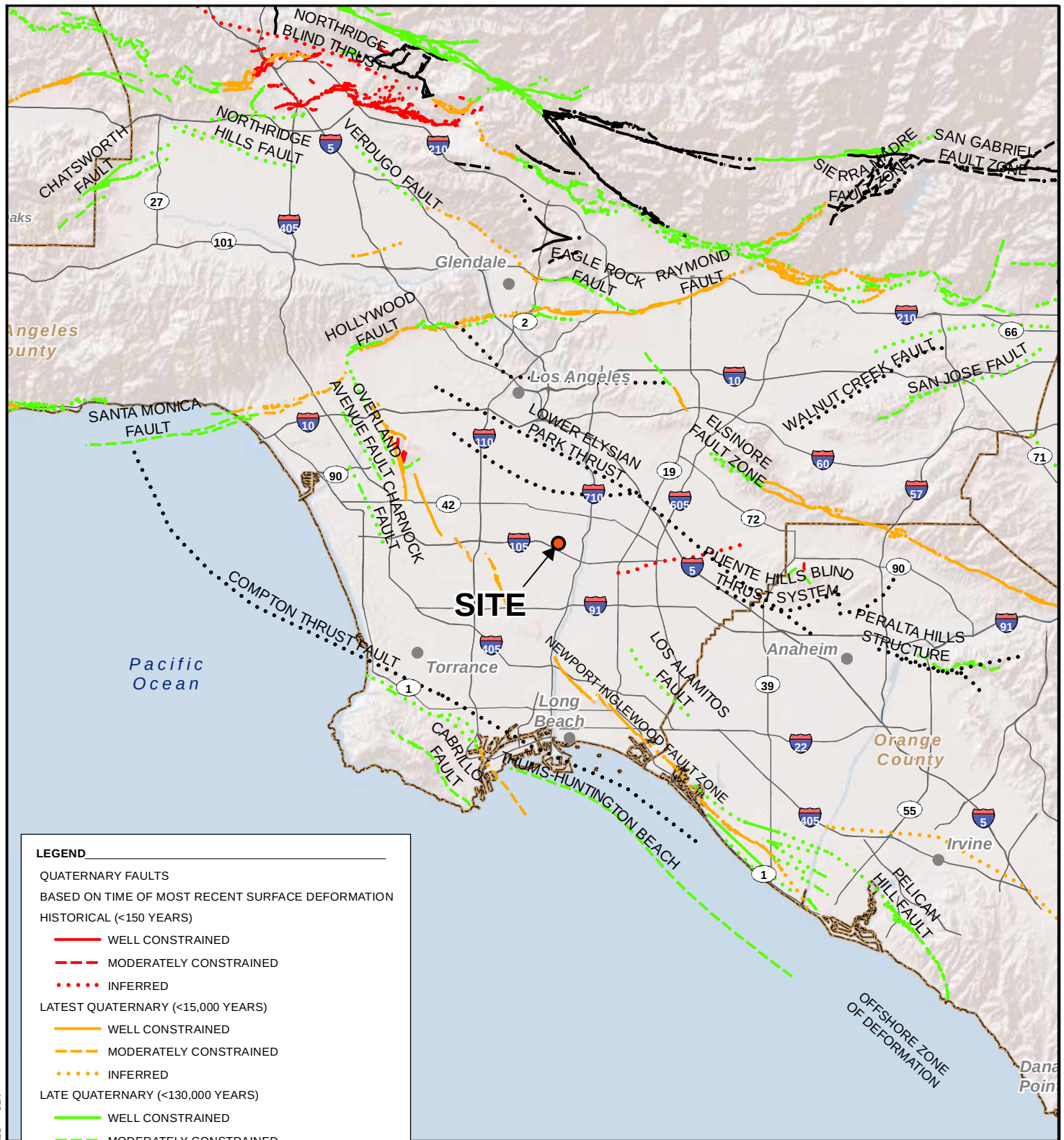


FIGURE 4



SOURCE: ESRI, 2023.



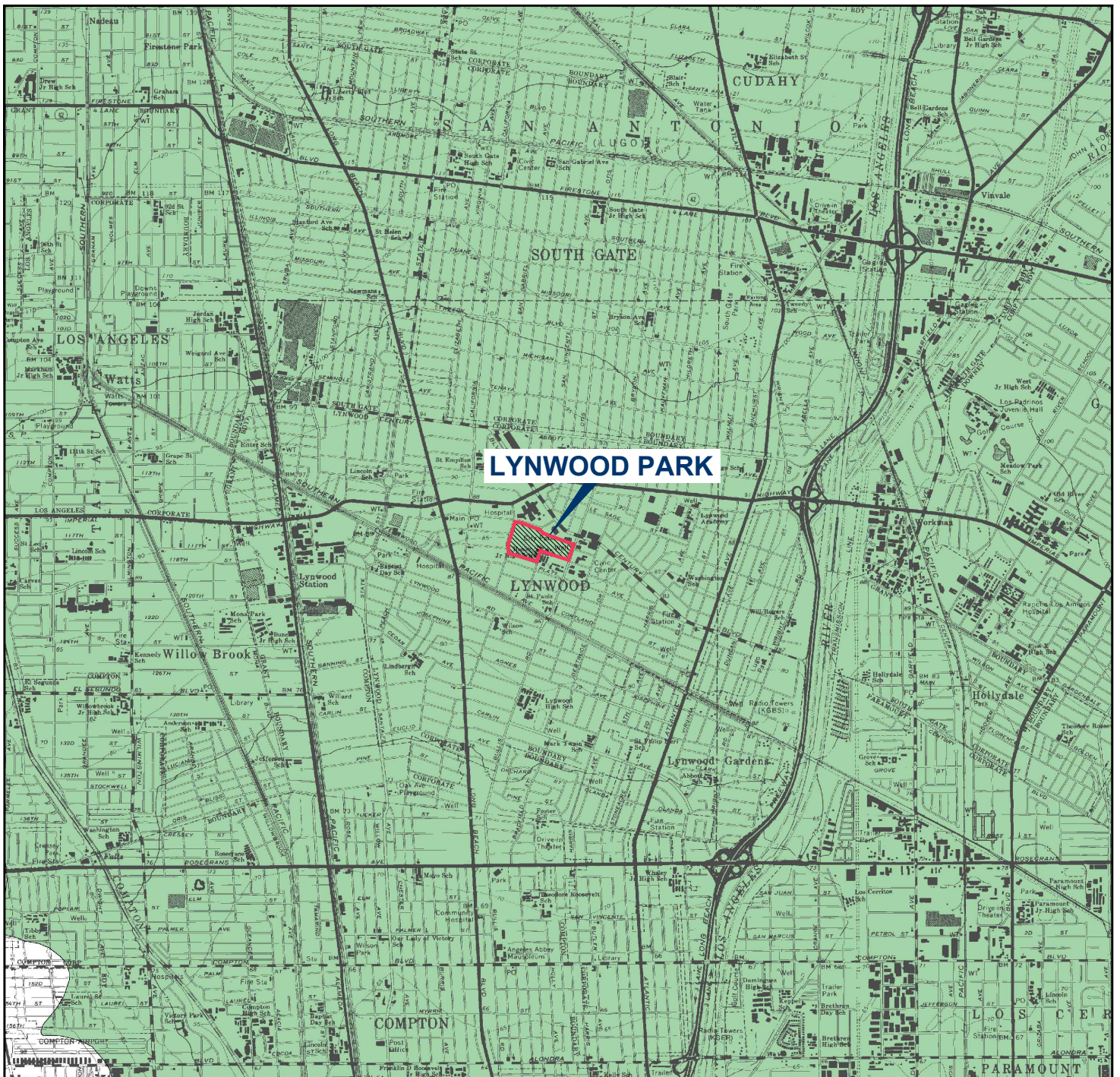
NOTE: DIRECTIONS, DIMENSIONS AND LOCATIONS ARE APPROXIMATE.

**FIGURE 5**

## FAULT LOCATIONS

LYNWOOD CITY PARK STORMWATER CAPTURE PROJECT  
LYNWOOD, CALIFORNIA

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## LEGEND



### LIQUEFACTION

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

NOTE: DIMENSIONS, DIRECTIONS AND LOCATIONS ARE APPROXIMATE. | REFERENCE: CDMG, 1999.

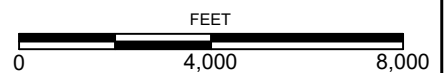
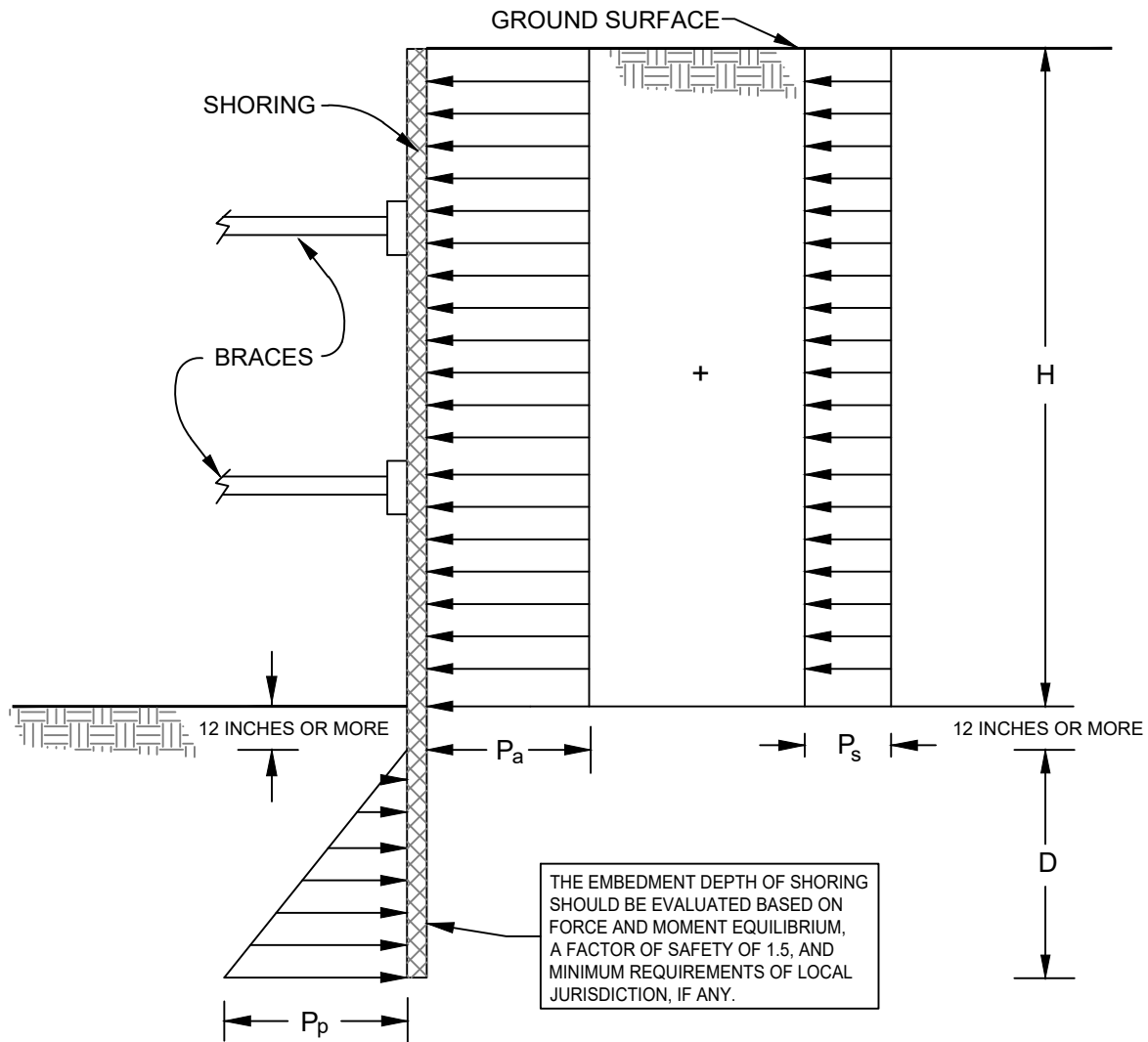


FIGURE 6

## SEISMIC HAZARD ZONES

LYNWOOD CITY PARK STORMWATER CAPTURE PROJECT  
LYNWOOD, CALIFORNIA



**NOTES:**

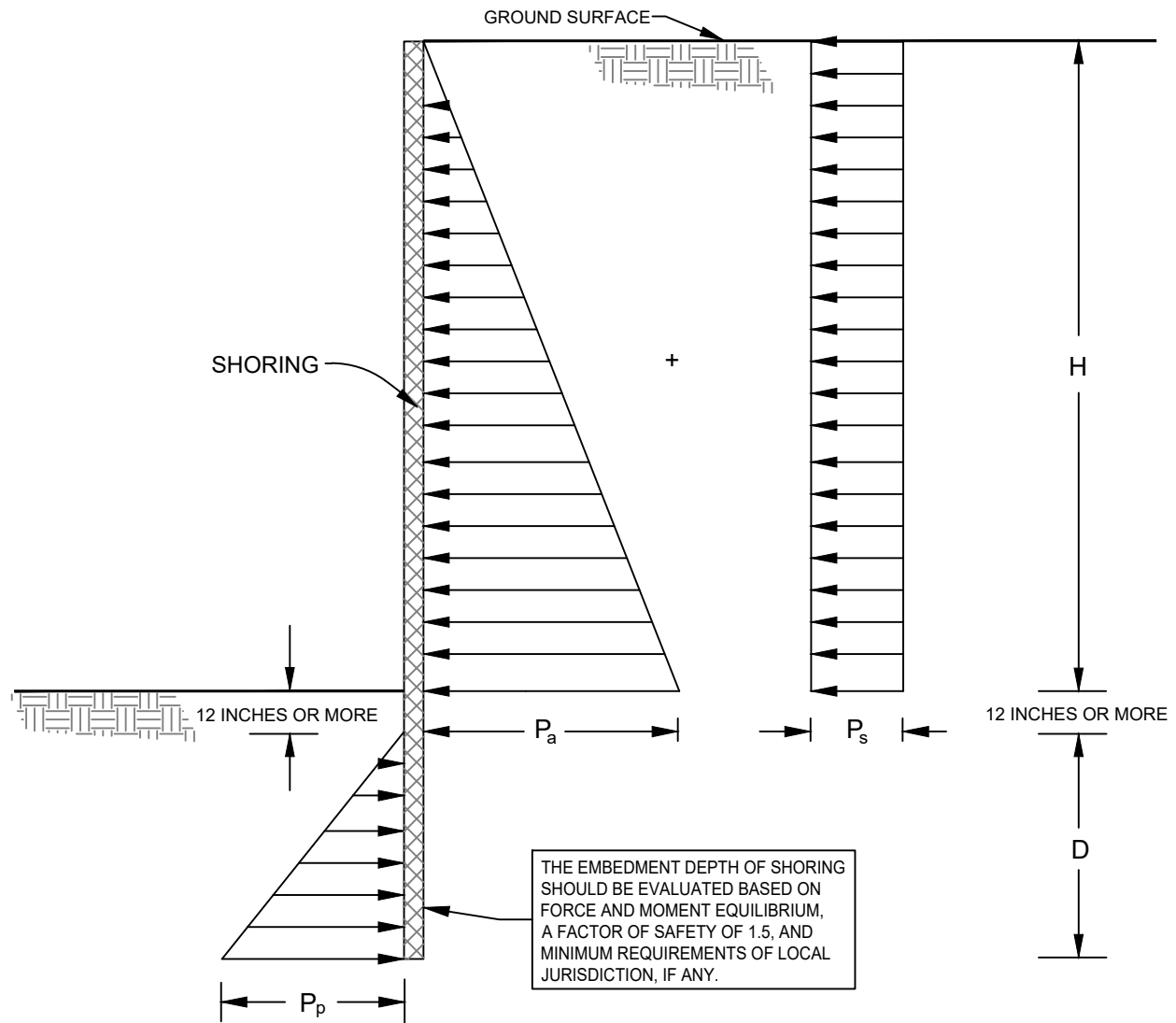
1. APPARENT LATERAL EARTH PRESSURE,  $P_a$   
 $P_a = 26H$  psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE,  $P_s$   
 $P_s = 120$  psf
3. PASSIVE LATERAL EARTH PRESSURE,  $P_p$   
 $P_p = 350D$  psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. SURCHARGES FROM EXCAVATED SOIL OR CONSTRUCTION MATERIALS ARE NOT INCLUDED
6. H AND D ARE IN FEET

NOT TO SCALE

**FIGURE 7**

**LATERAL EARTH PRESSURES  
FOR BRACED EXCAVATION**

LYNWOOD CITY PARK STORMWATER CAPTURE PROJECT  
LYNWOOD, CALIFORNIA



NOTES:

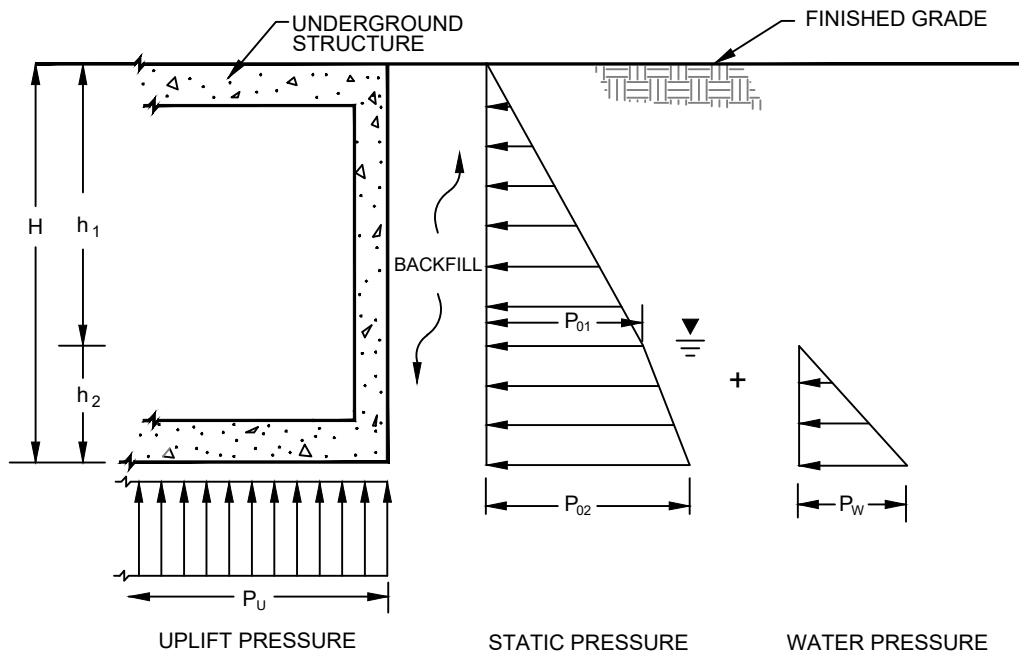
1. ACTIVE LATERAL EARTH PRESSURE,  $P_a$   
 $P_a = 40H$  psf
2. CONSTRUCTION TRAFFIC INDUCED SURCHARGE PRESSURE,  $P_s$   
 $P_s = 79$  psf
3. PASSIVE LATERAL EARTH PRESSURE,  $P_p$   
 $P_p = 350D$  psf
4. ASSUMES GROUNDWATER IS NOT PRESENT
5. H AND D ARE IN FEET

NOT TO SCALE

FIGURE 8

**LATERAL EARTH PRESSURES FOR  
TEMPORARY CANTILEVERED SHORING**

LYNWOOD CITY PARK STORMWATER CAPTURE PROJECT  
LYNWOOD, CALIFORNIA



**NOTES:**

1. APPARENT LATERAL EARTH PRESSURES,  $P_{01}$  AND  $P_{02}$   
 $P_{01} = 60h_1$  psf  
 $P_{02} = 60h_1 + 29h_2$  psf
2. HYDROSTATIC PRESSURE,  $P_w$   
 $P_w = 62.4h_2$  psf
3. UPLIFT PRESSURE,  $P_u$   
 $P_u = 62.4h_2$  psf
4. SURCHARGE PRESSURES CAUSED BY VEHICLES OR NEARBY STRUCTURES ARE NOT INCLUDED
5.  $H$ ,  $h_1$  AND  $h_2$  ARE IN FEET
6.  GROUNDWATER TABLE

NOT TO SCALE

**FIGURE 9**

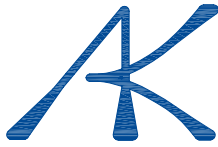
**LATERAL EARTH PRESSURES FOR UNDERGROUND STRUCTURES**

LYNWOOD CITY PARK STORMWATER CAPTURE PROJECT  
LYNWOOD, CALIFORNIA



# APPENDIX A

## Preliminary Infiltration Study Report by Albus-Keefe (2017)



## ***ALBUS-KEEFE & ASSOCIATES, INC.***

GEOTECHNICAL CONSULTANTS

January 10, 2017

J.N.: 2545.00

Mr. John Hunter  
John L. Hunter & Associates, Inc.  
6131 Orangethorpe Avenue, Suite 350  
Buena Park, CA 90620

**Subject: Preliminary Infiltration Study for Proposed Water Quality Improvements,  
Lynwood Park, City of Lynwood, California**

Dear Mr. Hunter,

Pursuant to your request, *Albus-Keefe & Associates, Inc.* has completed a preliminary geotechnical investigation of the site for evaluation of the percolation characteristics of the site soils. The scope of this investigation consisted of the following:

- Exploratory drilling, soil sampling and test well installation
- Field percolation testing
- Laboratory testing of selected soil samples
- Engineering analysis of the data
- Preparation of this report

### **SITE DESCRIPTION AND PROPOSED DEVELOPMENT**

#### **Site Location and Description**

The site is located at Lynwood Park, west of the intersection of Bullis Rd. and Martin Luther King Jr. Blvd., within the city of Lynwood, California. The site is bordered by Cesar E. Chavez Ln. to the north, Martin Luther King Jr. Blvd. to the northeast, Bullis Rd. to the east, Hosler Middle School to the southeast, Spruce St. to the south, and by Birch St. to the west. The location of the site and its relationship to the surrounding areas is shown on Figure 1, Site Location Map.

The specific area of our study is located within the center portion of Lynwood Park and is currently being utilized as soccer fields. The area is covered by grass with chain-link fencing bounding the limits of the soccer fields. Based on GoogleEarth, existing surface elevations within the property measure approximately 90 feet above Mean Sea Level (MSL). Drainage is generally directed as a sheet flow from the center of the field toward the north and south.

#### **Proposed Development**

We understand the proposed site improvements will likely consist of constructing a storm water infiltration system within the existing soccer field.



© 2016 Google



## SITE LOCATION MAP

John L. Hunter and Associates, Inc.

Lynwood Park

West of Intersection of Martin Luther King Jr Blvd. and Bullis Rd.

Lynwood, California

NOT TO SCALE

FIGURE 1

## **SUMMARY OF FIELD AND LABORATORY WORK**

### **Subsurface Investigation**

Subsurface exploration for this investigation was conducted on October 6, 2016. Our exploration consisted of drilling three (3) exploratory borings ranging in depth from 12 feet to 51.5 feet below the existing ground surface utilizing a truck-mounted, hollow-stem-auger drill rig. Representatives of *Albus-Keefe & Associates, Inc.* logged the exploratory excavation. Visual and tactile identifications were made of the materials encountered, and their descriptions are presented in the Exploration Logs in Appendix A. The locations of the borings are depicted the enclosed Geotechnical Map, Plate 1.

Bulk, relatively undisturbed and Standard Penetration Test (SPT) samples were obtained at selected depths within the exploratory borings for subsequent laboratory testing. Relatively undisturbed samples were obtained using a 3-inch O.D., 2.5-inch I.D., California split-spoon soil sampler lined with brass rings. SPT samples were obtained from the boring using a standard, unlined SPT soil sampler. During each sampling interval, the sampler was driven 12 or 18 inches with successive drops of a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampler was recorded for each six inches of advancement. The total blow count for the lower 12 inches of advancement per soil sample is recorded on the exploration log. Samples were placed in sealed containers or plastic bags and transported to our laboratory for analyses.

Upon completion of sampling, 2-inch-diameter casings were installed in borings B-2 and B-3 (P-1 and P-2) for percolation testing. Well screens were installed from near the bottom of the borings to ground surface. The annular space of the well screen sections were filled with sand for depths covering the extent of our testing. The remaining annular space was then backfilled with native soils. Subsequent to completion of well installations, the casings were then filled with water until the minimum volume of water was achieved for presoaking the test wells as required by test method USBR 7300-89.

### **Percolation Testing**

Percolation testing was performed on October 6, 2016, in general conformance with the constant-head test procedures outlined in the referenced Well Permeameter Method (USBR 7300-89). A water hose attached to a water source on site was connected to an inline flow meter to measure the water flow. The flow meter is capable of measuring flow rates up to 10 gallons per minute and as low as 0.1 gallons per minute. A valve was connected in line with the flow meter to control the flow rate. A filling hose was used to connect the flow meter and the test wells. Water was introduced by the filling hose near the bottom of the test wells. A water level meter with 1/100-foot divisions was used to measure the depths to water surface from the top of well casings.

Flow to the wells was terminated upon either completion of testing of all the pre-determined water levels or the flow rate exceeded the maximum capacity of the flow meter. In the case where the flow was less than the ability to measure the rate with our meter, a falling head test was performed. Falling head tests were performed in general conformance with the test procedures outlined in the referenced Naval Facilities Engineering Command (NAVFAC) P-418 Dewatering and Groundwater Control. Measurements obtained during the percolation testing are provided on Plates C-1 and C-2.

**Laboratory Testing**

Selected soil samples of representative earth materials were tested to assist in the formulation of conclusions and recommendations presented in this report. Tests consisted of in-situ moisture content and dry density, grain-size analysis. Laboratory testing relevant to percolation characteristics are presented in Appendix B.

**ANALYSIS OF DATA****Subsurface Conditions**

Soil materials encountered at the site consist of alluvial deposits to the maximum depth explored, 51.5 feet below the ground surface (bgs). The alluvial soils encountered are generally comprised of fine grained deposits in the near surface with interlayered fine- and coarse-grained deposits at depth. The fine grained deposits typically consist of silt, sandy silt, and clayey silt with occasional clay layers/lenses. These materials are range from damp to wet and medium stiff to stiff. The coarse-grained deposits generally consist of silty sands that are moist to wet and loose to medium dense. Although not encountered, artificial fill materials are anticipated beneath portions of the site in association with underground utility lines.

A more detailed description of the interpreted soil profile at each of the boring locations, based upon the borehole cuttings and soil samples, are presented in Appendix A. The stratigraphic descriptions in the logs represent the predominant materials encountered and relatively thin, often discontinuous layers of different material may occur within the major divisions.

**Ground Water**

Groundwater was encountered at a depth of 43 feet below the existing ground surface during this firm's exploration. A review of the CDMG Seismic Hazard Zone Report 034 indicates that historical high groundwater levels for the general site area are as shallow as 8 feet below the existing ground surface.

Additional review of the CDMG Seismic Hazard Report 034 makes mention to the fact that historic high ground water was determined from turn-of-the-century water-well logs, namely 1905 ground-water contour maps (Mendenhall, 1905, Conkling 1927), and 1952 ground-water contour maps (State Water Resources Board, 1952).

After review of historic ground water data made available by the County of Los Angeles Department of Public Works through online services, ground water depths in proximity to the site could be established from the 1920's to 2010. A graph of the data from the wells located near the site can be found below in Figure 2. Well 3S13W11K01 is located about 3500 feet southwest of the site while well 3S13W12E04 is located about 550 feet northeast of the site. The data indicates that regional groundwater has remained near a depth of approximately 90 feet since about 1990. The occurrence of groundwater at a depth of 43 feet in our boring appears to represent a localized perched condition within a more granular layer starting at a depth of about 42 feet.

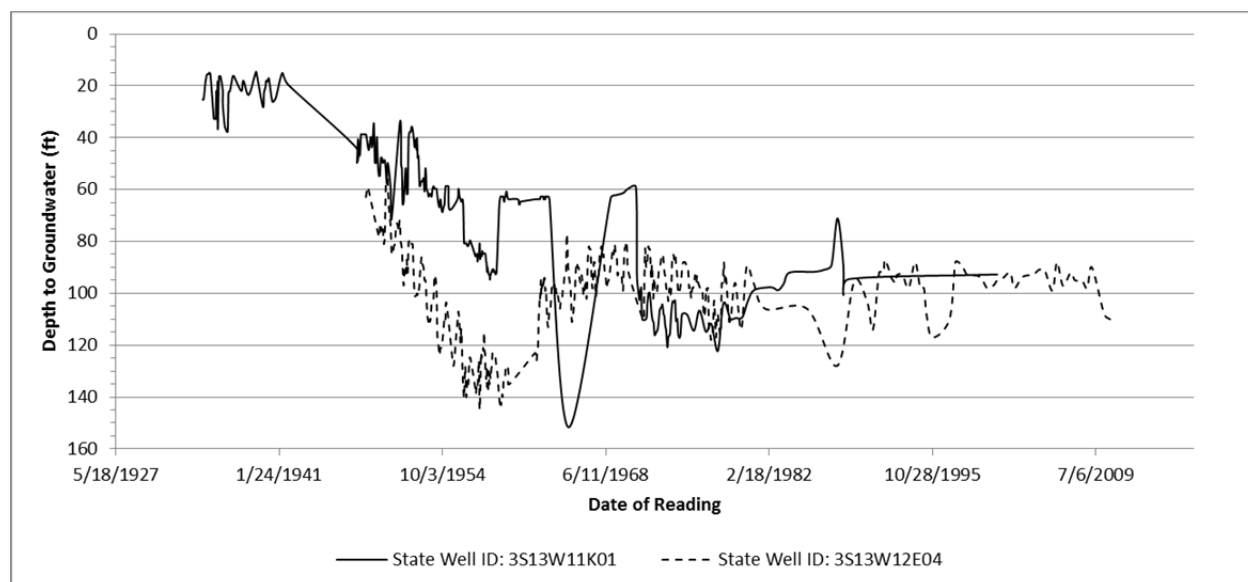


**Figure 2 – Historic Ground Water**

### **Percolation Data**

Analyses were performed to evaluate permeability using the data obtained from P-1 and P-2 based on a falling-head test. The drop in water level within the initial few readings was used to calculate the volume of water infiltrated during the associated reading period. The volume of water consists of water contained in the pore space of the sand outside the pipe and water contained inside the pipe. The sand was assumed to have a void ratio of 0.4 for determination of the water volume. Taking the volume divided by the duration, we obtain a flow rate. The calculation for the volume and flow rate is summarized in Table 1.

Using the equations presented in the USBR 7300-89 method, we then obtain an estimate of the permeability. The flow rate from Table 1 was used in combination with the average height of water within the well during the readings used. The results are included on Table 1 and summaries of the analyses are provided in Appendix C, Plates C-3 and C-4. Using correlations of grain-size tests to permeability based on the Kozemy-Carmen equation (Chapuis, R.P., and Aubertin, M 2003), we obtain an estimated permeability of 1.4 in./hr. for the predominate silt material we tested. This correlation confirms the values obtained by field testing.

**TABLE 1**  
**Summary of Permeabilities from Test Wells**

| <b>Location</b> | <b>Total Depth of Well (ft)</b> | <b>Initial Depth of Water (ft)</b> | <b>Final Depth of Water (ft)</b> | <b>Volume of Water Used (gal)</b> | <b>Duration (min)</b> | <b>Flow Rate (gal/min)</b> | <b>Estimated Permeability (in./hr.)</b> |
|-----------------|---------------------------------|------------------------------------|----------------------------------|-----------------------------------|-----------------------|----------------------------|-----------------------------------------|
| P-1             | 12                              | 7                                  | 8.2                              | 1.38                              | 3                     | 0.43                       | 0.83                                    |
| P-2             | 12                              | 7                                  | 8.8                              | 2.04                              | 4                     | 0.51                       | 1.03                                    |

### **Design of Dry Well**

Infiltration in a dry well was modeled using the software Seep/W, version 2007, by Geo-Slope International. The program allows for modeling of both partially-saturated and saturated porous medium using a finite element approach to solve Darcy's Law. The program can evaluate both steady-state and transient flow in planer and axisymmetric cases. Boundaries of the model can be identified with various conditions including fix total head, fix pressure head, fix flow rate, and head as a function of flow. Soil conductivity properties can be modeled with either Fredlund et al (1994), Green and Corey (1971), Van Genuchten (1980), or Saxton et al. (1986). The Van Genuchten parameters suggested by Saxton et al. (1986) were selected for use in our model and were based on test results of particle-size analyses and estimated in-place densities.

A Seep/W model was setup with the bottom of the dry well at a depth of 30 feet below ground surface. The upper 10 feet was assumed to have a shaft that is 6 feet in diameter and contains a settling chamber having an inside diameter of 4 feet and outside diameter of 4.5 feet. Below 10 feet, the shaft is assumed to be 4 feet in diameter. The annular space around the chamber and below the chamber is assumed to consist of gravel. A more detailed model of the dry well design can be found on Plate 2.

The model consisted of one (1) zone of material to represent the general soil profile. This zone (Soil #1) represents the infiltration zone and the saturated conductivity was based on the rates obtained during the percolation testing. A summary of the well model parameters are provided in Table 2. Groundwater was assumed to be present at a depth of 43 feet. The presence of the groundwater was modeled by placing a boundary fixed-head condition with a head set equivalent to a groundwater depth of 43 feet (elev. 57' in model). Water in the well was conservatively assumed to be held at a depth of 5 feet (elev. 95' in model) although we anticipate the well will likely be filled to the ground surface during a rain event and therefore increase the flow rate.

**TABLE 2**  
**Summary of Characteristic Curve Parameters**

| Zone No. | Material No. | USCS | Depth (ft) | Ks (in/hr) | Van Genuchten Parameters |      |      |                    |                        |
|----------|--------------|------|------------|------------|--------------------------|------|------|--------------------|------------------------|
|          |              |      |            |            | a (1/cm)                 | n    | m    | Sat. Water Content | Residual Water Content |
| 1        | 1            | ML   | 0-50       | 0.8        | 0.015                    | 1.25 | 0.20 | 0.44               | 0.01                   |

A steady state analysis was performed to estimate the maximum inflow that the well can accommodate. Using a well as described above, we obtain a static total flow of 0.03 ft<sup>3</sup>/sec. A plot depicting the resulting pressure head contours and flow vectors for the model is provided on Plate C-5.

To evaluate the time required to empty the well once no more water is introduced, the model was reanalyzed with a variable head condition that was dependent upon the volume of water leaving the well. As water infiltrates into the surrounding soil, the volume of water remaining in the well is

reduced as well as the resulting water head. A graph of the well head versus exit volume for a depth of 30 feet is provided in Figure 3. The function assumes a void ratio of 0.4 within the zones occupied by gravel. If some other well configuration is used, then the analyses may require updating.

The analysis was performed as a transient case over a total time of approximately 13 hours. The conditions in the model were evaluated in 90 minute increments of time over the total duration. From our analyses, the water is evacuated from the upper chamber in approximately 1.5 hours and is completely evacuated in approximately 11 hours. Plots depicting the resulting pressure head contours and flow vectors at selected times are provided in Appendix C on Plate C-6 through C-9. A plot of time versus water height in the well is shown on Figure 4.

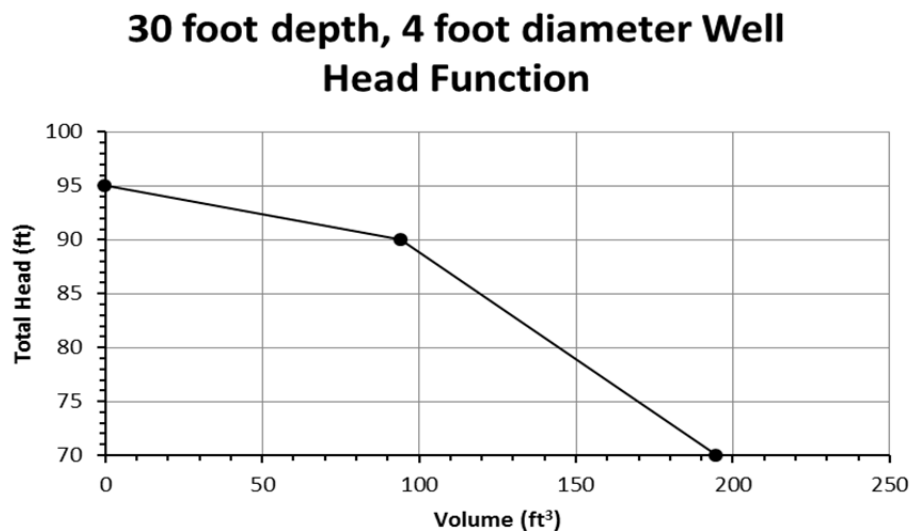


FIGURE 3

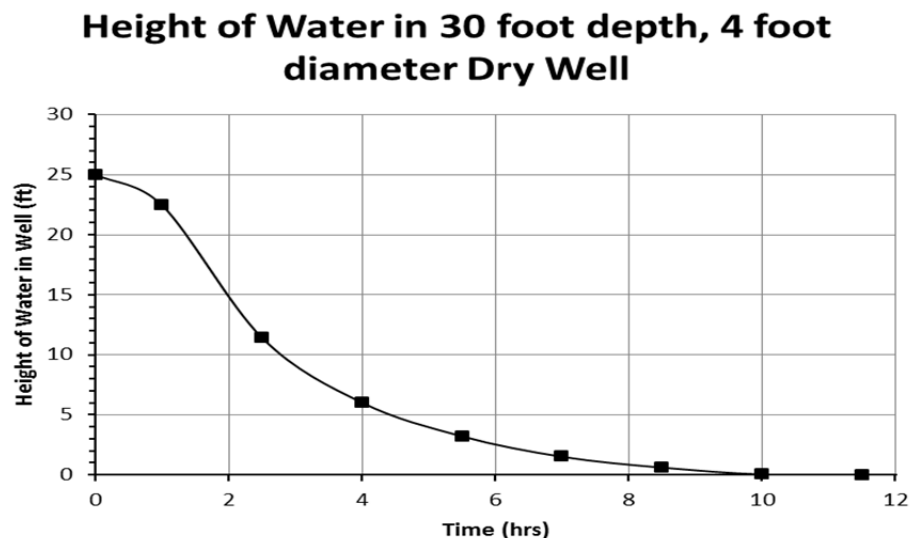


FIGURE 4

## **CONCLUSIONS AND RECOMMENDATIONS**

Results of our work indicate a storm water disposal system consisting of dry wells is feasible at the site. The use of dry wells is not anticipated to result in worsening any adverse conditions or hazards that may be present for the proposed site development or adjacent properties including subsidence, landsliding, or liquefaction. Historical shallowest groundwater has been estimated to occur below a depth of 43 feet. Therefore, a dry well having a total depth of 30 feet will maintain the minimum clearance of 10 feet above groundwater as required by the Technical Guidance Document.

Based on results of percolation testing and analyses, the percolation rate for a well configuration as depicted on Plate 2 may utilize an unfactored peak flow rate of 0.03 ft<sup>3</sup>/sec. An appropriate factor of safety should be applied to the flow rate as required by the appropriate governmental authority.

Should you require multiple dry wells across the site, the wells should be spaced at least 50 feet, center to center, to avoid cross influence. The wells should be located at least 10 feet horizontally from any habitable structure or property line.

The actual flow capacity of the dry well could be more or less than the estimated value. As such, provisions should be made to accommodate excess flow quantities in the event the dry well does not infiltrate the anticipated amount. The design also assumes that sediments will be removed from the inflowing water through an upper chamber or other device. Sediments that are allowed to enter the dry well will tend to degrade the flow capacity by plugging up the infiltration surfaces.

In general, the dry well may consist of a concrete inner chamber surrounded by ½-inch open graded gravel. The concrete chamber should have perforations to allow the well to drain. The holes should be sized to prevent piping of the gravel into the chamber. A general diagram of the dry well is provided on Plate 2.

In general, the dry well shaft is anticipated to be adequately stable under temporary construction conditions for uncased drilling. However, occasional layers or lenses of granular materials are likely to occur and may be prone to sloughing and caving. In the event of caving, casing will be required to install the well. Workers should not enter the shaft unless the excavation is laid back or shored in accordance with OSHA requirements. The placement and compaction of backfill materials, including the gravel, should be observed by the project geotechnical consultant.

## **LIMITATIONS**

This report is based on the geotechnical data as described herein. The materials encountered in our boring excavations and utilized in our laboratory testing for this investigation are believed representative of the project area, and the conclusions and recommendations contained in this report are presented on that basis. However, soil and bedrock materials can vary in characteristics between points of exploration, both laterally and vertically, and those variations could affect the conclusions and recommendations contained herein. As such, observations by a geotechnical consultant during the construction phase of the storm water infiltration systems are essential to confirming the basis of this report.

This report has been prepared consistent with that level of care being provided by other professionals providing similar services at the same locale and time period. The contents of this report are professional opinions and as such, are not to be considered a guaranty or warranty.

This report should be reviewed and updated after a period of one year or if the site ownership or project concept changes from that described herein.

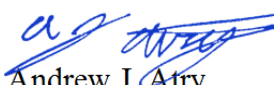
This report has been prepared for the exclusive use of **John L. Hunter & Assoc.** to assist the project consultants in the design of the proposed development. This report has not been prepared for use by parties or projects other than those named or described herein. This report may not contain sufficient information for other parties or other purposes.

This report is subject to review by the controlling governmental agency.

We appreciate this opportunity to be of service to you. If you should have any questions regarding the contents of this report, please do not hesitate to call.

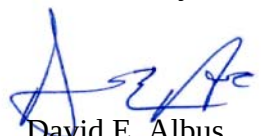
Sincerely,

**ALBUS-KEEFE & ASSOCIATES, INC.**

  
Andrew J. Atry  
Project Engineer  
P.E. C84728



Reviewed by:

  
David E. Albus  
Principal Engineer  
G.E. 2455



Enclosures: Plate 1- Geotechnical Map  
Plate 2- Dry Well Design  
Appendix A - Exploratory Logs  
Appendix B - Laboratory Testing  
Appendix C - Percolation Testing and Analyses

## **REFERENCES**

### **Publications and Reports**

*California Department of Conservation, Division of Mines and Geology, Seismic Hazard Report 034, "Seismic Hazard Zone Report for the Orange 7.5-Minute Quadrangle, Orange County, California", 1998.*

*California State Water Resources Board, 1952, Central Basin Investigation, Lower Los Angeles and San Gabriel Rivers Area, County of Los Angeles: Bulletin 8, 27 p.*

*Chapuis, R.P., and Aubertin, M (2003). "On the use of the Kozeny-Carman equation to predict the hydraulic conductivity of soils." Canadian Geotechnical Journal, 40, 616-628.*

*Conkling, H., 1927, San Gabriel investigation: California Division of Water Resources Bulletin 5, 640p.*

*Dewatering and Groundwater Control, by the Departments of The Army, The Navy, and The Air Force, TM 5-818-5/AFM 88-5, Chap 6/NAVFAC P-418, November 1983.*

*Mendenhall, W.C., 1905, Development of underground waters in the central coastal plain region of southern California: U.S. Geological Survey Water-Supply Paper 138, 160 p.*

*Procedure for Performing Field Permeability Testing by the Well Permeameter Method, by United States Department of The Interior, Bureau of Reclamation (USBR 7300-89).*

*Saxton, K.E., W.J. Rawls, J.S. Romberger, and R.I. Papendick. 1986. Estimating generalized soil-water characteristics from texture. Soil Sci. Soc. Am. J. 50(4):1031-103*



## EXPLANATION

(LOCATIONS APPROXIMATE)

B-1  
- Exploratory Boring

B-3/P-2  
- Exploratory Boring and  
Percolation Test Well



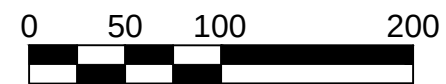
**ALBUS-KEEFE & ASSOCIATES, INC.**  
GEOTECHNICAL CONSULTANTS

## GEOTECHNICAL MAP

Job No.: 2545.00

Date: 1/10/16

Plate: 1



APPROXIMATE SCALE : 1" = 100'



# MAXWELL® IV DRAINAGE SYSTEM DETAIL AND SPECIFICATIONS

## ITEM NUMBERS

1. Manhole Cone - Modified Flat Bottom.
2. Moisture Membrane - 6 Mil. Plastic. Applies only when native material is used for backfill. Place membrane securely against eccentric cone and hole sidewall.
3. Bolted Ring & Grate - Diameter as shown. Clean cast iron with wording "Storm Water Only" in raised letters. Bolted in 2 locations and secured to cone with mortar. Rim elevation  $\pm 0.02'$  of plans.
4. Graded Basin or Paving (by Others).
5. Compacted Base Material - 1-Sack Slurry except in landscaped installations with no pipe connections.
6. PureFlo® Debris Shield - Rolled 16 ga. steel X 24" length with vented anti-siphon and Internal .265" Max. SWO flattened expanded steel screen X 12" length. Fusion bonded epoxy coated.
7. Pre-cast Liner - 4000 PSI concrete 48" ID. X 54" OD. Center in hole and align sections to maximize bearing surface.
8. Min. 6' Ø Drilled Shaft.
9. Support Bracket - Formed 12 Ga. steel. Fusion bonded epoxy coated.
10. Overflow Pipe - Sch. 40 PVC mated to drainage pipe at base seal.
11. Drainage Pipe - ADS highway grade with TRI-A coupler. Suspend pipe during backfill operations to prevent buckling or breakage. Diameter as noted.
12. Base Seal - Geotextile or concrete slurry.
13. Rock - Washed, sized between 3/8" and 1-1/2" to best complement soil conditions.
14. FloFast® Drainage Screen - Sch. 40 PVC 0.120" slotted well screen with 32 slots per row/ft. Diameter varies 120" overall length with TRI-B coupler.
15. Min. 4' Ø Shaft - Drilled to maintain permeability of drainage soils.
16. Fabric Seal - U.V. resistant geotextile - to be removed by customer at project completion.
17. Absorbent - Hydrophobic Petrochemical Sponge. Min. to 128 oz. capacity.
18. Freeboard Depth Varies with inlet pipe elevation. Increase settling chamber depth as needed to maintain all inlet pipe elevations above overflow pipe inlet.
19. Optional Inlet Pipe (Maximum 4", by Others). Extend moisture membrane and compacted base material or 1 sack slurry backfill below pipe invert.

The referenced drawing and specifications are available on CAD either through our office or web site. This detail is copyrighted (2004) but may be used as is in construction plans without further release. For information on product application, individual project specifications or site evaluation, contact our Design Staff for no-charge assistance in any phase of your planning.

## CALCULATING MAXWELL IV REQUIREMENTS

The type of property, soil permeability, rainfall intensity and local drainage ordinances determine the number and design of Maxwell Systems. For general applications draining retained stormwater, use one standard **MaxWell IV** per the instructions below for up to 3 acres of landscaped contributory area, and up to 1 acre of paved surface. For larger paved surfaces, subdivision drainage, nuisance water drainage, connecting pipes larger than 4" Ø from catch basins or underground storage, or other demanding applications, refer to our **MaxWell® Plus** System. For industrial drainage, including gasoline service stations, our **Envibro® System** may be recommended. For additional considerations, please refer to "Design Suggestions For Retention And Drainage Systems" or consult our Design Staff.

## COMPLETING THE MAXWELL IV DRAWING

To apply the **MaxWell IV** drawing to your specific project, simply fill in the blue boxes per instructions below. For assistance, please consult our Design Staff.

### ESTIMATED TOTAL DEPTH

The Estimated Total Depth is the approximate depth required to achieve 10 continuous feet of penetration into permeable soils. Torrent utilizes specialized "crowd" equipped drill rigs to penetrate difficult, cemented soils and to reach permeable materials at depths up to **180 feet**. Our extensive database of drilling logs and soils information is available for use as a reference. Please contact our Design Staff for site-specific information on your project.

### SETTLING CHAMBER DEPTH

On MaxWell IV Systems of over 30 feet overall depth and up to 0.25cfs design rate, the **standard** Settling Chamber Depth is **18 feet**. For systems exposed to greater contributory area than noted above, extreme service conditions, or that require higher design rates, chamber depths up to 25 feet are recommended.

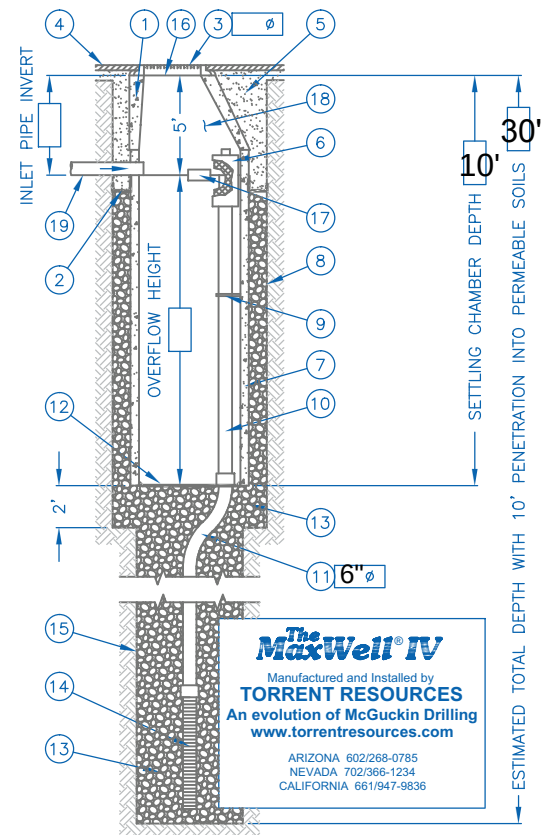
### OVERFLOW HEIGHT

The Overflow Height and Settling Chamber Depth determine the effectiveness of the settling process. The higher the overflow pipe, the deeper the chamber, the greater the settling capacity. For normal drainage applications, an overflow height of **13 feet** is used with the standard settling chamber depth of **18 feet**. Sites with higher design rates than noted above, heavy debris loading or unusual service conditions require greater settling capacities

### TORRENT RESOURCES INCORPORATED

1509 East Elwood Street, Phoenix Arizona 85040-1391  
phone 602-268-0785 fax 602-268-0820  
Nevada 702-366-1234

AZ Lic. ROC070465 A, ROC047067 B-4; ADWR 363  
CA Lic. 528080 A, C-42, HAZ - NV Lic. 0035350 A - NM Lic. 90504 GF04



### Ø DRAINAGE PIPE

This dimension also applies to the **PureFlo®** Debris Shield, the **FloFast®** Drainage Screen, and fittings. The size selected is based upon system design rates, soil conditions, and the need for adequate venting. Choices are 6", 8", or 12" diameter. Refer to "Design Suggestions for Retention and Drainage Systems" for recommendations on which size best matches your application.

### Ø BOLTED RING & GRATE

Standard models are quality cast iron and available to fit 24" Ø or 30" Ø manhole openings. All units are bolted in two locations with wording "Storm Water Only" in raised letters. For other surface treatments, please refer to "Design Suggestions for Retention and Drainage Systems."

### Ø INLET PIPE INVERT

Pipes up to 4" in diameter from catch basins, underground storage, etc. may be connected into the settling chamber. Inverts deeper than 5 feet will require additional settling chamber depth to maintain effective overflow height.

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phone 661-947-9836

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**APPENDIX A**  
**EXPLORATORY LOGS**

# EXPLORATION LOG

[illegible]

# EXPLORATION LOG

|                                               |  |  |                                 |  |                 |                 |  |  |  |
|-----------------------------------------------|--|--|---------------------------------|--|-----------------|-----------------|--|--|--|
| Project: Lynwood City Park                    |  |  |                                 |  | Location: B-1   |                 |  |  |  |
| Address: Cesar E Chavez Ln, Lynwood, CA 90262 |  |  |                                 |  | Elevation: 89.1 |                 |  |  |  |
| Job Number: 2545.00                           |  |  | Client: John L. Hunter & Assoc. |  |                 | Date: 10/6/2016 |  |  |  |
| Drill Method: Hollow-Stem Auger               |  |  | Driving Weight: 140 lbs / 30 in |  |                 | Logged By: MP   |  |  |  |

| Depth<br>(feet) | Lith-<br>ology | Material Description                                                                                        | Water | Samples              |      | Laboratory Tests |                            |                         |
|-----------------|----------------|-------------------------------------------------------------------------------------------------------------|-------|----------------------|------|------------------|----------------------------|-------------------------|
|                 |                |                                                                                                             |       | Blows<br>Per<br>Foot | Core | Bulk             | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) |
| 5               |                | <u>Silt (ML)</u> : brown, damp, trace mica                                                                  |       | 9                    |      |                  | 15.4                       | 81.5                    |
|                 |                | <u>Silty Sand / Sandy Silt (SM/ML)</u> : light grayish brown, damp, fine grained sand, trace mica, rootlets |       |                      |      |                  |                            |                         |
| 10              |                | <u>Silt (ML)</u> : light bluish gray, moist, medium stiff, little fine grained sand, trace clay             |       | 7                    |      |                  | 14.2                       | 80.1                    |
|                 |                | @ 8 ', few clay nodules in cuttings                                                                         |       |                      |      |                  |                            |                         |
| 15              |                | @ 10 ', some orange oxidation                                                                               |       | 7                    |      |                  |                            |                         |
|                 |                | @ 15 ', medium grayish brown, stiff, some clay lenses                                                       |       |                      |      |                  |                            |                         |
| 20              |                | @ 20 ', trace fine grained sand                                                                             |       | 7                    |      |                  |                            |                         |
|                 |                |                                                                                                             |       |                      |      |                  |                            |                         |

**Albus-Keefe & Associates, Inc.**
Plate A-2

# EXPLORATION LOG

| Project: Lynwood City Park                    |                |                                                                                                                |                                 |                      |      | Location: B-1   |                            |                         |                       |  |  |
|-----------------------------------------------|----------------|----------------------------------------------------------------------------------------------------------------|---------------------------------|----------------------|------|-----------------|----------------------------|-------------------------|-----------------------|--|--|
| Address: Cesar E Chavez Ln, Lynwood, CA 90262 |                |                                                                                                                |                                 |                      |      | Elevation: 89.1 |                            |                         |                       |  |  |
| Job Number: 2545.00                           |                |                                                                                                                | Client: John L. Hunter & Assoc. |                      |      | Date: 10/6/2016 |                            |                         |                       |  |  |
| Drill Method: Hollow-Stem Auger               |                |                                                                                                                | Driving Weight: 140 lbs / 30 in |                      |      | Logged By: MP   |                            |                         |                       |  |  |
| Depth<br>(feet)                               | Lith-<br>ology | Material Description                                                                                           | Water                           | Samples              |      |                 | Laboratory Tests           |                         |                       |  |  |
|                                               |                |                                                                                                                |                                 | Blows<br>Per<br>Foot | Core | Bulk            | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |  |  |
|                                               |                | @ 25 ', wet, very stiff, trace fine gravel, little fine grained sand                                           |                                 | 13                   |      |                 |                            |                         |                       |  |  |
|                                               |                | <u>Silty Sand / Sandy Silt (SM/ML):</u> light grayish brown, wet, medium dense / very stiff, fine sand         |                                 |                      |      |                 |                            |                         |                       |  |  |
| 30                                            |                |                                                                                                                |                                 | 21                   |      |                 | 33.7                       | 85.6                    |                       |  |  |
|                                               |                |                                                                                                                |                                 |                      |      |                 |                            |                         |                       |  |  |
| 35                                            |                |                                                                                                                |                                 | 21                   |      |                 | N.R.                       |                         |                       |  |  |
|                                               |                | <u>Silty Sand (SM):</u> gray, wet, loose, fine grained sand                                                    |                                 |                      |      |                 |                            |                         |                       |  |  |
| 40                                            |                |                                                                                                                |                                 | 8                    |      |                 | 22.5                       | 96.6                    |                       |  |  |
|                                               |                | <u>Clayey Silt (ML):</u> gray, moist, medium stiff, trace mica, trace pockets pf silty sand/sandy silt nodules |                                 | 11                   |      |                 |                            |                         |                       |  |  |
|                                               |                | @ 41.5 ', Very stiff, Some fine grained sand                                                                   |                                 |                      |      |                 |                            |                         |                       |  |  |
|                                               |                | <u>Silty Sand (SM):</u> gray, wet, medium dense, fine grained sand                                             |                                 |                      |      |                 |                            |                         |                       |  |  |
| 45                                            |                |                                                                                                                |                                 | 14                   |      |                 |                            |                         |                       |  |  |
|                                               |                |                                                                                                                |                                 |                      |      |                 |                            |                         |                       |  |  |
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# EXPLORATION LOG

| Project: Lynwood City Park                    |                |                                                                                                            |                                 |                      |      | Location: B-1    |                            |                         |                       |
|-----------------------------------------------|----------------|------------------------------------------------------------------------------------------------------------|---------------------------------|----------------------|------|------------------|----------------------------|-------------------------|-----------------------|
| Address: Cesar E Chavez Ln, Lynwood, CA 90262 |                |                                                                                                            |                                 |                      |      | Elevation: 89.1  |                            |                         |                       |
| Job Number: 2545.00                           |                |                                                                                                            | Client: John L. Hunter & Assoc. |                      |      | Date: 10/6/2016  |                            |                         |                       |
| Drill Method: Hollow-Stem Auger               |                |                                                                                                            | Driving Weight: 140 lbs / 30 in |                      |      | Logged By: MP    |                            |                         |                       |
| Depth<br>(feet)                               | Lith-<br>ology | Material Description                                                                                       | Water                           | Samples              |      | Laboratory Tests |                            |                         |                       |
|                                               |                |                                                                                                            |                                 | Blows<br>Per<br>Foot | Core | Bulk             | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |
|                                               |                |                                                                                                            |                                 | 13                   |      |                  |                            |                         |                       |
|                                               |                | End of Boring at 51.5 ft. Groundwater measured at 43 ft after half an hour. Backfilled with soil cuttings. |                                 |                      |      |                  |                            |                         |                       |
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# EXPLORATION LOG

|                                               |  |  |                                 |  |                 |                 |  |  |  |
|-----------------------------------------------|--|--|---------------------------------|--|-----------------|-----------------|--|--|--|
| Project: Lynwood City Park                    |  |  |                                 |  | Location: B-2   |                 |  |  |  |
| Address: Cesar E Chavez Ln, Lynwood, CA 90262 |  |  |                                 |  | Elevation: 89.1 |                 |  |  |  |
| Job Number: 2545.00                           |  |  | Client: John L. Hunter & Assoc. |  |                 | Date: 10/6/2016 |  |  |  |
| Drill Method: Hollow-Stem Auger               |  |  | Driving Weight: 140 lbs / 30 in |  |                 | Logged By: MP   |  |  |  |

| Depth<br>(feet) | Lith-<br>ology | Material Description                                                                                   | Water | Samples              |      | Laboratory Tests |                            |                         |                       |
|-----------------|----------------|--------------------------------------------------------------------------------------------------------|-------|----------------------|------|------------------|----------------------------|-------------------------|-----------------------|
|                 |                |                                                                                                        |       | Blows<br>Per<br>Foot | Core | Bulk             | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |
| 5               |                | <u>Silt (ML)</u> : tan brown, damp to moist, medium stiff, micaceous                                   |       |                      |      |                  |                            |                         |                       |
| 10              |                | <u>Clay (CL)</u> : grayish brown, moist, stiff                                                         |       | 11                   |      |                  | 37.4                       | 81.8                    | SA Hydro              |
|                 |                | End of boring at 12 feet. No groundwater encountered. Boring converted in percolation test well (P-1). |       |                      |      |                  |                            |                         |                       |

**Albus-Keefe & Associates, Inc.**
Plate A-5

# EXPLORATION LOG

|                                               |  |  |                                 |  |                 |                 |  |  |  |
|-----------------------------------------------|--|--|---------------------------------|--|-----------------|-----------------|--|--|--|
| Project: Lynwood City Park                    |  |  |                                 |  | Location: B-3   |                 |  |  |  |
| Address: Cesar E Chavez Ln, Lynwood, CA 90262 |  |  |                                 |  | Elevation: 89.1 |                 |  |  |  |
| Job Number: 2545.00                           |  |  | Client: John L. Hunter & Assoc. |  |                 | Date: 10/6/2016 |  |  |  |
| Drill Method: Hollow-Stem Auger               |  |  | Driving Weight: 140 lbs / 30 in |  |                 | Logged By: MP   |  |  |  |

| Depth<br>(feet) | Lith-<br>ology | Material Description                                                                                   | Water | Samples              |      | Laboratory Tests |                            |                         |                       |
|-----------------|----------------|--------------------------------------------------------------------------------------------------------|-------|----------------------|------|------------------|----------------------------|-------------------------|-----------------------|
|                 |                |                                                                                                        |       | Blows<br>Per<br>Foot | Core | Bulk             | Moisture<br>Content<br>(%) | Dry<br>Density<br>(pcf) | Other<br>Lab<br>Tests |
| 5               |                | <u>Silt (ML)</u> : Brown, damp to moist, medium stiff, micaceous                                       |       |                      |      |                  |                            |                         |                       |
| 10              |                |                                                                                                        |       |                      |      |                  |                            |                         |                       |
|                 |                | @ 11 ', Light grayish brown, moist, very stiff, trace fine sand, trace clay                            |       | 17                   |      |                  | 11.3                       | 84.2                    | SA Hydro              |
|                 |                | End of boring at 12 feet. No groundwater encountered. Boring converted in percolation test well (P-2). |       |                      |      |                  |                            |                         |                       |

**Albus-Keefe & Associates, Inc.**
Plate A-6

**APPENDIX B**  
**LABORATORY TESTING**



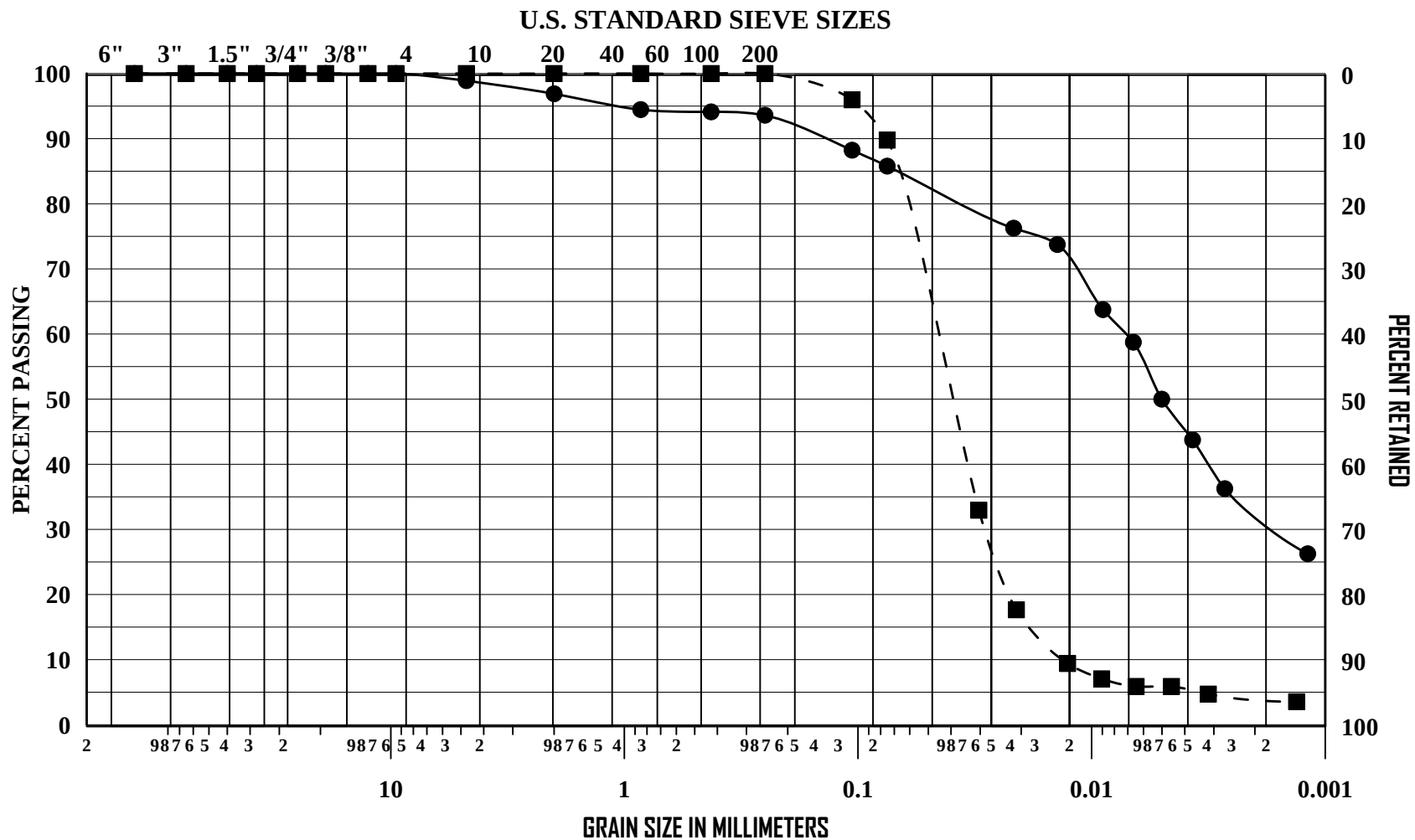
ALBUS-KEEFE & ASSOCIATES, INC.  
GEOTECHNICAL CONSULTANTS

## GRAIN SIZE DISTRIBUTION

Job No: 2545.00  
Plate No: B-1

## UNIFIED SOIL CLASSIFICATION

| COBBLES | GRAVEL |      | SAND   |        |      | SILT AND CLAY |
|---------|--------|------|--------|--------|------|---------------|
|         | COARSE | FINE | COARSE | MEDIUM | FINE |               |



| LOCATION | SAMPLE  | SYMBOL    | LL | PI | CLASSIFICATION |
|----------|---------|-----------|----|----|----------------|
| B-2      | 11 feet | ● — — — ● |    |    | Clay (CL)      |
| B-3      | 11 feet | ■ - - - ■ |    |    | Silt (ML)      |
|          |         |           |    |    |                |
|          |         |           |    |    |                |

**APPENDIX C**  
**PERCOLATION TESTING AND ANALYSES**

# Field Percolation Testing

Client: John L. Hunter & Assoc.  
Date Tested: 10/6/2016  
Location: Lynwood City Park

Job. No.: 2545.00  
Test by: MP

Top of Casing to Bottom of Well (ft): 12  
Elev. of Ground Surface (ft): 89.1  
Diam. of Test Hole (in): 8  
Diam. of Casing (in): 2  
Ht. to Top of Casing (ft): 0  
Water Temperature (C°): 21

## Constant Head

| Elapsed Time<br>(minutes) | Time  | Depth to H2O<br>(ft) | Flow Rate<br>(gal./min.) |
|---------------------------|-------|----------------------|--------------------------|
| 0.0                       | 12:32 | 7.00                 | 2.50                     |
| 1.0                       | 12:33 | 7.00                 | 2.00                     |
| 2.0                       | 12:34 | 7.00                 | 1.10                     |
| 3.0                       | 12:35 | 7.00                 | 0.50                     |
| 4.0                       | 12:36 | 7.00                 | <0.1                     |
|                           |       |                      |                          |
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## Falling Head

| Elapsed Time<br>(minutes) | Time     | Depth to H2O<br>(ft) |
|---------------------------|----------|----------------------|
| 0.0                       | 12:36:00 | 7.00                 |
| 1.0                       | 12:37:00 | 7.40                 |
| 2.0                       | 12:38:00 | 7.80                 |
| 3.0                       | 12:39:00 | 8.20                 |
| 4.0                       | 12:40:00 | 8.60                 |
| 5.0                       | 12:41:00 | 9.00                 |
|                           |          |                      |
| 7.0                       | 12:43:00 | 7.00                 |
| 8.0                       | 12:44:00 | 7.40                 |
| 9.0                       | 12:45:00 | 7.80                 |
| 10.0                      | 12:46:00 | 8.20                 |
|                           |          |                      |
|                           |          |                      |
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## Field Percolation Testing

Client: John L. Hunter & Assoc.

Job. No.: 2545.00

Date Tested: 10/6/2016

Test by: MP

Location: Lynwood City Park

Top of Casing to Bottom of Well (ft): 12

Elev. of Ground Surface (ft): 89.1

Diam. of Test Hole (in): 8

Diam. of Casing (in): 2

Ht. to Top of Casing (ft): 0

Water Temperature (C°): 21

### Constant Head

## Falling Head

[illegible][illegible]

# INFILTRATION WELL DESIGN

Constant Head

USBR 7300-89 Method

J.N.: 2438

Client: HQT Homes

Well No.: P-1

|                                                                                           |             |                       |
|-------------------------------------------------------------------------------------------|-------------|-----------------------|
| Low Water Table                                                                           | Condition 1 |                       |
| High Water Table & Water Below Bottom of Well                                             | Condition 2 |                       |
| High water Table with Water Above the Well Bottom                                         | Condition 3 |                       |
| <b>Units:</b>                                                                             |             |                       |
| <b>Enter Condition (1, 2 or 3):</b>                                                       | <b>1</b>    |                       |
| Ground Surface to Bottom of Well ( $h_1$ ):                                               | 12          | feet                  |
| Depth to Water ( $h_2$ ):                                                                 | 7.6         | feet                  |
| Height of Water in the Well ( $h_1-h_2=h$ ):                                              | 4.4         | feet                  |
| Radius of Well ( $r$ ):                                                                   | 4.0         | Inches                |
| Minimum Volume Required:                                                                  | 1089.7      | Gal.                  |
| Discharge Rate of Water Into Well for Steady-State Condition ( $q$ ):                     | 0.46        | Gal/min.              |
| Temperature ( $T$ ):                                                                      | 21          | Celsius               |
| (Viscosity of Water @ Temp. $T$ ) / (Viscosity of water @ 20° C) ( $V$ ):                 | 0.9647      | ft <sup>3</sup> /min. |
| Unsaturated Distance Between the Water Surface in the Well and the Water table ( $T_u$ ): |             | Ignore $T_u$          |
| Factor of Safety:                                                                         | 1           |                       |
| Coefficient of Permeability @ 20° C ( $k_{20}$ ):                                         | 1.16E-03    | ft/min.               |
| <b>Design <math>k_{20}</math>:</b>                                                        | <b>0.83</b> | in./hr.               |

The presence or absence of a water table or impervious soil layer within a distance of less than three times that of the water depth in the well (measured from the water surface) will enable the water table to be classified as **Condition I**, **Condition II**, **Condition III**.

**Low Water Table**-When the distance from the water surface in the test well to the ground water table, or to an impervious soil layer which is considered for test puposes to be equivalent to a water table, is greater than three times the depth of water in the well, classify as **Condition I**.

**High Water Table**-When the distance from the water surface in the test well to the ground water table or to an impervious layer is less than three times the depth of water in the well, a high water table condition exists. Use **Condition II** when the water table or impervious layer is below the well bottom. Use **Condition III** when the water table or impervious layer is above the well bottom.

# INFILTRATION WELL DESIGN

Constant Head

USBR 7300-89 Method

J.N.: 2438

Client: HQT Homes

Well No.: P-1

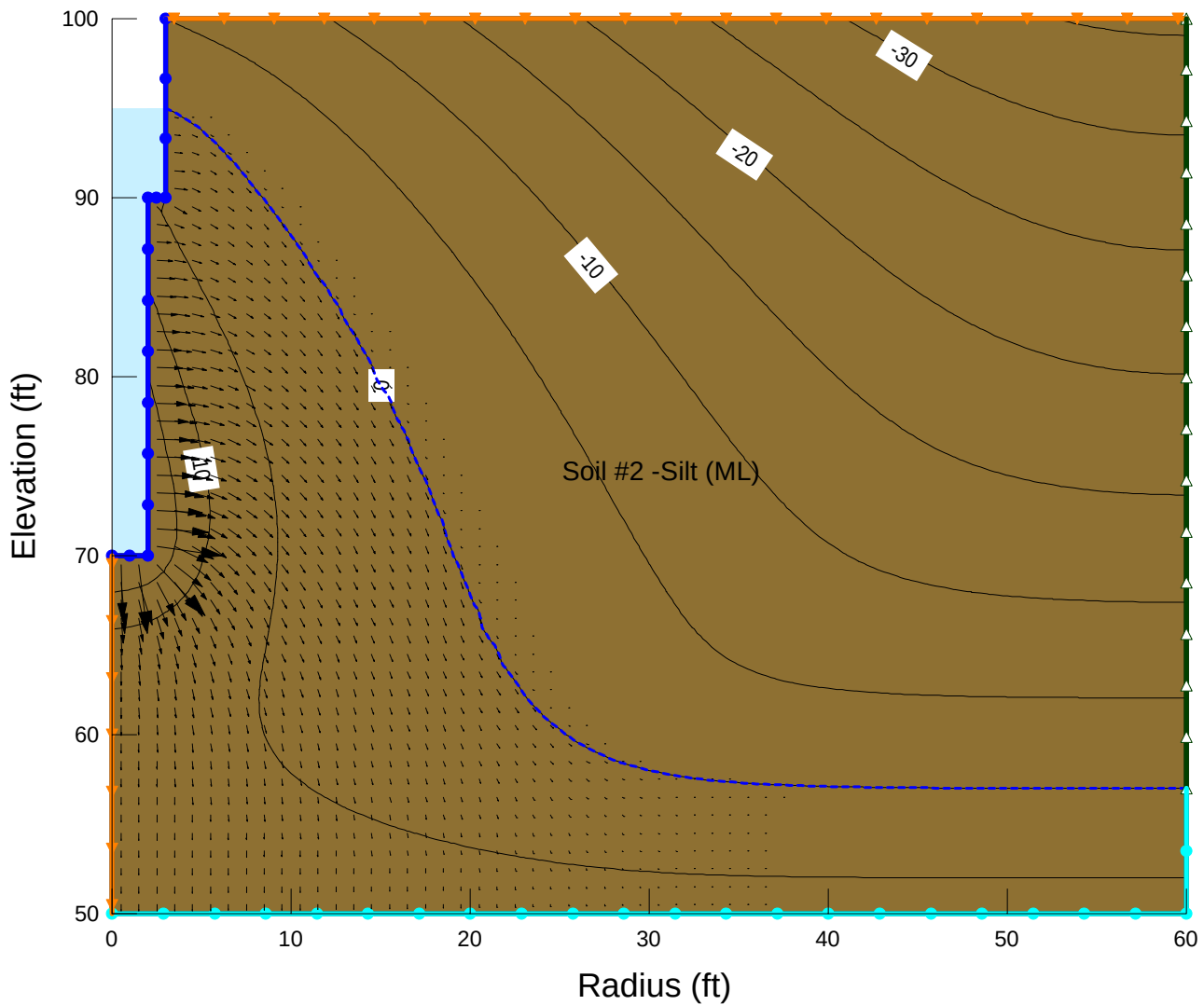
|                                                                                           |             |                       |
|-------------------------------------------------------------------------------------------|-------------|-----------------------|
| Low Water Table                                                                           | Condition 1 |                       |
| High Water Table & Water Below Bottom of Well                                             | Condition 2 |                       |
| High water Table with Water Above the Well Bottom                                         | Condition 3 |                       |
| <b>Units:</b>                                                                             |             |                       |
| <b>Enter Condition (1, 2 or 3):</b>                                                       | <b>1</b>    |                       |
| Ground Surface to Bottom of Well ( $h_1$ ):                                               | 12          | feet                  |
| Depth to Water ( $h_2$ ):                                                                 | 7.9         | feet                  |
| Height of Water in the Well ( $h_1-h_2=h$ ):                                              | 4.1         | feet                  |
| Radius of Well ( $r$ ):                                                                   | 4.0         | Inches                |
| Minimum Volume Required:                                                                  | 924.2       | Gal.                  |
| Discharge Rate of Water Into Well for Steady-State Condition ( $q$ ):                     | 0.51        | Gal/min.              |
| Temperature ( $T$ ):                                                                      | 21          | Celsius               |
| (Viscosity of Water @ Temp. T) / (Viscosity of water @ 20° C) ( $V$ ):                    | 0.9647      | ft <sup>3</sup> /min. |
| Unsaturated Distance Between the Water Surface in the Well and the Water table ( $T_u$ ): |             | Ignore $T_u$          |
| Factor of Safety:                                                                         | 1           |                       |
| Coefficient of Permeability @ 20° C ( $k_{20}$ ):                                         | 1.44E-03    | ft/min.               |
| <b>Design <math>k_{20}</math>:</b>                                                        | <b>1.03</b> | in./hr.               |

The presence or absence of a water table or impervious soil layer within a distance of less than three times that of the water depth in the well (measured from the water surface) will enable the water table to be classified as **Condition I**, **Condition II**, **Condition III**.

**Low Water Table**-When the distance from the water surface in the test well to the ground water table, or to an impervious soil layer which is considered for test puposes to be equivalent to a water table, is greater than three times the depth of water in the well, classify as **Condition I**.

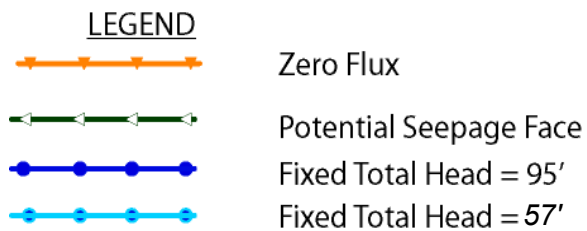
**High Water Table**-When the distance from the water surface in the test well to the ground water table or to an impervious layer is less than three times the depth of water in the well, a high water table condition exists. Use **Condition II** when the water table or impervious layer is below the well bottom. Use **Condition III** when the water table or impervious layer is above the well bottom.

# STEADY STATE FLOW ANALYSIS OF 30 ft DEEP, 4 ft DIAMETER DRY WELL

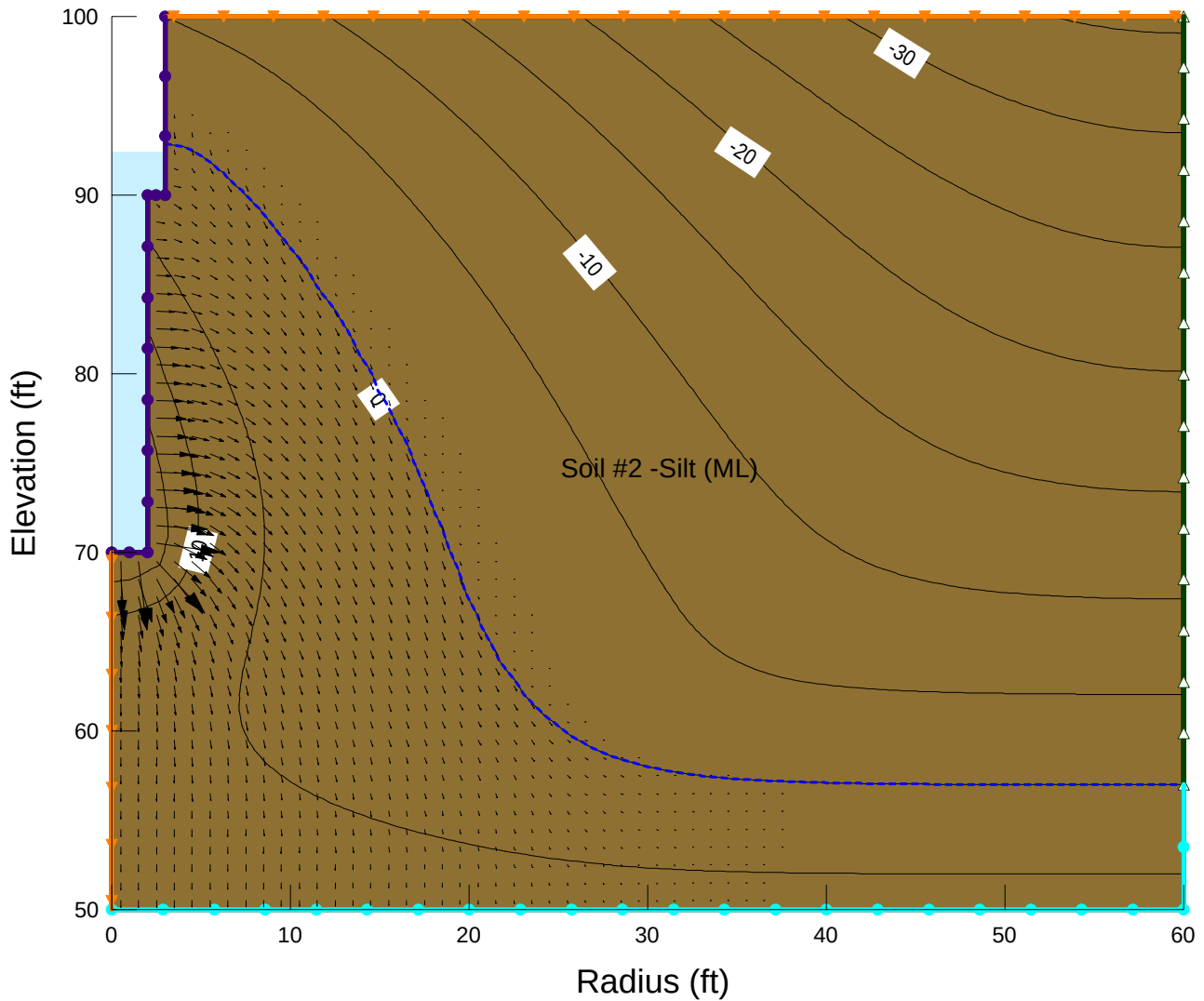


**Contours are Pressure Head in Feet.**

**Arrows indicate direction of flow and relative magnitude of velocity.**

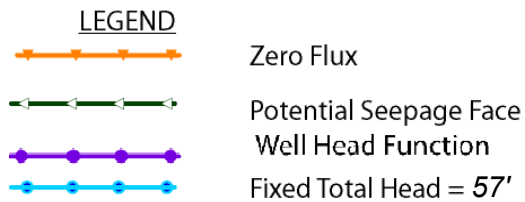


**TRANSIENT @ 1 hours**  
**FLOW ANALYSIS OF 30 ft DEEP, 4 ft DIAMETER DRY WELL**

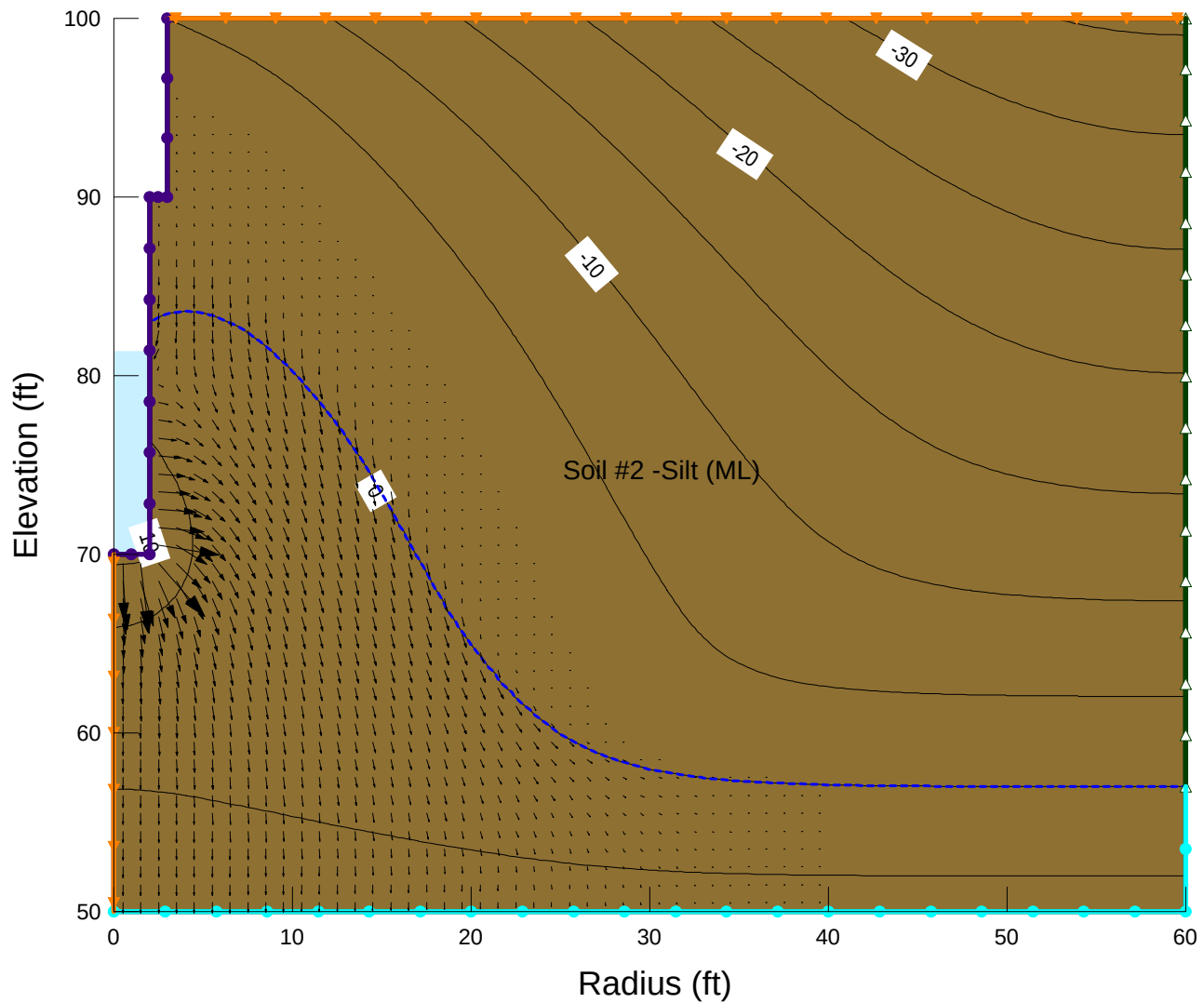


**Contours are Pressure Head in Feet.**

**Arrows indicate direction of flow and relative magnitude of velocity.**

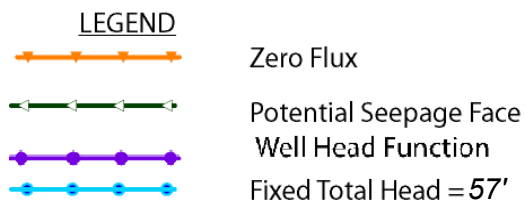


**TRANSIENT @ 2.5 hours**  
**FLOW ANALYSIS OF 30 ft DEEP, 4 ft DIAMETER DRY WELL**

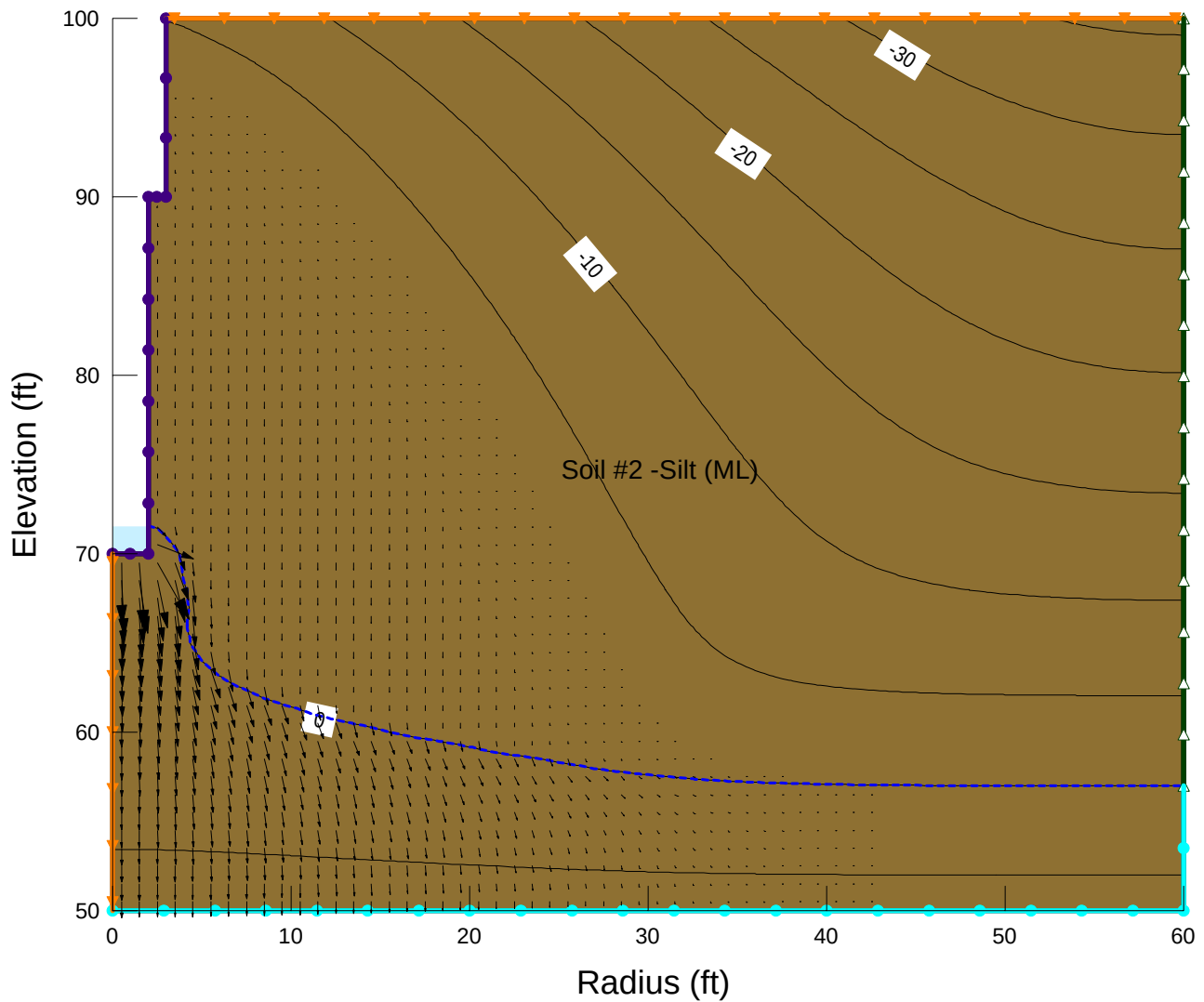


**Contours are Pressure Head in Feet.**

**Arrows indicate direction of flow and relative magnitude of velocity.**

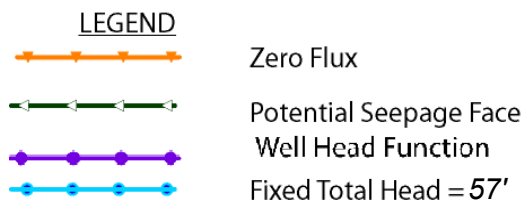


**TRANSIENT @ 7 hours**  
**FLOW ANALYSIS OF 30 ft DEEP, 4 ft DIAMETER DRY WELL**

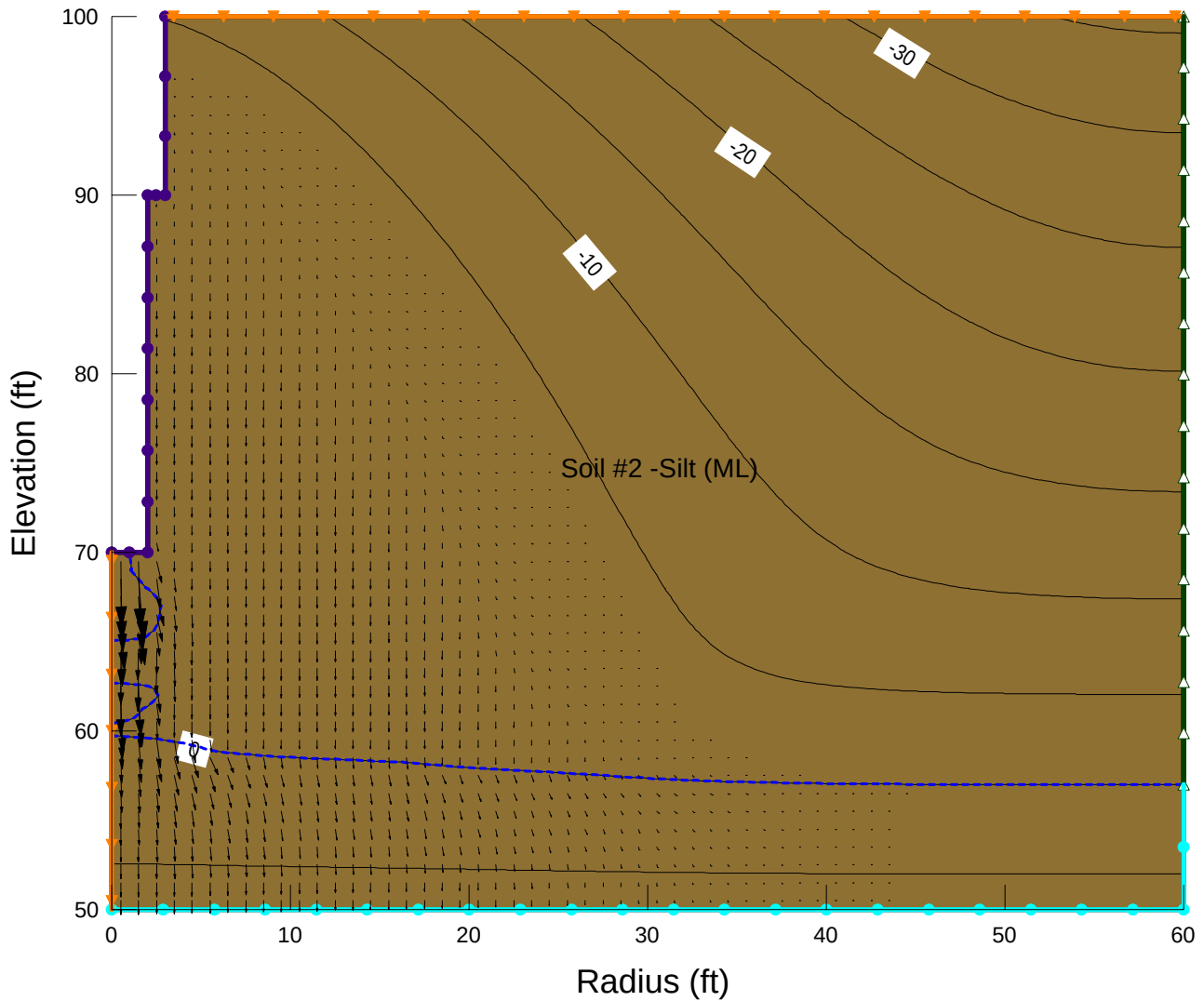


**Contours are Pressure Head in Feet.**

**Arrows indicate direction of flow and relative magnitude of velocity.**

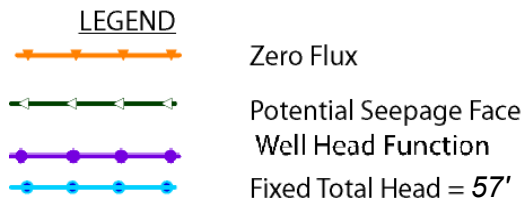


**TRANSIENT @ 11.5 hours**  
**FLOW ANALYSIS OF 30 ft DEEP, 4 ft DIAMETER DRY WELL**



**Contours are Pressure Head in Feet.**

**Arrows indicate direction of flow and relative magnitude of velocity.**





# APPENDIX B

## Boring Logs

## **APPENDIX B**

### **BORING LOGS**

#### **Field Procedure for the Collection of Disturbed Samples**

Disturbed soil samples were obtained in the field using the following methods.

##### **Bulk Samples**

Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

##### **The Standard Penetration Test (SPT) Sampler**

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of  $1\frac{3}{8}$  inches. The sampler was driven into the ground 12 to 18 inches with a 140-pound hammer falling freely from a height of 30 inches in general accordance with ASTM D 1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the logs are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed and transported to the laboratory for testing.

#### **Field Procedure for the Collection of Relatively Undisturbed Samples**

Relatively undisturbed soil samples were obtained in the field using the following method.

##### **The Modified Split-Barrel Drive Sampler**

The sampler, with an external diameter of 3 inches, was lined with 1-inch-long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a hammer in general accordance with ASTM D 3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer, and the number of blows per foot of driving are presented on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

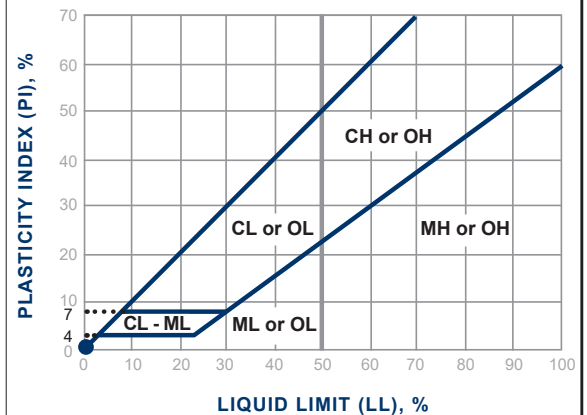
## Soil Classification Chart Per ASTM D 2488

| Primary Divisions                                                      |                                                                           |                                                     | Secondary Divisions             |                                |
|------------------------------------------------------------------------|---------------------------------------------------------------------------|-----------------------------------------------------|---------------------------------|--------------------------------|
|                                                                        |                                                                           |                                                     | Group Symbol                    | Group Name                     |
| <b>COARSE-GRAINED SOILS</b><br>more than 50% retained on No. 200 sieve | <b>GRAVEL</b><br>more than 50% of coarse fraction retained on No. 4 sieve | CLEAN GRAVEL<br>less than 5% fines                  | GW                              | well-graded GRAVEL             |
|                                                                        |                                                                           |                                                     | GP                              | poorly graded GRAVEL           |
|                                                                        |                                                                           | GRAVEL with DUAL CLASSIFICATIONS<br>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<br>more than 12% fines            | GM                              | silty GRAVEL                   |
|                                                                        |                                                                           |                                                     | GC                              | clayey GRAVEL                  |
|                                                                        |                                                                           |                                                     | GC-GM                           | silty, clayey GRAVEL           |
|                                                                        | <b>SAND</b><br>50% or more of coarse fraction passes No. 4 sieve          | CLEAN SAND<br>less than 5% fines                    | SW                              | well-graded SAND               |
|                                                                        |                                                                           |                                                     | SP                              | poorly graded SAND             |
|                                                                        |                                                                           | SAND with DUAL CLASSIFICATIONS<br>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<br>more than 12% fines              | SM                              | silty SAND                     |
|                                                                        |                                                                           |                                                     | SC                              | clayey SAND                    |
|                                                                        |                                                                           |                                                     | SC-SM                           | silty, clayey SAND             |
| <b>FINE-GRAINED SOILS</b><br>50% or more passes No. 200 sieve          | <b>SILT and CLAY</b><br>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                   |
|                                                                        | <b>SILT and CLAY</b><br>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     | 0.075 - 0.19"   | Rock-salt-sized to pea-sized   |
|             | Medium | #40 - #10    | 0.017 - 0.075"  | 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 |                                    | Automatic Trip Hammer |                                    |
|------------------|---------------------------|------------------------------------|-----------------------|------------------------------------|
|                  | SPT (blows/foot)          | Modified Split Barrel (blows/foot) | SPT (blows/foot)      | 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

| Consistency | Spooling Cable or Cathead |                                    | Automatic Trip Hammer |                                    |
|-------------|---------------------------|------------------------------------|-----------------------|------------------------------------|
|             | SPT (blows/foot)          | Modified Split Barrel (blows/foot) | SPT (blows/foot)      | 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                               |

# BORING LOG EXPLANATION SHEET

| DEPTH (feet) | Bulk<br>Driven<br>SAMPLES | BLOWS/FOOT | MOISTURE (%) | DRY DENSITY (PCF) | SYMBOL | CLASSIFICATION<br>U.S.C.S. |                                                                                                                                                                                                                         |
|--------------|---------------------------|------------|--------------|-------------------|--------|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0            |                           |            |              |                   |        |                            | Bulk sample.                                                                                                                                                                                                            |
|              |                           |            |              |                   |        |                            | Modified split-barrel drive sampler.                                                                                                                                                                                    |
|              |                           |            |              |                   |        |                            | No recovery with modified split-barrel drive sampler.                                                                                                                                                                   |
|              |                           |            |              |                   |        |                            | Sample retained by others.                                                                                                                                                                                              |
|              |                           |            |              |                   |        |                            | Standard Penetration Test (SPT).                                                                                                                                                                                        |
| 5            |                           |            |              |                   |        |                            | 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.                                                                                                                                                                                    |
| 15           |                           |            |              |                   |        |                            | Attitudes: Strike/Dip<br>b: Bedding<br>c: Contact<br>j: Joint<br>f: Fracture<br>F: Fault<br>cs: Clay Seam<br>s: Shear<br>bss: Basal Slide Surface<br>sf: Shear Fracture<br>sz: Shear Zone<br>sbs: Shear Bedding Surface |
| 20           |                           |            |              |                   |        |                            | The total depth line is a solid line that is drawn at the bottom of the boring.                                                                                                                                         |

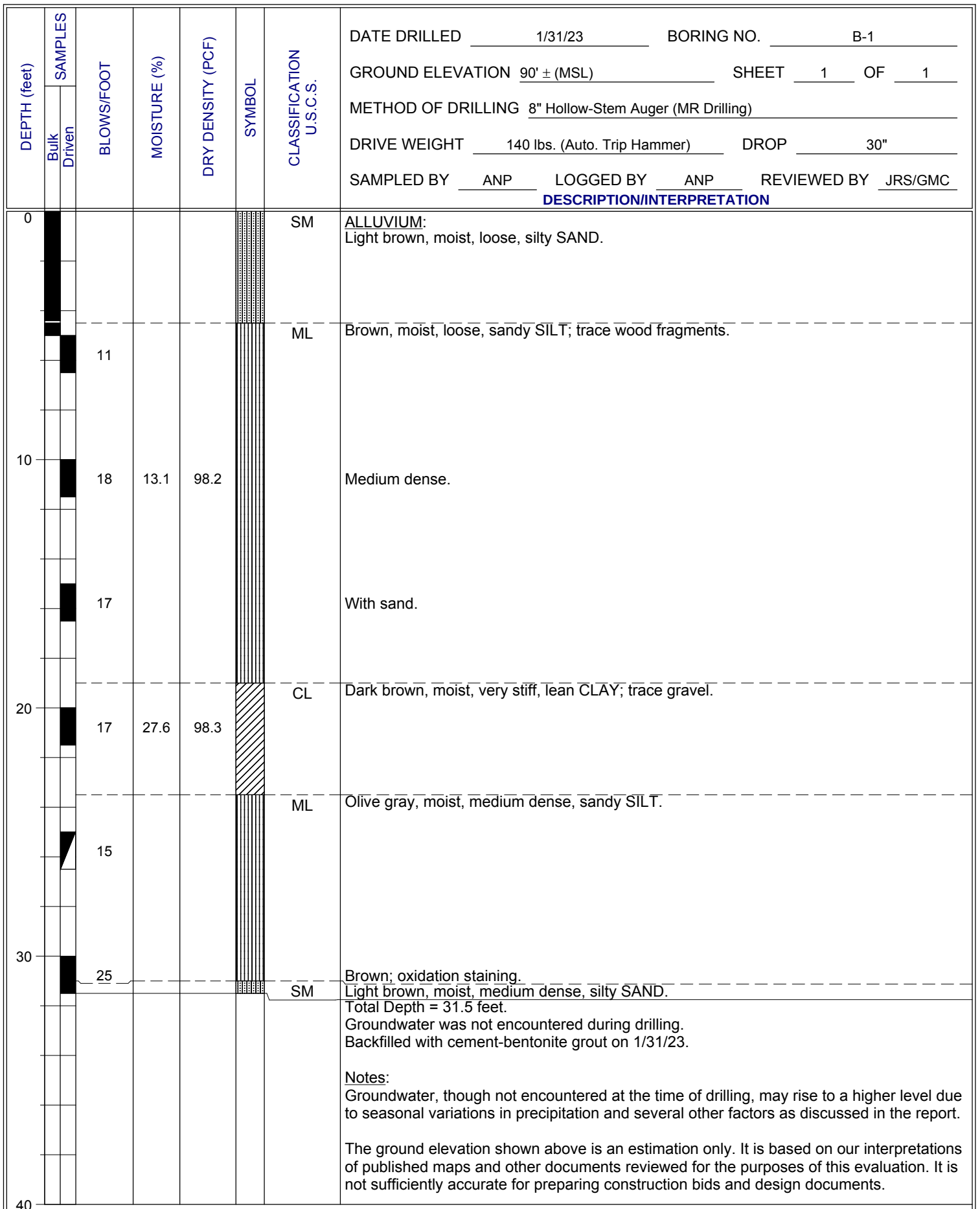


FIGURE B- 1

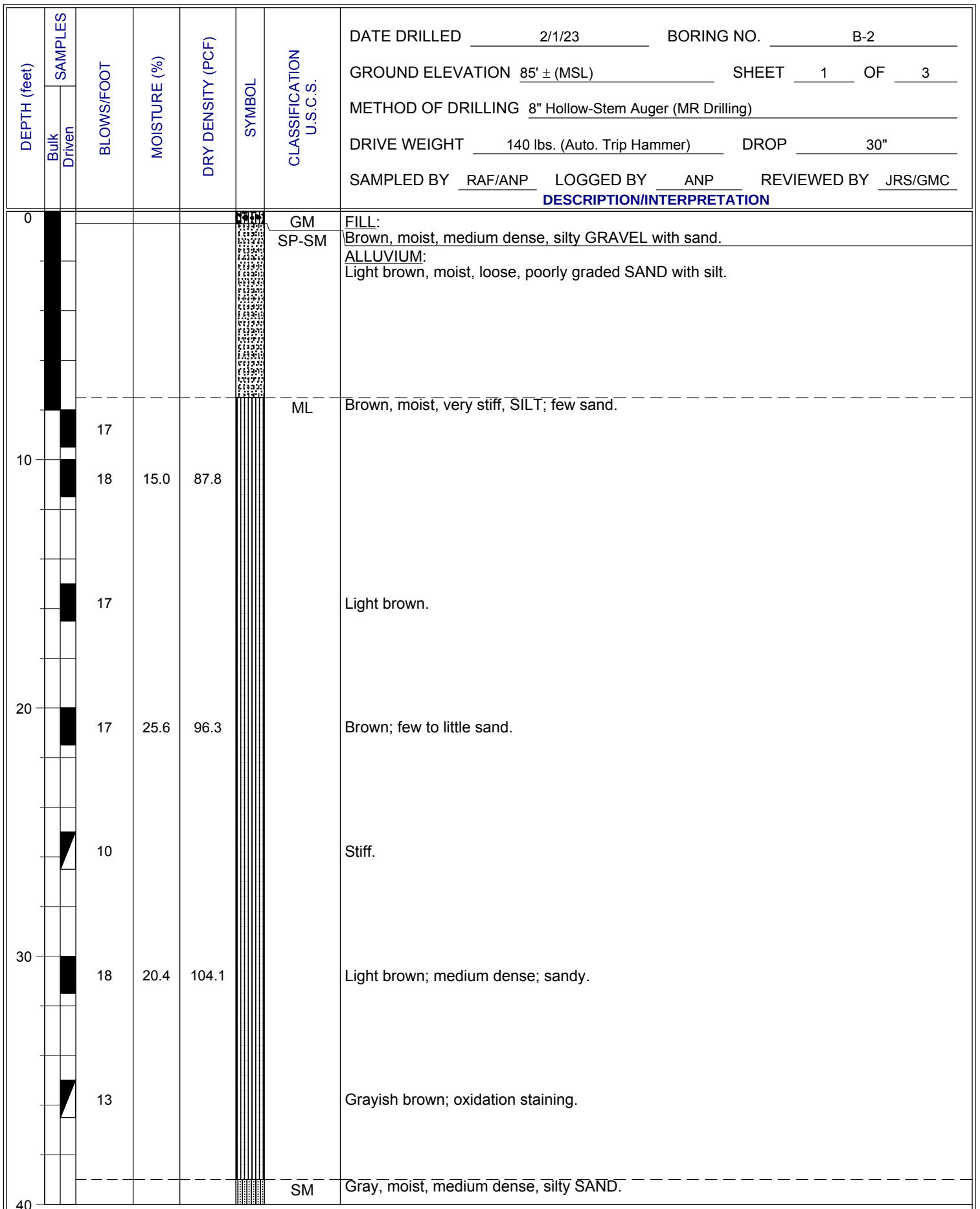


FIGURE B- 2

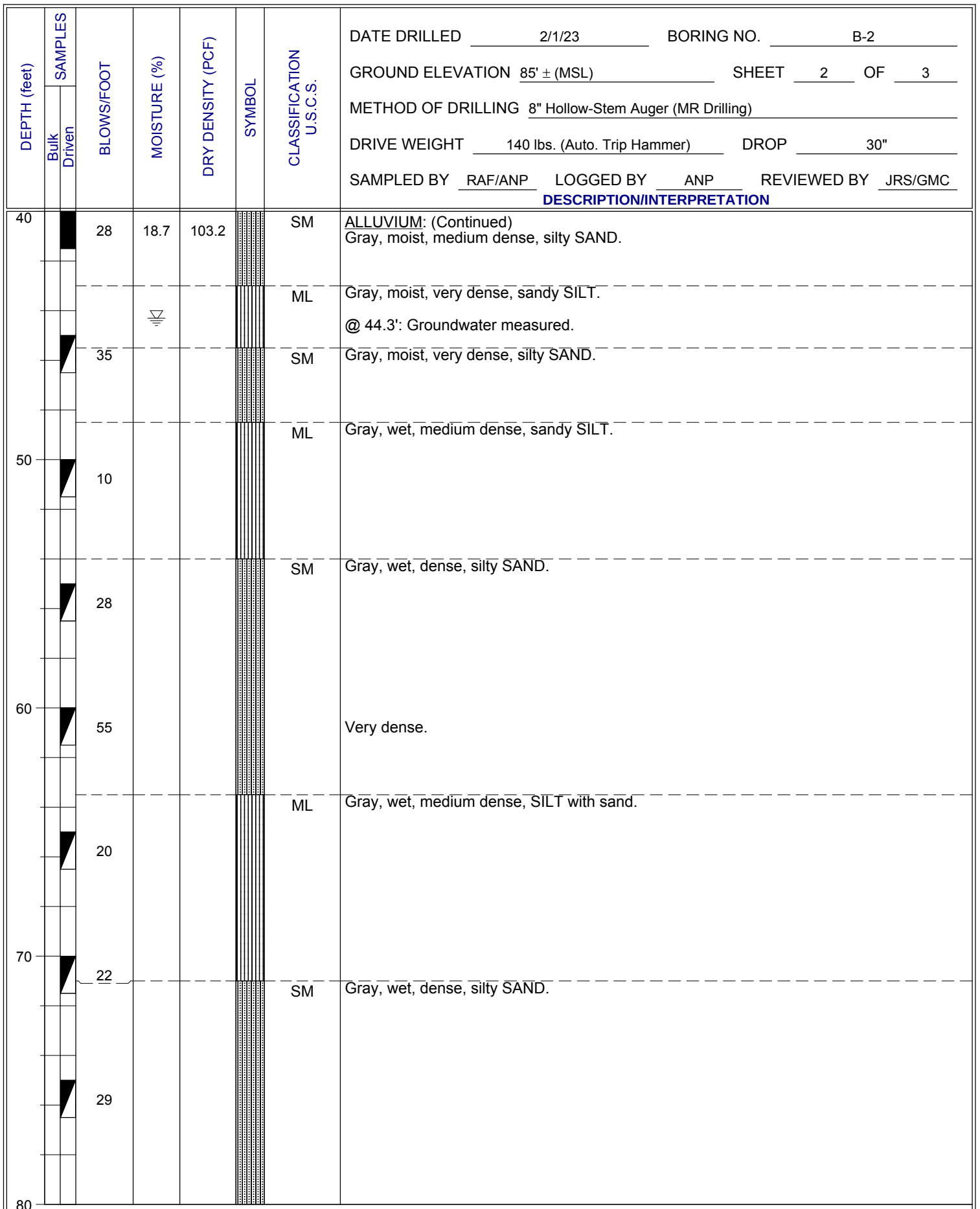


FIGURE B- 3

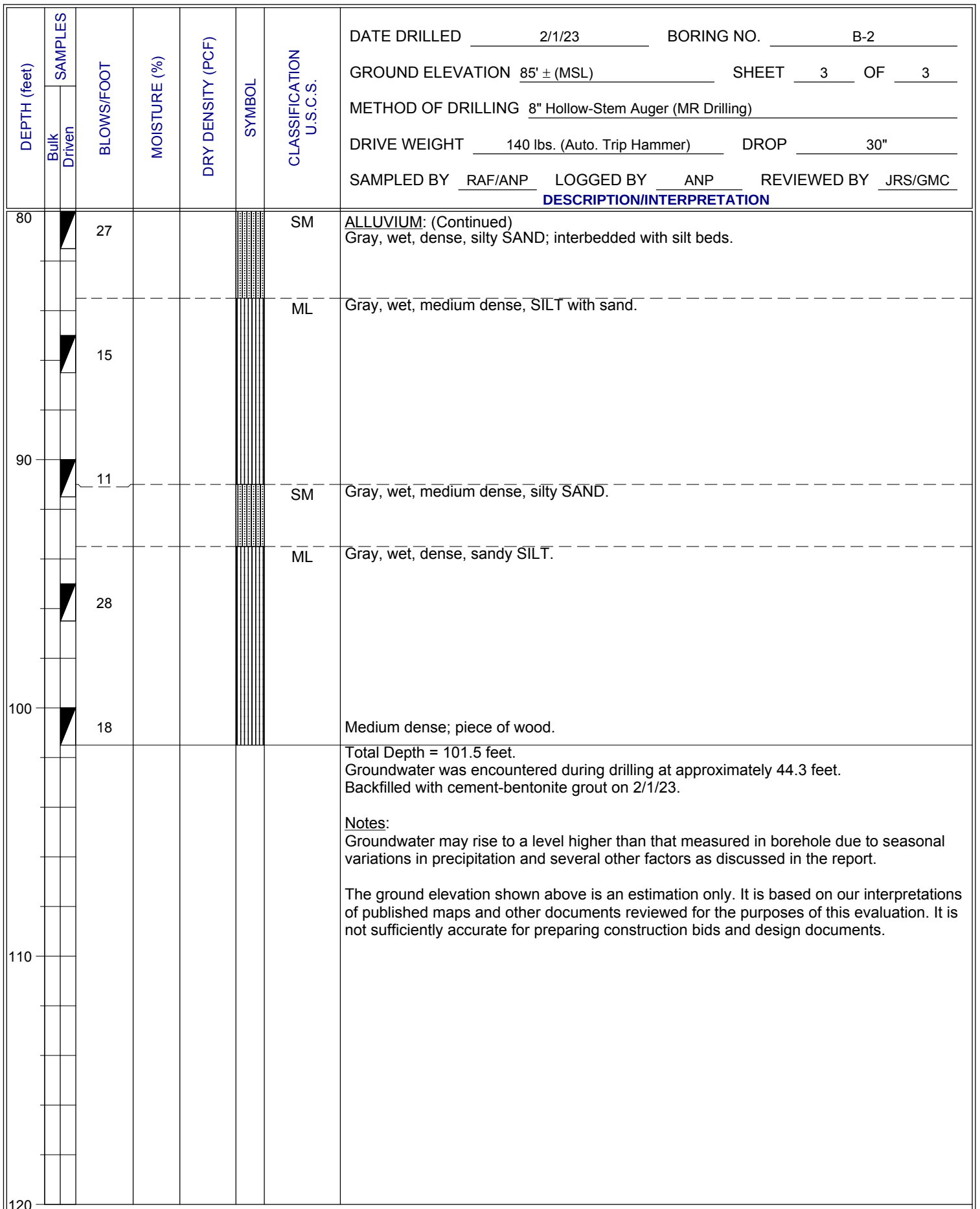


FIGURE B- 4

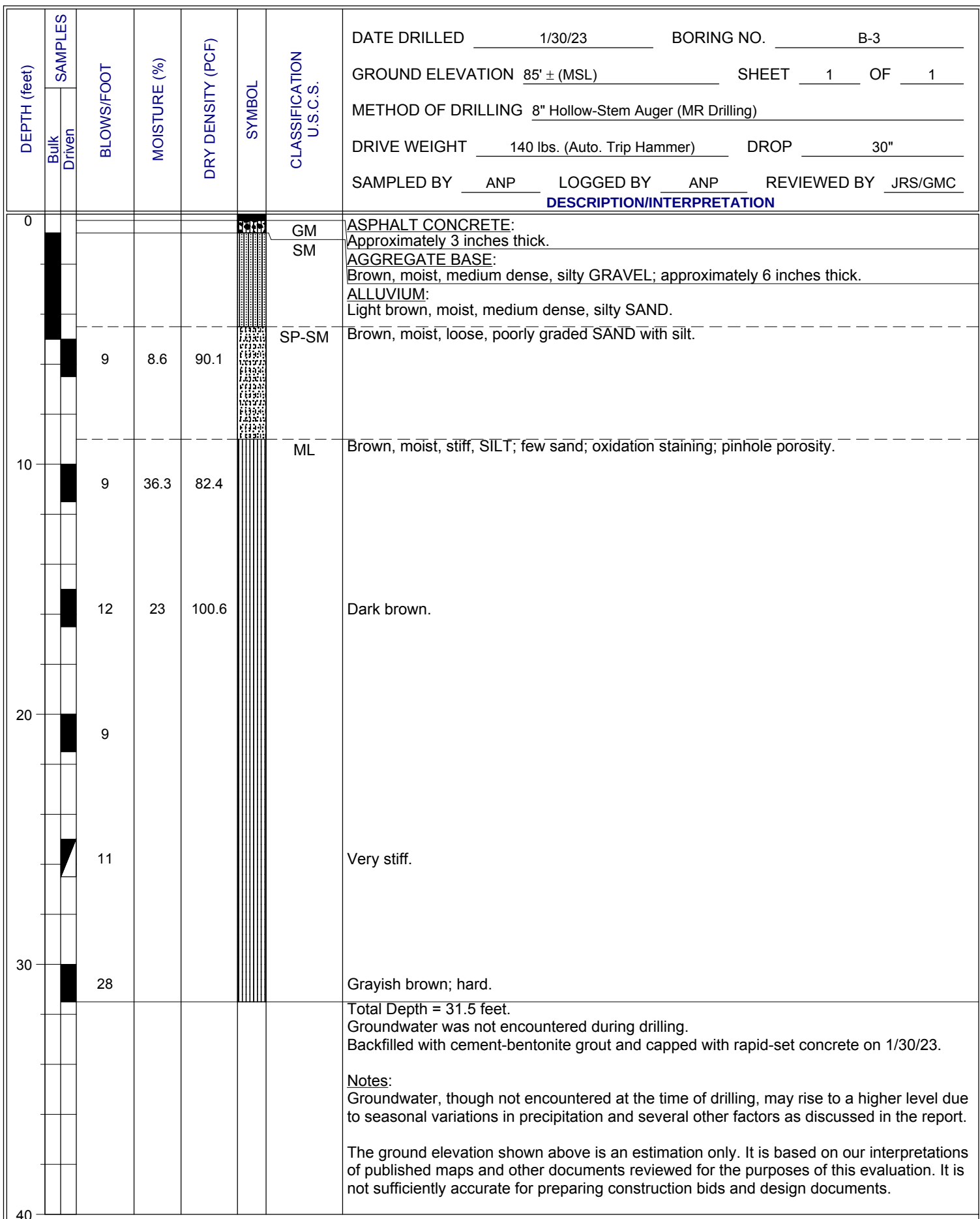


FIGURE B- 5

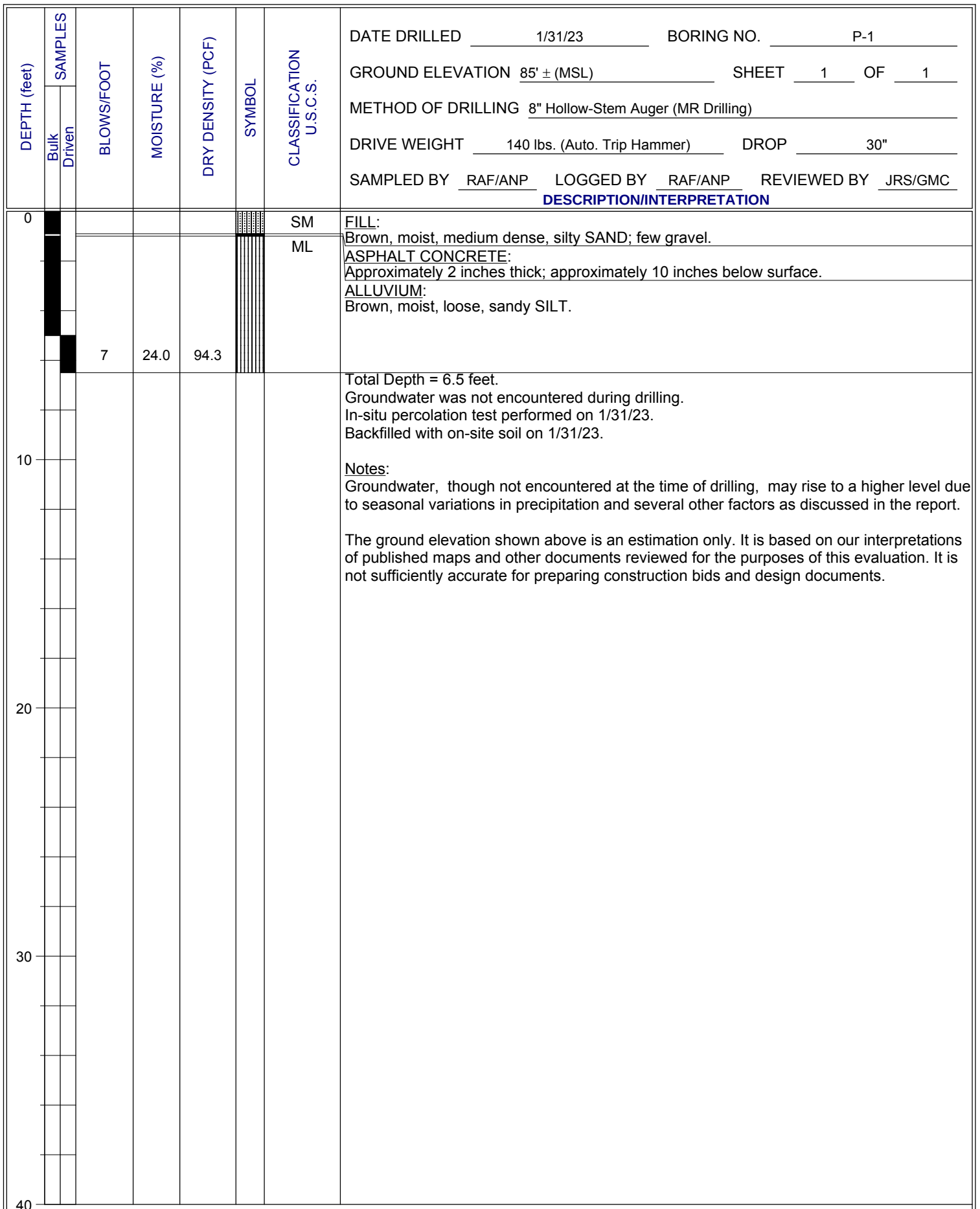


FIGURE B- 6

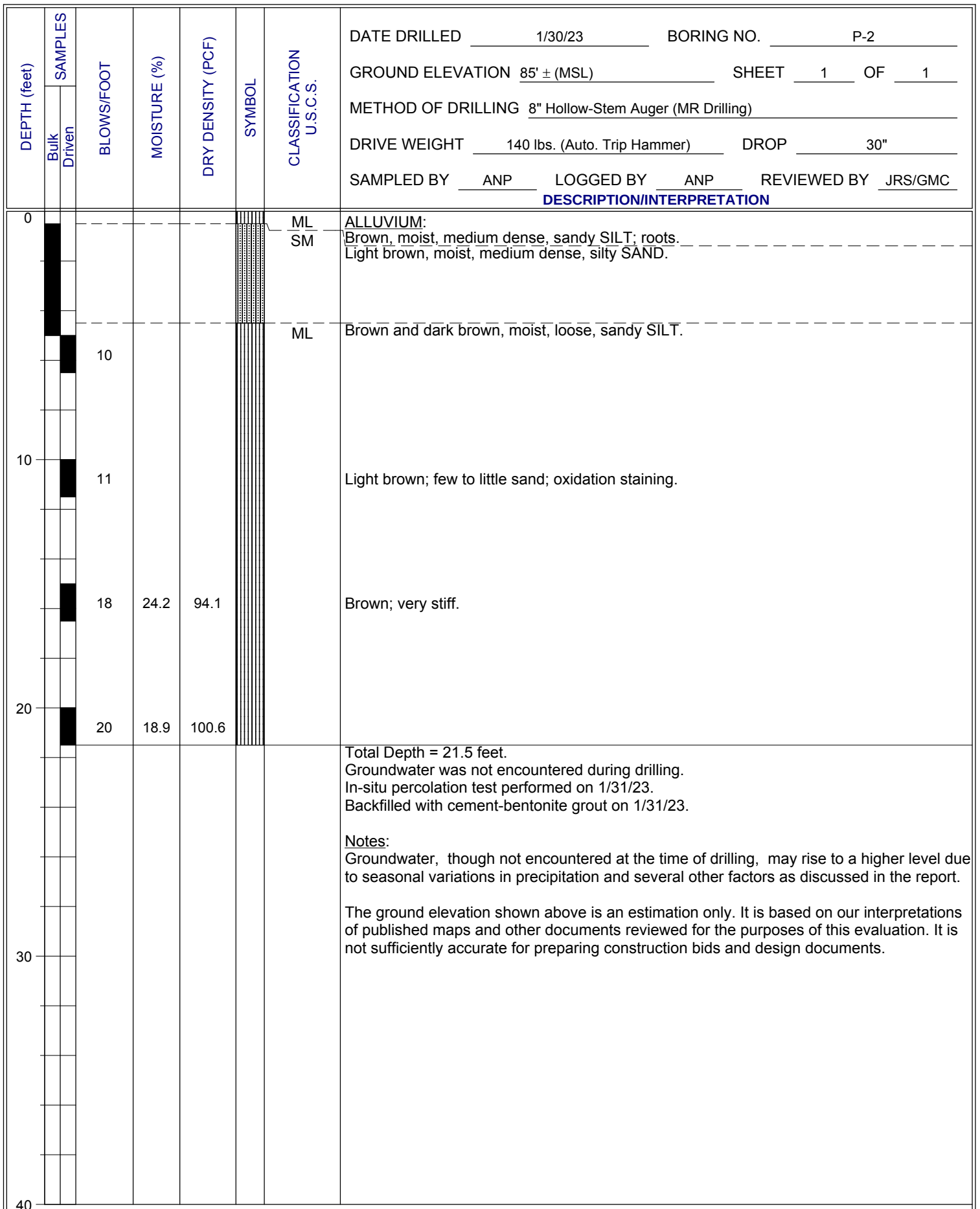


FIGURE B- 7

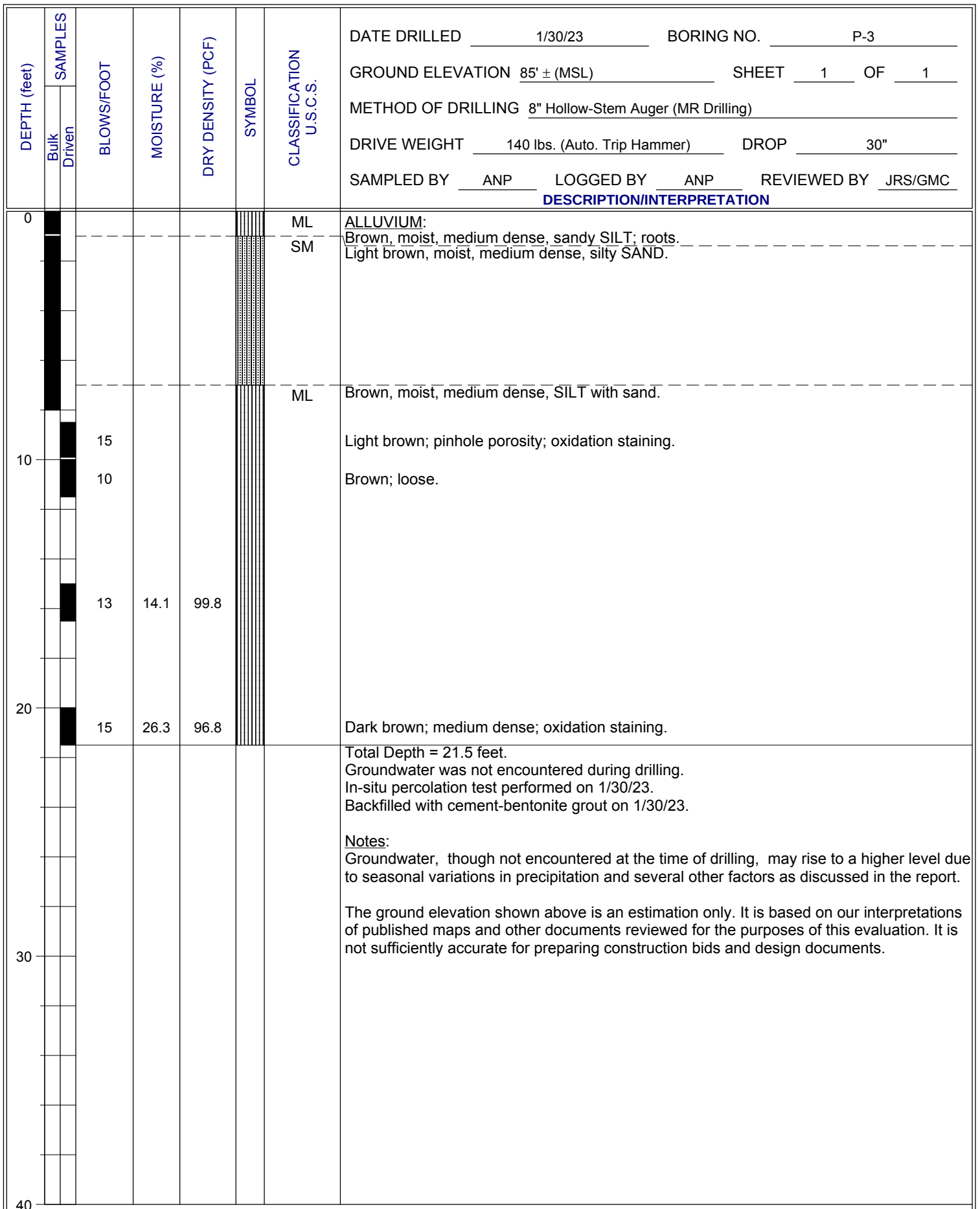


FIGURE B- 8

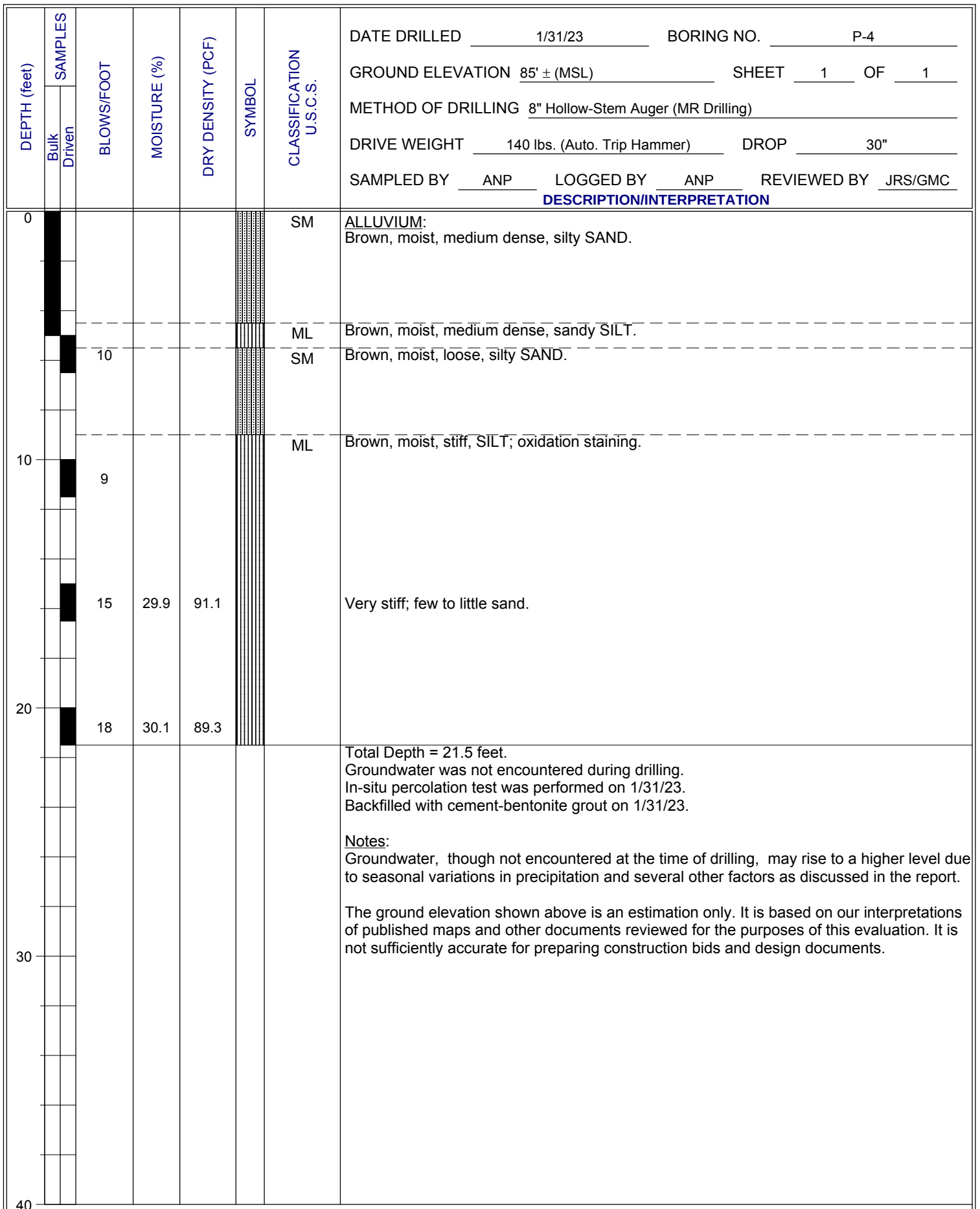


FIGURE B- 9



# APPENDIX C

## CPT Soundings

## APPENDIX C

### CPT SOUNDINGS

#### **Field Procedure for Cone Penetration Testing**

The cone penetration testing (CPT) described in this report was conducted by Kehoe Testing and Engineering in general accordance with ASTM D 5778. The cone penetrometer assembly used for this project consisted of a conical tip and a cylindrical friction sleeve. The conical tip had an apex angle of 60 degrees and a cross-section area of approximately 15 square centimeters. The interior of the CPT probe was instrumented with strain gauges that allowed simultaneous measurement of cone tip resistance and friction sleeve resistance during penetration. The cone hydraulically pushed into the soil using the reaction mass of a specially designed 30-ton truck at a constant rate while the cone tip resistance and sleeve friction were recorded at an approximately 1-inch interval and stored in digital form. The computer-generated logs presented in the following pages include cone resistance, sleeve friction, pore pressure, and soil behavior type.

# **SUMMARY OF CONE PENETRATION TEST DATA**

Project:

**Lynwood Stormwater Capture  
11301 Bullis Road  
Lynwood, CA  
January 30, 2023**

Prepared for:

**Ms. Aura Scharf  
Ninyo & Moore  
475 Goddard, Ste 200  
Irvine, CA 92618-4605  
Office (949) 753-7070 / Fax (949) 753-7071**

Prepared by:



**KEHOE TESTING & ENGINEERING**

5415 Industrial Drive  
Huntington Beach, CA 92649-1518  
Office (714) 901-7270 / Fax (714) 901-7289  
[www.kehoetesting.com](http://www.kehoetesting.com)

# **TABLE OF CONTENTS**

- 1. INTRODUCTION**
- 2. SUMMARY OF FIELD WORK**
- 3. FIELD EQUIPMENT & PROCEDURES**
- 4. CONE PENETRATION TEST DATA & INTERPRETATION**

## **APPENDIX**

- CPT Plots
- CPT Classification/Soil Behavior Chart
- Summary of Shear Wave Velocities
- Pore Pressure Dissipation Graphs
- CPT Data Files (sent via email)

# SUMMARY OF CONE PENETRATION TEST DATA

## 1. INTRODUCTION

This report presents the results of a Cone Penetration Test (CPT) program carried out for the Lynwood Stormwater Capture project located at 11301 Bullis Road in Lynwood, California. The work was performed by Kehoe Testing & Engineering (KTE) on January 30, 2023. The scope of work was performed as directed by Ninyo & Moore personnel.

## 2. SUMMARY OF FIELD WORK

The fieldwork consisted of performing CPT soundings at two locations to determine the soil lithology. A summary is provided in **TABLE 2.1**.

| LOCATION | DEPTH OF CPT (ft) | COMMENTS/NOTES: |
|----------|-------------------|-----------------|
| CPT-1    | 60                |                 |
| CPT-2    | 100               |                 |
|          |                   |                 |

**TABLE 2.1 - Summary of CPT Soundings**

## 3. FIELD EQUIPMENT & PROCEDURES

The CPT soundings were carried out by **KTE** using an integrated electronic cone system manufactured by Vertek. The CPT soundings were performed in accordance with ASTM standards (D5778). The cone penetrometers were pushed using a 30-ton CPT rig. The cone used during the program was a 15 cm<sup>2</sup> cone with a cone net area ratio of 0.83. The following parameters were recorded at approximately 2.5 cm depth intervals:

- Cone Resistance (qc)
- Sleeve Friction (fs)
- Dynamic Pore Pressure (u)
- Inclination
- Penetration Speed
- Pore Pressure Dissipation (at selected depths)

At location CPT-2, shear wave measurements were obtained at approximately 5-foot intervals. The shear wave is generated using an air-actuated hammer, which is located inside the front jack of the CPT rig. The cone has a triaxial geophone, which recorded the shear wave signal generated by the air hammer.

The above parameters were recorded and viewed in real time using a laptop computer. Data is stored at the KTE office for up to 2 years for future analysis and reference. A complete set of baseline readings was taken prior to each sounding to determine temperature shifts and any zero load offsets. Monitoring base line readings ensures that the cone electronics are operating properly.

#### **4. CONE PENETRATION TEST DATA & INTERPRETATION**

The Cone Penetration Test data is presented in graphical form in the attached Appendix. These plots were generated using the CPeT-IT program. Penetration depths are referenced to ground surface. The soil behavior type on the CPT plots is derived from the attached CPT SBT plot (Robertson, "Interpretation of Cone Penetration Test...", 2009) and presents major soil lithologic changes. The stratigraphic interpretation is based on relationships between cone resistance ( $q_c$ ), sleeve friction ( $f_s$ ), and penetration pore pressure ( $u$ ). The friction ratio ( $R_f$ ), which is sleeve friction divided by cone resistance, is a calculated parameter that is used along with cone resistance to infer soil behavior type. Generally, cohesive soils (clays) have high friction ratios, low cone resistance and generate excess pore water pressures. Cohesionless soils (sands) have lower friction ratios, high cone bearing and generate little (or negative) excess pore water pressures.

The CPT data files have also been provided. These files can be imported in CPeT-IT (software by GeoLogismiki) and other programs to calculate various geotechnical parameters.

It should be noted that it is not always possible to clearly identify a soil type based on  $q_c$ ,  $f_s$  and  $u$ . In these situations, experience, judgement and an assessment of the pore pressure data should be used to infer the soil behavior type.

If you have any questions regarding this information, please do not hesitate to call our office at (714) 901-7270.

Sincerely,

**KEHOE TESTING & ENGINEERING**



Steven P. Kehoe  
President

## APPENDIX

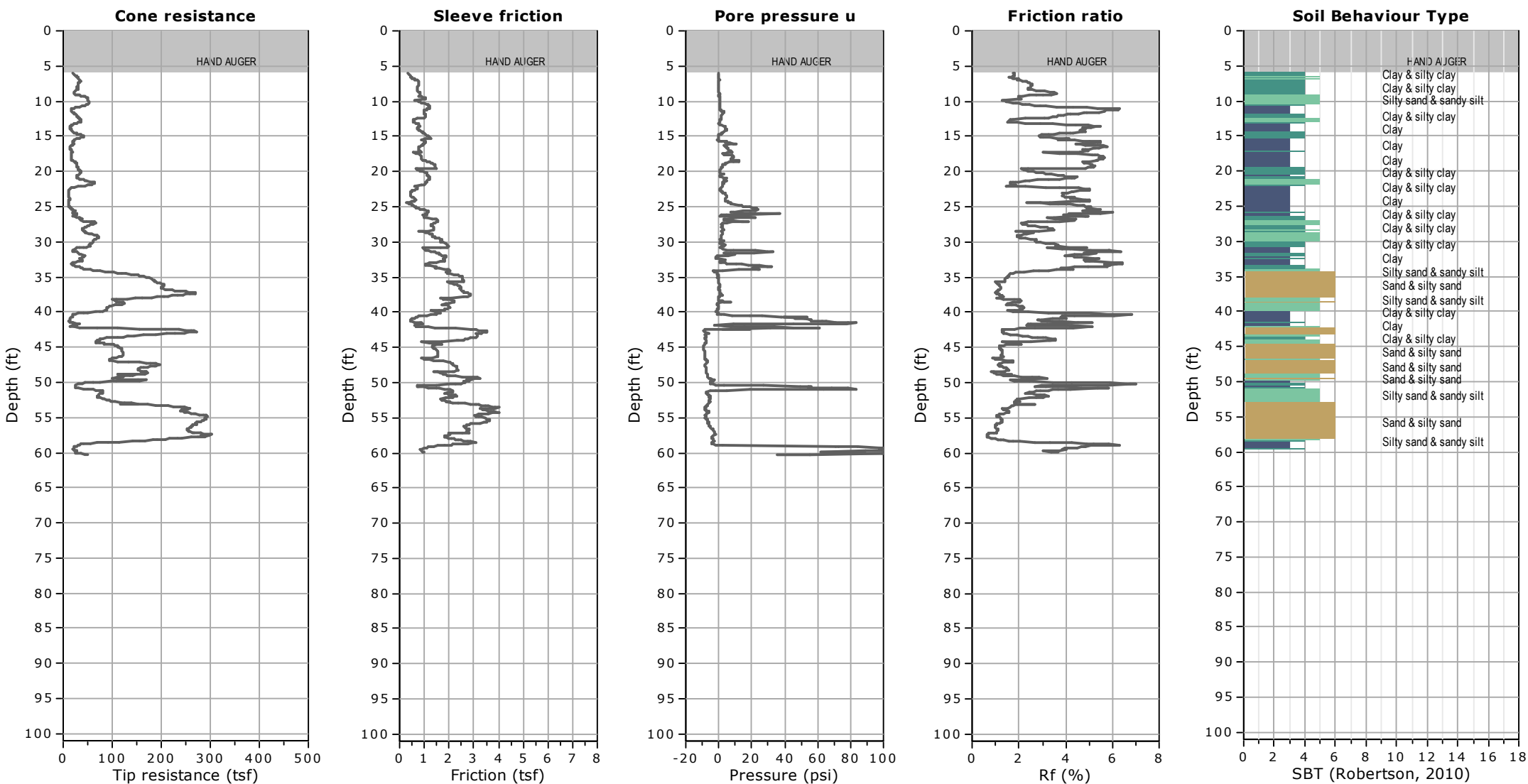


**Project:** Ninyo & Moore / Lynwood Stormwater Capture

**Location:** 11301 Bullis Rd, Lynwood, CA

**CPT-1**

Total depth: 60.31 ft, Date: 1/30/2023



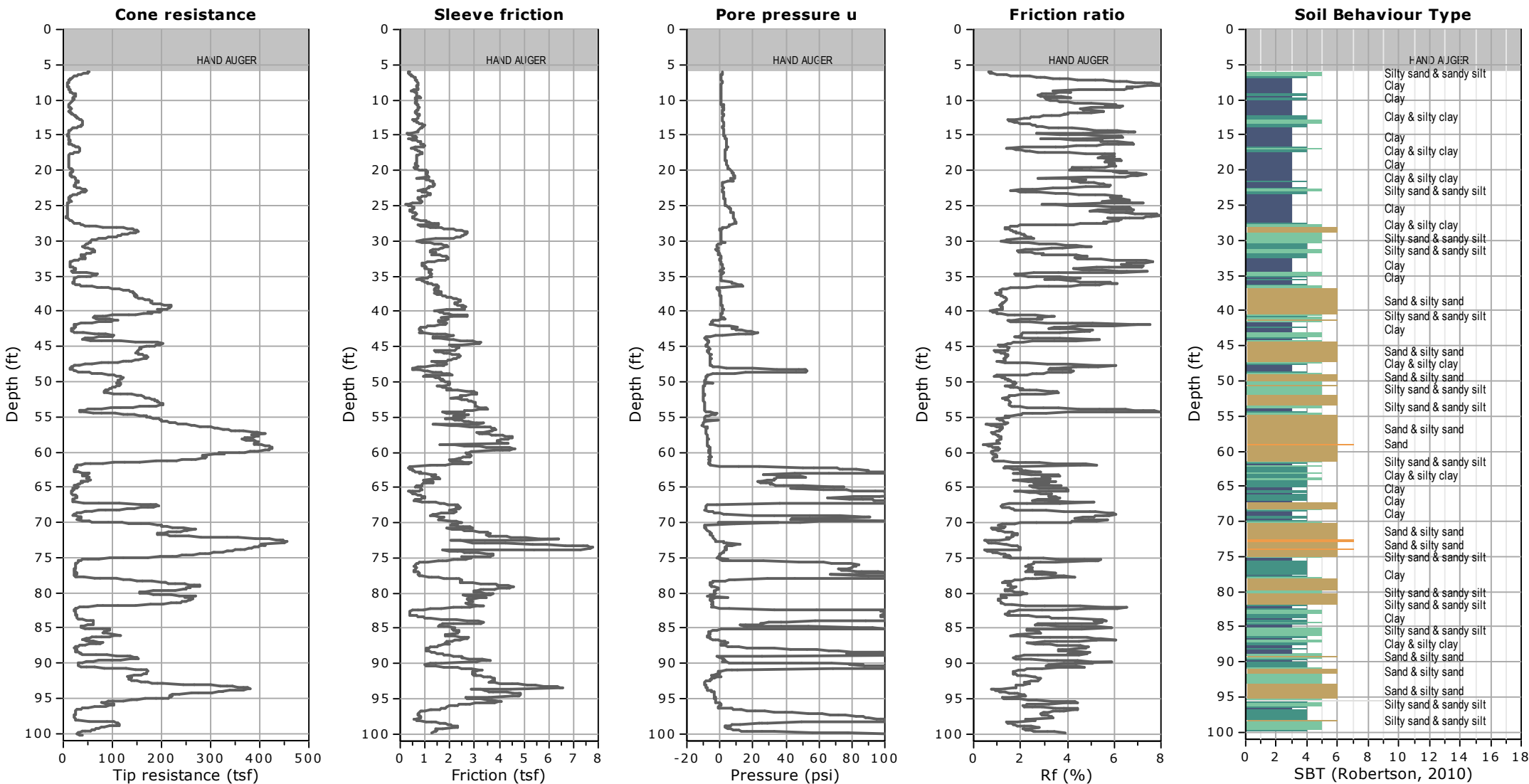


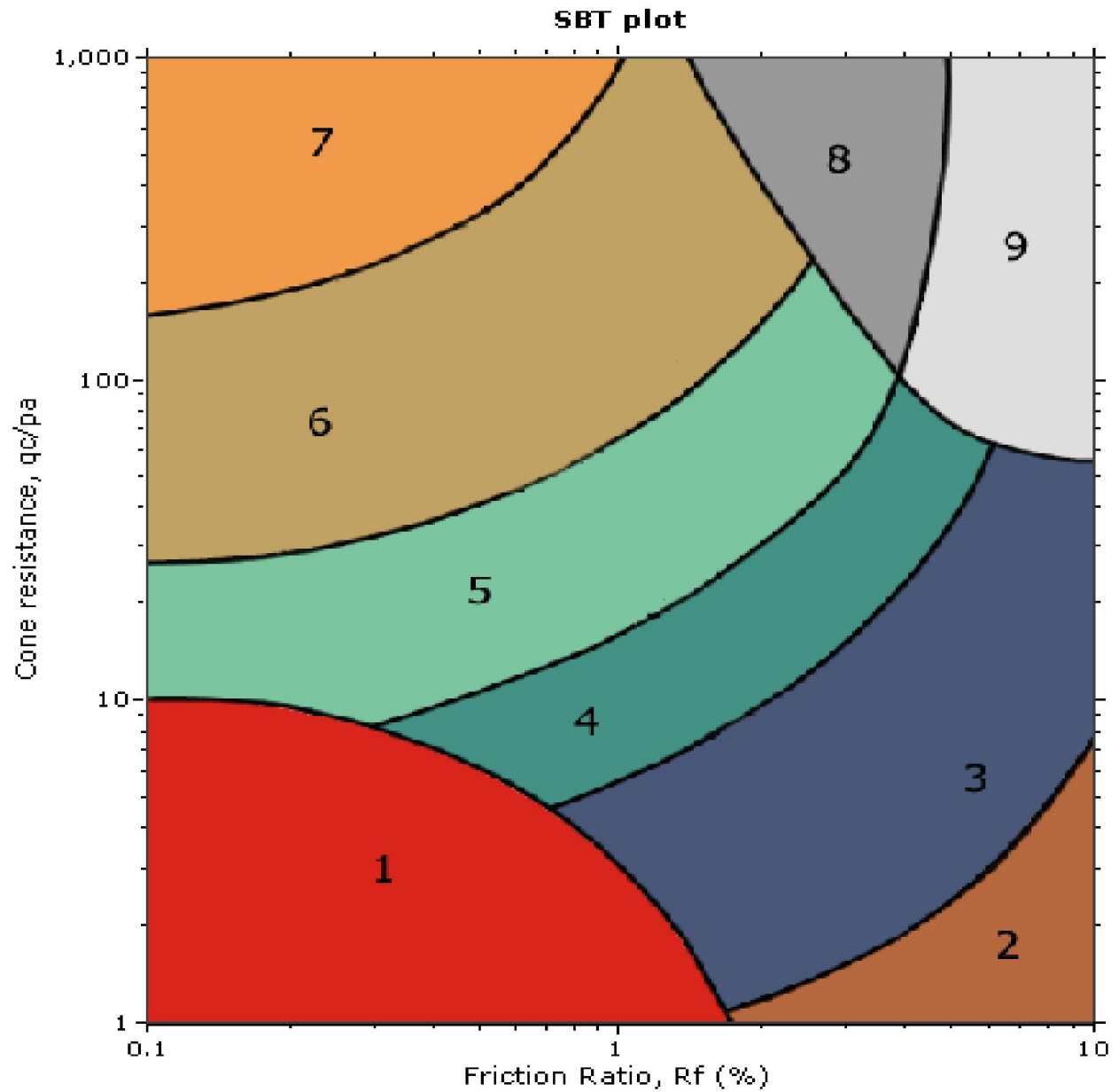
**Project:** Ninyo & Moore / Lynwood Stormwater Capture

**Location:** 11301 Bullis Rd, Lynwood, CA

**CPT-2**

Total depth: 100.20 ft, Date: 1/30/2023





**SBT legend**

- |                                                               |                                                                       |                                                                       |
|---------------------------------------------------------------|-----------------------------------------------------------------------|-----------------------------------------------------------------------|
| <span style="color: red;">■</span> 1. Sensitive fine grained  | <span style="color: teal;">■</span> 4. Clayey silt to silty clay      | <span style="color: orange;">■</span> 7. Gravely sand to sand         |
| <span style="color: brown;">■</span> 2. Organic material      | <span style="color: lightgreen;">■</span> 5. Silty sand to sandy silt | <span style="color: grey;">■</span> 8. Very stiff sand to clayey sand |
| <span style="color: darkblue;">■</span> 3. Clay to silty clay | <span style="color: tan;">■</span> 6. Clean sand to silty sand        | <span style="color: lightgrey;">■</span> 9. Very stiff fine grained   |

Ninyo & Moore  
Lynwood Stormwater Capture  
Lynwood, CA

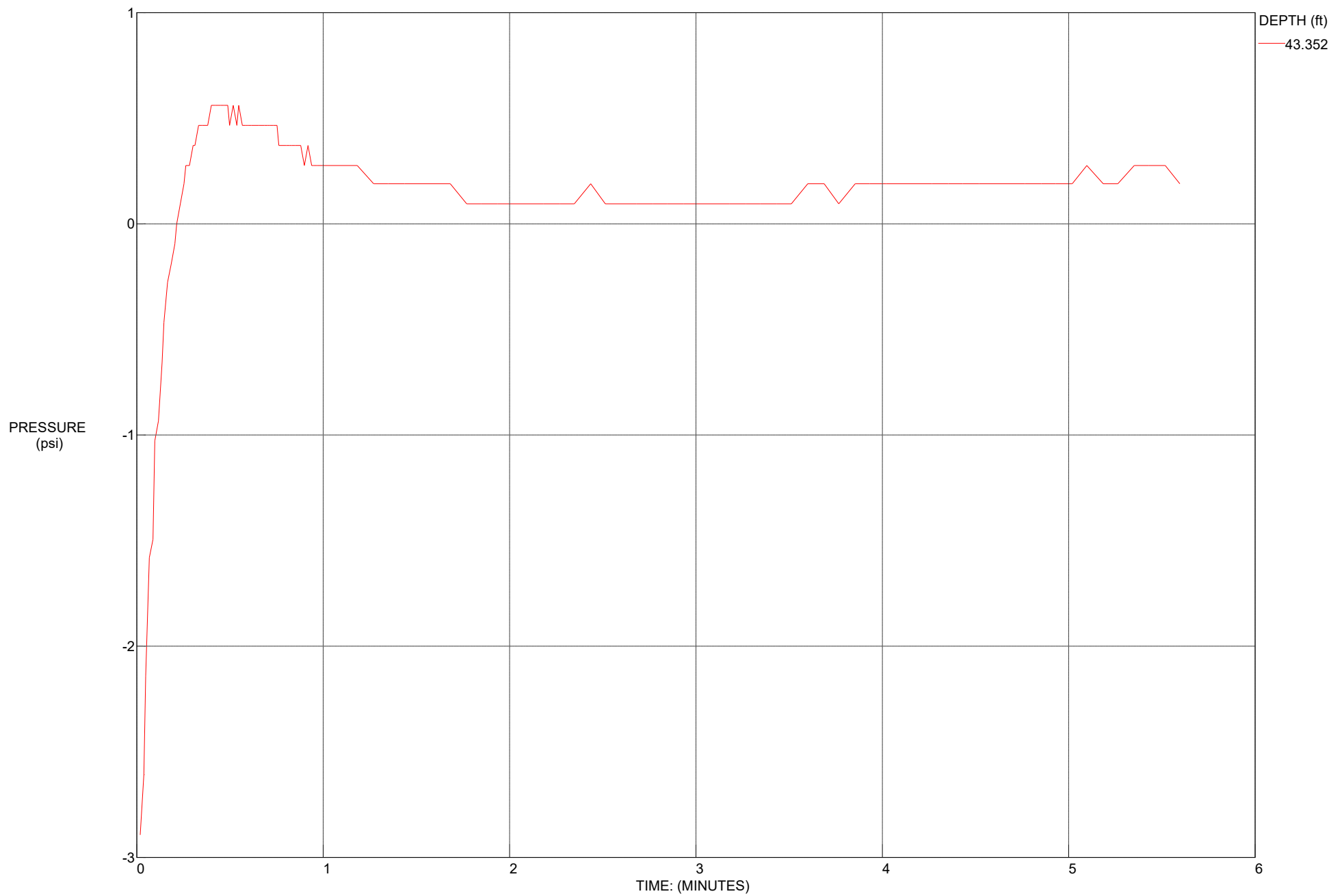
CPT Shear Wave Measurements

| Location | Tip<br>Depth<br>(ft) | Geophone<br>Depth<br>(ft) | Travel<br>Distance<br>(ft) | S-Wave<br>Arrival<br>(msec) | S-Wave<br>Velocity<br>from Surface<br>(ft/sec) | Interval<br>S-Wave<br>Velocity<br>(ft/sec) |
|----------|----------------------|---------------------------|----------------------------|-----------------------------|------------------------------------------------|--------------------------------------------|
| CPT-2    | 4.99                 | 3.99                      | 4.46                       | 8.76                        | 509                                            |                                            |
|          | 10.04                | 9.04                      | 9.26                       | 16.28                       | 569                                            | 638                                        |
|          | 15.03                | 14.03                     | 14.17                      | 26.56                       | 534                                            | 478                                        |
|          | 20.05                | 19.05                     | 19.15                      | 34.88                       | 549                                            | 599                                        |
|          | 25.10                | 24.10                     | 24.18                      | 42.84                       | 564                                            | 632                                        |
|          | 30.15                | 29.15                     | 29.22                      | 49.24                       | 593                                            | 787                                        |
|          | 35.04                | 34.04                     | 34.10                      | 57.16                       | 597                                            | 616                                        |
|          | 40.12                | 39.12                     | 39.17                      | 62.96                       | 622                                            | 875                                        |
|          | 45.05                | 44.05                     | 44.10                      | 69.26                       | 637                                            | 782                                        |
|          | 50.10                | 49.10                     | 49.14                      | 75.26                       | 653                                            | 841                                        |
|          | 55.12                | 54.12                     | 54.16                      | 81.70                       | 663                                            | 779                                        |
|          | 60.10                | 59.10                     | 59.13                      | 86.52                       | 683                                            | 1033                                       |
|          | 65.12                | 64.12                     | 64.15                      | 91.74                       | 699                                            | 961                                        |
|          | 70.08                | 69.08                     | 69.11                      | 98.28                       | 703                                            | 758                                        |
|          | 75.13                | 74.13                     | 74.16                      | 103.34                      | 718                                            | 998                                        |
|          | 80.02                | 79.02                     | 79.05                      | 108.76                      | 727                                            | 902                                        |
|          | 85.04                | 84.04                     | 84.06                      | 114.76                      | 733                                            | 836                                        |
|          | 90.09                | 89.09                     | 89.11                      | 119.68                      | 745                                            | 1026                                       |
|          | 95.05                | 94.05                     | 94.07                      | 125.04                      | 752                                            | 925                                        |
|          | 100.16               | 99.16                     | 99.18                      | 130.40                      | 761                                            | 953                                        |

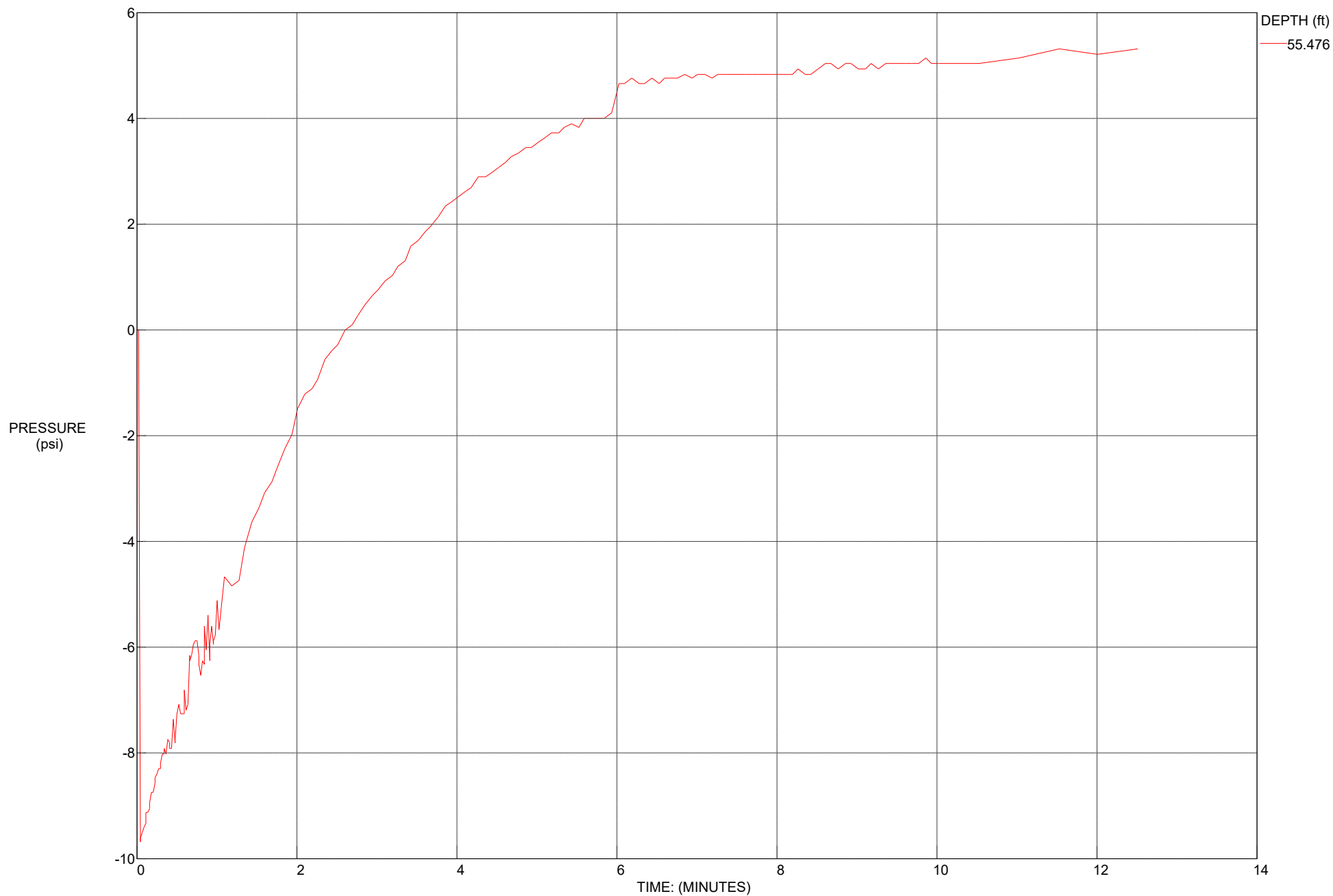
Shear Wave Source Offset - 2 ft

S-Wave Velocity from Surface = Travel Distance/S-Wave Arrival  
Interval S-Wave Velocity = (Travel Dist2-Travel Dist1)/(Time2-Time1)

TEST ID: CPT-1



TEST ID: CPT-2





# APPENDIX D

## Laboratory Testing

## **APPENDIX D**

### **LABORATORY TESTING**

#### **Classification**

Soils were visually and texturally classified in accordance with the Unified Soil Classification System (USCS) in general accordance with ASTM D 2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix B.

#### **In-Place Moisture and Density Tests**

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory borings were evaluated in general accordance with ASTM D 2937. The test results are presented on the logs of the exploratory borings in Appendix B.

#### **200 Wash**

An evaluation of the percentage of particles finer than the No. 200 sieve in selected soil samples was performed in general accordance with ASTM D 1140. The results of the tests are presented on Figures D-1 through D-3.

#### **Atterberg Limits**

Tests were performed on a selected representative fine-grained soil sample to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D 4318. These test results were utilized to evaluate the soil classification in accordance with the USCS. The test results and classification are shown on Figure D-4.

#### **Consolidation Tests**

Consolidation testing was performed on selected relatively undisturbed soil samples in general accordance with ASTM D 2435. The samples were inundated during testing to represent adverse field conditions. The percent of consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the sample. The results of the tests are summarized on Figures D-5 and D-6.

#### **Direct Shear Tests**

Direct shear tests were performed on relatively undisturbed samples in general accordance with ASTM D 3080 to evaluate the shear strength characteristics of selected materials. The samples were inundated during shearing to represent the adverse field conditions. The results are shown on Figures D-7 and D-8.

#### **Soil Corrosivity Tests**

Soil pH and resistivity tests were performed on representative samples in general accordance with CT 643. The soluble sulfate and chloride content of the selected samples were evaluated in general accordance with CT 417 and CT 422, respectively. The test results are presented on Figure D-9.

| SAMPLE LOCATION | SAMPLE DEPTH (ft) | DESCRIPTION    | PERCENT PASSING NO. 4 | PERCENT PASSING NO. 200 | USCS (TOTAL SAMPLE) |
|-----------------|-------------------|----------------|-----------------------|-------------------------|---------------------|
| B-1             | 5.0-6.5           | SANDY SILT     | 100                   | 63                      | ML                  |
| B-1             | 15.0-16.5         | SILT WITH SAND | 99                    | 71                      | ML                  |
| B-1             | 25.0-26.5         | SANDY SILT     | 100                   | 58                      | ML                  |
| B-2             | 10.0-11.5         | SILT           | 100                   | 91                      | ML                  |
| B-2             | 20.0-21.5         | SILT           | 100                   | 87                      | ML                  |
| B-2             | 30.0-31.5         | SANDY SILT     | 100                   | 53                      | ML                  |
| B-2             | 40.0-41.5         | SILTY SAND     | 100                   | 15                      | SM                  |
| B-2             | 45.0-45.5         | SANDY SILT     | 100                   | 63                      | ML                  |
| B-2             | 50.0-51.5         | SANDY SILT     | 100                   | 51                      | ML                  |

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 1140

FIGURE D-1

| SAMPLE LOCATION | SAMPLE DEPTH (ft) | DESCRIPTION    | PERCENT PASSING NO. 4 | PERCENT PASSING NO. 200 | USCS (TOTAL SAMPLE) |
|-----------------|-------------------|----------------|-----------------------|-------------------------|---------------------|
| B-2             | 60.0-61.5         | SILTY SAND     | 100                   | 16                      | SM                  |
| B-2             | 70.0-71.0         | SILT WITH SAND | 100                   | 85                      | ML                  |
| B-2             | 80.0-81.5         | SILTY SAND     | 100                   | 35                      | SM                  |
| B-2             | 90.0-91.0         | SILT WITH SAND | 100                   | 82                      | ML                  |
| B-3             | 10.0-11.5         | SILT           | 100                   | 92                      | ML                  |
| B-3             | 20.0-21.5         | SILT           | 99                    | 91                      | ML                  |
| P-1             | 0.0-1.0           | SILTY SAND     | 92                    | 46                      | SM                  |
| P-1             | 5.0-6.5           | SANDY SILT     | 100                   | 52                      | ML                  |
| P-2             | 0.5-5.0           | SILTY SAND     | 100                   | 41                      | SM                  |

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 1140

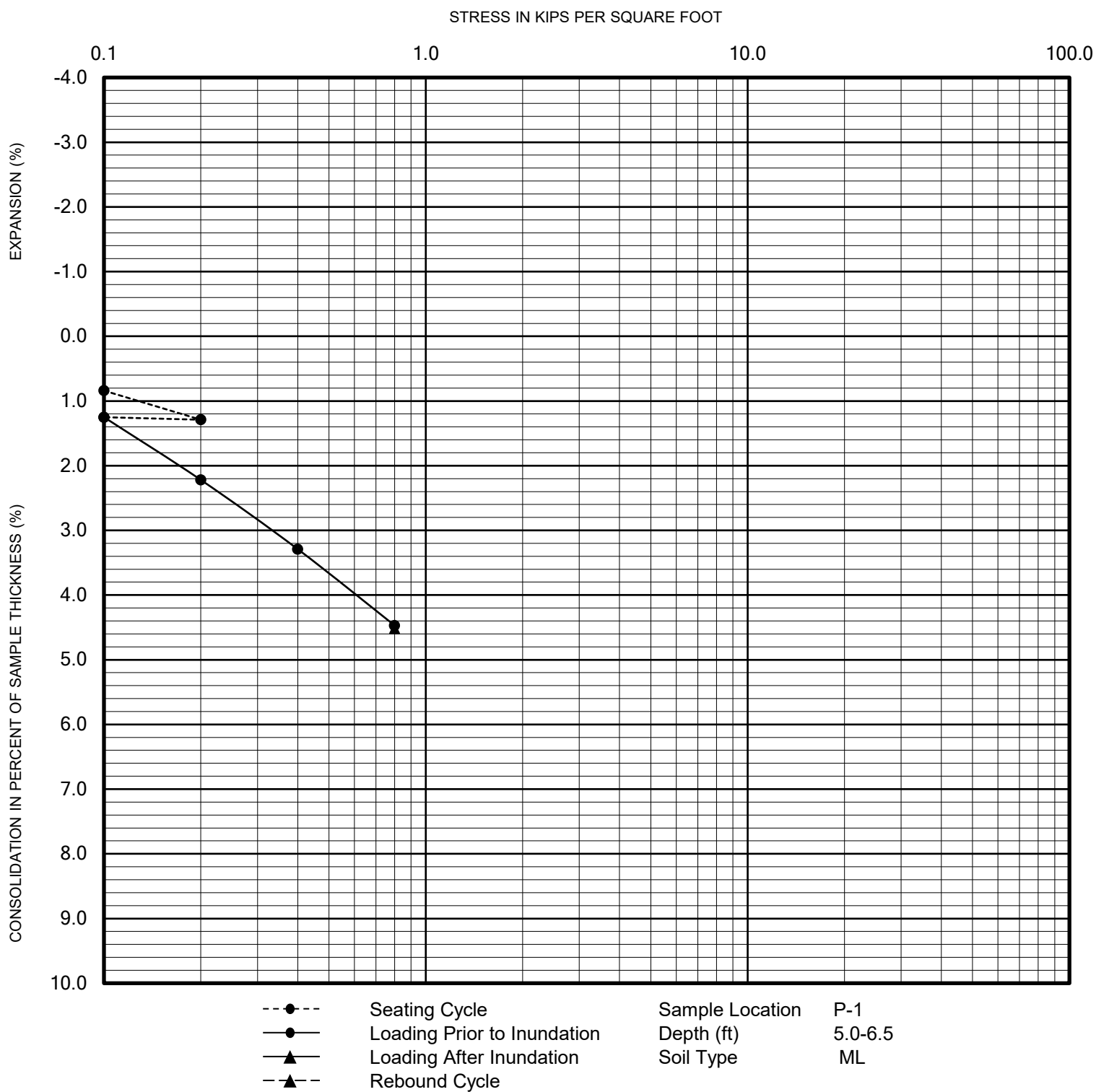
FIGURE D-2

| SAMPLE LOCATION | SAMPLE DEPTH (ft) | DESCRIPTION    | PERCENT PASSING NO. 4 | PERCENT PASSING NO. 200 | USCS (TOTAL SAMPLE) |
|-----------------|-------------------|----------------|-----------------------|-------------------------|---------------------|
| P-2             | 15.0-16.5         | SILT           | 100                   | 87                      | ML                  |
| P-3             | 0.0-1.0           | SANDY SILT     | 100                   | 50                      | ML                  |
| P-3             | 20.0-21.5         | SILT WITH SAND | 100                   | 84                      | ML                  |
| P-4             | 5.0-6.5           | SILTY SAND     | 100                   | 17                      | SM                  |
| P-4             | 15.0-16.5         | SILT           | 100                   | 89                      | ML                  |

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 1140

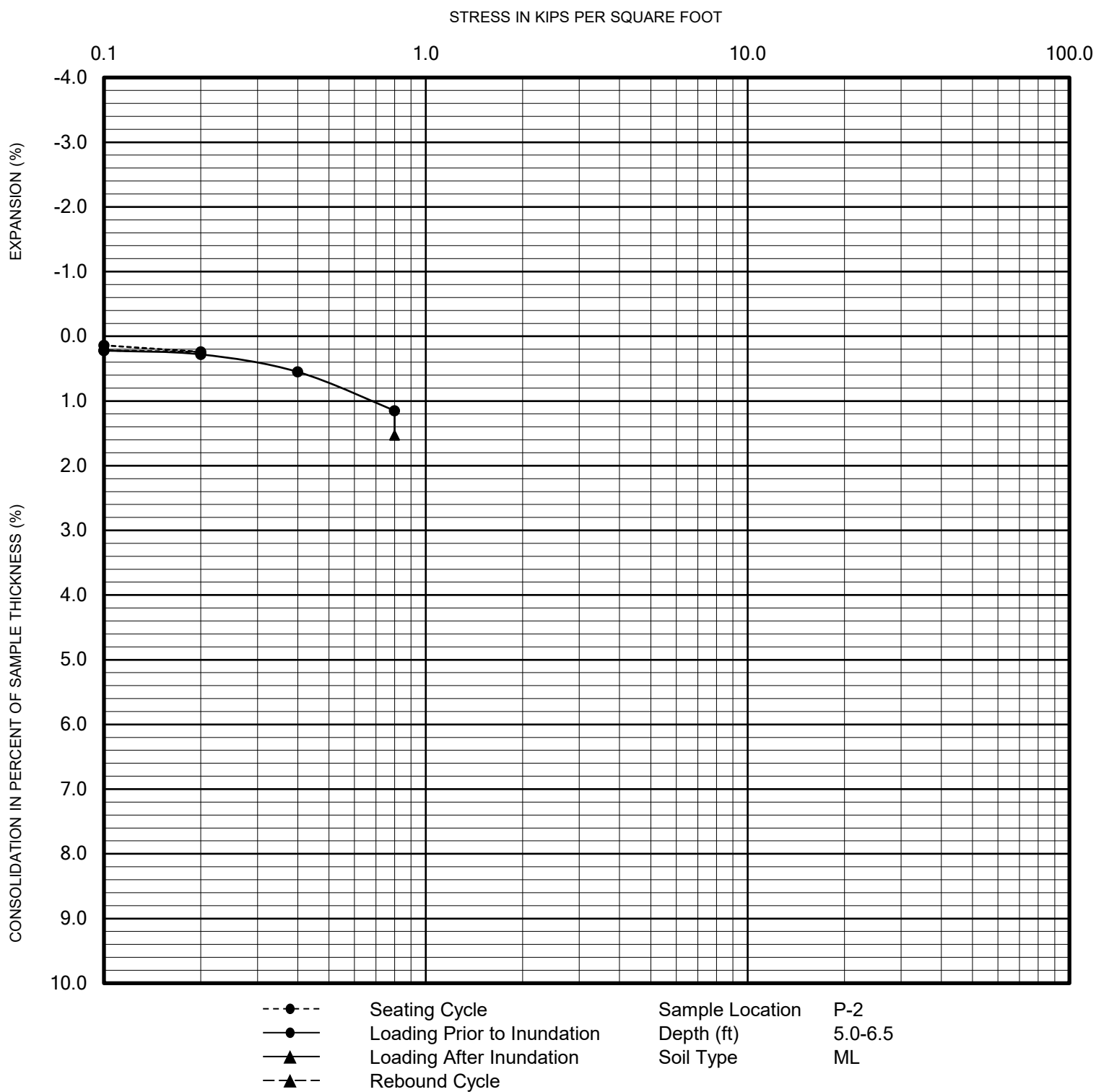
**FIGURE D-3**





PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

FIGURE D-5



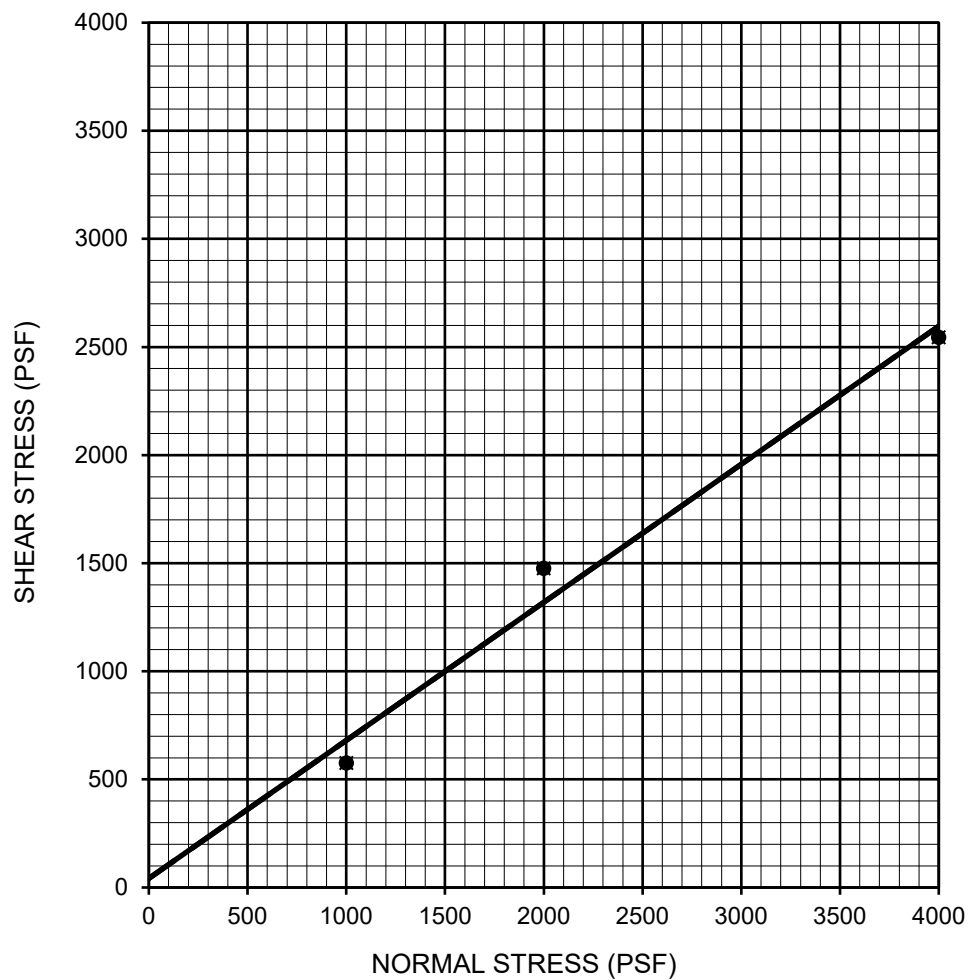
PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

**FIGURE D-6**



**CONSOLIDATION TEST RESULTS**

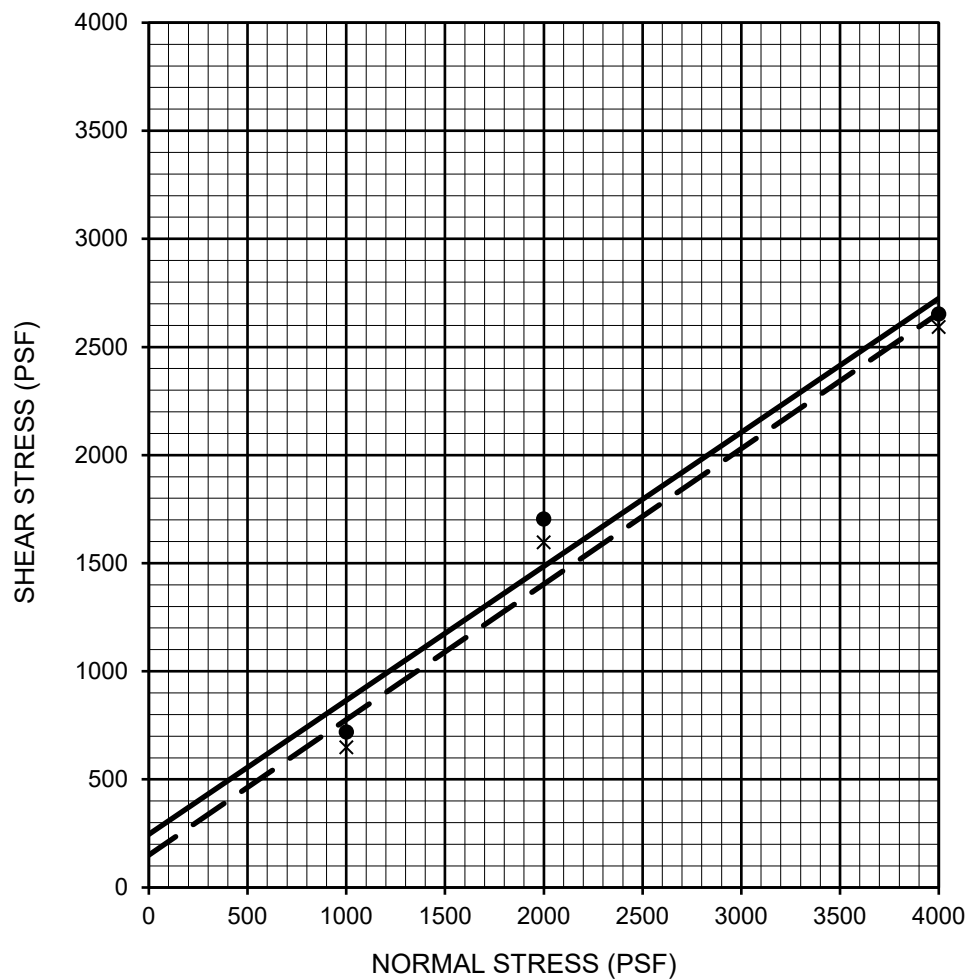
LYNWOD CITY PARK STORMWATER CAPTURE PROJECT  
LYNWOD, CALIFORNIA



| Description | Symbol                                                                              | Sample Location | Depth (ft) | Shear Strength | Cohesion (psf) | Friction Angle (degrees) | Soil Type |
|-------------|-------------------------------------------------------------------------------------|-----------------|------------|----------------|----------------|--------------------------|-----------|
| SILT        |  | B-2             | 10.0-11.5  | Peak           | 42             | 33                       | ML        |
| SILT        |  | B-2             | 10.0-11.5  | Ultimate       | 42             | 33                       | ML        |

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

FIGURE D-7



| Description | Symbol    | Sample Location | Depth (ft) | Shear Strength | Cohesion (psf) | Friction Angle (degrees) | Soil Type |
|-------------|-----------|-----------------|------------|----------------|----------------|--------------------------|-----------|
| SILT        | —●—       | B-2             | 20.0-21.5  | Peak           | 246            | 32                       | ML        |
| SILT        | - - X - - | B-2             | 20.0-21.5  | Ultimate       | 150            | 32                       | ML        |

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 3080

FIGURE D-8

| SAMPLE LOCATION | SAMPLE DEPTH (ft) | pH <sup>1</sup> | RESISTIVITY <sup>1</sup><br>(ohm-cm) | SULFATE CONTENT <sup>2</sup> |       | CHLORIDE CONTENT <sup>3</sup><br>(ppm) |
|-----------------|-------------------|-----------------|--------------------------------------|------------------------------|-------|----------------------------------------|
|                 |                   |                 |                                      | (ppm)                        | (%)   |                                        |
| B-1             | 4.5-5.0           | 7.4             | 8,745                                | 70                           | 0.007 | 60                                     |
| B-2             | 8.0-9.5           | 7.3             | 580                                  | 180                          | 0.018 | 650                                    |

<sup>1</sup> PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 643

<sup>2</sup> PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 417

<sup>3</sup> PERFORMED IN GENERAL ACCORDANCE WITH CALIFORNIA TEST METHOD 422

FIGURE D-9

CORROSIVITY TEST RESULTS

LYNWOOD CITY PARK STORMWATER CAPTURE PROJECT  
LYNWOOD, CALIFORNIA





# APPENDIX E

## Drum Characterization Test Results



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Lake Forest, California 92630  
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949.297.5027 Fax

09 February 2023

Jennifer Schmidt  
Ninyo & Moore  
475 Goddard, Ste. 200  
Irvine, CA 92618  
RE: Lynwood Park

Enclosed are the results of analyses for samples received by the laboratory on 02/03/23 12:26. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Joann Marroquin  
Director of Operations



25712 Commercentre Drive  
Lake Forest, California 92630  
949.297.5020 Phone  
949.297.5027 Fax

Ninyo & Moore  
475 Goddard, Ste. 200  
Irvine CA, 92618

Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

**Reported:**  
02/09/23 16:29

#### ANALYTICAL REPORT FOR SAMPLES

| Sample ID           | Laboratory ID | Matrix | Date Sampled   | Date Received  |
|---------------------|---------------|--------|----------------|----------------|
| 212102001_Composite | T230311-07    | Soil   | 01/30/23 14:04 | 02/03/23 12:26 |

SunStar Laboratories, Inc.

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Joann Marroquin, Director of Operations

Ninyo & Moore  
475 Goddard, Ste. 200  
Irvine CA, 92618

Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

**Reported:**  
02/09/23 16:29

### DETECTIONS SUMMARY

**Sample ID:** 212102001\_Composite

**Laboratory ID:** T230311-07

| Analyte  | Reporting |       | Units | Method    | Notes |
|----------|-----------|-------|-------|-----------|-------|
|          | Result    | Limit |       |           |       |
| Barium   | 130       | 1.0   | mg/kg | EPA 6010b |       |
| Chromium | 16        | 2.0   | mg/kg | EPA 6010b |       |
| Cobalt   | 11        | 2.0   | mg/kg | EPA 6010b |       |
| Copper   | 29        | 1.0   | mg/kg | EPA 6010b |       |
| Lead     | 4.1       | 3.0   | mg/kg | EPA 6010b |       |
| Nickel   | 12        | 2.0   | mg/kg | EPA 6010b |       |
| Vanadium | 39        | 5.0   | mg/kg | EPA 6010b |       |
| Zinc     | 58        | 1.0   | mg/kg | EPA 6010b |       |

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Joann Marroquin, Director of Operations

Ninyo & Moore  
475 Goddard, Ste. 200  
Irvine CA, 92618

Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

Reported:  
02/09/23 16:29

**212102001\_Composite  
T230311-07 (Soil)**

| Analyte | Result | Reporting<br>Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---------|--------|--------------------|-------|----------|-------|----------|----------|--------|-------|
|---------|--------|--------------------|-------|----------|-------|----------|----------|--------|-------|

**SunStar Laboratories, Inc.**

**Extractable Petroleum Hydrocarbons by 8015B**

|                                |    |        |        |   |         |          |          |           |  |
|--------------------------------|----|--------|--------|---|---------|----------|----------|-----------|--|
| C6-C12 (GRO)                   | ND | 10     | mg/kg  | 1 | 23B0069 | 02/03/23 | 02/06/23 | EPA 8015B |  |
| C13-C28 (DRO)                  | ND | 10     | "      | " | "       | "        | "        | "         |  |
| C29-C40 (MORO)                 | ND | 10     | "      | " | "       | "        | "        | "         |  |
| Surrogate: <i>p</i> -Terphenyl |    | 93.9 % | 65-135 |   | "       | "        | "        | "         |  |

**Metals by EPA 6010B**

|                 |            |     |       |   |         |          |          |           |  |
|-----------------|------------|-----|-------|---|---------|----------|----------|-----------|--|
| Antimony        | ND         | 4.0 | mg/kg | 1 | 23B0057 | 02/03/23 | 02/09/23 | EPA 6010b |  |
| Silver          | ND         | 2.0 | "     | " | "       | "        | "        | "         |  |
| Arsenic         | ND         | 5.0 | "     | " | "       | "        | "        | "         |  |
| <b>Barium</b>   | <b>130</b> | 1.0 | "     | " | "       | "        | "        | "         |  |
| Beryllium       | ND         | 1.0 | "     | " | "       | "        | 02/09/23 | "         |  |
| Cadmium         | ND         | 2.0 | "     | " | "       | "        | 02/09/23 | "         |  |
| <b>Chromium</b> | <b>16</b>  | 2.0 | "     | " | "       | "        | "        | "         |  |
| <b>Cobalt</b>   | <b>11</b>  | 2.0 | "     | " | "       | "        | "        | "         |  |
| <b>Copper</b>   | <b>29</b>  | 1.0 | "     | " | "       | "        | "        | "         |  |
| <b>Lead</b>     | <b>4.1</b> | 3.0 | "     | " | "       | "        | "        | "         |  |
| Molybdenum      | ND         | 5.0 | "     | " | "       | "        | "        | "         |  |
| <b>Nickel</b>   | <b>12</b>  | 2.0 | "     | " | "       | "        | "        | "         |  |
| Selenium        | ND         | 5.0 | "     | " | "       | "        | "        | "         |  |
| Thallium        | ND         | 5.0 | "     | " | "       | "        | "        | "         |  |
| <b>Vanadium</b> | <b>39</b>  | 5.0 | "     | " | "       | "        | "        | "         |  |
| <b>Zinc</b>     | <b>58</b>  | 1.0 | "     | " | "       | "        | "        | "         |  |

**Cold Vapor Extraction EPA 7470/7471**

|         |    |      |       |   |         |          |          |                   |  |
|---------|----|------|-------|---|---------|----------|----------|-------------------|--|
| Mercury | ND | 0.10 | mg/kg | 1 | 23B0058 | 02/03/23 | 02/07/23 | EPA 7471A<br>Soil |  |
|---------|----|------|-------|---|---------|----------|----------|-------------------|--|

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Ninyo & Moore  
475 Goddard, Ste. 200  
Irvine CA, 92618

Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

Reported:  
02/09/23 16:29

**212102001\_Composite**  
**T230311-07 (Soil)**

| Analyte | Result | Reporting<br>Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---------|--------|--------------------|-------|----------|-------|----------|----------|--------|-------|
|---------|--------|--------------------|-------|----------|-------|----------|----------|--------|-------|

**SunStar Laboratories, Inc.**

**Volatile Organic Compounds by EPA Method 8260B**

|                             |    |     |       |   |         |          |          |           |
|-----------------------------|----|-----|-------|---|---------|----------|----------|-----------|
| Bromobenzene                | ND | 2.5 | ug/kg | 1 | 23B0052 | 02/03/23 | 02/04/23 | EPA 8260B |
| Bromochloromethane          | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Bromodichloromethane        | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Bromoform                   | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Bromomethane                | ND | 2.5 | "     | " | "       | "        | "        | "         |
| n-Butylbenzene              | ND | 2.5 | "     | " | "       | "        | "        | "         |
| sec-Butylbenzene            | ND | 2.5 | "     | " | "       | "        | "        | "         |
| tert-Butylbenzene           | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Carbon tetrachloride        | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Chlorobenzene               | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Chloroethane                | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Chloroform                  | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Chloromethane               | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 2-Chlorotoluene             | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 4-Chlorotoluene             | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Dibromochloromethane        | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,2-Dibromo-3-chloropropane | ND | 5.0 | "     | " | "       | "        | "        | "         |
| 1,2-Dibromoethane (EDB)     | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Dibromomethane              | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,2-Dichlorobenzene         | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,3-Dichlorobenzene         | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,4-Dichlorobenzene         | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Dichlorodifluoromethane     | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,1-Dichloroethane          | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,2-Dichloroethane          | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,1-Dichloroethene          | ND | 2.5 | "     | " | "       | "        | "        | "         |
| cis-1,2-Dichloroethene      | ND | 2.5 | "     | " | "       | "        | "        | "         |
| trans-1,2-Dichloroethene    | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,2-Dichloropropane         | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,3-Dichloropropane         | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 2,2-Dichloropropane         | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,1-Dichloropropene         | ND | 2.5 | "     | " | "       | "        | "        | "         |

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Joann Marroquin, Director of Operations



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Ninyo & Moore  
475 Goddard, Ste. 200  
Irvine CA, 92618

Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

Reported:  
02/09/23 16:29

**212102001\_Composite**  
**T230311-07 (Soil)**

| Analyte | Result | Reporting<br>Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---------|--------|--------------------|-------|----------|-------|----------|----------|--------|-------|
|---------|--------|--------------------|-------|----------|-------|----------|----------|--------|-------|

**SunStar Laboratories, Inc.**

**Volatile Organic Compounds by EPA Method 8260B**

|                           |    |     |       |   |         |          |          |           |
|---------------------------|----|-----|-------|---|---------|----------|----------|-----------|
| cis-1,3-Dichloropropene   | ND | 2.5 | ug/kg | 1 | 23B0052 | 02/03/23 | 02/04/23 | EPA 8260B |
| trans-1,3-Dichloropropene | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Hexachlorobutadiene       | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Isopropylbenzene          | ND | 2.5 | "     | " | "       | "        | "        | "         |
| p-Isopropyltoluene        | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Methylene chloride        | ND | 10  | "     | " | "       | "        | "        | "         |
| Naphthalene               | ND | 2.5 | "     | " | "       | "        | "        | "         |
| n-Propylbenzene           | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Styrene                   | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,1,2,2-Tetrachloroethane | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,1,1,2-Tetrachloroethane | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Tetrachloroethene         | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,2,3-Trichlorobenzene    | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,2,4-Trichlorobenzene    | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,1,2-Trichloroethane     | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,1,1-Trichloroethane     | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Trichloroethene           | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Trichlorofluoromethane    | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,2,3-Trichloropropane    | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,3,5-Trimethylbenzene    | ND | 2.5 | "     | " | "       | "        | "        | "         |
| 1,2,4-Trimethylbenzene    | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Vinyl chloride            | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Benzene                   | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Toluene                   | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Ethylbenzene              | ND | 2.5 | "     | " | "       | "        | "        | "         |
| m,p-Xylene                | ND | 5.0 | "     | " | "       | "        | "        | "         |
| o-Xylene                  | ND | 2.5 | "     | " | "       | "        | "        | "         |
| Acetone                   | ND | 5.0 | "     | " | "       | "        | "        | "         |
| Methyl ethyl ketone       | ND | 5.0 | "     | " | "       | "        | "        | "         |
| Methyl isobutyl ketone    | ND | 5.0 | "     | " | "       | "        | "        | "         |
| 2-Hexanone (MBK)          | ND | 5.0 | "     | " | "       | "        | "        | "         |

Surrogate: 4-Bromofluorobenzene

124 %

75.4-139

"

"

"

"

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475 Goddard, Ste. 200  
Irvine CA, 92618

Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

Reported:  
02/09/23 16:29

**212102001\_Composite**  
**T230311-07 (Soil)**

| Analyte | Result | Reporting<br>Limit | Units | Dilution | Batch | Prepared | Analyzed | Method | Notes |
|---------|--------|--------------------|-------|----------|-------|----------|----------|--------|-------|
|---------|--------|--------------------|-------|----------|-------|----------|----------|--------|-------|

**SunStar Laboratories, Inc.**

**Volatile Organic Compounds by EPA Method 8260B**

|                                 |        |          |         |          |          |           |
|---------------------------------|--------|----------|---------|----------|----------|-----------|
| Surrogate: Dibromofluoromethane | 112 %  | 73.1-125 | 23B0052 | 02/03/23 | 02/04/23 | EPA 8260B |
| Surrogate: Toluene-d8           | 99.8 % | 82.6-117 | "       | "        | "        | "         |

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Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

Reported:  
02/09/23 16:29

### Extractable Petroleum Hydrocarbons by 8015B - Quality Control

#### SunStar Laboratories, Inc.

| Analyte | Result | Reporting<br>Limit | Units | Spike<br>Level | Source<br>Result | %REC | %REC<br>Limits | RPD | RPD<br>Limit | Notes |
|---------|--------|--------------------|-------|----------------|------------------|------|----------------|-----|--------------|-------|
|---------|--------|--------------------|-------|----------------|------------------|------|----------------|-----|--------------|-------|

#### Batch 23B0069 - EPA 3550B GC

##### Blank (23B0069-BLK1)

Prepared: 02/03/23 Analyzed: 02/06/23

|                                |      |    |       |     |  |      |        |  |  |  |
|--------------------------------|------|----|-------|-----|--|------|--------|--|--|--|
| C6-C12 (GRO)                   | ND   | 10 | mg/kg |     |  |      |        |  |  |  |
| C13-C28 (DRO)                  | ND   | 10 | "     |     |  |      |        |  |  |  |
| C29-C40 (MORO)                 | ND   | 10 | "     |     |  |      |        |  |  |  |
| Surrogate: <i>p</i> -Terphenyl | 92.9 |    | "     | 100 |  | 92.9 | 65-135 |  |  |  |

##### LCS (23B0069-BS1)

Prepared: 02/03/23 Analyzed: 02/06/23

|                                |      |    |       |     |  |      |        |  |  |  |
|--------------------------------|------|----|-------|-----|--|------|--------|--|--|--|
| C13-C28 (DRO)                  | 470  | 10 | mg/kg |     |  |      | 75-125 |  |  |  |
| Surrogate: <i>p</i> -Terphenyl | 98.9 |    | "     | 100 |  | 98.9 | 65-135 |  |  |  |

##### LCS Dup (23B0069-BSD1)

Prepared: 02/03/23 Analyzed: 02/06/23

|                                |     |    |       |     |  |     |        |      |    |  |
|--------------------------------|-----|----|-------|-----|--|-----|--------|------|----|--|
| C13-C28 (DRO)                  | 480 | 10 | mg/kg |     |  |     | 75-125 | 2.38 | 20 |  |
| Surrogate: <i>p</i> -Terphenyl | 106 |    | "     | 100 |  | 106 | 65-135 |      |    |  |

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Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

Reported:  
02/09/23 16:29

### Metals by EPA 6010B - Quality Control

### SunStar Laboratories, Inc.

| Analyte | Result | Reporting<br>Limit | Units | Spike<br>Level | Source<br>Result | %REC | %REC<br>Limits | RPD | RPD<br>Limit | Notes |
|---------|--------|--------------------|-------|----------------|------------------|------|----------------|-----|--------------|-------|
|---------|--------|--------------------|-------|----------------|------------------|------|----------------|-----|--------------|-------|

#### Batch 23B0057 - EPA 3050B

##### Blank (23B0057-BLK1)

Prepared: 02/03/23 Analyzed: 02/09/23

|            |    |     |       |
|------------|----|-----|-------|
| Antimony   | ND | 4.0 | mg/kg |
| Silver     | ND | 2.0 | "     |
| Arsenic    | ND | 5.0 | "     |
| Barium     | ND | 1.0 | "     |
| Beryllium  | ND | 1.0 | "     |
| Cadmium    | ND | 2.0 | "     |
| Chromium   | ND | 2.0 | "     |
| Cobalt     | ND | 2.0 | "     |
| Copper     | ND | 1.0 | "     |
| Lead       | ND | 3.0 | "     |
| Molybdenum | ND | 5.0 | "     |
| Nickel     | ND | 2.0 | "     |
| Selenium   | ND | 5.0 | "     |
| Thallium   | ND | 5.0 | "     |
| Vanadium   | ND | 5.0 | "     |
| Zinc       | ND | 1.0 | "     |

##### LCS (23B0057-BS1)

Prepared: 02/03/23 Analyzed: 02/09/23

|          |     |     |       |     |     |        |
|----------|-----|-----|-------|-----|-----|--------|
| Arsenic  | 102 | 5.0 | mg/kg | 100 | 102 | 75-125 |
| Barium   | 105 | 1.0 | "     | 100 | 105 | 75-125 |
| Cadmium  | 107 | 2.0 | "     | 100 | 107 | 75-125 |
| Chromium | 108 | 2.0 | "     | 100 | 108 | 75-125 |
| Lead     | 106 | 3.0 | "     | 100 | 106 | 75-125 |

##### Matrix Spike (23B0057-MS1)

Source: T230291-01

Prepared: 02/03/23 Analyzed: 02/09/23

|          |      |     |       |     |      |      |        |
|----------|------|-----|-------|-----|------|------|--------|
| Arsenic  | 81.5 | 5.0 | mg/kg | 100 | ND   | 81.5 | 75-125 |
| Barium   | 166  | 1.0 | "     | 100 | 82.7 | 83.6 | 75-125 |
| Cadmium  | 77.7 | 2.0 | "     | 100 | ND   | 77.7 | 75-125 |
| Chromium | 112  | 2.0 | "     | 100 | 19.0 | 92.7 | 75-125 |
| Lead     | 95.7 | 3.0 | "     | 100 | 14.5 | 81.2 | 75-125 |

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Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

Reported:  
02/09/23 16:29

### Metals by EPA 6010B - Quality Control

### SunStar Laboratories, Inc.

| Analyte | Result | Reporting<br>Limit | Units | Spike<br>Level | Source<br>Result | %REC | %REC<br>Limits | RPD | RPD<br>Limit | Notes |
|---------|--------|--------------------|-------|----------------|------------------|------|----------------|-----|--------------|-------|
|---------|--------|--------------------|-------|----------------|------------------|------|----------------|-----|--------------|-------|

#### Batch 23B0057 - EPA 3050B

#### Matrix Spike Dup (23B0057-MSD1)

Source: T230291-01

Prepared: 02/03/23 Analyzed: 02/09/23

|          |      |     |       |     |      |      |        |      |    |       |
|----------|------|-----|-------|-----|------|------|--------|------|----|-------|
| Arsenic  | 86.0 | 5.0 | mg/kg | 100 | ND   | 86.0 | 75-125 | 5.31 | 20 |       |
| Barium   | 176  | 1.0 | "     | 100 | 82.7 | 92.9 | 75-125 | 5.48 | 20 |       |
| Cadmium  | 80.8 | 2.0 | "     | 100 | ND   | 80.8 | 75-125 | 3.93 | 20 |       |
| Chromium | 101  | 2.0 | "     | 100 | 19.0 | 81.8 | 75-125 | 10.2 | 20 |       |
| Lead     | 88.9 | 3.0 | "     | 100 | 14.5 | 74.4 | 75-125 | 7.38 | 20 | QM-07 |

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Reported:  
02/09/23 16:29

### Cold Vapor Extraction EPA 7470/7471 - Quality Control

#### SunStar Laboratories, Inc.

| Analyte | Result | Reporting<br>Limit | Units | Spike<br>Level | Source<br>Result | %REC | %REC<br>Limits | RPD | RPD<br>Limit | Notes |
|---------|--------|--------------------|-------|----------------|------------------|------|----------------|-----|--------------|-------|
|---------|--------|--------------------|-------|----------------|------------------|------|----------------|-----|--------------|-------|

#### Batch 23B0058 - EPA 7471A Soil

##### Blank (23B0058-BLK1)

Prepared: 02/03/23 Analyzed: 02/07/23

|         |    |      |       |  |  |  |  |  |  |  |
|---------|----|------|-------|--|--|--|--|--|--|--|
| Mercury | ND | 0.10 | mg/kg |  |  |  |  |  |  |  |
|---------|----|------|-------|--|--|--|--|--|--|--|

##### LCS (23B0058-BS1)

Prepared: 02/03/23 Analyzed: 02/07/23

|         |       |      |       |       |  |     |        |  |  |  |
|---------|-------|------|-------|-------|--|-----|--------|--|--|--|
| Mercury | 0.447 | 0.10 | mg/kg | 0.397 |  | 113 | 80-120 |  |  |  |
|---------|-------|------|-------|-------|--|-----|--------|--|--|--|

##### Matrix Spike (23B0058-MS1)

Source: T230291-02

Prepared: 02/03/23 Analyzed: 02/07/23

|         |       |      |       |       |    |     |        |  |  |  |
|---------|-------|------|-------|-------|----|-----|--------|--|--|--|
| Mercury | 0.426 | 0.10 | mg/kg | 0.385 | ND | 111 | 75-125 |  |  |  |
|---------|-------|------|-------|-------|----|-----|--------|--|--|--|

##### Matrix Spike Dup (23B0058-MSD1)

Source: T230291-02

Prepared: 02/03/23 Analyzed: 02/07/23

|         |       |      |       |       |    |     |        |      |    |  |
|---------|-------|------|-------|-------|----|-----|--------|------|----|--|
| Mercury | 0.475 | 0.10 | mg/kg | 0.417 | ND | 114 | 75-125 | 10.7 | 20 |  |
|---------|-------|------|-------|-------|----|-----|--------|------|----|--|

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Project Number: 212102001  
Project Manager: Jennifer Schmidt

Reported:  
02/09/23 16:29

### Volatile Organic Compounds by EPA Method 8260B - Quality Control

SunStar Laboratories, Inc.

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---------|--------|-----------------|-------|-------------|---------------|------|-------------|-----|-----------|-------|
|---------|--------|-----------------|-------|-------------|---------------|------|-------------|-----|-----------|-------|

#### Batch 23B0052 - EPA 5030 GCMS

##### Blank (23B0052-BLK1)

Prepared: 02/02/23 Analyzed: 02/03/23

|                             |    |     |       |
|-----------------------------|----|-----|-------|
| Bromobenzene                | ND | 2.5 | ug/kg |
| Bromochloromethane          | ND | 2.5 | "     |
| Bromodichloromethane        | ND | 2.5 | "     |
| Bromoform                   | ND | 2.5 | "     |
| Bromomethane                | ND | 2.5 | "     |
| n-Butylbenzene              | ND | 2.5 | "     |
| sec-Butylbenzene            | ND | 2.5 | "     |
| tert-Butylbenzene           | ND | 2.5 | "     |
| Carbon tetrachloride        | ND | 2.5 | "     |
| Chlorobenzene               | ND | 2.5 | "     |
| Chloroethane                | ND | 2.5 | "     |
| Chloroform                  | ND | 2.5 | "     |
| Chloromethane               | ND | 2.5 | "     |
| 2-Chlorotoluene             | ND | 2.5 | "     |
| 4-Chlorotoluene             | ND | 2.5 | "     |
| Dibromochloromethane        | ND | 2.5 | "     |
| 1,2-Dibromo-3-chloropropane | ND | 5.0 | "     |
| 1,2-Dibromoethane (EDB)     | ND | 2.5 | "     |
| Dibromomethane              | ND | 2.5 | "     |
| 1,2-Dichlorobenzene         | ND | 2.5 | "     |
| 1,3-Dichlorobenzene         | ND | 2.5 | "     |
| 1,4-Dichlorobenzene         | ND | 2.5 | "     |
| Dichlorodifluoromethane     | ND | 2.5 | "     |
| 1,1-Dichloroethane          | ND | 2.5 | "     |
| 1,2-Dichloroethane          | ND | 2.5 | "     |
| 1,1-Dichloroethene          | ND | 2.5 | "     |
| cis-1,2-Dichloroethene      | ND | 2.5 | "     |
| trans-1,2-Dichloroethene    | ND | 2.5 | "     |
| 1,2-Dichloropropane         | ND | 2.5 | "     |
| 1,3-Dichloropropane         | ND | 2.5 | "     |
| 2,2-Dichloropropane         | ND | 2.5 | "     |
| 1,1-Dichloropropene         | ND | 2.5 | "     |
| cis-1,3-Dichloropropene     | ND | 2.5 | "     |
| trans-1,3-Dichloropropene   | ND | 2.5 | "     |
| Hexachlorobutadiene         | ND | 2.5 | "     |
| Isopropylbenzene            | ND | 2.5 | "     |

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Project Number: 212102001  
Project Manager: Jennifer Schmidt

Reported:  
02/09/23 16:29

### Volatile Organic Compounds by EPA Method 8260B - Quality Control

SunStar Laboratories, Inc.

| Analyte | Result | Reporting Limit | Units | Spike Level | Source Result | %REC | %REC Limits | RPD | RPD Limit | Notes |
|---------|--------|-----------------|-------|-------------|---------------|------|-------------|-----|-----------|-------|
|---------|--------|-----------------|-------|-------------|---------------|------|-------------|-----|-----------|-------|

#### Batch 23B0052 - EPA 5030 GCMS

##### Blank (23B0052-BLK1)

Prepared: 02/02/23 Analyzed: 02/03/23

|                                 |      |     |       |      |  |      |          |  |  |  |
|---------------------------------|------|-----|-------|------|--|------|----------|--|--|--|
| p-Isopropyltoluene              | ND   | 2.5 | ug/kg |      |  |      |          |  |  |  |
| Methylene chloride              | ND   | 10  | "     |      |  |      |          |  |  |  |
| Naphthalene                     | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| n-Propylbenzene                 | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| Styrene                         | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| 1,1,2,2-Tetrachloroethane       | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| 1,1,1,2-Tetrachloroethane       | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| Tetrachloroethene               | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| 1,2,3-Trichlorobenzene          | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| 1,2,4-Trichlorobenzene          | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| 1,1,2-Trichloroethane           | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| 1,1,1-Trichloroethane           | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| Trichloroethene                 | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| Trichlorofluoromethane          | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| 1,2,3-Trichloropropane          | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| 1,3,5-Trimethylbenzene          | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| 1,2,4-Trimethylbenzene          | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| Vinyl chloride                  | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| Benzene                         | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| Toluene                         | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| Ethylbenzene                    | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| m,p-Xylene                      | ND   | 5.0 | "     |      |  |      |          |  |  |  |
| o-Xylene                        | ND   | 2.5 | "     |      |  |      |          |  |  |  |
| Acetone                         | ND   | 5.0 | "     |      |  |      |          |  |  |  |
| Methyl ethyl ketone             | ND   | 5.0 | "     |      |  |      |          |  |  |  |
| Methyl isobutyl ketone          | ND   | 5.0 | "     |      |  |      |          |  |  |  |
| 2-Hexanone (MBK)                | ND   | 5.0 | "     |      |  |      |          |  |  |  |
| Surrogate: 4-Bromofluorobenzene | 61.1 |     | "     | 50.0 |  | 122  | 75.4-139 |  |  |  |
| Surrogate: Dibromofluoromethane | 52.1 |     | "     | 50.0 |  | 104  | 73.1-125 |  |  |  |
| Surrogate: Toluene-d8           | 49.2 |     | "     | 50.0 |  | 98.4 | 82.6-117 |  |  |  |

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Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

Reported:  
02/09/23 16:29

### Volatile Organic Compounds by EPA Method 8260B - Quality Control

#### SunStar Laboratories, Inc.

| Analyte | Result | Reporting<br>Limit | Units | Spike<br>Level | Source<br>Result | %REC | %REC<br>Limits | RPD | RPD<br>Limit | Notes |
|---------|--------|--------------------|-------|----------------|------------------|------|----------------|-----|--------------|-------|
|---------|--------|--------------------|-------|----------------|------------------|------|----------------|-----|--------------|-------|

#### Batch 23B0052 - EPA 5030 GCMS

##### LCS (23B0052-BS1)

Prepared: 02/02/23 Analyzed: 02/03/23

|                                 |      |     |       |      |  |      |          |  |  |  |
|---------------------------------|------|-----|-------|------|--|------|----------|--|--|--|
| Chlorobenzene                   | 49.6 | 2.5 | ug/kg | 50.0 |  | 99.3 | 65.2-124 |  |  |  |
| 1,1-Dichloroethene              | 40.5 | 2.5 | "     | 50.0 |  | 80.9 | 60.9-131 |  |  |  |
| Trichloroethene                 | 41.2 | 2.5 | "     | 50.0 |  | 82.3 | 62.1-126 |  |  |  |
| Benzene                         | 43.7 | 2.5 | "     | 50.0 |  | 87.5 | 65.3-127 |  |  |  |
| Toluene                         | 41.0 | 2.5 | "     | 50.0 |  | 81.9 | 64.3-122 |  |  |  |
| Surrogate: 4-Bromofluorobenzene | 63.4 |     | "     | 50.0 |  | 127  | 75.4-139 |  |  |  |
| Surrogate: Dibromofluoromethane | 49.6 |     | "     | 50.0 |  | 99.2 | 73.1-125 |  |  |  |
| Surrogate: Toluene-d8           | 48.9 |     | "     | 50.0 |  | 97.9 | 82.6-117 |  |  |  |

##### Matrix Spike (23B0052-MS1)

Source: T230291-01

Prepared: 02/02/23 Analyzed: 02/03/23

|                                 |      |     |       |      |    |      |          |  |  |  |
|---------------------------------|------|-----|-------|------|----|------|----------|--|--|--|
| Chlorobenzene                   | 44.4 | 2.5 | ug/kg | 50.0 | ND | 88.8 | 65.2-125 |  |  |  |
| 1,1-Dichloroethene              | 41.2 | 2.5 | "     | 50.0 | ND | 82.4 | 60.9-131 |  |  |  |
| Trichloroethene                 | 40.0 | 2.5 | "     | 50.0 | ND | 80.0 | 62.1-126 |  |  |  |
| Benzene                         | 41.0 | 2.5 | "     | 50.0 | ND | 82.0 | 65.3-127 |  |  |  |
| Toluene                         | 38.4 | 2.5 | "     | 50.0 | ND | 76.8 | 64.3-125 |  |  |  |
| Surrogate: 4-Bromofluorobenzene | 64.6 |     | "     | 50.0 |    | 129  | 75.4-139 |  |  |  |
| Surrogate: Dibromofluoromethane | 51.1 |     | "     | 50.0 |    | 102  | 73.1-125 |  |  |  |
| Surrogate: Toluene-d8           | 49.6 |     | "     | 50.0 |    | 99.1 | 82.6-117 |  |  |  |

##### Matrix Spike Dup (23B0052-MSD1)

Source: T230291-01

Prepared: 02/02/23 Analyzed: 02/03/23

|                                 |      |     |       |      |    |      |          |      |    |  |
|---------------------------------|------|-----|-------|------|----|------|----------|------|----|--|
| Chlorobenzene                   | 37.4 | 2.5 | ug/kg | 50.0 | ND | 74.9 | 65.2-125 | 17.0 | 20 |  |
| 1,1-Dichloroethene              | 36.2 | 2.5 | "     | 50.0 | ND | 72.3 | 60.9-131 | 13.0 | 20 |  |
| Trichloroethene                 | 35.0 | 2.5 | "     | 50.0 | ND | 70.1 | 62.1-126 | 13.2 | 20 |  |
| Benzene                         | 36.3 | 2.5 | "     | 50.0 | ND | 72.6 | 65.3-127 | 12.2 | 20 |  |
| Toluene                         | 34.2 | 2.5 | "     | 50.0 | ND | 68.5 | 64.3-125 | 11.5 | 20 |  |
| Surrogate: 4-Bromofluorobenzene | 62.2 |     | "     | 50.0 |    | 124  | 75.4-139 |      |    |  |
| Surrogate: Dibromofluoromethane | 50.2 |     | "     | 50.0 |    | 100  | 73.1-125 |      |    |  |
| Surrogate: Toluene-d8           | 50.0 |     | "     | 50.0 |    | 99.9 | 82.6-117 |      |    |  |

SunStar Laboratories, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Joann Marroquin, Director of Operations



25712 Commercentre Drive  
Lake Forest, California 92630  
949.297.5020 Phone  
949.297.5027 Fax

Ninyo & Moore  
475 Goddard, Ste. 200  
Irvine CA, 92618

Project: Lynwood Park  
Project Number: 212102001  
Project Manager: Jennifer Schmidt

**Reported:**  
02/09/23 16:29

### Notes and Definitions

QM-07     The spike recovery and or RPD was outside acceptance limits for the MS and/or MSD. The batch was accepted based on acceptable LCS recovery.

DET        Analyte DETECTED

ND        Analyte NOT DETECTED at or above the reporting limit

NR        Not Reported

dry        Sample results reported on a dry weight basis

RPD        Relative Percent Difference

SunStar Laboratories, Inc.

*The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.*

Joann Marroquin, Director of Operations

SunStar Laboratories, Inc.  
25712 Commerce Centre Dr  
Lake Forest, CA 92630  
949-297-5020

# Chain of Custody Record

Client: Ninyo & Moore  
Address: 475 Goddard Suite 200  
Phone: 949-753-7270 Fax: \_\_\_\_\_  
Project Manager: Jennifer Schmidt

Date: 2/1/2023 Page: 1 Of 1  
Project Name: Lynwood Park  
Collector: \_\_\_\_\_ Client Project #: 212102001  
Batch #: 1230311 EDF #: \_\_\_\_\_

| Sample ID                                                                                                                                                                                                                                                                                                                                          | Date Sampled | Time    | Sample Type | Container Type | 8260 | 8260 + OXY | 8260 BTEX, OXY only | 8270 | 8021 BTEX | 8015M (gasoline) | 8015M (diesel) | 8015M Ext./Carbon Chain | 6010/7000 Title 22 Metals | Laboratory ID # | Comments/Preservative | Total # of containers |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------|-------------|----------------|------|------------|---------------------|------|-----------|------------------|----------------|-------------------------|---------------------------|-----------------|-----------------------|-----------------------|
| 212102001-DUM T+Z                                                                                                                                                                                                                                                                                                                                  | 1/30/23      | 12:30pm | Soil        | 4oz jar        | X    |            |                     |      |           |                  |                | X                       | X                         | 01              |                       |                       |
| 212102001-DUM 4                                                                                                                                                                                                                                                                                                                                    | 1/31/23      | 12:30pm | Soil        |                | X    |            |                     |      |           |                  |                | X                       | X                         | 02              |                       |                       |
| 212102001-DUM 9                                                                                                                                                                                                                                                                                                                                    | 1/31/23      | 10:00am | Soil        |                | X    |            |                     |      |           |                  |                | X                       | X                         | 03              | Composite run         |                       |
| 212102001-DUM 38/412                                                                                                                                                                                                                                                                                                                               | 2/1/23       | 1:00pm  | Soil        |                | X    |            |                     |      |           |                  |                | X                       | X                         | 04              | 1 test                |                       |
| 212102001-DUM 1                                                                                                                                                                                                                                                                                                                                    | 1/30/23      | 10:20am | Soil        |                | X    |            |                     |      |           |                  |                | X                       | X                         | 05              |                       |                       |
| 212102001-DUM 6+5                                                                                                                                                                                                                                                                                                                                  | 1/30/23      | 2:04pm  | Soil        |                | X    |            |                     |      |           |                  |                | X                       | X                         | 06              |                       |                       |
| <div>Relinquished by: (signature) _____ Date / Time _____ Received by: (signature) _____ Date / Time _____</div> <div>Relinquished by: (signature) _____ Date / Time _____ Received by: (signature) _____ Date / Time _____</div> <div>Relinquished by: (signature) _____ Date / Time _____ Received by: (signature) _____ Date / Time _____</div> |              |         |             |                |      |            |                     |      |           |                  |                |                         |                           |                 |                       |                       |

Turn around time: \_\_\_\_\_

Total # of containers: PS

Chain of Custody seals: Y/N/A

Seals intact? Y/N/A: NA

Received good condition/cold: 3.1°C

Notes: \_\_\_\_\_

## SAMPLE RECEIVING REVIEW SHEET

Batch/Work Order #: T230311

Client Name: Ninyo + Moore Project: Lynwood Park

Delivered by: ☒ Client ☐ SunStar Courier ☐ GLS ☐ FedEx ☐ Other

If Courier, Received by: \_\_\_\_\_ Date/Time Courier Received: \_\_\_\_\_

Lab Received by: Pawl Date/Time Lab Received: 2/3/23 12:26

Total number of coolers received: 1 Thermometer ID: SC-1 Calibration due: 8/2/23

|                                                                                           |                               |                                                                                                                   |                          |
|-------------------------------------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------|--------------------------|
| Temperature: Cooler #1                                                                    | 3.0 °C +/- the CF (+ 0.1°C) = | 3.1 °C                                                                                                            | corrected temperature    |
| Temperature: Cooler #2                                                                    | °C +/- the CF (+ 0.1°C) =     |                                                                                                                   | °C corrected temperature |
| Temperature: Cooler #3                                                                    | °C +/- the CF (+ 0.1°C) =     |                                                                                                                   | °C corrected temperature |
| <b>Temperature criteria = ≤ 6°C (no frozen containers)</b>                                |                               | Within criteria? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A |                          |
| <b>If NO:</b>                                                                             |                               |                                                                                                                   |                          |
| Samples received on ice? <input type="checkbox"/> Yes                                     |                               | <input type="checkbox"/> No → Complete Non-Conformance Sheet                                                      |                          |
| If on ice, samples received same day collected? <input type="checkbox"/> Yes → Acceptable |                               | <input type="checkbox"/> No → Complete Non-Conformance Sheet                                                      |                          |

Custody seals intact on cooler/sample ☐ Yes ☐ No\* ☒ N/A

Sample containers intact ☒ Yes ☐ No\*

Sample labels match Chain of Custody IDs ☒ Yes ☐ No\*

Total number of containers received match COC ☒ Yes ☐ No\*

Proper containers received for analyses requested on COC ☒ Yes ☐ No\*

Proper preservative indicated on COC/containers for analyses requested ☐ Yes ☐ No\* ☒ N/A

Complete shipment received in good condition with correct temperatures, containers, labels, volumes preservatives and within method specified holding times ☒ Yes ☐ No\*

\* Complete Non-Conformance Receiving Sheet if checked Cooler/Sample Review - Initials and date: PB 2/3/23

**Comments:**

---



---



---

Custody seals intact on cooler/sample

Sample containers intact

**WORK ORDER**

**T230311**

**Client: Ninyo & Moore**

**Project: Lynwood Ave.**

**Project Manager: Joann Marroquin**

**Project Number: 212102001**

**Report To:**

Ninyo & Moore  
Jennifer Schmidt  
475 Goddard, Ste. 200  
Irvine, CA 92618

Date Due: 02/10/23 17:00 (5 day TAT)

Received By: Paul Berner

Date Received: 02/03/23 12:26

Logged In By: Rebecca Traficanto

Date Logged In: 02/03/23 14:55

Samples Received at: **3.1°C**

Custody Seals Yes Received On Ice Yes

Containers Intact Yes

COC/Labels Agree Yes

Preservation Confirmed Yes

| Analysis | Due | TAT | Expires | Comments |
|----------|-----|-----|---------|----------|
|----------|-----|-----|---------|----------|

**T230311-01 212102001\_Drum 7+2 [Soil] Sampled 01/30/23 12:30 (GMT-08:00)**

**Pacific Time (US &**

**[NO ANALYSES]**

**T230311-02 212102001\_Drum 4 [Soil] Sampled 01/30/23 12:30 (GMT-08:00)**

**Pacific Time (US &**

**[NO ANALYSES]**

**T230311-03 212102001\_Drum 9 [Soil] Sampled 01/30/23 10:00 (GMT-08:00)**

**Pacific Time (US &**

**[NO ANALYSES]**

**T230311-04 212102001\_Drum 3,8,10,11,12 [Soil] Sampled 01/30/23 13:00**

**(GMT-08:00) Pacific Time (US &**

**[NO ANALYSES]**

**T230311-05 212102001\_Drum 1 [Soil] Sampled 01/30/23 10:20 (GMT-08:00)**

**Pacific Time (US &**

**[NO ANALYSES]**

**T230311-06 212102001\_Drum 6+5 [Soil] Sampled 01/30/23 14:04 (GMT-08:00)**

**Pacific Time (US &**

**[NO ANALYSES]**

**WORK ORDER**

**T230311**

**Client: Ninyo & Moore**

**Project Manager: Joann Marroquin**

**Project: Lynwood Ave.**

**Project Number: 212102001**

| Analysis                                                                                                                                 | Due            | TAT | Expires        | Comments                          |
|------------------------------------------------------------------------------------------------------------------------------------------|----------------|-----|----------------|-----------------------------------|
| <b>T230311-07 212102001_Composite [Soil] Sampled 01/30/23 14:04 (GMT-08:00) Composite 6:1 Samples 1,2,3,4,5,6 Pacific Time (US &amp;</b> |                |     |                |                                   |
| 6010 Title 22                                                                                                                            | 02/10/23 15:00 | 5   | 07/29/23 14:04 | Composite 6:1 Samples 1,2,3,4,5,6 |
| 8015 Carbon Chain                                                                                                                        | 02/08/23 15:00 | 3   | 02/13/23 14:04 | Composite 6:1 Samples 1,2,3,4,5,6 |
| 8260                                                                                                                                     | 02/08/23 15:00 | 3   | 02/13/23 14:04 | Composite 6:1 Samples 1,2,3,4,5,6 |

**Analysis groups included in this work order**

6010 Title 22

subgroup 6010B T22      7470/71 Hg

**WORK ORDER**

**T230311**

**Client:** Ninyo & Moore

**Project Manager:** Joann Marroquin

**Project:** Lynwood Park

**Project Number:** 212102001

**Report To:**

Ninyo & Moore  
Jennifer Schmidt  
475 Goddard, Ste. 200  
Irvine, CA 92618

Date Due: 02/10/23 17:00 (5 day TAT)

Received By: Paul Berner

Date Received: 02/03/23 12:26

Logged In By: Rebecca Traficanto

Date Logged In: 02/03/23 14:55

Samples Received at: 3.1°C  
Custody Seals Yes Received On Ice Yes  
Containers Intact Yes  
COC/Labels Agree Yes  
Preservation Confirmed Yes

| Analysis | Due | TAT | Expires | Comments |
|----------|-----|-----|---------|----------|
|----------|-----|-----|---------|----------|

**T230311-01 212102001\_Drum 7+2 [Soil] Sampled 01/30/23 12:30 (GMT-08:00)**

**Pacific Time (US &**

**[NO ANALYSES]**

**T230311-02 212102001\_Drum 4 [Soil] Sampled 01/30/23 12:30 (GMT-08:00)**

**Pacific Time (US &**

**[NO ANALYSES]**

**T230311-03 212102001\_Drum 9 [Soil] Sampled 01/30/23 10:00 (GMT-08:00)**

**Pacific Time (US &**

**[NO ANALYSES]**

**T230311-04 212102001\_Drum 3,8,10,11,12 [Soil] Sampled 01/30/23 13:00**

**(GMT-08:00) Pacific Time (US &**

**[NO ANALYSES]**

**T230311-05 212102001\_Drum 1 [Soil] Sampled 01/30/23 10:20 (GMT-08:00)**

**Pacific Time (US &**

**[NO ANALYSES]**

**T230311-06 212102001\_Drum 6+5 [Soil] Sampled 01/30/23 14:04 (GMT-08:00)**

**Pacific Time (US &**

**[NO ANALYSES]**

**WORK ORDER**

**T230311**

**Client:** Ninyo & Moore

**Project Manager:** Joann Marroquin

**Project:** Lynwood Park

**Project Number:** 212102001

| Analysis                                                                                               | Due            | TAT | Expires        | Comments                                 |
|--------------------------------------------------------------------------------------------------------|----------------|-----|----------------|------------------------------------------|
| <b>T230311-07 212102001_Composite [Soil] Sampled 01/30/23 14:04 (GMT-08:00) Pacific Time (US &amp;</b> |                |     |                | <b>Composite 6:1 Samples 1,2,3,4,5,6</b> |
| 6010 Title 22                                                                                          | 02/10/23 15:00 | 5   | 07/29/23 14:04 | Composite 6:1 Samples 1,2,3,4,5,6        |
| 8015 Carbon Chain                                                                                      | 02/08/23 15:00 | 3   | 02/13/23 14:04 | Composite 6:1 Samples 1,2,3,4,5,6        |
| 8260                                                                                                   | 02/10/23 15:00 | 3   | 02/13/23 14:04 | Composite 6:1 Samples 1,2,3,4,5,6        |

**Analysis groups included in this work order**

6010 Title 22

subgroup 6010B T22 7470/71 Hg



# APPENDIX F

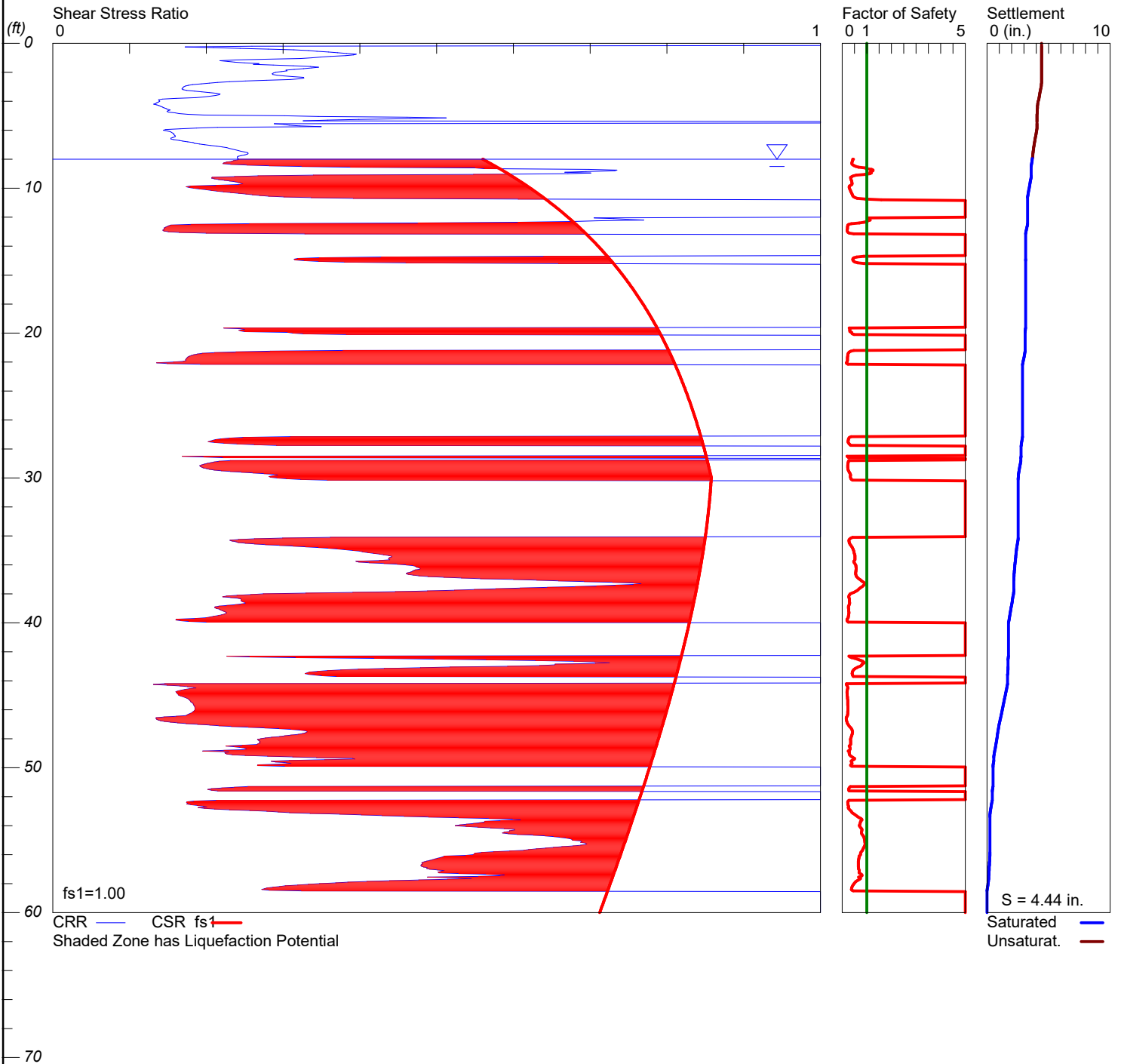
## Liquefaction Analysis

# LIQUEFACTION ANALYSIS

## Lynwood City Park Stormwater Capture Project

Hole No.=CPT-1 Water Depth=8 ft

Magnitude=7.3  
Acceleration=0.878g



\*\*\*\*\*

LIQUEFACTION ANALYSIS SUMMARY  
Copyright by CivilTech Software  
www.civiltech.com

\*\*\*\*\*

Font: Courier New, Regular, Size 8 is recommended for this report.  
Licensed to , 3/2/2023 2:40:55 PM

Input File Name: G:\File Share\RVC temp\Projects\212102001 Lynwood City Park Stormwater Capture\Geo  
Calcs\Liq\212102001 Lynwood City Park CPT-1.liq  
Title: Lynwood City Park Stormwater Capture Project  
Subtitle: 212102001

Surface Elev.=  
Hole No.=CPT-1  
Depth of Hole= 60.00 ft  
Water Table during Earthquake= 8.00 ft  
Water Table during In-Situ Testing= 42.40 ft  
Max. Acceleration= 0.88 g  
Earthquake Magnitude= 7.30

Input Data:

Surface Elev.=  
Hole No.=CPT-1  
Depth of Hole=60.00 ft  
Water Table during Earthquake= 8.00 ft  
Water Table during In-Situ Testing= 42.40 ft  
Max. Acceleration=0.88 g  
Earthquake Magnitude=7.30  
No-Liquefiable Soils: CL, OL are Non-Liq. Soil

1. CPT Calculation Method: Modify Robertson\*
2. Settlement Analysis Method: Ishihara / Yoshimine
3. Fines Correction for Liquefaction: Stark/Olson et al.\*
4. Fine Correction for Settlement: During Liquefaction\*
5. Settlement Calculation in: All zones\*
9. User request factor of safety (apply to CSR) , User= 1  
Plot one CSR curve (fs1=User)

10. Use Curve Smoothing: Yes\*

\* Recommended Options

In-Situ Test Data:

| Depth<br>ft | qc<br>atm | fs<br>atm | Rf<br>pcf | gamma<br>% | Fines<br>mm | D50  |
|-------------|-----------|-----------|-----------|------------|-------------|------|
| 0.00        | 0.00      | 0.04      | 100.00    | 120.00     | *           | 0.50 |
| 0.93        | 19.25     | 0.46      | 2.40      | 120.00     | *           | 0.50 |
| 1.87        | 28.72     | 0.54      | 1.87      | 120.00     | *           | 0.50 |
| 2.77        | 28.72     | 0.42      | 1.48      | 120.00     | *           | 0.50 |
| 3.68        | 34.58     | 0.47      | 1.35      | 120.00     | *           | 0.50 |
| 4.59        | 21.49     | 0.37      | 1.71      | 120.00     | *           | 0.50 |
| 5.53        | 11.14     | 0.36      | 3.20      | 120.00     | *           | 0.50 |
| 6.47        | 26.47     | 0.47      | 1.76      | 120.00     | *           | 0.50 |
| 7.38        | 32.14     | 0.79      | 2.45      | 120.00     | *           | 0.50 |
| 8.31        | 29.31     | 0.69      | 2.37      | 120.00     | *           | 0.50 |
| 9.20        | 33.51     | 0.82      | 2.45      | 120.00     | *           | 0.50 |
| 10.11       | 53.63     | 0.82      | 1.52      | 120.00     | *           | 0.50 |
| 11.03       | 19.34     | 1.14      | 5.92      | 120.00     | *           | 0.50 |
| 11.96       | 26.47     | 1.04      | 3.92      | 120.00     | *           | 0.50 |
| 12.86       | 35.46     | 0.56      | 1.57      | 120.00     | *           | 0.50 |
| 13.80       | 14.85     | 0.73      | 4.90      | 120.00     | *           | 0.50 |
| 14.70       | 32.34     | 1.05      | 3.25      | 120.00     | *           | 0.50 |
| 15.63       | 21.10     | 1.00      | 4.75      | 120.00     | *           | 0.50 |
| 16.55       | 14.17     | 0.80      | 5.62      | 120.00     | *           | 0.50 |
| 17.47       | 17.10     | 0.71      | 4.16      | 120.00     | *           | 0.50 |
| 18.38       | 17.39     | 0.94      | 5.42      | 120.00     | *           | 0.50 |
| 19.29       | 27.74     | 1.45      | 5.21      | 120.00     | *           | 0.50 |
| 20.21       | 35.56     | 1.08      | 3.05      | 120.00     | *           | 0.50 |
| 21.14       | 36.54     | 1.20      | 3.29      | 120.00     | *           | 0.50 |
| 22.05       | 43.08     | 0.63      | 1.46      | 120.00     | *           | 0.50 |
| 22.99       | 10.45     | 0.43      | 4.09      | 120.00     | *           | 0.50 |
| 23.89       | 14.17     | 0.63      | 4.45      | 120.00     | *           | 0.50 |
| 24.80       | 11.14     | 0.53      | 4.79      | 120.00     | *           | 0.50 |
| 25.73       | 20.91     | 1.17      | 5.61      | 120.00     | *           | 0.50 |
| 26.66       | 37.51     | 1.33      | 3.55      | 120.00     | *           | 0.50 |
| 27.59       | 54.41     | 1.26      | 2.32      | 120.00     | *           | 0.50 |

|       |        |      |      |        |   |      |
|-------|--------|------|------|--------|---|------|
| 28.49 | 41.62  | 0.77 | 1.84 | 120.00 | * | 0.50 |
| 29.42 | 71.22  | 1.46 | 2.05 | 120.00 | * | 0.50 |
| 30.32 | 54.51  | 1.90 | 3.49 | 120.00 | * | 0.50 |
| 31.24 | 19.88  | 1.17 | 5.91 | 120.00 | * | 0.50 |
| 32.16 | 40.35  | 1.82 | 4.52 | 120.00 | * | 0.50 |
| 33.07 | 17.49  | 1.13 | 6.47 | 120.00 | * | 0.50 |
| 34.00 | 55.49  | 2.01 | 3.62 | 120.00 | * | 0.50 |
| 34.90 | 159.30 | 2.49 | 1.56 | 120.00 | * | 0.50 |
| 35.84 | 193.00 | 2.05 | 1.06 | 120.00 | * | 0.50 |
| 36.78 | 207.60 | 2.46 | 1.18 | 120.00 | * | 0.50 |
| 37.67 | 223.50 | 2.85 | 1.28 | 120.00 | * | 0.50 |
| 38.58 | 114.80 | 2.22 | 1.93 | 120.00 | * | 0.50 |
| 39.51 | 88.90  | 1.90 | 2.14 | 120.00 | * | 0.50 |
| 40.42 | 18.37  | 1.12 | 6.10 | 120.00 | * | 0.50 |
| 41.34 | 12.41  | 0.49 | 3.98 | 120.00 | * | 0.50 |
| 42.27 | 69.65  | 1.88 | 2.71 | 120.00 | * | 0.50 |
| 43.17 | 188.00 | 3.12 | 1.66 | 120.00 | * | 0.50 |
| 44.09 | 68.19  | 2.31 | 3.39 | 120.00 | * | 0.50 |
| 45.01 | 112.20 | 1.34 | 1.19 | 120.00 | * | 0.50 |
| 45.94 | 122.50 | 1.57 | 1.28 | 120.00 | * | 0.50 |
| 46.86 | 94.86  | 1.37 | 1.45 | 120.00 | * | 0.50 |
| 47.77 | 177.60 | 2.32 | 1.30 | 120.00 | * | 0.50 |
| 48.69 | 173.10 | 1.70 | 0.98 | 120.00 | * | 0.50 |
| 49.60 | 153.10 | 2.69 | 1.75 | 120.00 | * | 0.50 |
| 50.54 | 24.96  | 0.69 | 2.77 | 120.00 | * | 0.50 |
| 51.47 | 80.40  | 1.83 | 2.27 | 120.00 | * | 0.50 |
| 52.37 | 84.31  | 1.64 | 1.95 | 120.00 | * | 0.50 |
| 53.29 | 200.80 | 3.46 | 1.72 | 120.00 | * | 0.50 |
| 54.21 | 247.70 | 3.97 | 1.60 | 120.00 | * | 0.50 |
| 55.15 | 289.90 | 3.51 | 1.21 | 120.00 | * | 0.50 |
| 56.04 | 272.10 | 2.74 | 1.01 | 120.00 | * | 0.50 |
| 56.98 | 256.90 | 2.71 | 1.05 | 120.00 | * | 0.50 |
| 57.89 | 242.70 | 2.01 | 0.83 | 120.00 | * | 0.50 |
| 58.80 | 37.03  | 2.16 | 5.84 | 120.00 | * | 0.50 |
| 59.73 | 26.67  | 0.87 | 3.24 | 120.00 | * | 0.50 |

---

\* Modify Robertson method generates Fines from qc/fs. Inputted Fines are not relevant.

Output Results:

Settlement of Saturated Sands=3.67 in.

Settlement of Unsaturated Sands=0.76 in.

Total Settlement of Saturated and Unsaturated Sands=4.44 in.

Differential Settlement=2.218 to 2.928 in.

| Depth<br>ft | CRRm | CSRfs | F.S.  | S_sat.<br>in. | S_dry<br>in. | S_all<br>in. |
|-------------|------|-------|-------|---------------|--------------|--------------|
| 0.00        | 2.00 | 0.57  | 5.00  | 3.67          | 0.76         | 4.44         |
| 1.00        | 0.34 | 0.57  | 5.00  | 3.67          | 0.76         | 4.43         |
| 2.00        | 0.29 | 0.57  | 5.00  | 3.67          | 0.76         | 4.43         |
| 3.00        | 0.17 | 0.57  | 5.00  | 3.67          | 0.72         | 4.40         |
| 4.00        | 0.14 | 0.57  | 5.00  | 3.67          | 0.49         | 4.16         |
| 5.00        | 0.30 | 0.56  | 5.00  | 3.67          | 0.39         | 4.06         |
| 6.00        | 0.14 | 0.56  | 5.00  | 3.67          | 0.36         | 4.04         |
| 7.00        | 0.20 | 0.56  | 5.00  | 3.67          | 0.15         | 3.83         |
| 8.00        | 0.24 | 0.56  | 0.43* | 3.67          | 0.00         | 3.67         |
| 9.00        | 0.67 | 0.59  | 1.13  | 3.59          | 0.00         | 3.59         |
| 10.00       | 0.18 | 0.62  | 0.29* | 3.42          | 0.00         | 3.42         |
| 11.00       | 2.00 | 0.65  | 5.00  | 3.30          | 0.00         | 3.30         |
| 12.00       | 2.00 | 0.67  | 5.00  | 3.30          | 0.00         | 3.30         |
| 13.00       | 0.15 | 0.69  | 0.22* | 3.16          | 0.00         | 3.16         |
| 14.00       | 2.00 | 0.71  | 5.00  | 3.13          | 0.00         | 3.13         |
| 15.00       | 0.33 | 0.73  | 0.45* | 3.13          | 0.00         | 3.13         |
| 16.00       | 2.00 | 0.74  | 5.00  | 3.13          | 0.00         | 3.13         |
| 17.00       | 2.00 | 0.76  | 5.00  | 3.13          | 0.00         | 3.13         |
| 18.00       | 2.00 | 0.77  | 5.00  | 3.13          | 0.00         | 3.13         |
| 19.00       | 2.00 | 0.78  | 5.00  | 3.13          | 0.00         | 3.13         |
| 20.00       | 0.31 | 0.79  | 0.40* | 3.09          | 0.00         | 3.09         |
| 21.00       | 2.00 | 0.80  | 5.00  | 3.09          | 0.00         | 3.09         |
| 22.00       | 0.16 | 0.81  | 0.19* | 2.93          | 0.00         | 2.93         |
| 23.00       | 2.00 | 0.82  | 5.00  | 2.88          | 0.00         | 2.88         |
| 24.00       | 2.00 | 0.82  | 5.00  | 2.88          | 0.00         | 2.88         |
| 25.00       | 2.00 | 0.83  | 5.00  | 2.88          | 0.00         | 2.88         |
| 26.00       | 2.00 | 0.84  | 5.00  | 2.88          | 0.00         | 2.88         |
| 27.00       | 2.00 | 0.84  | 5.00  | 2.88          | 0.00         | 2.88         |
| 28.00       | 2.00 | 0.85  | 5.00  | 2.77          | 0.00         | 2.77         |

|       |      |      |       |      |      |      |
|-------|------|------|-------|------|------|------|
| 29.00 | 0.20 | 0.85 | 0.24* | 2.71 | 0.00 | 2.71 |
| 30.00 | 0.29 | 0.86 | 0.34* | 2.54 | 0.00 | 2.54 |
| 31.00 | 2.00 | 0.86 | 5.00  | 2.53 | 0.00 | 2.53 |
| 32.00 | 2.00 | 0.85 | 5.00  | 2.53 | 0.00 | 2.53 |
| 33.00 | 2.00 | 0.85 | 5.00  | 2.53 | 0.00 | 2.53 |
| 34.00 | 2.00 | 0.85 | 5.00  | 2.53 | 0.00 | 2.53 |
| 35.00 | 0.39 | 0.85 | 0.46* | 2.39 | 0.00 | 2.39 |
| 36.00 | 0.46 | 0.84 | 0.55* | 2.26 | 0.00 | 2.26 |
| 37.00 | 0.60 | 0.84 | 0.71* | 2.18 | 0.00 | 2.18 |
| 38.00 | 0.27 | 0.84 | 0.33* | 2.15 | 0.00 | 2.15 |
| 39.00 | 0.21 | 0.83 | 0.26* | 1.95 | 0.00 | 1.95 |
| 40.00 | 2.00 | 0.83 | 5.00  | 1.74 | 0.00 | 1.74 |
| 41.00 | 2.00 | 0.82 | 5.00  | 1.74 | 0.00 | 1.74 |
| 42.00 | 2.00 | 0.82 | 5.00  | 1.74 | 0.00 | 1.74 |
| 43.00 | 0.59 | 0.82 | 0.73* | 1.71 | 0.00 | 1.71 |
| 44.00 | 2.00 | 0.81 | 5.00  | 1.67 | 0.00 | 1.67 |
| 45.00 | 0.16 | 0.81 | 0.20* | 1.48 | 0.00 | 1.48 |
| 46.00 | 0.19 | 0.80 | 0.23* | 1.24 | 0.00 | 1.24 |
| 47.00 | 0.19 | 0.79 | 0.24* | 0.99 | 0.00 | 0.99 |
| 48.00 | 0.27 | 0.79 | 0.34* | 0.80 | 0.00 | 0.80 |
| 49.00 | 0.22 | 0.78 | 0.29* | 0.59 | 0.00 | 0.59 |
| 50.00 | 2.00 | 0.78 | 5.00  | 0.48 | 0.00 | 0.48 |
| 51.00 | 2.00 | 0.77 | 5.00  | 0.48 | 0.00 | 0.48 |
| 52.00 | 2.00 | 0.77 | 5.00  | 0.42 | 0.00 | 0.42 |
| 53.00 | 0.28 | 0.76 | 0.37* | 0.27 | 0.00 | 0.27 |
| 54.00 | 0.52 | 0.75 | 0.70* | 0.23 | 0.00 | 0.23 |
| 55.00 | 0.68 | 0.75 | 0.91* | 0.23 | 0.00 | 0.23 |
| 56.00 | 0.55 | 0.74 | 0.74* | 0.23 | 0.00 | 0.23 |
| 57.00 | 0.49 | 0.73 | 0.67* | 0.17 | 0.00 | 0.17 |
| 58.00 | 0.35 | 0.73 | 0.48* | 0.09 | 0.00 | 0.09 |
| 59.00 | 2.00 | 0.72 | 5.00  | 0.00 | 0.00 | 0.00 |
| 60.00 | 2.00 | 0.71 | 5.00  | 0.00 | 0.00 | 0.00 |

---

\* F.S.<1, Liquefaction Potential Zone

(F.S. is limited to 5, CRR is limited to 2, CSR is limited to 2)

Units: Unit: qc, fs, Stress or Pressure = atm (1.0581tsf); Unit Weight = pcf; Depth = ft;  
Settlement = in.

---

1 atm (atmosphere) = 1 tsf (ton/ft<sup>2</sup>)

CRRm                      Cyclic resistance ratio from soils

safety)                      CSRsf                      Cyclic stress ratio induced by a given earthquake (with user request factor of

F.S.                      Factor of Safety against liquefaction,  $F.S. = CRRm / CSRsf$

S\_sat                      Settlement from saturated sands

S\_dry                      Settlement from Unsaturated Sands

S\_all                      Total Settlement from Saturated and Unsaturated Sands

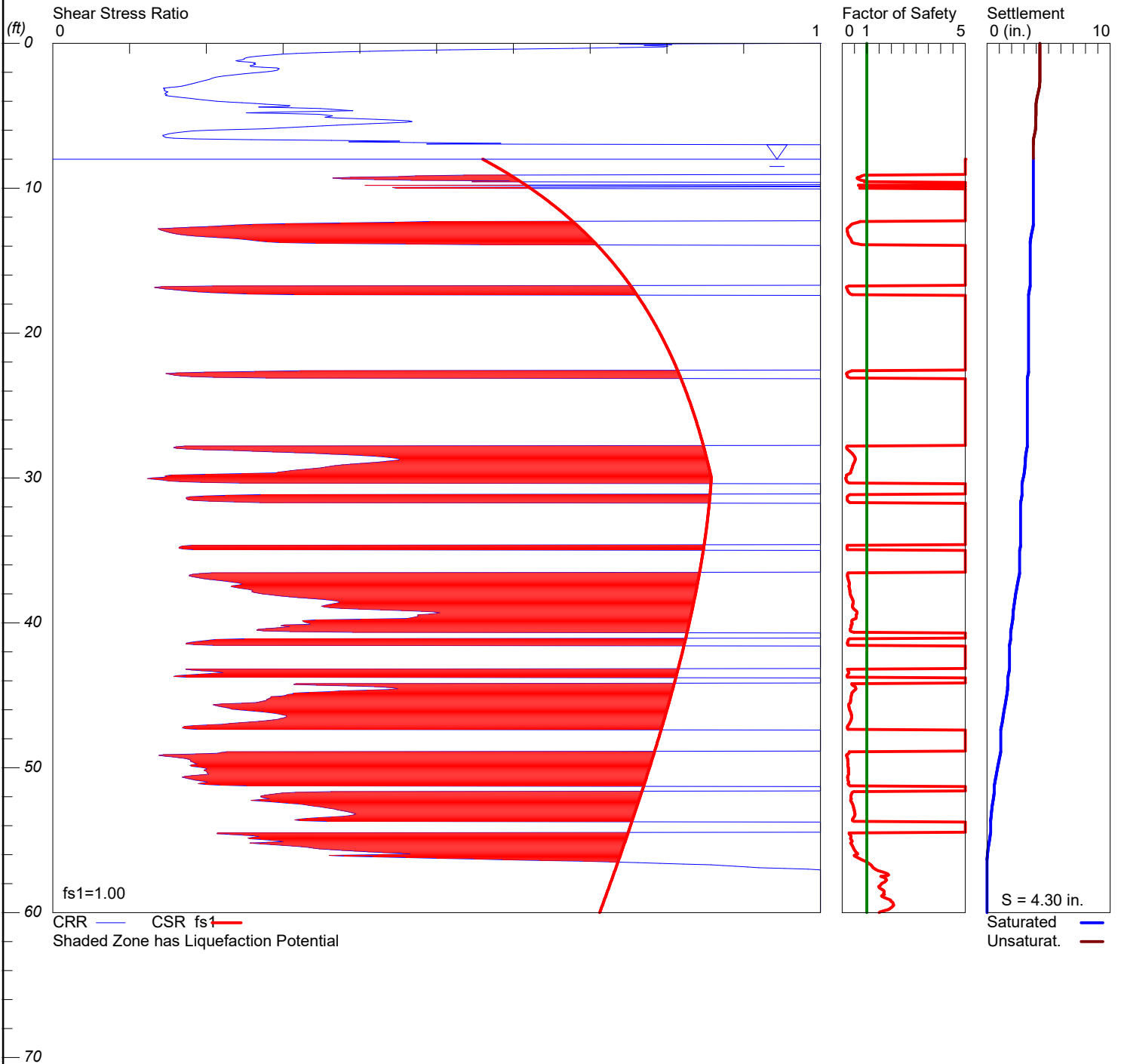
NoLiq                      No-Liquefy Soils

# LIQUEFACTION ANALYSIS

## Lynwood City Park Stormwater Capture Project

Hole No.=CPT-2 Water Depth=8 ft

Magnitude=7.3  
Acceleration=0.878g



\*\*\*\*\*

LIQUEFACTION ANALYSIS SUMMARY  
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Input File Name: G:\File Share\RVC temp\Projects\212102001 Lynwood City Park Stormwater Capture\Geo  
Calcs\Liq\212102001 Lynwood City Park CPT-2.liq  
Title: Lynwood City Park Stormwater Capture Project  
Subtitle: 212102001

Surface Elev.=  
Hole No.=CPT-2  
Depth of Hole= 60.00 ft  
Water Table during Earthquake= 8.00 ft  
Water Table during In-Situ Testing= 42.40 ft  
Max. Acceleration= 0.88 g  
Earthquake Magnitude= 7.30

Input Data:

Surface Elev.=  
Hole No.=CPT-2  
Depth of Hole=60.00 ft  
Water Table during Earthquake= 8.00 ft  
Water Table during In-Situ Testing= 42.40 ft  
Max. Acceleration=0.88 g  
Earthquake Magnitude=7.30  
No-Liquefiable Soils: CL, OL are Non-Liq. Soil

1. CPT Calculation Method: Modify Robertson\*
2. Settlement Analysis Method: Ishihara / Yoshimine
3. Fines Correction for Liquefaction: Stark/Olson et al.\*
4. Fine Correction for Settlement: During Liquefaction\*
5. Settlement Calculation in: All zones\*
9. User request factor of safety (apply to CSR) , User= 1  
Plot one CSR curve (fs1=User)

10. Use Curve Smoothing: Yes\*

\* Recommended Options

In-Situ Test Data:

| Depth<br>ft | qc<br>atm | fs<br>atm | Rf<br>pcf | gamma<br>% | Fines<br>mm | D50  |
|-------------|-----------|-----------|-----------|------------|-------------|------|
| 0.00        | 0.10      | 0.11      | 109.00    | 120.00     | *           | 0.50 |
| 1.00        | 17.67     | 0.34      | 1.95      | 120.00     | *           | 0.50 |
| 1.99        | 28.12     | 0.51      | 1.82      | 120.00     | *           | 0.50 |
| 2.99        | 24.80     | 0.35      | 1.40      | 120.00     | *           | 0.50 |
| 3.94        | 40.23     | 0.42      | 1.04      | 120.00     | *           | 0.50 |
| 4.92        | 71.18     | 0.47      | 0.66      | 120.00     | *           | 0.50 |
| 5.91        | 57.32     | 0.72      | 1.25      | 120.00     | *           | 0.50 |
| 6.91        | 17.48     | 0.60      | 3.40      | 120.00     | *           | 0.50 |
| 7.89        | 8.59      | 0.70      | 8.10      | 120.00     | *           | 0.50 |
| 8.87        | 14.74     | 0.61      | 4.14      | 120.00     | *           | 0.50 |
| 9.86        | 19.33     | 0.63      | 3.26      | 120.00     | *           | 0.50 |
| 10.83       | 11.91     | 0.73      | 6.09      | 120.00     | *           | 0.50 |
| 11.82       | 14.26     | 0.63      | 4.45      | 120.00     | *           | 0.50 |
| 12.80       | 35.15     | 0.51      | 1.46      | 120.00     | *           | 0.50 |
| 13.78       | 33.69     | 0.93      | 2.75      | 120.00     | *           | 0.50 |
| 14.77       | 9.76      | 0.26      | 2.69      | 120.00     | *           | 0.50 |
| 15.75       | 12.01     | 0.66      | 5.49      | 120.00     | *           | 0.50 |
| 16.75       | 29.88     | 0.63      | 2.12      | 120.00     | *           | 0.50 |
| 17.72       | 13.28     | 0.80      | 6.05      | 120.00     | *           | 0.50 |
| 18.74       | 11.52     | 0.65      | 5.63      | 120.00     | *           | 0.50 |
| 19.72       | 13.47     | 0.63      | 4.65      | 120.00     | *           | 0.50 |
| 20.70       | 15.23     | 1.08      | 7.08      | 120.00     | *           | 0.50 |
| 21.66       | 29.20     | 1.34      | 4.58      | 120.00     | *           | 0.50 |
| 22.65       | 42.18     | 1.06      | 2.52      | 120.00     | *           | 0.50 |
| 23.62       | 15.82     | 0.97      | 6.14      | 120.00     | *           | 0.50 |
| 24.60       | 10.55     | 0.77      | 7.26      | 120.00     | *           | 0.50 |
| 25.60       | 7.32      | 0.48      | 6.61      | 120.00     | *           | 0.50 |
| 26.60       | 6.83      | 0.51      | 7.44      | 120.00     | *           | 0.50 |
| 27.59       | 33.88     | 1.54      | 4.54      | 120.00     | *           | 0.50 |
| 28.54       | 150.30    | 2.50      | 1.66      | 120.00     | *           | 0.50 |
| 29.53       | 92.76     | 2.26      | 2.44      | 120.00     | *           | 0.50 |

|       |        |      |      |        |   |      |
|-------|--------|------|------|--------|---|------|
| 30.51 | 47.26  | 1.65 | 3.48 | 120.00 | * | 0.50 |
| 31.53 | 62.69  | 1.22 | 1.94 | 120.00 | * | 0.50 |
| 32.51 | 43.94  | 1.95 | 4.44 | 120.00 | * | 0.50 |
| 33.48 | 13.67  | 0.88 | 6.46 | 120.00 | * | 0.50 |
| 34.45 | 18.26  | 1.15 | 6.29 | 120.00 | * | 0.50 |
| 35.43 | 21.58  | 0.65 | 3.01 | 120.00 | * | 0.50 |
| 36.42 | 47.55  | 1.54 | 3.23 | 120.00 | * | 0.50 |
| 37.43 | 144.40 | 1.49 | 1.03 | 120.00 | * | 0.50 |
| 38.40 | 171.90 | 2.40 | 1.40 | 120.00 | * | 0.50 |
| 39.39 | 218.60 | 2.61 | 1.20 | 120.00 | * | 0.50 |
| 40.37 | 164.80 | 1.95 | 1.18 | 120.00 | * | 0.50 |
| 41.37 | 104.00 | 1.52 | 1.46 | 120.00 | * | 0.50 |
| 42.33 | 23.24  | 0.81 | 3.47 | 120.00 | * | 0.50 |
| 43.31 | 87.10  | 1.80 | 2.07 | 120.00 | * | 0.50 |
| 44.29 | 148.20 | 3.09 | 2.09 | 120.00 | * | 0.50 |
| 45.27 | 158.50 | 2.28 | 1.44 | 120.00 | * | 0.50 |
| 46.26 | 163.50 | 2.39 | 1.46 | 120.00 | * | 0.50 |
| 47.24 | 111.50 | 1.47 | 1.32 | 120.00 | * | 0.50 |
| 48.24 | 15.62  | 0.54 | 3.48 | 120.00 | * | 0.50 |
| 49.25 | 114.90 | 1.24 | 1.08 | 120.00 | * | 0.50 |
| 50.20 | 114.60 | 1.93 | 1.69 | 120.00 | * | 0.50 |
| 51.21 | 88.17  | 2.10 | 2.38 | 120.00 | * | 0.50 |
| 52.16 | 164.70 | 2.47 | 1.50 | 120.00 | * | 0.50 |
| 53.17 | 202.60 | 3.06 | 1.51 | 120.00 | * | 0.50 |
| 54.15 | 33.69  | 2.59 | 7.68 | 120.00 | * | 0.50 |
| 55.11 | 174.50 | 2.62 | 1.50 | 120.00 | * | 0.50 |
| 56.10 | 250.90 | 1.46 | 0.58 | 120.00 | * | 0.50 |
| 57.08 | 367.30 | 3.67 | 1.00 | 120.00 | * | 0.50 |
| 58.07 | 370.40 | 4.36 | 1.18 | 120.00 | * | 0.50 |
| 59.07 | 412.10 | 2.58 | 0.63 | 120.00 | * | 0.50 |

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\* Modify Robertson method generates Fines from qc/fs. Inputted Fines are not relevant.

#### Output Results:

Settlement of Saturated Sands=3.76 in.

Settlement of Unsaturated Sands=0.54 in.

Total Settlement of Saturated and Unsaturated Sands=4.30 in.

Differential Settlement=2.152 to 2.840 in.

| Depth<br>ft | CRRm | CSRfs | F.S.  | S_sat.<br>in. | S_dry<br>in. | S_all<br>in. |
|-------------|------|-------|-------|---------------|--------------|--------------|
| 0.00        | 2.00 | 0.57  | 5.00  | 3.76          | 0.54         | 4.30         |
| 1.00        | 0.25 | 0.57  | 5.00  | 3.76          | 0.54         | 4.30         |
| 2.00        | 0.27 | 0.57  | 5.00  | 3.76          | 0.53         | 4.30         |
| 3.00        | 0.16 | 0.57  | 5.00  | 3.76          | 0.49         | 4.26         |
| 4.00        | 0.21 | 0.57  | 5.00  | 3.76          | 0.25         | 4.01         |
| 5.00        | 0.36 | 0.56  | 5.00  | 3.76          | 0.21         | 3.97         |
| 6.00        | 0.20 | 0.56  | 5.00  | 3.76          | 0.17         | 3.93         |
| 7.00        | 2.00 | 0.56  | 5.00  | 3.76          | 0.00         | 3.76         |
| 8.00        | 2.00 | 0.56  | 5.00  | 3.76          | 0.00         | 3.76         |
| 9.00        | 2.00 | 0.59  | 5.00  | 3.76          | 0.00         | 3.76         |
| 10.00       | 0.45 | 0.62  | 0.72* | 3.76          | 0.00         | 3.76         |
| 11.00       | 2.00 | 0.65  | 5.00  | 3.76          | 0.00         | 3.76         |
| 12.00       | 2.00 | 0.67  | 5.00  | 3.76          | 0.00         | 3.76         |
| 13.00       | 0.15 | 0.69  | 0.21* | 3.66          | 0.00         | 3.66         |
| 14.00       | 2.00 | 0.71  | 5.00  | 3.51          | 0.00         | 3.51         |
| 15.00       | 2.00 | 0.73  | 5.00  | 3.51          | 0.00         | 3.51         |
| 16.00       | 2.00 | 0.74  | 5.00  | 3.51          | 0.00         | 3.51         |
| 17.00       | 0.16 | 0.76  | 0.21* | 3.45          | 0.00         | 3.45         |
| 18.00       | 2.00 | 0.77  | 5.00  | 3.38          | 0.00         | 3.38         |
| 19.00       | 2.00 | 0.78  | 5.00  | 3.38          | 0.00         | 3.38         |
| 20.00       | 2.00 | 0.79  | 5.00  | 3.38          | 0.00         | 3.38         |
| 21.00       | 2.00 | 0.80  | 5.00  | 3.38          | 0.00         | 3.38         |
| 22.00       | 2.00 | 0.81  | 5.00  | 3.38          | 0.00         | 3.38         |
| 23.00       | 0.18 | 0.82  | 0.22* | 3.30          | 0.00         | 3.30         |
| 24.00       | 2.00 | 0.82  | 5.00  | 3.28          | 0.00         | 3.28         |
| 25.00       | 2.00 | 0.83  | 5.00  | 3.28          | 0.00         | 3.28         |
| 26.00       | 2.00 | 0.84  | 5.00  | 3.28          | 0.00         | 3.28         |
| 27.00       | 2.00 | 0.84  | 5.00  | 3.28          | 0.00         | 3.28         |
| 28.00       | 0.17 | 0.85  | 0.20* | 3.23          | 0.00         | 3.23         |
| 29.00       | 0.40 | 0.85  | 0.47* | 3.10          | 0.00         | 3.10         |
| 30.00       | 0.13 | 0.86  | 0.15* | 2.94          | 0.00         | 2.94         |
| 31.00       | 2.00 | 0.86  | 5.00  | 2.85          | 0.00         | 2.85         |
| 32.00       | 2.00 | 0.85  | 5.00  | 2.73          | 0.00         | 2.73         |
| 33.00       | 2.00 | 0.85  | 5.00  | 2.73          | 0.00         | 2.73         |

|       |      |      |       |      |      |      |
|-------|------|------|-------|------|------|------|
| 34.00 | 2.00 | 0.85 | 5.00  | 2.73 | 0.00 | 2.73 |
| 35.00 | 2.00 | 0.85 | 5.00  | 2.65 | 0.00 | 2.65 |
| 36.00 | 2.00 | 0.84 | 5.00  | 2.65 | 0.00 | 2.65 |
| 37.00 | 0.20 | 0.84 | 0.24* | 2.55 | 0.00 | 2.55 |
| 38.00 | 0.27 | 0.84 | 0.33* | 2.33 | 0.00 | 2.33 |
| 39.00 | 0.37 | 0.83 | 0.45* | 2.16 | 0.00 | 2.16 |
| 40.00 | 0.33 | 0.83 | 0.40* | 2.04 | 0.00 | 2.04 |
| 41.00 | 2.00 | 0.82 | 5.00  | 1.92 | 0.00 | 1.92 |
| 42.00 | 2.00 | 0.82 | 5.00  | 1.82 | 0.00 | 1.82 |
| 43.00 | 2.00 | 0.82 | 5.00  | 1.82 | 0.00 | 1.82 |
| 44.00 | 2.00 | 0.81 | 5.00  | 1.69 | 0.00 | 1.69 |
| 45.00 | 0.30 | 0.81 | 0.38* | 1.60 | 0.00 | 1.60 |
| 46.00 | 0.24 | 0.80 | 0.30* | 1.40 | 0.00 | 1.40 |
| 47.00 | 0.22 | 0.79 | 0.28* | 1.21 | 0.00 | 1.21 |
| 48.00 | 2.00 | 0.79 | 5.00  | 1.11 | 0.00 | 1.11 |
| 49.00 | 0.22 | 0.78 | 0.27* | 1.10 | 0.00 | 1.10 |
| 50.00 | 0.20 | 0.78 | 0.25* | 0.86 | 0.00 | 0.86 |
| 51.00 | 0.20 | 0.77 | 0.26* | 0.64 | 0.00 | 0.64 |
| 52.00 | 0.27 | 0.77 | 0.35* | 0.54 | 0.00 | 0.54 |
| 53.00 | 0.38 | 0.76 | 0.50* | 0.37 | 0.00 | 0.37 |
| 54.00 | 2.00 | 0.75 | 5.00  | 0.29 | 0.00 | 0.29 |
| 55.00 | 0.28 | 0.75 | 0.38* | 0.20 | 0.00 | 0.20 |
| 56.00 | 0.42 | 0.74 | 0.57* | 0.04 | 0.00 | 0.04 |
| 57.00 | 0.98 | 0.73 | 1.34  | 0.00 | 0.00 | 0.00 |
| 58.00 | 1.16 | 0.73 | 1.60  | 0.00 | 0.00 | 0.00 |
| 59.00 | 1.27 | 0.72 | 1.76  | 0.00 | 0.00 | 0.00 |
| 60.00 | 1.07 | 0.71 | 1.50  | 0.00 | 0.00 | 0.00 |

---

\* F.S.<1, Liquefaction Potential Zone

(F.S. is limited to 5, CRR is limited to 2, CSR is limited to 2)

Units: Unit: qc, fs, Stress or Pressure = atm (1.0581tsf); Unit Weight = pcf; Depth = ft;  
Settlement = in.

---

1 atm (atmosphere) = 1 tsf (ton/ft<sup>2</sup>)

CRRm                      Cyclic resistance ratio from soils

CSRsf                      Cyclic stress ratio induced by a given earthquake (with user request factor of  
safety)

|                  |                                                              |
|------------------|--------------------------------------------------------------|
| F.S.             | Factor of Safety against liquefaction, $F.S.=CRR_m/CSR_{sf}$ |
| S <sub>sat</sub> | Settlement from saturated sands                              |
| S <sub>dry</sub> | Settlement from Unsaturated Sands                            |
| S <sub>all</sub> | Total Settlement from Saturated and Unsaturated Sands        |
| NoLiq            | No-Liquefy Soils                                             |



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