Appendix E

Geotechnical Engineering Investigation

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December 2, 2019
Revised January 6, 2021
File Number 21850

Faring
8715 Melrose Avenue, Suite 103
West Hollywood, California 90069

Attention: Darren Embry

Subject: Geotechnical Engineering Investigation
Proposed Mixed-Use Development
21207 Avalon Boulevard, Carson, California

Dear Mr. Embry:

This letter transmits the Geotechnical Engineering Investigation for the subject site prepared by Geotechnologies, Inc. This report provides geotechnical recommendations for the development of the site, including earthwork, seismic design, retaining walls, excavations, shoring and foundation design. Engineering for the proposed project should not begin until approval of the geotechnical investigation is granted by the local building official. Significant changes in the geotechnical recommendations may result due to the building department review process.

The validity of the recommendations presented herein is dependent upon review of the geotechnical aspects of the project during construction by this firm. The subsurface conditions described herein have been projected from limited subsurface exploration and laboratory testing. The exploration and testing presented in this report should in no way be construed to reflect any variations which may occur between the exploration locations or which may result from changes in subsurface conditions.

Should you have any questions please contact this office.

Respectfully submitted,
GEOTECHNOLOGIES, INC.

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PROPOSED MIXED-USE DEVELOPMENT
21207 AVALON BOULEVARD
CARSON, CALIFORNIA

INTRODUCTION

This report presents the results of the geotechnical engineering investigation performed on the subject site. The purpose of this investigation was to identify the distribution and engineering properties of the geologic materials underlying the site, and to provide geotechnical recommendations for the design of the proposed development.

This investigation included thirty seven exploratory excavations, collection of representative samples, laboratory testing, engineering analysis, review of published geologic data, review of available geotechnical engineering information and the preparation of this report. The exploratory excavation locations are shown on the enclosed Plot Plan. The results of the exploration and the laboratory testing are presented in the Appendix of this report.

PROPOSED DEVELOPMENT

Information concerning the proposed development was furnished by the client. In addition, the Site Plan prepared by Architects Orange, dated November 20, 2020 was reviewed for the preparation of this investigation. The proposed project consists of construction of a mixed-use development. The development will include four large buildings, labeled Buildings A through D in the enclosed Plot Plan, as well as 48 smaller townhome buildings which will contain a total of 380 units. Buildings A and B will be four stories in height, while Building C will be five stories in height and Building D will be seven stories in height. The 48 townhome buildings will be three stories in height. A single-story building, to be used as leasing office and fitness club, is also being proposed. The location and alignment of the proposed buildings is shown in the enclosed Plot Plan. All buildings are expected to be built at or near the existing grade. Grading is expected to consist of the removal and recompaction of existing unsuitable soils.

Any changes in the design of the project or location of any structure, as outlined in this report, should be reviewed by this office. The recommendations contained in this report should not be considered valid until reviewed and modified or reaffirmed, in writing, subsequent to such review.

SITE CONDITIONS

The site is located at 21207 Avalon Boulevard, in the City of Carson, California. The site is quasi-quadrilateral in shape, and just over 24 acres in area. The site is bounded by a flood control channel followed by a landfill to the north, Avalon Boulevard to the east, an auto dealership and residential developments to the south, and Grace Avenue to the west. The site is shown relative to nearby topographic features in the enclosed Vicinity Map.

The site is relatively level, with no pronounced highs or lows. The site is currently developed with the Imperial Avalon Mobile Estates mobile-home park. The existing development is comprised of 225 mobile homes, a storage yard, and a common area including a clubhouse, recreation building and swimming pool complex.

Vegetation at the site is limited, and consists of miscellaneous grass lawns, mature trees, and bushes. Drainage appears to be by sheetflow to the city streets.

Previous Site Topography

Based on review of historical topographic maps available for the site, the site used to be a part of a slough. It is believed this slough was backfilled and graded sometime in the first half of the past century. It is the opinion of this firm that the relatively deep fill observed throughout the site was placed as part of the backfilling of the slough. As addressed in a following section, fill depths in excess of 35 feet were observed during exploration. Fill depths are also illustrated in the enclosed Plot Plan.

GEOTECHNICAL EXPLORATION

FIELD EXPLORATION

The site was explored on September 25, 26, 27, 30, and October 1, 2, 3, 28, 29 and 30, 2019, by drilling a total of thirty seven borings. The borings were drilled to depths ranging between 20 and 70 feet below the existing grade, with the aid of a truck-mounted drilling machine using 8-inch diameter hollowstem augers. The exploration locations are shown on the Plot Plan and the geologic materials encountered are logged on Plates A-1 through A-37.

The location of exploratory excavations was determined from hardscaped features shown in the enclosed Plot Plan. The location of the exploratory excavations should be considered accurate only to the degree implied by the method used.

Geologic Materials

Fill materials were encountered in all exploratory excavations, to depths ranging between 7½ and more than 35 feet in depth. The enclosed Plot Plan shows the depth of fill encountered at each boring. It should be noted that at the location where the deepest fill was observed (Boring B15), a large piece of concrete encountered at a depth of 35 feet prevented the prosecution of this borehole. Therefore, the total depth of fill could not be obtained at this location. As mentioned in a previous section, it is the opinion of this firm that the fill was placed for the backfill of an old slough, which extended beyond the site limits.

The fill observed in the borings consists of a mixture of clay, silt and sand, which ranges from yellowish brown to dark brown to gray to dark gray in color, and is moist, stiff, medium dense to dense, and fine grained, with occasional gravel and cobbles. Various amounts of construction debris, such as concrete, bricks, asphalt and wood were observed in the fill.

The fill is in turn underlain by native alluvial soils, consisting of interlayered mixtures of sandy to silty clay, clayey to sandy silt, silty to clayey sand, and sands. The native soils range from yellowish brown to dark brown to gray to dark gray in color, and are moist to wet, stiff to very stiff, medium dense to very dense, and fine to medium grained. Occasional shells were observed in the native soils. Some of the native soils were observed to me diatomaceous.

More detailed descriptions of the earth materials encountered may be obtained from individual logs of the subsurface excavations.

Groundwater

Groundwater was encountered during exploration, in ten of the thirty seven borings. The table below provides a summary of the depth to groundwater observed in the borings:

BORING NUMBER	DEPTH TO GROUNDWATER (FEET)
B1	26.5
B6	30
B10	31
B17	28
B20	23.5
B21	31
B27	25
B29	33.5
B31	30
B37	26

The historically highest groundwater level was established by review of California Geological Survey Seismic Hazard Evaluation Report for the Torrance Quadrangle, Plate 1.2 entitled "Historically Highest Ground Water Contours". Review of this plate indicates that the historically highest groundwater level is on the order of 20 feet below grade.

Fluctuations in the level of groundwater may occur due to variations in rainfall, temperature, and other factors not evident at the time of the measurements reported herein. Fluctuations also may occur across the site. High groundwater levels can result in changed conditions.

Caving

Caving could not be directly observed during exploration due to the continuously cased design of the hollow stem auger. Based on the experience of this firm, large diameter excavations, excavations that encounter granular, cohesionless soils and excavations below the groundwater table will likely experience caving.

SEISMIC EVALUATION

REGIONAL GEOLOGIC SETTING

The subject site is located in the Los Angeles Basin which is considered the northern portion of the Peninsular Ranges Geomorphic Province. The Peninsular Ranges are characterized by northwest-trending blocks of mountain ridges and sediment-floored valleys. The dominant geologic structural features are northwest trending fault zones that either die out to the northwest or terminate at east-trending reverse faults that form the southern margin of the Transverse Ranges.

The Los Angeles Basin is located at the northern end of the Peninsular Ranges Geomorphic Province. The basin is bounded by the east and southeast by the Santa Ana Mountains and San Joaquin Hills, to the northwest by the Santa Monica Mountains. Over 22 million years ago the Los Angeles basin was a deep marine basin formed by tectonic forces between the North American and Pacific plates. Since that time, over 5 miles of marine and non-marine sedimentary rock as well as intrusive and extrusive igneous rocks have filled the basin. During the last 2 million years, defined by the Pleistocene and Holocene epochs, the Los Angeles basin and surrounding mountain ranges have been uplifted to form the present day landscape. Erosion of the surrounding mountains has resulted in deposition of unconsolidated sediments in low-lying areas by rivers such as the Los Angeles River. Areas that have experienced subtle uplift have been eroded with gullies.

REGIONAL FAULTING

Based on criteria established by the California Division of Mines and Geology (CDMG) now called California Geologic Survey (CGS), Faults may be categorized as Holocene-active, Pre-Holocene faults, and Age-undetermined faults. Holocene-active faults are those which show evidence of surface displacement within the last 11,700 years. Pre-Holocene faults are those that have not moved in the past 11,700 years. Age-undetermined faults are faults where the recency of fault movement has not been determined.

Buried thrust faults are faults without a surface expression but are a significant source of seismic activity. They are typically broadly defined based on the analysis of seismic wave recordings of hundreds of small and large earthquakes in the southern California area. Due to the buried nature of these thrust faults, their existence is usually not known until they produce an earthquake. The risk for surface rupture potential of these buried thrust faults is inferred to be low (Leighton, 1990). However, the seismic risk of these buried structures in terms of recurrence and maximum potential magnitude is not well established. Therefore, the potential for surface rupture on these surface-verging splays at magnitudes higher than 6.0 cannot be precluded.

The enclosed Regional Fault Location Map shows faults located in the region. This map is based on the 2010 Fault Activity Map, prepared by the California Department of Conservation. Some of the Holocene-active and Blind Thrusts faults located closest to the site are addressed in the following sections.

Holocene-Active Faults

Newport-Inglewood Fault System

The Newport-Inglewood fault system is located 1.8 miles to the east of the site. The Newport-Inglewood fault zone is a broad zone of discontinuous north to northwestern echelon faults and northwest to west trending folds. The fault zone extends southeastward from West Los Angeles, across the Los Angeles Basin, to Newport Beach and possibly offshore beyond San Diego (Barrows, 1974; Weber, 1982; Ziony, 1985).

The onshore segment of the Newport-Inglewood fault zone extends for about 37 miles from the Santa Ana River to the Santa Monica Mountains. Here it is overridden by, or merges with, the east-west trending Santa Monica zone of reverse faults.

The surface expression of the Newport-Inglewood fault zone is made up of a strikingly linear alignment of domal hills and mesas that rise on the order of 400 feet above the surrounding plains. From the northern end to its southernmost onshore expression, the Newport-Inglewood fault zone is made up of: Cheviot Hills, Baldwin Hills, Rosecrans Hills, Dominguez Hills, Signal Hill-Reservoir Hill, Alamitos Heights, Landing Hill, Bolsa Chica Mesa, Huntington Beach Mesa, and Newport Mesa. Several single and multiple fault strands, arranged in a roughly left stepping en echelon arrangement, make up the fault zone and account for the uplifted mesas.

The most significant earthquake associated with the Newport-Inglewood fault system was the Long Beach earthquake of 1933 with a magnitude of 6.3 on the Richter scale. It is believed that the Newport-Inglewood fault zone is capable of producing a 7.5 magnitude earthquake.

Palos Verdes Fault

Studies indicate that there are several active on-shore extensions of the strike-slip Palos Verdes fault, which is located approximately 4.9 miles west of the site. Geophysical data also indicate the off-shore extensions of the fault are active, offsetting Holocene age deposits. No historic large magnitude earthquakes are associated with this fault. However, the fault is considered active by the California Geological Survey. It is estimated that the Palos Verdes fault is capable of producing a maximum 7.7 magnitude earthquake.

Whittier-Elsinore Fault System

The Whittier fault is located approximately 16.5 miles to the east of the site. The Whittier fault together with the Chino fault comprises the northernmost extension of the northwest trending Elsinore fault system. The mapped surface of the Whittier fault extends in a west-northwest direction for a distance of 20 miles from the Santa Ana River to the terminus of the Puente Hills. The Whittier fault is essentially a strike-slip, northeast dipping fault zone which also exhibits evidence of reverse movement along with en echelon[a] fault segments, en echelon folds and anatomizing (braided) fault segments. Right lateral offsets of stream drainages of up to 8800 feet (Durham and Yerkes, 1964) and vertical separation of the basement complex of 6,000 to 12,000 feet (Yerkes, 1972), have been documented. It is believed that the Whittier fault is capable of producing a 7.8 magnitude earthquake.

[a] *En echelon refers to closely-spaced, parallel or subparallel, overlapping or step-like minor structural features.*

The Whittier Narrows earthquakes of October 1, 1987, and October 4, 1987, occurred in the area between the westernmost terminus of the mapped trace of the Whittier fault and the frontal fault system. The main 5.9 magnitude shock of October 1, 1987 was not caused by slip on the Whittier fault. The quake ruptured a gently dipping thrust fault with an east-west strike (Haukson, Jones, Davis and others, 1988). In contrast, the earthquake of October 4, 1987, is assumed to have occurred on the Whittier fault as focal mechanisms show mostly strike-slip movement with a small reverse component on a steeply dipping northwest striking plane (Haukson, Jones, Davis and others, 1988).

Santa Monica Fault

In 2018, the California Geological Survey established an Earthquake Fault Zone for the Santa Monica Fault. The nearest segment of the active portion of the Santa Monica fault is located approximately 17.8 miles to the north of the site. The Santa Monica fault is a part of the Transverse Ranges Southern Boundary fault system, extending east from the coastline in Pacific Palisades through Santa Monica and West Los Angeles and merges with the Hollywood fault at the West Beverly Hills Lineament in Beverly Hills where its strike is northeast. It is believed that at least six surface ruptures have occurred in the past 50 thousand years. In addition, a well-documented surface rupture occurred between 10 and 17 thousand years ago, although a more recent earthquake probably occurred 1 to 3 thousand years ago. This leads to an average earthquake recurrence interval of 7 to 8 thousand years.[b] It is thought that the Santa Monica fault system may produce earthquakes with a maximum magnitude of 7.4.

[b] *Southern California Earthquake Center, a National Science Foundation and U.S. Geological Survey Center. Active Faults in the Los Angeles Metropolitan Region, www.scec.org/research/special/SCEC001activefaultsLA.pdf; accessed May 24, 2012.*

Hollywood Fault

The Hollywood fault is part of the Transverse Ranges Southern Boundary fault system. The Hollywood fault is located approximately 18.8 miles north of the site. This fault trends east-west along the base of the Santa Monica Mountains from the West Beverly Hills Lineament in the West Hollywood–Beverly Hills area to the Los Feliz area of Los Angeles. The Hollywood fault is the eastern segment of the reverse oblique Santa Monica–Hollywood fault. Based on geomorphic evidence, stratigraphic correlation between exploratory borings, and fault trenching studies, this fault is classified as active.

Until recently, the approximately 9.3-mile long Hollywood fault was considered to be expressed as a series of linear ground-surface geomorphic expressions and south-facing ridges along the south margin of the eastern Santa Monica Mountains and the Hollywood Hills. Multiple recent fault rupture hazard investigations have shown that the Hollywood fault is located south of the ridges and bedrock outcroppings along portions of Sunset Boulevard. The Hollywood fault has not produced any damaging earthquakes during the historical period and has had relatively minor micro-seismic activity. It is estimated that the Hollywood fault is capable of producing a maximum 6.7 magnitude earthquake. In 2014, the California Geological Survey established an Earthquake Fault Zone for the Hollywood Fault. A copy of this map may be found in the Appendix.

Raymond Fault

The Raymond fault is located approximately 19.7 miles to the northeast of the site. The Raymond fault is an effective groundwater barrier which divides the San Gabriel Valley into groundwater sub-basins. Much of the geomorphic evidence for the Raymond fault has been obliterated by urbanization of the San Gabriel Valley. However, a discontinuous escarpment can be traced from Monrovia to the Arroyo Seco in South Pasadena. The very bold, “knife edge” escarpment in Monrovia parallel to Scenic Drive is believed to be a fault scarp of the Raymond fault. Trenching of the Raymond fault is reported to have revealed Holocene movement (Weaver and Dolan, 1997).

The recurrence interval for the Raymond fault is probably slightly less than 3,000 years, with the most recent documented event occurring approximately 1,600 years ago (Crook, et al, 1978). However, historical accounts of an earthquake that occurred in July 1855 as reported by Toppozada and others, 1981, places the epicenter of a Richter Magnitude 6 earthquake within the Raymond fault. It is believed that the Raymond fault is capable of producing a 6.8 magnitude earthquake. The Raymond Fault is considered active by the California Geological Survey.

Malibu Coast Fault

The Malibu Coast fault is part of the Transverse Ranges Southern Boundary fault system, a west-trending system of reverse, oblique-slip, and strike-slip faults that extends for more than approximately 124 miles along the southern edge of the Transverse Ranges and includes the Hollywood, Raymond, Anacapa–Dume, Malibu Coast, Santa Cruz Island, and Santa Rosa Island faults.

The Malibu Coast fault zone runs in an east-west orientation onshore subparallel to and along the shoreline for a linear distance of about 17 miles through the Malibu City limits, but also extends offshore to the east and west for a total length of approximately 37.5 miles. The onshore Malibu Coast fault zone involves a broad, wide zone of faulting and shearing as much as 1 mile in width. While the Malibu Coast Fault Zone has not been officially designated as an active fault zone by the State of California and no Special Studies Zones have been delineated along any part of the fault zone under the Alquist-Priolo Act of 1972, evidence for Holocene activity (movement in the last 11,000 years) has been established in several locations along individual fault splays within the fault zone. Due to such evidence, several fault splays within the onshore portion of the fault zone are identified as active.[c]

Large historic earthquakes along the Malibu Coast fault include the 1979, 5.2 magnitude earthquake and the 1989, 5.0 magnitude earthquake.[d] The Malibu Coast fault zone is approximately 19.9 miles northwest of the site and is believed to be capable of producing a maximum 7.0 magnitude earthquake.

Verdugo Fault

The Verdugo Fault is located approximately 21.2 miles to the northeast of the site. The Verdugo Fault runs along the southwest edge of the Verdugo Mountains. The fault displays a reverse motion. According to Weber, et. al., (1980) 2 to 3 meter high scarps were identified in alluvial fan deposits in the Burbank and Glendale areas. Further to the northeast, in Sun Valley, a fault was reportedly identified at a depth of 40 feet in a sand and gravel pit. Although considered active by the County of Los Angeles, Department of Public Works (Leighton, 1990), and the United States Geological Survey, the fault is not designated with an Earthquake Fault Zone by the California Geological Survey. It is estimated that the Verdugo Fault is capable of producing a maximum 6.9 magnitude earthquake.

Sierra Madre Fault System

The Sierra Madre fault alone forms the southern tectonic boundary of the San Gabriel Mountains in the northern San Fernando Valley. It consists of a system of faults approximately 75 miles in length. The individual segments of the Sierra Madre fault system range up to 16 miles in length and display a reverse sense of displacement and dip to the north. The most recently active

[c] *City of Malibu Planning Department, Malibu General Plan, Chapter 5.0, Safety and Health Element, http://qcode.us/codes/malibu-general-plan/; accessed October 25, 2012.*
[d] *California Institute of Technology, Southern California Data Center. Chronological Earthquake Index, www.data.scec.org/significant/malibu1979.html; accessed October 25, 2012.*

portions of the zone include the Mission Hills, Sylmar and Lakeview segments, which produced an earthquake in 1971 of magnitude 6.4. Tectonic rupture along the Lakeview Segment during the San Fernando Earthquake of 1971 produced displacements of approximately 2½ to 4 feet upward and southwestward.

It is believed that the Sierra Madre fault zone is capable of producing an earthquake of magnitude 7.3. The closest trace of the fault is located approximately 25.9 miles northeast of the site.

San Gabriel Fault System

The San Gabriel fault system is located approximately 33.1 miles northeast of the site. The San Gabriel fault system comprises a series of subparallel, steeply north-dipping faults trending approximately north 40 degrees west with a right-lateral sense of displacement. There is also a small component of vertical dip-slip separation. The fault system exhibits a strong topographic expression and extends approximately 90 miles from San Antonio Canyon on the southeast to Frazier Mountain on the northwest. The estimated right lateral displacement on the fault varies from 34 miles (Crowell, 1982) to 40 miles (Ehlig, 1986), to 10 miles (Weber, 1982). Most scholars accept the larger displacement values and place the majority of activity between the Late Miocene and Late Pliocene Epochs of the Tertiary Era (65 to 1.8 million years before present).

Portions of the San Gabriel fault system are considered active by California Geological Survey. Recent seismic exploration in the Valencia area (Cotton and others, 1983; Cotton, 1985) has established Holocene offset. Radiocarbon data acquired by Cotton (1985) indicate that faulting in the Valencia area occurred between 3,500 and 1,500 years before present.

It is hypothesized by Ehlig (1986) and Stitt (1986) that the Holocene offset on the San Gabriel fault system is due to sympathetic (passive) movement as a result of north-south compression of the upper Santa Susana thrust sheet. Seismic evidence indicates that the San Gabriel fault system is truncated at depth by the younger, north-dipping Santa Susana-Sierra Madre faults (Oakeshott, 1975; Namson and Davis, 1988).

Santa Susana Fault

The Santa Susana fault extends approximately 35.4 miles west-northwest from the northwest edge of the San Fernando Valley into Ventura County and is at the surface high on the south flank of the Santa Susana Mountains. The fault ends near the point where it overrides the south-side-up South strand of the Oak Ridge fault. The Santa Susana fault strikes northeast at the Fernando lateral ramp and turns east at the northern margin of the Sylmar Basin to become the Sierra Madre fault. This fault is exposed near the base of the San Gabriel Mountains for approximately 46 miles from the San Fernando Pass at the Fernando lateral ramp east to its intersection with the San Antonio Canyon fault in the eastern San Gabriel Mountains, east of which the range front is formed by the Cucamonga fault. The Santa Susana fault has not experienced any recent major ruptures except for a slight rupture during the 6.5 magnitude 1971 Sylmar earthquake.[e] The Santa Susana Fault is considered to be active by the County of Los Angeles. It is believed that the Santa Susana fault has the potential to produce a 6.9 magnitude earthquake. The closest trace of the fault is located approximately 18 miles north of the site.

San Andreas Fault System

The San Andreas Fault system forms a major plate tectonic boundary along the western portion of North America. The system is predominantly a series of northwest trending faults

[e] *California Institute of Technology, Southern California Data Center. Chronological Earthquake Index, www.data.scec.org/significant/santasusana.html; accessed May 24, 2012.*

characterized by a predominant right lateral sense of movement. At its closest point the San Andreas Fault system is located approximately 48 miles to the northeast of the site.

The San Andreas and associated faults have had a long history of inferred and historic earthquakes. Cumulative displacement along the system exceeds 150 miles in the past 25 million years (Jahns, 1973). Large historic earthquakes have occurred at Fort Tejon in 1857, at Point Reyes in 1906, and at Loma Prieta in 1989. Based on single-event rupture length, the maximum Richter magnitude earthquake is expected to be approximately 8.25 (Allen, 1968). The recurrence interval for large earthquakes on the southern portion of the fault system is on the order of 100 to 200 years.

Blind Thrusts Faults

Blind or buried thrust faults are faults without a surface expression but are a significant source of seismic activity. By definition, these faults have no surface trace, therefore the potential for ground surface rupture is considered remote. They are typically broadly defined based on the analysis of seismic wave recordings of hundreds of small and large earthquakes in the Southern California area. Due to the buried nature of these thrust faults, their existence is sometimes not known until they produce an earthquake. Two blind thrust faults in the Los Angeles metropolitan area are the Puente Hills blind thrust and the Elysian Park blind thrust. Another blind thrust fault of note is the Northridge fault located in the northwestern portion of the San Fernando Valley.

The Puente Hills blind thrust fault extends eastward from Downtown Los Angeles to the City of Brea in northern Orange County. The Puente Hills blind thrust fault includes three north-dipping segments, named from east to west as the Coyote Hills segment, the Santa Fe Springs segment, and the Los Angeles segment. These segments are overlain by folds expressed at the surface as the Coyote Hills, Santa Fe Springs Anticline, and the Montebello Hills.

The Santa Fe Springs segment of the Puente Hills blind thrust is located approximately 8.7 miles to the east of the site. The Santa Fe Springs segment of the Puente Hills blind thrust fault is believed to be the cause of the October 1, 1987, Whittier Narrows Earthquake. Based on deformation of late Quaternary age sediments above this fault system and the occurrence of the Whittier Narrows earthquake, the Puente Hills blind thrust fault is considered an active fault capable of generating future earthquakes beneath the Los Angeles Basin. A maximum moment magnitude of 7.0 is estimated by researchers for the Puente Hills blind thrust fault.

The Elysian Park anticline is thought to overlie the Elysian Park blind thrust. This fault has been estimated to cause an earthquake every 500 to 1,300 years in the magnitude range 6.2 to 6.7. The Elysian Park anticline is approximately 15.9 miles to the northeast of the site.

The Mw 6.7 Northridge earthquake was caused by the sudden rupture of a previously unknown, blind thrust fault. This fault has since been named the Northridge Thrust, however it is also known in some of the literature as the Pico Thrust. It has been assigned a maximum magnitude of 6.9 and a 1,500 to 1,800 year recurrence interval. The Northridge thrust is located 33.2 miles to the northwest of the site.

SEISMIC HAZARDS AND DESIGN CONSIDERATIONS

The primary geologic hazard at the site is moderate to strong ground motion (acceleration) caused by an earthquake on any of the local or regional faults. The potential for other earthquake-induced hazards was also evaluated including surface rupture, liquefaction, dynamic settlement, inundation and landsliding.

Surface Rupture

In 1972, the Alquist-Priolo Special Studies Zones Act (now known as the Alquist-Priolo Earthquake Fault Zoning Act) was passed into law. As revised in 2018, The Act defines

"Holocene-active" Faults utilizing the same aging criteria as that used by California Geological Survey (CGS). However, established state policy has been to zone only those faults which have direct evidence of movement within the last 11,700 years. It is this recency of fault movement that the CGS considers as a characteristic for faults that have a relatively high potential for ground rupture in the future.

CGS policy is to delineate a boundary from 200 to 500 feet wide on each side of the Holocene-Active fault trace based on the location precision, the complexity, or the regional significance of the fault. If a site lies within an Earthquake Fault Zone, a geologic fault rupture investigation must be performed that demonstrates that the proposed building site is not threatened by surface displacement from the fault before development permits may be issued.

Ground rupture is defined as surface displacement which occurs along the surface trace of the causative fault during an earthquake. Based on research of available literature and results of site reconnaissance, no known Holocene-active or Pre-Holocene faults underlie the subject site. In addition, the subject site is not located within an Alquist-Priolo Earthquake Fault Zone. Based on these considerations, the potential for surface ground rupture at the subject site is considered low.

Liquefaction

Liquefaction is a phenomenon in which saturated silty to cohesionless soils below the groundwater table are subject to a temporary loss of strength due to the buildup of excess pore pressure during cyclic loading conditions such as those induced by an earthquake. Liquefaction-related effects include loss of bearing strength, amplified ground oscillations, lateral spreading, and flow failures.

Liquefaction typically occurs in areas where groundwater is less than 50 feet from the surface, and where the soils are composed of poorly consolidated, fine to medium-grained sand. In addition to the necessary soil conditions, the ground acceleration and duration of the earthquake must also be of a sufficient level to initiate liquefaction.

The Seismic Hazards Zone Map of the Torrance Quadrangle by the State of California (CDMG, 1997), indicates that the subject site is located within an area designated as “Liquefiable.” A copy of this map is provided in the Appendix.

Ten site-specific liquefaction analyses were performed following the Recommended Procedures for Implementation of the California Geologic Survey Special Publication 117A, Guidelines for Analyzing and Mitigating Seismic Hazards in California (CGS, 2008), the EERI Monograph (MNO-12) by Idriss and Boulanger (2008), and County of Los Angeles policy GS 045.0 (2014). This semi-empirical method is based on a correlation between measured values of Standard Penetration Test (SPT) resistance and field performance data.

Groundwater was encountered during exploration, at depths ranging between 23½ and 32½ feet below the existing grade. According to the Seismic Hazard Zone Report of the Torrance 7½-Minute Quadrangle (CDMG, 2006), the historically highest groundwater level for the site was approximately 20 feet below the existing ground surface. The enclosed liquefaction analyses are based on the historically highest and current groundwater levels.

Section 11.8.3 of ASCE 7-10 indicates that the potential for liquefaction shall be evaluated utilizing an acceleration consistent with the MCE_G PGA. Utilizing the OSHPD seismic utility program, this corresponds to a PGA_M of 0.83g. The USGS Probabilistic Seismic Hazard Deaggregation program (USGS, 2014) indicates a PGA of 0.69g (2 percent in 50 years ground motion) and a modal magnitude of 6.8 for the site. The liquefaction potential evaluation was performed by utilizing a magnitude 6.8 earthquake, and a peak horizontal acceleration of 0.83g.

The enclosed "Empirical Estimations of Liquefaction Potential" are based on the results obtained from 10 of the exploratory borings, which were prosecuted to depths between 50 and 70 feet below grade. Standard Penetration Test (SPT) data were collected at 5-foot intervals. Samples of the collected materials were conveyed to the laboratory for testing and analysis. The percent passing a Number 200 sieve, Atterberg Limits, and the plasticity index (PI) of representative samples of the soils encountered in the exploratory borings are presented on the enclosed E-Plate and F-Plate.

Based on CGS Special Publication 117A (CDMG, 2008) and (Bray and Sancio, 2006), the vast majority of liquefaction hazards are associated with sandy soils and silty soils of low plasticity. Furthermore, soils having a PI greater than 18 exhibit clay-like behavior, and the liquefaction potential of these soils are considered to be low. The results of Atterberg Limits testing (shown on Plates F) indicate that some of soil layers below the subject site have PI greater than 18. Therefore, these soils are not considered prone to liquefaction, and the analysis of these soil layers was turned off in the liquefaction susceptibility columns.

The enclosed liquefaction analysis indicates that factors of safety against liquefaction are below 1.3 for some of the soil layers and/or lenses encountered in the borings. These potentially liquefiable layers are illustrated in the following section. The factor of safety against liquefaction is defined as the ratio of the cyclic stress ratio to cause liquefaction to the earthquake-induced cyclic stress ratio. Therefore, the liquefaction analyses indicate these soil layers and/or lenses may liquefy in the event of an earthquake on a local or regional fault.

Dynamic (Seismic) Settlement

Liquefaction settlement analyses have been performed utilizing the results of the liquefaction analyses based on SPT blow count data. According to SP117A, the differential settlement used in foundation design should be up to two-thirds of the total settlement. A summary of the analyses is presented below:

BORING NUMBER	DEPTH OF LIQUEFIABLE LAYERS	TOTAL SETTLEMENT (inches)	DIFFERENTIAL SETTLEMENT (inches)
B1	None	0	0
B6	61’ - 67½’	1.90	1.27
B10	35’ - 40’	1.16	0.77
B17	15’ - 20’ 22½’ - 30’	2.19	1.46
B20	35’ - 37½’	0.32	0.21
B21	35’ - 42½’	1.98	1.32
B27	47½’ - 52½’	0.71	0.47
B29	32½’ - 40’ 45’ - 50’	2.12	1.41
B31	25’ - 35’ 40’ - 45’	2.27	1.51
B37	20’ - 30’	1.61	1.07

Surface Manifestation

It has been shown in studies by O’Rourke and Pease (1997) and Youd and Garris (1995), building upon work by Ishihara (1985), that the visible effects of liquefaction on the ground surface are only manifested if the relative and absolute thicknesses of liquefiable soils to overlying non-liquefiable surface material fall within a certain range. Surface manifestations of liquefaction include phenomena such as sand boils.

The liquefaction analyses indicate relative thicknesses of liquefiable to non-liquefiable soils that are within the bounds where surface manifestations have been observed during past earthquakes. According to (Boulanger and Idriss, 2008), “damage from liquefaction is seldom, however, due to sand boils themselves, but rather due to the loss of strength and stiffness in the soils that have liquefied and the associated ground deformations that ensue.”

The potentially liquefiable soils below the site occur in layers and/or lenses that are not laterally extensive throughout the site. Provided the recommendations presented herein are implemented during design and construction of the proposed structure, the potential for surface manifestations of liquefaction affecting the proposed structure is considered to be low.

Lateral Spreading

Lateral spreading is the most pervasive type of liquefaction-induced ground failure. During lateral spread, blocks of mostly intact, surficial soil displace downslope or towards a free face along a shear zone that has formed within the liquefied sediment. According to the procedure provided by Bartlett, Hansen, and Youd, "Revised Multilinear Regression Equations for Prediction of Lateral Spread Displacement", ASCE, Journal of Geotechnical Engineering, Vol. 128, No. 12, December 2002, when the saturated cohesionless sediments with $(N_1)_{60} > 15$, significant displacement is not likely for $M < 8$ earthquakes.

The saturated cohesionless sediments underlying the site have corrected $(N_1)_{60}$ value greater than 15. According to the USGS Probabilistic Seismic Hazard Deaggregation program (USGS, 2008), the mean predominant earthquake magnitude (M_W) for the site is 6.7. In addition, the potentially liquefiable layer consists of a stratified layer, which is not expected to be continuous throughout the site. Therefore, the potential for lateral spread is considered to be remote for the subject site.

Tsunamis, Seiches and Flooding

Tsunamis are large ocean waves generated by sudden water displacement caused by a submarine earthquake, landslide, or volcanic eruption. Review of the County of Los Angeles Flood and Inundation Hazards Map, Leighton (1990), indicates the site does not lie within the mapped tsunami inundation boundaries.

Seiches are oscillations generated in enclosed bodies of water which can be caused by ground shaking associated with an earthquake. Review of the County of Los Angeles Flood and Inundation Hazards Map, Leighton (1990), indicates the site is not located within mapped

Review of the applicable Flood Insurance Rate Map (06037C1935F) indicates the site lies within an area of reduced flood risk due to levee.

Landsliding

The probability of seismically-induced landslides occurring on the site is considered to be remote due to the general lack of elevation difference across or adjacent to the site.

CONCLUSIONS AND RECOMMENDATIONS

Based upon the exploration, laboratory testing, and research, it is the finding of Geotechnologies, Inc. that construction of the proposed development is considered feasible from a geotechnical engineering standpoint provided the advice and recommendations presented herein are followed and implemented during construction.

During exploration, fill materials were observed to extend between 7½ and more than 35 feet below the existing grade. The existing fill materials are unsuitable for support of new foundations and concrete slabs-on-grade, but they may be re-used for the preparation of a compacted fill pad. Groundwater was encountered during exploration at depths ranging between 23½ and 32½ feet below the existing site grade. Historical groundwater data provided in the Seismic Hazard Zone Report of the Torrance 7½-Minute Quadrangle indicates the historically highest groundwater level at the site was 20 feet below the ground surface.

Based on the liquefaction analyses, seismically induced settlement between 0 and 2.27 inches could potentially occur as a result of liquefaction. Such settlements are typically most damaging when the settlements are differential in nature across the length of structures. Seismically induced differential settlement is anticipated to be on the order of 1.51 inches. In addition to seismically induced settlement, the proposed structures will be subject to static settlement. Based on the anticipated dynamic and static settlement, it is recommended that the proposed structure is supported on a mat foundation system, bearing in a newly place compacted fill pad.

All fill materials shall be properly removed and recompacted for the creation of a compacted fill pad. If desired, individual fill pads may be created for each structure. As a minimum, the compacted fill pad shall extend to depth of 10 feet below the bottom of the proposed mat foundation. The compacted fill pad will extend deeper where deeper fill materials are encountered. Based on the depth of fill observed during exploration, it is anticipated that the depth of the compacted fill will range between 10 feet below the bottom of the mat foundations, and more than 35 feet below the existing grade. In addition to the vertical excavation, the proposed fill pad shall be overexcavated horizontally beyond the edge of foundations, for a distance equal to the depth of fill below the foundations. The depth of fill encountered during exploration is illustrated in the enclosed Plot Plan. The following table provides a summary of the fill depth observed within each of the proposed structures, as well as the observed groundwater level:

Building	Fill Depth Range (feet)	Shallowest Groundwater Depth (feet)
A	10 to 12.5	28
B	7.5 to 12.5	23.5
C	10 to 12.5	26
D	10 to 12.5	25
1 through 48	7.5 to over 35	23.5

Based on the information provided in the above table, it is anticipated that within some areas of the proposed townhome buildings, the existing fill materials extend below the level were the shallowest groundwater was observed during exploration. Therefore, temporary dewatering shall be anticipated within these areas, in order to allow for the complete removal and recompaction of the fill materials.

As an alternative to dewatering for the complete removal and recompaction of the existing fill, the client has inquired about the possibility of employing ground improvement methods to remediate the fill located below the groundwater level. The use of ground improvement methods to remediate the fill located below the groundwater level is acceptable to this firm. The ground improvements may consist of stone columns extending to the top of the native alluvial soils. These ground improvements are designed and installed by design-build foundation contractors, specializing and experienced with these remediation methods. The specialty contractor shall provide material requirements, preliminary spacing, and other design information.

The temporary excavations required for the creation of the recommended compacted fill pads may be performed with the aid of sloped embankments, as recommended in the "Temporary Excavation" section of this report. Where there is not enough space to perform a temporary sloped embankment, or where a vertical excavation is necessary, the installation of a temporary shoring system will be required.

Due to the anticipated liquefaction potential, it is recommended that buried utilities and drain lines be equipped with flexible or swing joints to allow for differential vertical displacements.

The validity of the conclusions and design recommendations presented herein is dependent upon review of the geotechnical aspects of the proposed construction by this firm. The subsurface conditions described herein have been projected from borings on the site as indicated and should in no way be construed to reflect any variations which may occur between these borings or which may result from changes in subsurface conditions. Any changes in the design or location of any structure, as outlined in this report, should be reviewed by this office. The recommendations contained herein should not be considered valid until reviewed and modified or reaffirmed subsequent to such review.

Los Angeles County Code Sections 110 and 111

The following statement is made in regard to Los Angeles County Code Sections 110 and 111: It is the opinion of the undersigned based on the findings of this investigation that provided the recommendations presented in this report are followed, the proposed development will be safe for its intended use against hazard from landsliding, settlement or slippage. The proposed development will have no adverse effect on the stability of the site of adjoining properties.

2019 CALIFORNIA BUILDING CODE SEISMIC PARAMETERS

According to Table 20.3-1 presented in ASCE 7-16, the subject site is classified as Site Class F due to the liquefiable nature of the underlying soils. For Site Class F soils, ASCE 7-16 requires that a site-specific response spectrum evaluation be conducted. However, according to Section 20.3.1 of ASCE 7-16 (site class definition for Site Class F) the following exception is provided under Site Classification F:

EXCEPTION: *For structures having fundamental periods of vibration equal to or less than 0.5 s, site-response analysis is not required to determine spectral accelerations for liquefiable soils. Rather, a site class is permitted to be determined in accordance with Section 20.3 and the corresponding values of F_a and F_v determined from Tables 11.4-1 and 11.4-2.*

The soils underlying the subject site do not fall under any other characteristics of Site Class F, but fall within the characteristics of Site Class D. If the proposed buildings will have a fundamental period of vibration equal or less than 0.5 second, then the subject site may be classified as Site Class D, which corresponds to a “Stiff Soil” Profile in accordance with the

ASCE 7 standard, and the seismic parameters provided below apply. But if the structure will have a fundamental period of vibration of more than 0.5 second, the seismic parameters provided below are not applicable, and a site-specific response spectrum will have to be prepared. Please inform this office once the structural engineer has determined the period of vibration of the proposed buildings.

2019 CALIFORNIA BUILDING CODE SEISMIC PARAMETERS	
Site Class	D **(Limited to structures with a fundamental period of vibration equal or less than 0.5 second)**
Mapped Spectral Acceleration at Short Periods (S_S)	1.720g
Site Coefficient (F_a)	1.0
Maximum Considered Earthquake Spectral Response for Short Periods (S_{MS})	1.720g
Five-Percent Damped Design Spectral Response Acceleration at Short Periods (S_{DS})	1.147g
Mapped Spectral Acceleration at One-Second Period (S_1)	0.619g
Site Coefficient (F_v)	1.7
Maximum Considered Earthquake Spectral Response for One-Second Period (S_{M1})	1.052g
Five-Percent Damped Design Spectral Response Acceleration for One-Second Period (S_{D1})	0.701g

* *According to ASCE 7-16, a Long Period Site Coefficient (F_v) of 1.7 may be utilized provided that the value of the Seismic Response Coefficient (C_s) is determined by Equation 12.8-2 for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either Equation 12.8-3 for $T_L \geq T > 1.5T_s$ or equation 12.8-4 for $T > T_L$. Alternatively, a site-specific ground motion hazard analysis may be performed in accordance with ASCE 7-16 Section 21.1 and/or a ground motion hazard analysis in accordance with ASCE 7-16 Section 21.2 to determine ground motions for any structure.*

EXPANSIVE SOILS

The onsite geologic materials are in the low to high expansion range. The Expansion Index was found to be between 43 and 102 for representative bulk samples. Recommended reinforcing is provided in the “Foundation Design” and “Slab-On-Grade” sections of this report.

SOIL CORROSION POTENTIAL

The results of the soil corrosivity testing performed on ten samples representative of the onsite soils by Project X Corrosion Engineering indicate that the electrical resistivities of the soils are severely corrosive to general metals when saturated. The soil pH value of the samples was 8.2 and 9.2. The average pH level of the soils is alkaline, and can accelerated corrosion of copper and aluminum alloys. Chloride levels in most of the samples are low and may cause insignificant corrosion of metals, except for Sample B16 at 10 feet, which had extremely high levels of chloride. Ammonia and Nitrates concentrations were not high enough to cause accelerated corrosion of copper and copper alloys.

Sulfate levels at B16 and B20 at depths of 10 and 22 feet are severe for corrosion of metals and cement. Type V cement and coatings for metals should be used. The concrete should have a maximum water/cement ration of 0.45, and a minimum strength of 4,500 psi. The sulfate content of all other samples is negligible for corrosion of metals and cement.

Detailed results, discussion of results and recommended mitigating measures are provided within the enclosed Corrosion Evaluation Report prepared by Project X Corrosion Engineering, dated November 25, 2019.

DEWATERING

The existing fill materials extend below the existing groundwater level at some areas of the proposed townhome buildings. The removal and recompaction of the fill materials located below the current groundwater level may be performed with the aid of temporary dewatering. It is recommended that a qualified dewatering consultant be retained in order to determine if a formal temporary dewatering program will be required. The expected number and depths of well-points, expected flow rates, and expected pre-pumping time frames should be determined by the dewatering consultant.

GRADING GUIDELINES

Site Preparation

- A thorough search should be made for possible underground utilities and/or structures. Any existing or abandoned utilities or structures located within the footprint of the proposed grading should be removed or relocated as appropriate.

- All vegetation, existing fill, and soft or disturbed geologic materials should be removed from the areas to receive controlled fill. All existing fill materials and any disturbed geologic materials resulting from grading operations shall be completely removed and properly recompacted prior to foundation excavation.

- Any vegetation or associated root system located within the footprint of the proposed structures should be removed during grading.

- Subsequent to the indicated removals, the exposed grade shall be scarified to a depth of six inches, moistened to optimum moisture content, and recompacted in excess of the minimum required comparative density.

- The excavated areas shall be observed by the geotechnical engineer prior to placing compacted fill.

Recommended Overexcavation and Blending

In order to create a compacted fill pad, all fill materials and upper native soils shall be properly removed. The removals shall extend for a minimum depth of 10 feet below the bottom of the mat foundations. Removals shall extend deeper where deep fill materials are encountered. Based on the depth of fill observed during exploration, it is anticipated that the depth of the removal will range between 10 feet below the bottom of the mat and more than 35 feet below the existing grade. In addition, the proposed fill pad shall be overexcavated horizontally beyond the edge of foundations for a distance equal to the depth of fill below the foundations. Removal of fill materials below the groundwater level will not be required if the client elects to remediate this fill with the aid of ground improvements, as addressed in a following section.

Once the onsite soils have been removed, it is recommended that they should be well blended to reduce the overall expansion index and moisture content of the newly placed controlled fill.

Compaction

All fill should be mechanically compacted in layers not more than 8 inches thick. Based on the moderate to high expansion index of the site soils, it is recommended that fill materials are moisture conditioned to approximately 3 percent over optimum moisture content before recompaction. All fill shall be compacted to at least 90 percent of the maximum laboratory density for the materials used. The maximum density shall be determined by the laboratory operated by Geotechnologies, Inc. in general accordance with the most recent revision of ASTM D 1557.

Field observation and testing shall be performed by a representative of the geotechnical engineer during grading to assist the contractor in obtaining the required degree of compaction and the proper moisture content. Where compaction is less than required, additional compactive effort shall be made with adjustment of the moisture content, as necessary, until a minimum of 90 percent compaction is obtained.

Acceptable Materials

The excavated onsite materials are considered satisfactory for reuse in the controlled fills as long as any debris and/or organic matter is removed. Any imported materials shall be observed and tested by the representative of the geotechnical engineer prior to use in fill areas. Imported materials should contain sufficient fines so as to be relatively impermeable and result in a stable subgrade when compacted. Any required import materials should consist of geologic materials with an expansion index of less than 50. The water-soluble sulfate content of the import materials should be less than 0.1% percentage by weight.

Imported materials should be free from chemical or organic substances which could affect the proposed development. A competent professional should be retained in order to test imported materials and address environmental issues and organic substances which might affect the proposed development.

Utility Trench Backfill

Utility trenches should be backfilled with controlled fill. The utility should be bedded with clean sands at least one foot over the crown. The remainder of the backfill may be onsite soil compacted to 90 percent of the laboratory maximum density. Utility trench backfill should be tested by representatives of this firm in general accordance with the most recent revision of ASTM D 1557.

Wet Soils

At the time of exploration, the soils which will be exposed at the bottom of the excavation, as well as some of the soils to be used for the preparation of a compacted fill pad, were well above optimum moisture content. It is anticipated that the excavated material to be placed as compacted fill, and the materials exposed at the bottom of excavated plane will require significant drying and aeration prior to recompaction.

Pumping (yielding or vertical deflection) of the high-moisture content soils at the bottom of the excavation will likely occur during operation of heavy equipment. Where pumping is encountered, angular minimum ¾-inch gravel should be placed and worked into the subgrade. The exact thickness of the gravel would be a trial and error procedure, and would be determined in the field. It would likely be on the order of 1 to 2 feet thick.

The gravel will help to densify the subgrade as well as function as a stabilization material upon which heavy equipment may operate. It is not recommended that rubber tire construction equipment attempt to operate directly on the pumping subgrade soils prior to placing the gravel. Direct operation of rubber tire equipment on the soft subgrade soils will likely result in excessive disturbance to the soils, which in turn will result in a delay to the construction schedule since those disturbed soils would then have to be removed and properly recompacted. Extreme care should be utilized to place gravel as the subgrade becomes exposed.

The simplest method to reduce the moisture content of the on-site soils would involve spreading out the soils in order to dry them naturally while the weather is warm and sunny. As an alternative, dry soils could be imported and used for one of two purposes. The existing saturated soils could be replaced by the dry soils, or the dry soils could be blended with the onsite soils in order to reduce the overall moisture content.

The use of lime or cement is also an acceptable method of reducing moisture content in soils. Lime or cement should be added to the soils at a minimum rate of 5 percent by weight. The lime or cement shall be thoroughly mixed and blended with the soils to be treated. A uniform distribution of the lime or cement within the treated soil is critical. If lime or cement will be utilized for the drying of soils, it is recommended that the entire building subgrade is treated in order to achieve a uniform and stable subgrade; this recommendation is intended to prevent the effects of possible hard versus soft areas.

The entire mixing operation should be completed within 72 hours of the initial use of lime or cement. The treated soil should be compacted to a minimum relative compaction of 90 percent of the laboratory maximum density for the mixed material. Final compaction should be completed within 36 hours of final mixing.

Shrinkage

Shrinkage results when a volume of soil removed at one density is compacted to a higher density. A shrinkage factor between 10 and 20 percent should be anticipated when excavating and recompacting the existing fill and underlying native geologic materials on the site to an average comparative compaction of 92 percent.

Weather Related Grading Considerations

When rain is forecast all fill that has been spread and awaits compaction shall be properly compacted prior to stopping work for the day or prior to stopping due to inclement weather. These fills, once compacted, shall have the surface sloped to drain to an area where water can be removed.

Temporary drainage devices should be installed to collect and transfer excess water to the street in non-erosive drainage devices. Drainage should not be allowed to pond anywhere on the site, and especially not against any foundation or retaining wall. Drainage should not be allowed to flow uncontrolled over any descending slope.

Work may start again, after a period of rainfall, once the site has been reviewed by a representative of this office. Any soils saturated by the rain shall be removed and aerated so that the moisture content will fall within three percent of the optimum moisture content.

Surface materials previously compacted before the rain shall be scarified, brought to the proper moisture content and recompacted prior to placing additional fill, if considered necessary by a representative of this firm.

Abandoned Seepage Pits

No abandoned seepage pits were encountered during exploration and none are known to exist on the site. However, should such a structure be encountered during grading, options to permanently abandon seepage pits include complete removal and backfill of the excavation with compacted fill, or drilling out the loose materials and backfilling to within a few feet of grade with slurry, followed by a compacted fill cap.

If the subsurface structures are to be removed by grading, the entire structure should be demolished. The resulting void may be refilled with compacted soil. Concrete and brick generated during the seepage pit removal may be reused in the fill as long as all fragments are less than 6 inches in longest dimension and the debris comprises less than 15 percent of the fill by volume. All grading should comply with the recommendations of this report.

Where the seepage pit structure is to be left in place, the seepage pits should cleaned of all soil and debris. This may be accomplished by drilling. The pits should be filled with minimum 1-1/2 sack concrete slurry to within 5 feet of the bottom of the proposed foundations. In order to provide a more uniform foundation condition, the remainder of the void should be filled with controlled fill.

Geotechnical Observations and Testing During Grading

Geotechnical observations and testing during grading are considered to be a continuation of the geotechnical investigation. It is critical that the geotechnical aspects of the project be reviewed by representatives of Geotechnologies, Inc. during the construction process. Compliance with the design concepts, specifications or recommendations during construction requires review by this firm during the course of construction. Any fill which is placed should be observed, tested, and verified if used for engineered purposes. Please advise this office at least twenty-four hours prior to any required site visit.

Proper compaction is necessary to reduce settlement of overlying improvements. Some settlement of compacted fill should be anticipated. Any utilities supported therein should be designed to accept differential settlement. Differential settlement should also be considered at the points of entry to the structure.

LEED Considerations

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System encourages adoption of sustainable green building and development practices. Credit for LEED Certification can be assigned for reuse of construction waste and diversion of materials from landfills in new construction.

In an effort to provide the design team with a viable option in this regard, demolition debris could be crushed onsite in order to use it in the ongoing grading operations. The environmental ramifications of this option, if any, should be considered by the team.

The demolition debris should be limited to concrete, asphalt and other non-deleterious materials. All deleterious materials should be removed including, but not limited to, paper, garbage, ceramic materials and wood.

For structural fill applications, the materials should be crushed to 2 inches in maximum dimension or smaller. The crushed materials should be thoroughly blended and mixed with onsite soils prior to placement as compacted fill. The amount of crushed material should not exceed 20 percent. The blended and mixed materials should be tested by this office prior to placement to insure it is suitable for compaction purposes. The blended and mixed materials should be tested by Geotechnologies, Inc. during placement to insure that it has been compacted in a suitable manner.

GROUND IMPROVEMENT ALTERNATIVE FOR FILL BELOW GROUNDWATER

As mentioned before, it is anticipated that within some areas of the proposed townhome buildings the existing fill materials extend below the level where groundwater was observed. The excavation for the recommended removal and recompaction of these materials would require temporary dewatering.

As an alternative to dewatering for the complete removal and recompaction of the existing fill, the client has inquired about the possibility of employing ground improvement methods to remediate the fill located below the groundwater level. The use of ground improvement methods to remediate the fill located below the groundwater level is acceptable to this firm. The ground improvements may consist of stone columns extending through the fill to the top of the native alluvial soils. To install stone columns, a mechanical probe is utilized to advance into the ground by means of vibration to the design treatment depth. The mechanical probe is then lifted several feet, and gravel is fed into the resulting void at the tip of the probe, through a delivery tube attached to the probe. The vibrating probe is then advanced back into the deposited gravel, displacing it and compacting it. The probe is lifted and lowered repeatedly until a densified stone column is installed to the ground surface. Ground improvement is achieved by the formation of these stone columns within the ground and by densifying the soil adjacent to the stone columns. The stiffer stone column matrix also helps to redistribute the shear stresses in the soil.

The design of a stone column ground improvement system is also performed by a design-build contractor specializing and experienced with this mitigation method. The specialty contractor shall provide material requirements, preliminary spacing, and other design information.

It should be noted that at the location where the deepest fill was observed (Boring B15), a large piece of concrete encountered at a depth of 35 feet prevented the prosecution of this borehole. The potential for large pieces of construction debris will most likely have an impact on the ground improvement installation.

FOUNDATION DESIGN

Mat Foundation

Subsequent to the recommended grading, all the proposed structures may be supported on a mat foundation system bearing on the newly placed compacted fill pad.

For design purposes, an average bearing pressure of 2,000 pounds per square foot, with locally higher pressures up to 5,000 pounds per square foot may be utilized in the mat foundation design. The mat foundation may be designed utilizing a modulus of subgrade reaction of 250 pounds per cubic inch. This value is a unit value for use with a one-foot square footing. The modulus should be reduced in accordance with the following equation when used with larger foundations.

$$K = K_1 * [(B + 1) / (2 * B)]^2$$

where K = Reduced Subgrade Modulus
K_1 = Unit Subgrade Modulus
B = Foundation Width (feet)

The bearing values indicated above are for the total of dead and frequently applied live loads, and may be increased by one third for short duration loading, which includes the effects of wind or seismic forces. Since the recommended bearing value is a net value, the weight of concrete in the foundations may be taken as 50 pounds per cubic foot and the weight of the soil backfill may be neglected when determining the downward load on the foundations.

The allowable bearing values provided above, including the one third increase for short duration loading, were developed using a factor of safety of 3.0.

Miscellaneous Conventional Foundations

Foundations for small miscellaneous outlying structures, such as property line fence walls, planters, exterior canopies, and trash enclosures, which will not be tied-in to the proposed structure, may be supported on conventional foundations bearing in properly compacted fill and/or the native soils. Wall footings may be designed for a bearing value of 1,500 pounds per square foot, and should be a minimum of 12 inches in width, 24 inches in depth below the lowest adjacent grade and 24 inches into the recommended bearing material. No bearing value increases are recommended. The client should be aware that miscellaneous structures constructed in this manner may potentially be damaged and will require replacement should liquefaction occurs during a major seismic event.

Since the recommended bearing capacity is a net value, the weight of concrete in the foundations may be taken as 50 pounds per cubic foot and the weight of the soil backfill may be neglected when determining the downward load on the foundations. All continuous foundations should be reinforced with a minimum of four #4 steel bars. Two should be placed near the top of the foundation, and two should be placed near the bottom.

Lateral Design

Resistance to lateral loading may be provided by friction acting at the base of foundations and by passive earth pressure. An allowable coefficient of friction of 0.3 may be used with the dead load forces.

Passive geologic pressure for the sides of foundations poured against undisturbed or recompacted soil may be computed as an equivalent fluid having a density of 200 pounds per cubic foot with a maximum earth pressure of 2,000 pounds per square foot. The passive and friction components may be combined for lateral resistance without reduction. A one-third increase in the passive value may be used for short duration loading such as wind or seismic forces.

Foundation Settlement

Static settlement of a mat foundation is expected to occur on application of loading. The maximum static settlement is expected to occur within the center of the proposed structures. For Buildings A through D, the maximum static settlement is expected to be on the order of up to 1.2 inches. The static settlement along the edges of the mats is expected to be on the order of 0.6 inches. Therefore, the differential static settlement anticipated across the mats for Buildings A through D is not expected to exceed 0.6 inches.

For the proposed townhome buildings, the maximum static settlement is expected to be on the order of up to 0.75 inches. The static settlement along the edges of the mats is expected to be on the order of 0.375 inches. Therefore, the differential static settlement anticipated across the mats for the townhome buildings is not expected to exceed 0.375 inches.

In addition to static settlement, the maximum total seismic settlement due to a major seismic event is expected to be on the order of 2.27 inches, and the anticipated seismically induced differential settlement is anticipated to be on the order of 1.51 inches. The static and seismic settlement reported herein are additive.

Foundation Observations

It is critical that all foundation excavations are observed by a representative of this firm to verify penetration into the recommended bearing materials. The observation should be performed prior to the placement of reinforcement. Foundations should be deepened to extend into satisfactory geologic materials, if necessary. Foundation excavations should be cleaned of all loose soils prior to placing steel and concrete. Any required foundation backfill should be mechanically compacted, flooding is not permitted.

RETAINING WALL DESIGN

Miscellaneous Retaining Walls

Subterranean basements are not being proposed for the project, and all structures will be built at-grade. Retaining wall recommendations are provided herein to aid in the design of miscellaneous retaining walls, such as the ones required for elevator pits or planters. Foundations for these walls may be designed in accordance with the “Foundation Design” section above.

Additional active pressure should be added to the retaining wall design for any additional surcharge conditions, such as adjacent traffic and structures. For traffic surcharge, the upper 10 feet of any retaining wall adjacent to streets, driveways or parking areas should be designed to resist a uniform lateral pressure of 100 pounds per square foot, acting as a result of an assumed 300 pounds per square foot traffic surcharge. If the traffic is more than 10 feet from the retaining walls, the traffic surcharge may be neglected.

Retaining walls may be designed as cantilever, or restrained, based on the following table:

	RESTRAINED CONDITION (at-rest earth pressure)	**CANTILEVER CONDITION (active earth pressure)**
Height of Wall (Feet)	Triangular Distribution of Pressure (Pounds per Cubic Foot)	Triangular Distribution of Pressure (Pounds per Cubic Foot)
Up to 6 feet	74	45

Additional active pressure should be added for a surcharge condition due to sloping ground, vehicular traffic or adjacent structures.

Dynamic (Seismic) Earth Pressure

Based on the California Building Code, retaining walls exceeding 6 feet in height shall be designed to resist the additional earth pressure caused by seismic ground shaking. Miscellaneous retaining walls anticipated for the proposed project are not expected to exceed 6 feet in height. Therefore, the dynamic earth pressure may be omitted.

Retaining Wall Drainage

Retaining walls should be provided with a subdrain covered with a minimum of 12 inches of gravel, and a compacted fill blanket or other seal at the surface. The onsite geologic materials are acceptable for use as retaining wall backfill as long as they are compacted to a minimum of 90 percent of the maximum density as determined by the most recent revision of ASTM D 1557.

As an alternative to the standard perforated subdrain pipe and gravel drainage system, the use of gravel pockets and weepholes is an acceptable drainage method. Weepholes shall be a minimum of 2 inches in diameter, placed at 8 feet on center along the base of the wall. Gravel pockets shall be a minimum of 1 cubic foot in dimension and may consist of three-quarter inch to one-inch crushed rocks, wrapped in filter fabric. Subdrainage pipes should outlet to an acceptable location.

Certain types of subdrain pipe are not acceptable to the various municipal agencies, it is recommended that prior to purchasing subdrainage pipe, the type and brand is cleared with the proper municipal agencies.

The lateral earth pressures recommended above for retaining walls assume that a permanent drainage system will be installed so that external water pressure will not be developed against the walls. If a drainage system is not provided, the walls should be designed to resist an external hydrostatic pressure due to water in addition to the lateral earth pressure. In any event, it is recommended that retaining walls be waterproofed.

Sump Pump Design

The purpose of the recommended retaining wall backdrainage system is to relieve hydrostatic pressure. The potential miscellaneous retaining walls are not expected to exceed a depth of 6 feet. Therefore the only water which could affect the proposed retaining walls would be irrigation water and precipitation. Additionally, the proposed site grading is such that all drainage is directed to the street and the structure has been designed with adequate non-erosive drainage devices.

Based on these considerations the retaining wall backdrainage system is not expected to experience an appreciable flow of water, and in particular, no groundwater will affect it. However, for the purposes of design, a flow of 5 gallons per minute may be assumed.

Waterproofing

Moisture effecting retaining walls is one of the most common post construction complaints. Poorly applied or omitted waterproofing can lead to efflorescence or standing water inside the building. Efflorescence is a process in which a powdery substance is produced on the surface of the concrete by the evaporation of water. The white powder usually consists of soluble salts such as gypsum, calcite, or common salt. Efflorescence is common to retaining walls and does not affect their strength or integrity.

It is recommended that retaining walls be waterproofed. Waterproofing design and inspection of its installation is not the responsibility of the geotechnical engineer. A qualified waterproofing consultant should be retained in order to recommend a product or method which would provide protection to below grade walls.

Retaining Wall Backfill

Any required backfill should be mechanically compacted in layers not more than 8 inches thick, to at least 90 percent of the maximum density obtainable by the most recent revision of ASTM D 1557 method of compaction. Flooding should not be permitted. Compaction within 5 feet, measured horizontally, behind a retaining structure should be achieved by use of light weight, hand operated compaction equipment.

Proper compaction of the backfill will be necessary to reduce settlement of overlying walks and paving. Some settlement of required backfill should be anticipated, and any utilities supported therein should be designed to accept differential settlement.

TEMPORARY EXCAVATIONS

Excavations on the order of 12 to more than 35 feet in vertical height are anticipated for the recommended removal and recompaction of unsuitable soils. The excavations are expected to expose fill and native soils, which are suitable for vertical excavations up to 5 feet where not surcharged by adjacent traffic or structures. Excavations which will be surcharged by adjacent traffic or structures should be shored.

Where sufficient space is available, temporary unsurcharged embankments could be cut at a uniform 1:1 slope gradient, up to a maximum height of 30 feet, and at a 1½:1 (h:v) up to a maximum height of 40 feet. A uniform sloped excavation is sloped from bottom to top and does not have a vertical component.

Where sloped embankments are utilized, the tops of the slopes should be barricaded to prevent vehicles and storage loads near the top of slope within a horizontal distance equal to the depth of the excavation. If the temporary construction embankments are to be maintained during the rainy season, berms are strongly recommended along the tops of the slopes to prevent runoff water from entering the excavation and eroding the slope faces. Water should not be allowed to pond on top of the excavation nor to flow towards it.

Excavation Observations

It is critical that the soils exposed in the cut slopes are observed by a representative of Geotechnologies, Inc. during excavation so that modifications of the slopes can be made if variations in the geologic material conditions occur. Many building officials require that temporary excavations should be made during the continuous observations of the geotechnical engineering investigation.

SHORING DESIGN

The following shoring recommendations are provided for areas where space limitations prohibit the use of temporary embankments. The following information on the design and installation of the shoring is as complete as possible at this time. It is suggested that a review of the final shoring plans and specifications be made by this office prior to bidding or negotiating with a shoring contractor be made.

The recommended method of shoring consists of steel soldier piles, placed in drilled holes and backfilled with concrete. As discussed below vibrating methods may also be utilized. The soldier piles may be designed as cantilevers or laterally braced utilizing drilled tie-back anchors.

Soldier Piles – Drilled

Drilled cast-in-place soldier piles should be placed no closer than 2 diameters on center. The minimum diameter of the piles is 18 inches. Structural concrete should be used for the soldier piles below the excavation; lean-mix concrete may be employed above that level. As an alternative, lean-mix concrete may be used throughout the pile where the reinforcing consists of a wideflange section. The slurry must be of sufficient strength to impart the lateral bearing pressure developed by the wideflange section to the earth materials. For design purposes, an allowable passive value for the earth materials below the bottom plane of excavation may be assumed to be 500 pounds per square foot per foot. To develop the full lateral value, provisions should be implemented to assure firm contact between the soldier piles and the undisturbed earth materials.

The frictional resistance between the soldier piles and retained earth material may be used to resist the vertical component of the anchor load. The coefficient of friction may be taken as 0.3 based on uniform contact between the steel beam and lean-mix concrete and retained earth. The portion of soldier piles below the plane of excavation may also be employed to resist the downward loads. The downward capacity may be determined using a frictional resistance of 450 pounds per square foot. The minimum depth of embedment for shoring piles is 5 feet below the bottom of the footing excavation, or 7 feet below the bottom of excavated plane, whichever is deeper.

Groundwater was encountered during exploration at depths ranging between 23½ and 32½ feet below the existing site grade. Caving of the saturated earth materials below the groundwater level may occur during drilling of piles. Casing or polymer drilling fluid will most likely be required during drilling in order to maintain open shafts. If casing is used, extreme care should be employed so that the pile is not pulled apart as the casing is withdrawn. At no time should the distance between the surface of the concrete and the bottom of the casing be less than 5 feet.

Piles placed below the water level will require the use of a tremie to place the concrete into the bottom of the hole. A tremie shall consist of a water-tight tube having a diameter of not less than 10 inches with a hopper at the top. The tube shall be equipped with a device that will close the discharge end and prevent water from entering the tube while it is being charged with concrete. The tremie shall be supported so as to permit free movement of the discharge end over the entire top surface of the work and to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be closed at the start of the work to prevent water entering the tube and shall be entirely sealed at all times, except when the concrete is being placed. The tremie tube shall be kept full of concrete. The flow shall be continuous until the work is completed and the resulting concrete seal shall be monolithic and homogeneous. The tip of the tremie tube shall always be kept about five feet below the surface of the concrete and definite steps and safeguards should be taken to insure that the tip of the tremie tube is never raised above the surface of the concrete.

A special concrete mix should be used for concrete to be placed below water. The design shall provide for concrete with strength of 1,000 psi over the initial job specification. An admixture that reduces the problem of segregation of paste/aggregates and dilution of paste shall be included. The slump shall be commensurate to any research report for the admixture, provided that it shall also be the minimum for a reasonable consistency for placing when water is present.

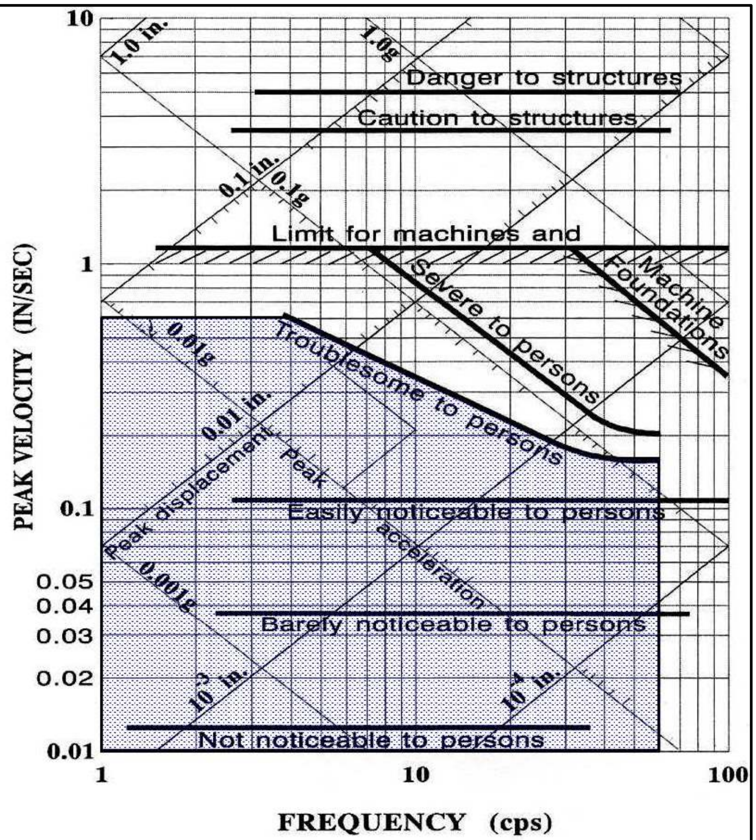
<u>Soldier Piles – Vibration Method of Installation</u>

The vibration method of shoring pile installation is acceptable to this firm from a geotechnical standpoint provided the recommendations presented herein are implemented. When using the vibration method of installing the soldier beams, the minimum embedment depth shall be 10 feet below the lowest excavated plane. The available passive resistance of the pile may be determined using the diagonal length from the outer edges of opposite flange sections.

Predrilling may be utilized by the shoring contractor in order to vibrate and install the shoring beams to the design depths. However, the depth of the predrilled holes should not exceed the planned excavation depth. In addition, it is recommended that the diameter of the predrilled holes does not exceed 75 percent of the depth of the web of the I-beam. When predrilling, the auger shall be backspun out of the pilot holes, leaving the soils in place. All shoring (predrilling, installation of shoring piles, and lagging) shall be performed under the continuous inspections by a deputy grading inspector of this firm.

The allowable level of vibration that results from the installation of the piles should not exceed a threshold where occupants of the nearby structures are disturbed, despite higher vibration tolerances that a building may endure without deformation. There is a relationship between particle velocity and vibration frequency that will occur due to the installation. A range of tolerable particle peak velocity and frequency of vibration is shown in the graph below. The shaded area on the graph is considered within acceptable limits to avoid damage to nearby structures. The acceptable limits should be measured at the neighboring structures.

The vibrations should be monitored with a seismograph during pile installation to detect the magnitude of vibration and oscillation experienced by the adjacent structure. The results should be recorded and provided to the owner. If, during installation, the vibrations exceed the range shown on the graph below, the shoring contractor should modify the installation procedure to reduce the values to the acceptable range.



Given Velocity = 0.2 inch/sec.
Frequency = 10 cps
Then from Graph, Displacement = 0.003 inches
Acceleration = 0.03g
Motion is easy noticeable or troublesome to persons

NOTE: Shaded area considered below threshold for structure damage

REFERENCE: Department of Defense, 1997, Soil Dynamics and Special Design Aspects, MIL-HDBK-1007/3

Lagging

Soldier piles and anchors should be designed for the full anticipated pressures. Due to the cohesionless nature of the underlying earth materials, lagging will be required throughout the entire depth of the excavation. Due to arching in the geologic materials, the pressure on the lagging will be less. It is recommended that the lagging should be designed for the full design pressure but be limited to a maximum of 400 pounds per square foot. It is recommended that a representative of this firm observe the installation of lagging to insure uniform support of the excavated embankment.

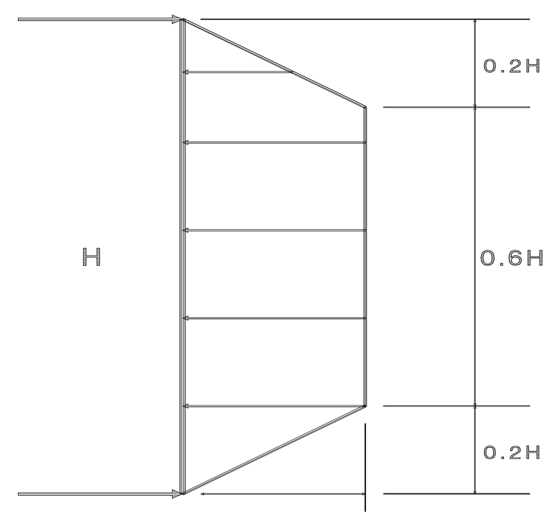
Lateral Pressures

A triangular distribution of lateral earth pressure should be utilized for the design of cantilevered shoring system. A trapezoidal distribution of lateral earth pressure would be appropriate where shoring is to be restrained at the top by bracing or tie backs. The design of trapezoidal distribution of pressure is shown in the diagram below. Equivalent fluid pressures for the design of cantilevered and restrained shoring are presented in the following table:

Height of Shoring (feet)	Cantilever Shoring System Equivalent Fluid Pressure (pcf) Triangular Distribution of Pressure	Restrained Shoring System Lateral Earth Pressure (psf)* Trapezoidal Distribution of Pressure
25	37 pcf	24H psf
30	40 pcf	26H psf
36	44 pcf	28H psf

*Where H is the height of the shoring in feet.

TRAPEZOIDAL DISTRIBUTION OF PRESSURE



Where a combination of sloped embankment and shoring is utilized, the pressure will be greater and must be determined for each combination. Additional active pressures should be applied where the shoring will be surcharged by adjacent traffic or structures.

Tied-Back Anchors

Tied-back anchors may be used to resist lateral loads. Friction anchors are recommended. For design purposes, it may be assumed that the active wedge adjacent to the shoring is defined by a plane drawn 35 degrees with the vertical through the bottom plane of the excavation. Friction anchors should extend a minimum of 20 feet beyond the potentially active wedge.

Drilled friction anchors may be designed for a skin friction of 400 pounds per square foot. Pressure grouted anchor may be designed for a skin friction of 2,000 pounds per square foot. Where belled anchors are utilized, the capacity of belled anchors may be designed by assuming the diameter of the bonded zone is equivalent to the diameter of the bell. Only the frictional resistance developed beyond the active wedge would be effective in resisting lateral loads.

It is recommended that at least 3 of the initial anchors have their capacities tested to 200 percent of their design capacities for a 24-hour period to verify their design capacity. The total deflection during this test should not exceed 12 inches. The anchor deflection should not exceed 0.75 inches during the 24 hour period, measured after the 200 percent load has been applied.

All anchors should be tested to at least 150 percent of design load. The total deflection during this test should not exceed 12 inches. The rate of creep under the 150 percent test load should not exceed 0.1 inch over a 15 minute period in order for the anchor to be approved for the design loading.

After a satisfactory test, each anchor should be locked-off at the design load. This should be verified by rechecking the load in the anchor. The load should be within 10 percent of the design load. Where satisfactory tests are not attained, the anchor diameter and/or length should be increased or additional anchors installed until satisfactory test results are obtained. The installation and testing of the anchors should be observed by the geotechnical engineer. Minor caving during drilling of the anchors should be anticipated.

Anchor Installation

Tied-back anchors may be installed between 20 and 45 degrees below the horizontal. Caving of the anchor shafts, particularly within sand deposits, should be anticipated and the following provisions should be implemented in order to minimize such caving. The anchor shafts should be filled with concrete by pumping from the tip out, and the concrete should extend from the tip of the anchor to the active wedge. In order to minimize the chances of caving, it is recommended that the portion of the anchor shaft within the active wedge be backfilled with sand before testing the anchor. This portion of the shaft should be filled tightly and flush with the face of the excavation. The sand backfill should be placed by pumping; the sand may contain a small amount of cement to facilitate pumping.

Deflection

It is difficult to accurately predict the amount of deflection of a shored embankment. It should be realized that some deflection will occur. It is estimated that the deflection could be on the order of one inch at the top of the shored embankment. If greater deflection occurs during construction, additional bracing may be necessary to minimize settlement of adjacent buildings and utilities in adjacent street and alleys. If desired to reduce the deflection, a greater active pressure could be used in the shoring design. Where internal bracing is used, the rakers should be tightly wedged to minimize deflection. The proper installation of the raker braces and the wedging will be critical to the performance of the shoring.

It is recommended limiting shoring deflection to ½ inch at the top of the shored embankment where a structure is within a 1:1 (h:v) plane projected up from the base of the excavation. A maximum deflection of 1-inch has been allowed provided there are no structures within a 1:1 (h:v) plane drawn upward from the base of the excavation.

Monitoring

Because of the depth of the excavation, some mean of monitoring the performance of the shoring system is suggested. The monitoring should consist of periodic surveying of the lateral and vertical locations of the tops of all soldier piles and the lateral movement along the entire lengths of selected soldier piles. Also, some means of periodically checking the load on selected anchors will be necessary, where applicable.

Some movement of the shored embankments should be anticipated as a result of the relatively deep excavation. It is recommended that photographs of the existing buildings on the adjacent properties be made during construction to record any movements for use in the event of a dispute.

Shoring Observations

It is critical that the installation of shoring is observed by a representative of Geotechnologies, Inc. Many building officials require that shoring installation should be performed during continuous observation of a representative of the geotechnical engineer. The observations insure that the recommendations of the geotechnical report are implemented and so that modifications of the recommendations can be made if variations in the geologic material or groundwater conditions warrant. The observations will allow for a report to be prepared on the installation of shoring for the use of the local building official, where necessary.

SLABS ON GRADE

Outdoor Concrete Slabs

Outdoor concrete flatwork should be a minimum of 4 inches in thickness. Outdoor concrete flatwork should be cast over undisturbed alluvial soils or properly controlled fill materials. Any geologic materials loosened or over-excavated should be wasted from the site or properly compacted to 90 percent of the maximum dry density. Outdoor flatwork should be reinforced with a minimum of #3 steel bars on 18-inch centers each way.

Design of Slabs That Receive Moisture-Sensitive Floor Coverings

Geotechnologies, Inc. does not practice in the field of moisture vapor transmission evaluation and mitigation. Therefore, it is recommended that a qualified consultant be engaged to evaluate the general and specific moisture vapor transmission paths and any impact on the proposed construction. The qualified consultant should provide recommendations for mitigation of potential adverse impacts of moisture vapor transmission on various components of the structure.

Concrete Crack Control

The recommendations presented in this report are intended to reduce the potential for cracking of concrete slabs due to settlement. However, even where these recommendations have been implemented concrete slabs may display some cracking due to minor soil movement and/or concrete shrinkage. The occurrence of concrete cracking may be reduced and/or controlled by limiting the slump of the concrete used, proper concrete placement and curing, and by placement of crack control joints at reasonable intervals.

For standard control of concrete cracking, a maximum crack control joint spacing of 10 feet should not be exceeded. Lesser spacings would provide greater crack control. Joints at curves and angle points are recommended. The crack control joints should be installed as soon as practical following concrete placement. Crack control joints should extend a minimum depth of one-fourth the slab thickness. Construction joints should be designed by a structural engineer.

Complete removal of the existing fill soils beneath outdoor flatwork such as walkways or patio areas, is not required. However, due to the rigid nature of concrete, some cracking, a shorter design life and increased maintenance costs should be anticipated. In order to provide uniform support beneath the flatwork it is recommended that a minimum of 12 inches of the exposed subgrade beneath the flatwork be scarified and recompacted to 90 percent relative compaction.

PAVEMENTS

Prior to placing paving, the existing grade should be scarified to a depth of 12 inches, moistened as required to obtain optimum moisture content, and recompacted to 90 percent relative compaction, as determined by the most recent revision of ASTM D 1557. The client should be aware that removal of all existing fill in the area of new paving is not required, however, pavement constructed in this manner will most likely have a shorter design life and increased maintenance costs. The following pavement sections are recommended:

Service	Asphalt Pavement Thickness Inches	Base Course Inches
Passenger Car Traffic	3	6
Moderate Truck Traffic	4	8
Heavy Truck Traffic	5	10

Concrete paving may also be used on the project. For passenger cars and moderate truck traffic, concrete paving should be 6 inches of concrete over 4 inches of compacted base. For heavy truck traffic, concrete paving should be 7 inches of concrete over 4 inches of compacted base. For standard crack control maximum expansion joint spacing of 10 feet should not be exceeded. Lesser spacings would provide greater crack control. Joints at curves and angle points are recommended. Concrete paving should be reinforced with a minimum of #3 steel bars on 18-inch centers each way.

Aggregate base should be compacted to a minimum of 95 percent of the most recent revision of ASTM D 1557 laboratory maximum dry density. Base materials should conform to Sections 200-2.2 or 200-2.4 of the "Standard Specifications for Public Works Construction", (Green Book), latest edition.

The performance of pavement is highly dependent upon providing positive surface drainage away from the edges. Ponding of water on or adjacent to pavement can result in saturation of the subgrade materials and subsequent pavement distress. If planter islands are planned, the perimeter curb should extend a minimum of 12 inches below the bottom of the aggregate base.

SITE DRAINAGE

Proper surface drainage is critical to the future performance of the project. Saturation of a soil can cause it to lose internal shear strength and increase its compressibility, resulting in a change in the designed engineering properties. Proper site drainage should be maintained at all times.

All site drainage, with the exception of any required to disposed of onsite by stormwater regulations, should be collected and transferred to the street in non-erosive drainage devices. The proposed structure should be provided with roof drainage. Discharge from downspouts, roof drains and scuppers should not be permitted on unprotected soils within five feet of the building perimeter. Drainage should not be allowed to pond anywhere on the site, and especially not against any foundation or retaining wall. Drainage should not be allowed to flow uncontrolled over any descending slope. Planters which are located within a distance equal to the depth of a retaining wall should be sealed to prevent moisture adversely affecting the wall. Planters which are located within five feet of a foundation should be sealed to prevent moisture affecting the earth materials supporting the foundation.

STORMWATER DISPOSAL

Recently regulatory agencies have been requiring the disposal of a certain amount of stormwater generated on a site by infiltration into the site soils. Increasing the moisture content of a soil can cause it to lose internal shear strength and increase its compressibility, resulting in a change in the designed engineering properties. This means that any overlying structure, including buildings, pavements and concrete flatwork, could sustain damage due to saturation of the subgrade soils. Structures serviced by subterranean levels could be adversely impacted by stormwater disposal by increasing the design fluid pressures on retaining walls and causing leaks in the walls. Proper site drainage is critical to the performance of any structure in the built environment.

This firm performed several percolation tests within the on-site native soils. The results obtained were well below the minimum infiltration rate of 0.3 inches per hour recommended by the County of Los Angeles. In addition, the site soils are susceptible to liquefaction hazards, and relatively shallow groundwater was encountered at the site. Based on the above considerations, it is the opinion of this firm that onsite stormwater infiltration is not suitable for the site.

Where infiltration of stormwater into the subgrade soils is not advisable, most Building Officials have allowed the stormwater to be filtered through soils in planter areas. Once the water has been filtered through a planter it may be released into the storm drain system. It is recommended that overflow pipes are incorporated into the design of the discharge system in the planters to prevent flooding. In addition, the planters shall be sealed and waterproofed to prevent leakage. Please be advised that adverse impact to landscaping and periodic maintenance may result due to excessive water and contaminants discharged into the planters.

It is recommended that the design team (including the structural engineer, waterproofing consultant, plumbing engineer, and landscape architect) be consulted in regards to the design and construction of filtration systems.

DESIGN REVIEW

Engineering of the proposed project should not begin until approval of the geotechnical report by the Building Official is obtained in writing. Significant changes in the geotechnical recommendations may result during the building department review process.

It is recommended that the geotechnical aspects of the project be reviewed by this firm during the design process. This review provides assistance to the design team by providing specific recommendations for particular cases, as well as review of the proposed construction to evaluate whether the intent of the recommendations presented herein are satisfied.

CONSTRUCTION MONITORING

Geotechnical observations and testing during construction are considered to be a continuation of the geotechnical investigation. It is critical that this firm review the geotechnical aspects of the project during the construction process. Compliance with the design concepts, specifications or recommendations during construction requires review by this firm during the course of construction. All foundations should be observed by a representative of this firm prior to placing concrete or steel. Any fill which is placed should be observed, tested, and verified if used for engineered purposes. Please advise Geotechnologies, Inc. at least twenty-four hours prior to any required site visit.

If conditions encountered during construction appear to differ from those disclosed herein, notify Geotechnologies, Inc. immediately so the need for modifications may be considered in a timely manner.

It is the responsibility of the contractor to ensure that all excavations and trenches are properly sloped or shored. All temporary excavations should be cut and maintained in accordance with applicable OSHA rules and regulations.

EXCAVATION CHARACTERISTICS

The exploration performed for this investigation is limited to the geotechnical excavations described. Direct exploration of the entire site would not be economically feasible. The owner, design team and contractor must understand that differing excavation and drilling conditions may be encountered based on boulders, gravel, oversize materials, groundwater and many other conditions. Fill materials, especially when they were placed without benefit of modern grading codes, regularly contain materials which could impede efficient grading and drilling. Southern California sedimentary bedrock is known to contain variable layers which reflect differences in depositional environment. Such layers may include abundant gravel, cobbles and boulders. Similarly bedrock can contain concretions. Concretions are typically lenticular and follow the bedding. They are formed by mineral deposits. Concretions can be very hard. Excavation and drilling in these areas may require full size equipment and coring capability. The contractor should be familiar with the site and the geologic materials in the vicinity.

CLOSURE AND LIMITATIONS

The purpose of this report is to aid in the design and completion of the described project. Implementation of the advice presented in this report is intended to reduce certain risks associated with construction projects. The professional opinions and geotechnical advice contained in this report are sought because of special skill in engineering and geology and were prepared in accordance with generally accepted geotechnical engineering practice. Geotechnologies, Inc. has a duty to exercise the ordinary skill and competence of members of the engineering profession. Those who hire Geotechnologies, Inc. are not justified in expecting infallibility, but can expect reasonable professional care and competence.

The recommendations of this report pertain only to the site investigated and are based upon the assumption that the geologic conditions do not deviate from those disclosed in the investigation. If any variations are encountered during construction, or if the proposed construction will differ from that anticipated herein, Geotechnologies, Inc. should be notified so that supplemental recommendations can be prepared.

This report is issued with the understanding that it is the responsibility of the owner, or the owner's representatives, to ensure that the information and recommendations contained herein are brought to the attention of the project architect and engineer and are incorporated into the plans. The owner is also responsible to see that the contractor and subcontractors carry out the geotechnical recommendations during construction.

The findings of this report are valid as of the date of this report. However, changes in the conditions of a property can occur with the passage of time, whether they are due to natural processes or the works of man on this or adjacent properties. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside control of this firm. Therefore, this report is subject to review and should not be relied upon after a period of three years.

Geotechnical observations and testing during construction is considered to be a continuation of the geotechnical investigation. It is, therefore, most prudent to employ the consultant performing the initial investigative work to provide observation and testing services during construction. This practice enables the project to flow smoothly from the planning stages through to completion.

Should another geotechnical firm be selected to provide the testing and observation services during construction, that firm should prepare a letter indicating their assumption of the responsibilities of geotechnical engineer of record. A copy of the letter should be provided to the regulatory agency for review. The letter should acknowledge the concurrence of the new geotechnical engineer with the recommendations presented in this report.

EXCLUSIONS

Geotechnologies, Inc. does not practice in the fields of methane gas, radon gas, environmental engineering, waterproofing, dewatering organic substances or the presence of corrosive soils or wetlands which could affect the proposed development including mold and toxic mold. Nothing in this report is intended to address these issues and/or their potential effect on the proposed development. A competent professional consultant should be retained in order to address environmental issues, waterproofing, organic substances and wetlands which might effect the proposed development.

GEOTECHNICAL TESTING

Classification and Sampling

The soil is continuously logged by a representative of this firm and classified by visual examination in accordance with the Unified Soil Classification system. The field classification is verified in the laboratory, also in accordance with the Unified Soil Classification System. Laboratory classification may include visual examination, Atterberg Limit Tests and grain size distribution. The final classification is shown on the excavation logs.

Samples of the geologic materials encountered in the exploratory excavations were collected and transported to the laboratory. Undisturbed samples of soil are obtained at frequent intervals. Unless noted on the excavation logs as an SPT sample, samples acquired while utilizing a hollow-stem auger drill rig are obtained by driving a thin-walled, California Modified Sampler with successive 30-inch drops of a 140-pound hammer. The soil is retained in brass rings of 2.50 inches outside diameter and 1.00 inch in height. The central portion of the samples are stored in close fitting, waterproof containers for transportation to the laboratory. Samples noted on the excavation logs as SPT samples are obtained in general accordance with the most recent revision of ASTM D 1586. Samples are retained for 30 days after the date of the geotechnical report.

Moisture and Density Relationships

The field moisture content and dry unit weight are determined for each of the undisturbed soil samples, and the moisture content is determined for SPT samples in general accordance with the most recent revision of ASTM D 4959 or ASTM D 4643. This information is useful in providing a gross picture of the soil consistency between exploration locations and any local variations. The dry unit weight is determined in pounds per cubic foot and shown on the "Excavation Logs", A-Plates. The field moisture content is determined as a percentage of the dry unit weight.

Direct Shear Testing

Shear tests are performed in general accordance with the most recent revision of ASTM D 3080 with a strain controlled, direct shear machine manufactured by Soil Test, Inc. or a Direct Shear Apparatus manufactured by GeoMatic, Inc. The rate of deformation ranges between approximately 0.005 and 0.025 inches per minute. Each sample is sheared under varying confining pressures in order to determine the Mohr-Coulomb shear strength parameters of the cohesion intercept and the angle of internal friction. Samples are generally tested in an artificially saturated condition. Depending upon the sample location and future site conditions, samples may be tested at field moisture content. The results are plotted on the "Shear Test Diagram," B-Plates.

The most recent revision of ASTM 3080 limits the particle size to 10 percent of the diameter of the direct shear test specimen. The sheared sample is inspected by the laboratory technician running the test. The inspection is performed by splitting the sample along the sheared plane and observing the soils exposed on both sides. Where oversize particles are observed in the shear plane, the results are discarded and the test run again with a fresh sample.

Consolidation Testing

Settlement predictions of the soil's behavior under load are made on the basis of the consolidation tests in general accordance with the most recent revision of ASTM D 2435. The consolidation apparatus is designed to receive a single one-inch high ring. Loads are applied in several increments in a geometric progression, and the resulting deformations are recorded at selected time intervals. Porous stones are placed in contact with the top and bottom of each specimen to permit addition and release of pore fluid. Samples are generally tested at increased moisture content to determine the effects of water on the bearing soil. The normal pressure at which the water is added is noted on the drawing. Results are plotted on the "Consolidation Test," C-Plates.

Expansion Index Testing

The expansion tests performed on the remolded samples are in accordance with the Expansion Index testing procedures, as described in the most recent revision of ASTM D 4829. The soil sample is compacted into a metal ring at a saturation degree of 50 percent. The ring sample is then placed in a consolidometer, under a vertical confining pressure of 1 lbf/square inch and inundated with distilled water. The deformation of the specimen is recorded for a period of 24 hour or until the rate of deformation becomes less than 0.0002 inches/hour, whichever occurs first. The expansion index, EI, is determined by dividing the difference between final and initial height of the ring sample by the initial height, and multiplied by 1,000. Results are presented in Plate D of this report.

Laboratory Compaction Characteristics

The maximum dry unit weight and optimum moisture content of a soil are determined in general accordance with the most recent revision of ASTM D 1557. A soil at a selected moisture content is placed in five layers into a mold of given dimensions, with each layer compacted by 25 blows of a 10 pound hammer dropped from a distance of 18 inches subjecting the soil to a total compactive effort of about 56,000 pounds per cubic foot. The resulting dry unit weight is determined. The procedure is repeated for a sufficient number of moisture contents to establish a relationship between the dry unit weight and the water content of the soil. The data when plotted represent a curvilinear relationship known as the compaction curve. The values of optimum moisture content and modified maximum dry unit weight are determined from the compaction curve. Results are presented in Plate D of this report.

Grain Size Distribution

These tests cover the quantitative determination of the distribution of particle sizes in soils. Sieve analysis is used to determine the grain size distribution of the soil larger than the Number 200 sieve. The most recent revision of ASTM D 422 is used to determine particle sizes smaller than the Number 200 sieve. A hydrometer is used to determine the distribution of particle sizes by a sedimentation process. The grain size distributions are plotted on the E-Plates presented in the Appendix of this report.

Atterberg Limits

Depending on their moisture content, cohesive soils can be solid, plastic, or liquid. The water contents corresponding to the transitions from solid to plastic or plastic to liquid are known as the Atterberg Limits. The transitions are called the plastic limit and liquid limit. The difference between the liquid and plastic limits is known as the plasticity index. ASTM D 4318 is utilized to determine the Atterberg Limits. The results are shown on the enclosed F-Plates.

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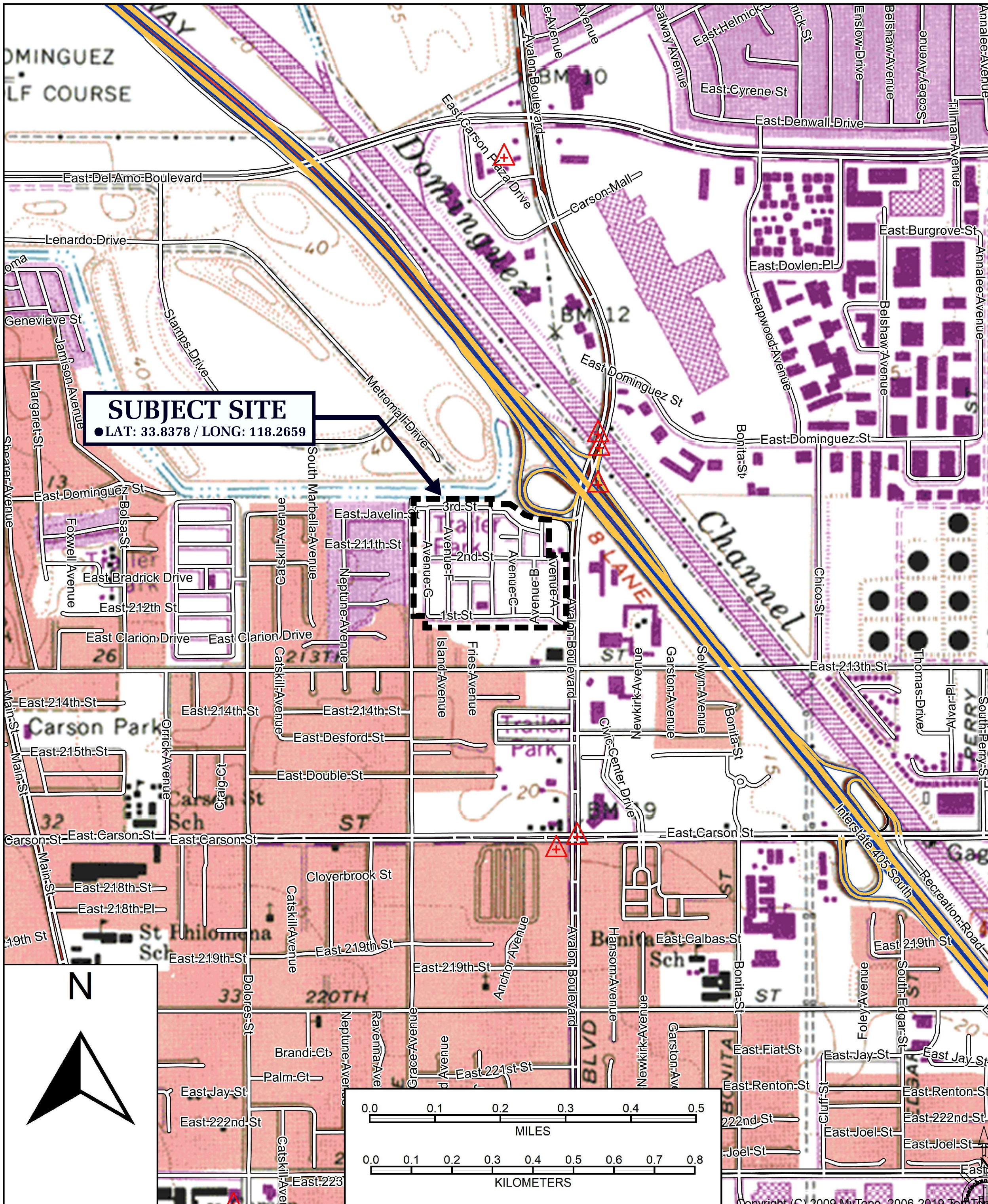

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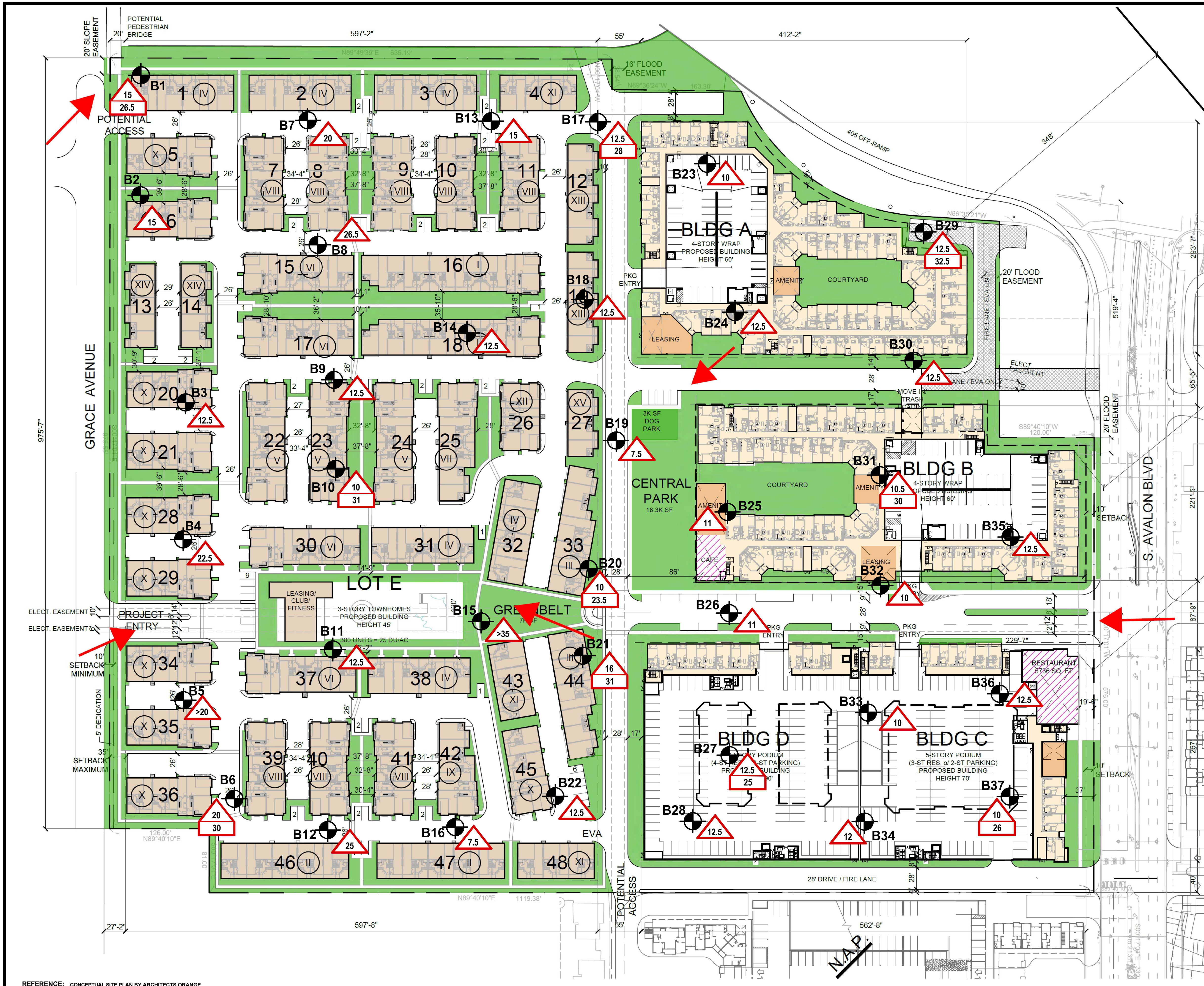
TORRANCE, CA QUADRANGLE

VICINITY MAP

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING

FILE NO. 21850



LEGEND

B37 — LOCATION & NUMBER OF BORING

35 / 23.5 — DEPTH OF FILL ENCOUNTERED IN BORING (IN FEET); GROUNDWATER DEPTH OBSERVED IN BORING (IN FEET)

PLOT PLAN

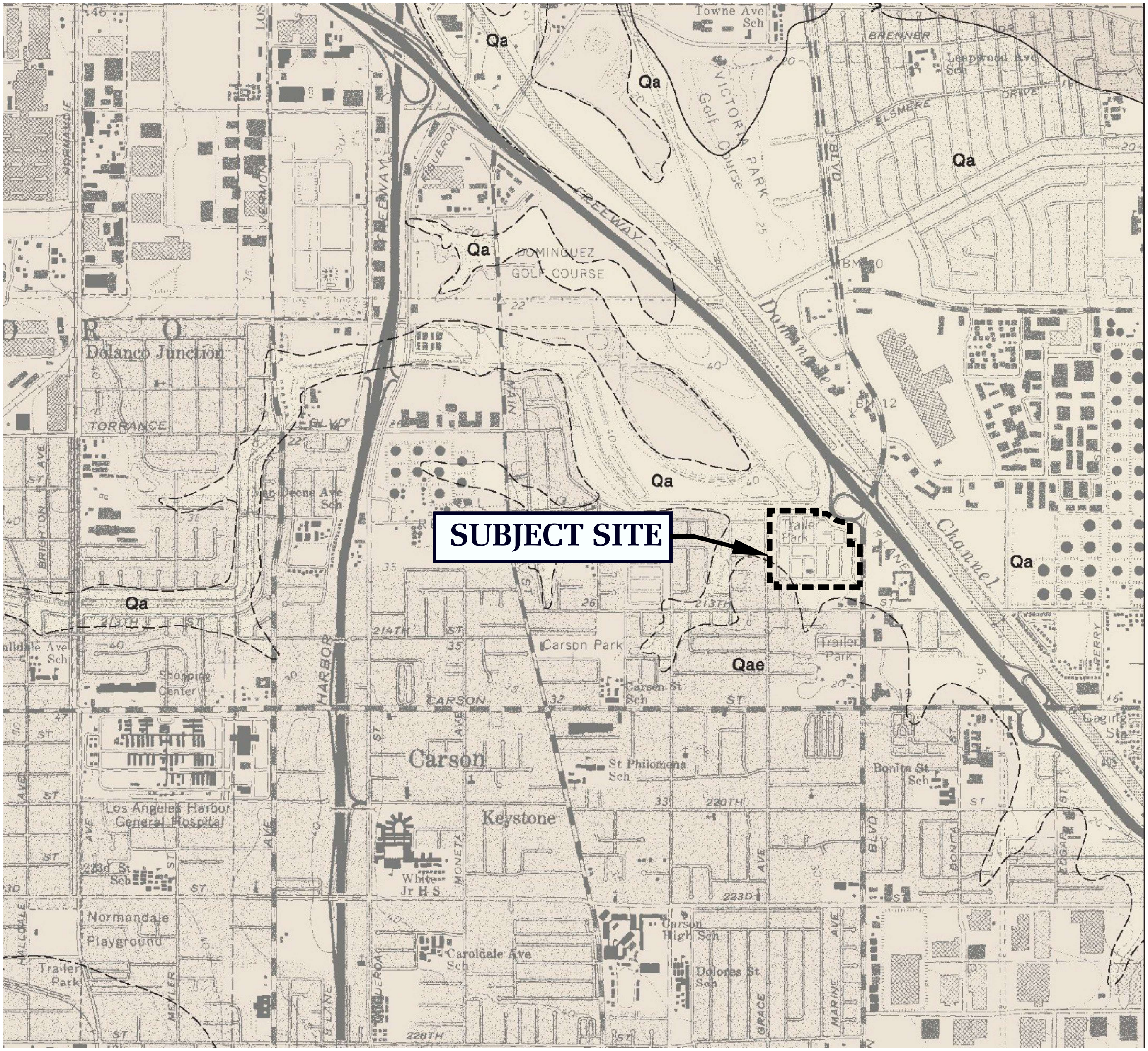
Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING

FILE No. 21850

DATE: January 2021

REFERENCE: CONCEPTUAL SITE PLAN BY ARCHITECTS ORANGE DATED NOVEMBER 20, 2020



LEGEND

Qa *Alluvium, mostly loamy clay of valley and flood plains; includes fine sand near Palos Verdes Hills*

Qae *Alluvium, similar to* **Qa** *but slightly elevated and locally dissected*

REFERENCE: DIBBLEE, T.W., (1999), GEOLOGIC MAP OF THE PALOS VERDES PENINSULA AND VICINITY, MAP #DF-70

LOCAL GEOLOGIC MAP

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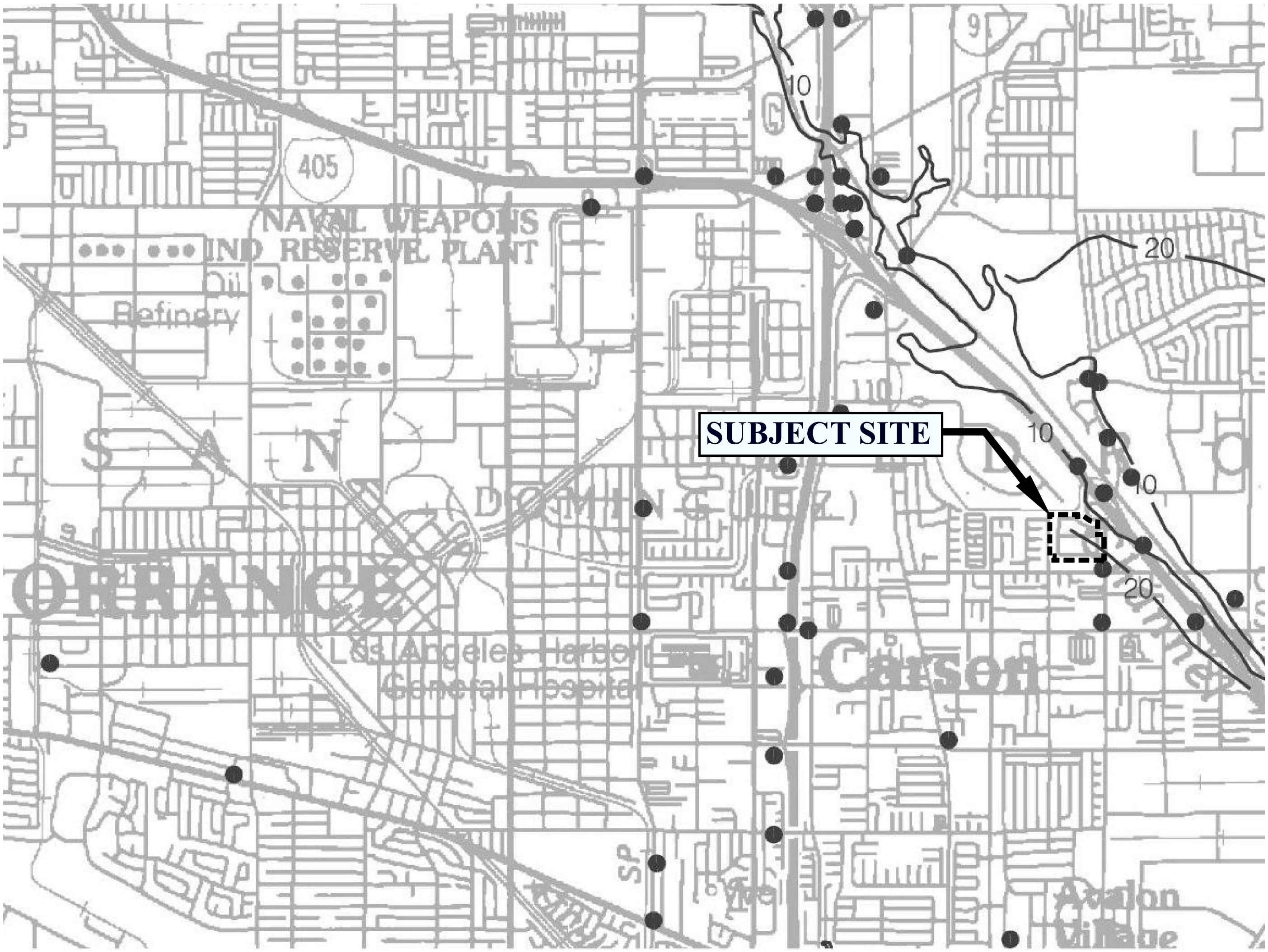
Consulting Geotechnical Engineers

FARING

FILE NO. 21850



ONE MILE

SCALE

20 *Depth to groundwater in feet*

REFERENCE: **PLATE 1.2, GROUNDWATER MAP, SEISMIC HAZARD EVALUATION REPORT, OFR 98-26**
7.5 MINUTE QUADRANGLES, TORRANCE, CA QUADRANGLE

HISTORICALLY HIGHEST GROUNDWATER LEVELS

Geotechnologies, Inc.
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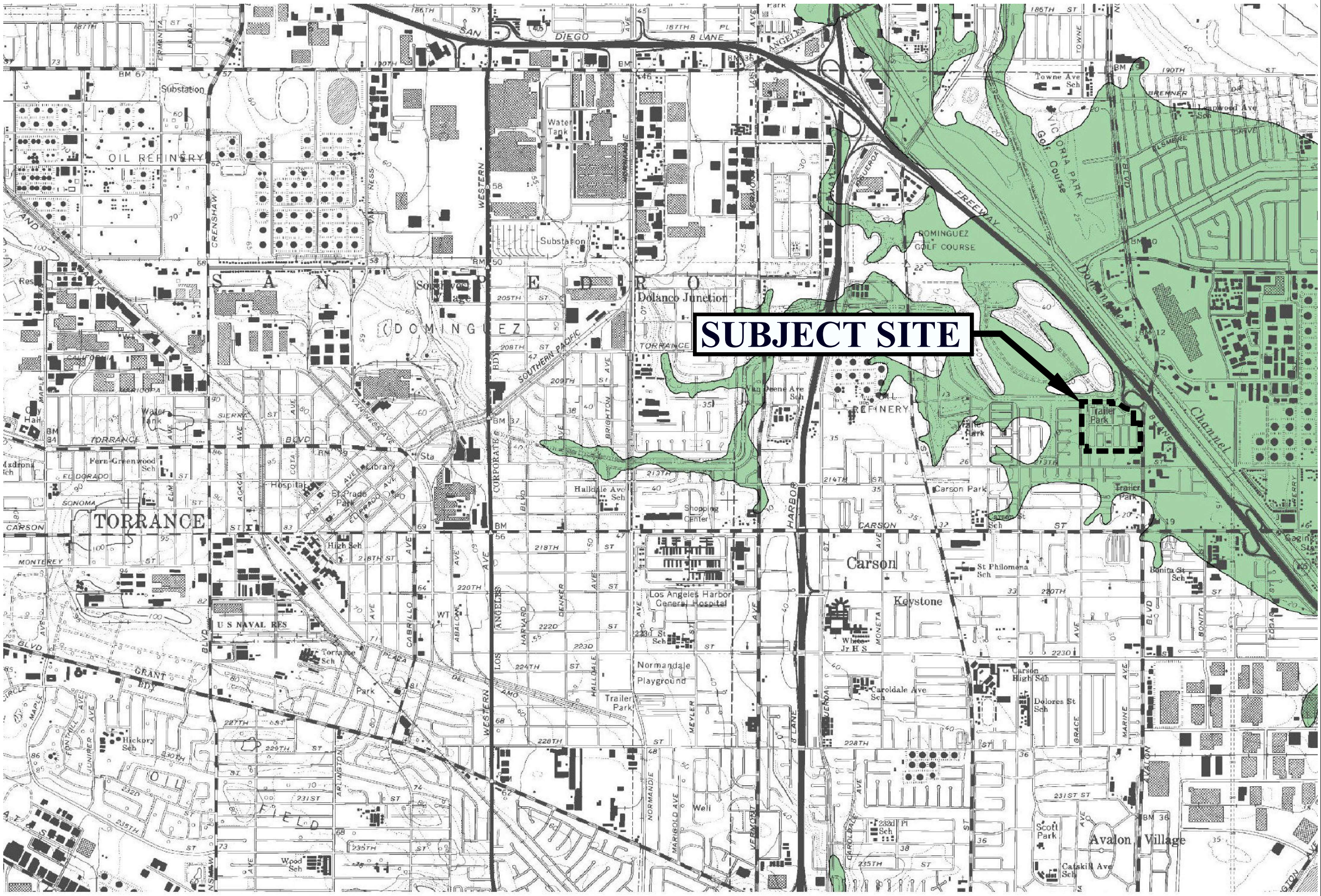
FARING

FILE No. 21850



SCALE 1:24,000

1 .5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

LIQUEFACTION AREA

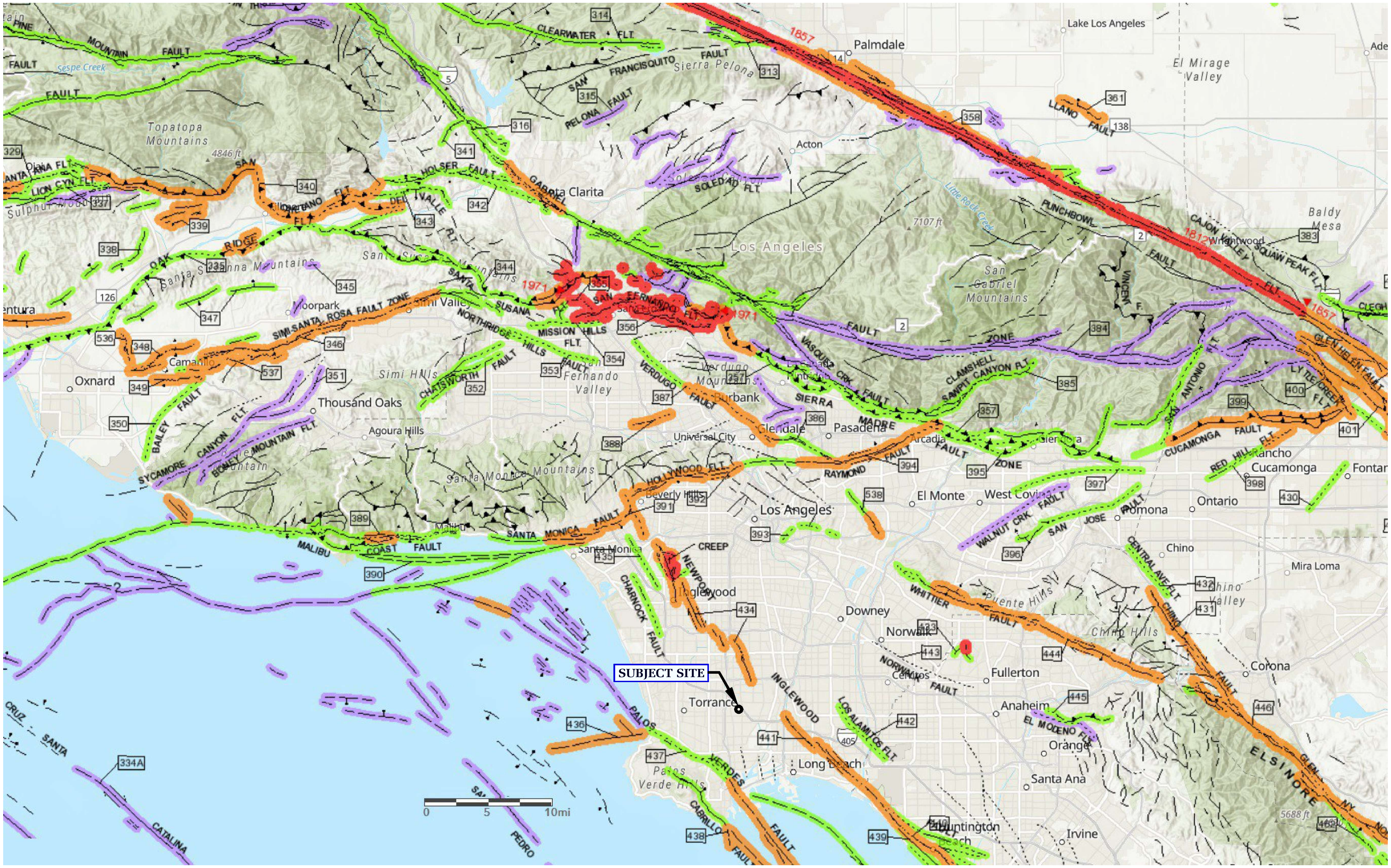
REFERENCE: SEISMIC HAZARD ZONE MAP, TORRANCE QUADRANGLE, 1997, DIVISION OF MINES AND GEOLOGY

SEISMIC HAZARD ZONE MAP

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING

FILE NO. 21850



REGIONAL FAULT LOCATION MAP

FARING

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FILE No. 21850

REFERENCE: California Department of Conservation, 2010 Fault Activity Map

BORING LOG NUMBER 1

Faring | **Date: 09/25/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

sm/km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Parking
				0 --		5-inch Asphalt, No Base
				-		
				1 --		FILL: Sandy Silt, dark brown, moist, stiff
				-		
				2 --		
2.5	64	21.7	107.7	-		
				3 --		
				-		Silty Sand, dark and yellowish brown, dense, fine grained
				4 --		
				-		
5	12	20.2	SPT	5 --		
				-		Silty Sand to Sandy Silt, dark and gray, medium dense, stiff
				6 --		
				-		
				7 --		
7.5	60	19.5	111.2	-		
				8 --		Clayey Silt to Silty Clay, yellowish brown to dark gray, stiff, minor brick fragments
				-		
				9 --		
				-		
10	16	17.8	SPT	10 --		
				-		gray to dark gray, minor asphalt and wood fragments
				11 --		
				-		
				12 --		
12.5	35	8.9	116.1	-		
				13 --		Sandy Silt to Clayey, dark brown and gray, some asphalt fragments
				-		
				14 --		
				-		
15	11	38.1	SPT	15 --		
				-	CL	NATIVE SOILS: Silty Clay, gray, moist, stiff
				16 --		
				-		
				17 --		
17.5	22	40.3	76.1	-		
				18 --		
				-		
				19 --		
				-		
20	8	41.9	SPT	20 --		
				-		
				21 --		
				-		
				22 --		
22.5	13	39.5	77.9	-		
				23 --		
				-		
				24 --		
				-		
25	8	34.3	SPT	25 --		
				-		wet

BORING LOG NUMBER 1

Faring

File No. 21850

sm/km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				26 --		
				-		
				27 --		
27.5	25	41.3	83.0	-		
				28 --		
				-		
				29 --		
				-		
30	10	41.6	SPT	30 --		
				-		
				31 --		
				-		
				32 --		
32.5	24	39.7	80.6	-		
				33 --		
				-		
				34 --		
				-		
35	9	45.2	SPT	35 --		
				-		
				36 --		
				-		
				37 --		
37.5	21	44.7	78.8	-		
				38 --		
				-		
				39 --		
				-		
40	12	43.8	SPT	40 --		
				-		
				41 --		
				-		
				42 --		
42.5	25	45.9	69.7	-		
				43 --		few shell fragments
				-		
				44 --		
				-		
45	10	47.5	SPT	45 --		
				-		
				46 --		
				-		
				47 --		
47.5	23	35.5	87.2	-		
				48 --		
				-		
				49 --		
				-		
50	15	32.4	SPT	50 --		
				-		

BORING LOG NUMBER 1

Faring

File No. 21850

sm/km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				51 --		
				-		
				52 --		
52.5	49	21.8	107.5	-		
				53 --	CL	Silty Clay, dark gray, moist, stiff
				-		
				54 --		
				-		
55	14	22.8	SPT	55 --		
				-		
				56 --		
				-		
				57 --		
57.5	72	21.6	107.5	-		
				58 --		
				-		
				59 --		
				-		
60	37	21.2	SPT	60 --		
				-	SM/ML	Silty Sand to Clayey Silt, dark and grayish brown, moist, medium dense, stiff, fine grained
				61 --		
				-		
				62 --		
62.5	61	18.7	115.3	-		
				63 --	SM/SP	Silty Sand to Sand, gray, wet, dense, fine to medium grained
				-		
				64 --		
				-		
65	39	27.7	SPT	65 --		
				-	SM/ML	Silty Sand to Clayey Silt, gray and yellowish brown, medium dense, fine grained, stiff, some shell fragments
				66 --		
				-		
				67 --		
67.5	72	25.5	100.7	-		
				68 --	SM/ML	Silty Sand to Sandy Silt, gray and yellowish brown, wet, dense, stiff, fine grained
				-		
				69 --		
				-	SM	Silty Sand, yellowish brown, wet, dense, fine grained
70	36	24.8	SPT	70 --		
				-		Total Depth 70 feet
				71 --		Water at 27 feet
				-		Fill to 15 feet
				72 --		
				-		
				73 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				74 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				75 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted
						SPT=Standard Penetration Test

BORING LOG NUMBER 2

Faring | **Date: 09/25/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Parking
				0 --		1½-inch Asphalt over 2-inch Base
				-		
				1 --		FILL: Sandy Silt, dark brown, moist, medium dense, fine grained
				-		
				2 --		
2.5	63	12.4	116.0	-		
				3 --		Sandy Silt, dark and gray, moist, stiff
				-		
				4 --		
				-		
5	59	18.9	110.2	5 --		
				-		Sandy Silt to Silty Sand, dark and yellowish brown, moist, medium dense, stiff, fine grained
				6 --		
				-		
				7 --		
				-		
				8 --		
				-		
				9 --		
				-		
10	45	18.6	113.2	10 --		
				-		Silty Clay to Clayey Silt, dark and gray, moist, stiff
				11 --		
				-		
				12 --		
12.5	22	25.0	96.7	-		
				13 --		Clayey Silt to Silty Clay, gray to dark gray, moist, stiff, minor asphalt fragments
				-		
				14 --		
				-		
15	24	39.5	75.9	15 --		
				-	ML/CL	NATIVE SOILS: Clayey Silt to Silty Clay, dark gray, moist, stiff, minor shell fragments
				16 --		
				-		
				17 --		
17.5	17	41.0	76.3	-		
				18 --		
				-		
				19 --		
				-		
20	19	43.8	78.0	20 --		
				-		Total Depth 20 feet No Water Fill to 15 feet
				21 --		
				-		
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual.
				-		
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted
				25 --		
				-		

BORING LOG NUMBER 3

Faring — **Date: 09/25/19**

File No. 21850 — **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		1½-inch Asphalt, No Base
				-		
				1 --		FILL: Sandy to Clayey Silt, dark and gray, moist, stiff
				-		
				2 --		
2.5	20	19.6	105.7	-		
				3 --		Clayey Silt to Silty Clay
				-		
				4 --		
				-		
5	26	23.5	105.1	5 --		
				-		
				6 --		
				-		
				7 --		
7.5	35	18.4	107.0	-		
				8 --		
				-		
				9 --		
				-		
10	32	18.2	99.0	10 --		
				-		
				11 --		
				-		
				12 --		
12.5	46	20.8	99.6	-		
				13 --	ML	NATIVE SOILS: Sandy to Clayey Silt, yellow and gray, moist, stiff, some caliche
				-		
				14 --		
				-		
15	37	22.7	99.0	15 --		
				-		
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		Silty Sand, dark and gray, moist, medium dense to dense, fine grained
				-	SM	
20	61	12.3	105.3	20 --		
				-		Total Depth 20 feet No Water Fill to 12½ feet
				21 --		
				-		
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual.
				-		
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted
				25 --		
				-		

BORING LOG NUMBER 4

Faring **Date: 09/30/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		3-inch Asphalt over 4-inch Base
				-		
				1 --		FILL: Sandy to Clayey Silt, dark and gray, moist, stiff
				-		
				2 --		
2.5	24	15.4	114.4	-		
				3 --		Sandy Silt to Silty Clay
				-		
				4 --		
				-		
5	28	15.9	117.8	5 --		
				-		
				6 --		
				-		
				7 --		
				-		
				8 --		
				-		
				9 --		
				-		
10	29	18.1	113.2	10 --		
				-		
				11 --		
				-		
				12 --		
12.5	72	17.7	110.0	-		
				13 --		few brick and rock fragments
				-		
				14 --		
				-		
15	68	16.8	104.6	15 --		
				-		Silty Clay, few brick and rock fragments, asphalt and concrete
				16 --		
				-		
				17 --		
17.5	82	14.9	100.7	-		
				18 --		
				-		
				19 --		
				-		
20	38 50/4"	11.3	123.1	20 --		
				-		
				21 --		
				-		
				22 --		
22.5	35 50/3"	12.4	118.3	-		
				23 --	SM/SP	NATIVE SOILS: Silty Sand to Sand, dark gray, moist, very dense, fine grained
				-		
				24 --		
				-		
25	68	24.4	102.7	25 --		
				-	SM/ML	Silty Sand to Sandy Silt, dark gray, moist, stiff

BORING LOG NUMBER 4

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				26 --		
				-		
				27 --		
				-		
				28 --		Total Depth 27½ feet
				-		No Water
				29 --		Fill to 22½ feet
				-		
				30 --		
				-		NOTE: The stratification lines represent the approximate
				31 --		boundary between earth types; the transition may be gradual.
				-		
				32 --		Used 8-inch diameter Hollow-Stem Auger
				-		140-lb. Automatic Hammer, 30-inch drop
				33 --		Modified California Sampler used unless otherwise noted
				-		
				34 --		
				-		
				35 --		
				-		
				36 --		
				-		
				37 --		
				-		
				38 --		
				-		
				39 --		
				-		
				40 --		
				-		
				41 --		
				-		
				42 --		
				-		
				43 --		
				-		
				44 --		
				-		
				45 --		
				-		
				46 --		
				-		
				47 --		
				-		
				48 --		
				-		
				49 --		
				-		
				50 --		
				-		

BORING LOG NUMBER 5

Faring **Date: 09/30/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		3-inch Asphalt over 2-inch Base
				-		
				1 --		FILL: Sandy to Clayey Silt, dark grayish brown, moist, stiff
				-		
				2 --		
				-		
3	37	14.2	116.9	3 --		
				-		
				4 --		
				-		
				5 --		
				-		
				6 --		
				-		
7	30	19.2	107.4	7 --		
				-		
				8 --		
				-		
				9 --		
				-		
10	28	18.0	109.9	10 --		
				-		Clayey Silt to Silty Clay, gray to dark gray, few brick fragments
				11 --		
				-		
				12 --		
				-		
				13 --		
				-		
				14 --		
				-		
15	86	20.8	105.2	15 --		
				-		
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-		refusal on large piece of concrete
20	100/3"	No Recovery		20 --		
				-		Total Depth 20 feet by refusal
				21 --		No Water
				-		Hitting Concrete for 12"
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 6

Faring **Date: 09/30/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Parking
				0 --		4-inch Asphalt, No Base
				-		
				1 --		FILL: Clayey Silt to Silty Clay, dark gray, moist, stiff
				-		
				2 --		
2.5	66	10.5	124.3	-		
				3 --		Silty Sand to Sandy Silt, dark brown and gray, moist, medium dense, stiff, fine grained
				-		
				4 --		
				-		
5	14	15.3	SPT	5 --		
				-		Sandy to Clayey Silt, dark and gray, moist, stiff
				6 --		
				-		
				7 --		
7.5	48	17.0	107.4	-		
				8 --		
				-		
				9 --		
				-		
10	22	21.4	SPT	10 --		
				-		Clayey Silt to Silty Clay, few concrete fragments
				11 --		
				-		
				12 --		
12.5	72	16.2	114.0	-		
				13 --		Sandy Silt, gray to dark gray, few brick fragments
				-		
				14 --		
				-		
15	78	18.4	SPT	15 --		
				-		few rock and concrete fragments
				16 --		
				-		
				17 --		
17.5	100/8"	12.9	Disturbed	-		
				18 --		more concrete fragments
				-		
				19 --		
				-		
20	20	9.9	SPT	20 --		
				-	SM/SP	NATIVE SOILS: Silty Sand to Sand, dark and gray, moist, medium dense, fine grained
				21 --		
				-		
				22 --		
22.5	75	14.8	117.2	-		
				23 --	SM	Silty Sand, dark gray, moist, dense, fine grained
				-		
				24 --		
				-		
25	28	11.1	SPT	25 --		
				-	SM/SP	Silty Sand to Sand, dark and gray, moist, medium dense, fine grained

BORING LOG NUMBER 6

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				26 --		
				-		
				27 --		
27.5	52	16.5	115.1	-		
				28 --		
				-		
				29 --		
				-		
30	21	18.6	SPT	30 --		
				-	SM/ML	Silty Sand to Sandy Silt, dark brown and gray, moist, medium dense, stiff, fine grained
				31 --		
				-		
				32 --		
32.5	48	19.0	110.7	-		
				33 --	CL	Sandy Clay, dark brown and gray, moist, stiff
				-		
				34 --		
				-		
35	19	19.5	SPT	35 --		
				-		
				36 --		
				-		
				37 --		
37.5	65	16.3	111.4	-		
	50/5"			38 --	SM/SP	Silty Sand to Sand, dark brown and gray, moist, very dense, fine grained
				-		
				39 --		
				-		
40	33	19.3	SPT	40 --		
				-	SP	Sand, dark brown and gray, wet, medium dense, fine grained
				41 --		
				-		
				42 --		
42.5	82	25.2	89.7	-		
				43 --		dark and grayish brown
				-		
				44 --		
				-		
45	33	21.8	SPT	45 --		
				-		
				46 --		
				-		
				47 --		
47.5	68	20.5	109.5	-		
				48 --	SM/SP	Sand to Silty Sand, dark brown and gray, wet, dense, fine grained
				-		
				49 --		
				-		
50	39	19.4	SPT	50 --		
				-		

BORING LOG NUMBER 6

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				51 --		
				52 --		
52.5	88	20.6	109.1	53 --	SP/CL	Sand to Silty Clay, dark and gray, moist to wet, very dense, very stiff, fine grained
				54 --		
55	11	35.4	SPT	55 --		
				56 --	CL	Silty Clay, gray, moist, stiff
				57 --		
57.5	46	35.5	86.8	58 --		
				59 --		
60	14	28.6	SPT	60 --		
				61 --		
				62 --		
62.5	61	21.8	105.2	63 --	SM	Silty Sand, gray to dark gray, wet, dense, fine to medium grained
				64 --		
65	16	20.8	SPT	65 --		
				66 --		
				67 --		
67.5	84	18.4	111.9	68 --	SM	Silty Sand, dark and gray, moist, dense, fine grained
				69 --		
70	55	19.4	SPT	70 --		
				71 --		Total Depth 70 feet Water at 25 feet Fill to 20 feet
				72 --		
				73 --		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual.
				74 --		
				75 --		Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted SPT=Standard Penetration Test

BORING LOG NUMBER 7

Faring **Date: 09/25/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		6-inch Asphalt, No Base
				-		
				1 --		FILL: Sandy to Clayey Silt, dark and gray, moist, stiff
				-		
				2 --		
2.5	21	17.8	108.7	-		
				3 --		
				-		
				4 --		
				-		
5	21	16.9	102.3	5 --		
				-		Silty Sand to Sandy Silt, dark brown, moist, stiff, medium dense, fine grained
				6 --		
				-		
				7 --		
7.5	61	20.4	115.0	-		
				8 --		Sandy Silt, dark brown, moist, stiff
				-		
				9 --		
				-		
10	41	23.0	106.8	10 --		
				-		Sandy Silt to Silty Clay, gray, moist, stiff, few brick fragments
				11 --		
				-		
				12 --		
12.5	40	12.0	117.3	-		
				13 --		
				-		
				14 --		
				-		
15	32	15.2	99.2	15 --		
				-		few wood fragments
				16 --		
				-		
				17 --		
17.5	28	20.4	91.2	-		
				18 --		few brick fragments
				-		
				19 --		
				-		
20	34	38.6	83.0	20 --		
				-	CL	NATIVE SOILS: Silty Clay, yellowish brown and gray, moist, stiff
				21 --		
				-		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual.
				22 --		
				-		
				23 --		Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted
				-		
				24 --		
				-		
25	27	34.0	86.6	25 --		
				-		Total Depth 25 feet; No Water; Fill to 20 feet

BORING LOG NUMBER 8

Faring **Date: 09/25/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		5-inch Asphalt, No Base
				-		
				1 --		FILL: Sandy Silt, dark brown, moist, stiff
				-		
				2 --		
2.5	33	16.1	109.1	-		
				3 --		Silty Clay to Clayey Silt, dark brown, moist, stiff
				-		
				4 --		
				-		
5	36	9.8	118.6	5 --		
				-		Sandy Silt to Silty Sand, gray to dark gray, moist, medium dense, stiff, fine grained
				6 --		
				-		
				7 --		
				-		
				8 --		
				-		
				9 --		
				-		
10	30	16.5	105.3	10 --		
				-		
				11 --		
				-		
				12 --		
12.5	61	19.1	95.6	-		
				13 --		
				-		
				14 --		
				-		
15	42	18.6	95.6	15 --		
				-		few asphalt fragments
				16 --		
				-		
				17 --		
17.5	45	22.1	98.1	-		
				18 --		
				-		
				19 --		
				-		
20	54	19.0	95.3	20 --		
				-		
				21 --		
				-		
				22 --		
				-		
				23 --		
				-		
				24 --		
				-		
25	78	No Recovery		25 --		
				-		

BORING LOG NUMBER 8

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				26 --		
26.5	52	33.9	89.0	-		NATIVE SOILS: Sandy Silt, dark and yellowish brown, moist,
				27 --	ML	stiff
				-		
28	78	14.2	114.3	28 --	SM	Silty Sand, dark and yellowish brown, moist, dense, fine grained
				-		
				29 --		Total Depth 28½ feet
				-		No Water
				30 --		Fill to 26½ feet
				-		
				31 --		
				-		NOTE: The stratification lines represent the approximate
				32 --		boundary between earth types; the transition may be gradual.
				-		
				33 --		Used 8-inch diameter Hollow-Stem Auger
				-		140-lb. Automatic Hammer, 30-inch drop
				34 --		Modified California Sampler used unless otherwise noted
				-		
				35 --		
				-		
				36 --		
				-		
				37 --		
				-		
				38 --		
				-		
				39 --		
				-		
				40 --		
				-		
				41 --		
				-		
				42 --		
				-		
				43 --		
				-		
				44 --		
				-		
				45 --		
				-		
				46 --		
				-		
				47 --		
				-		
				48 --		
				-		
				49 --		
				-		
				50 --		
				-		

BORING LOG NUMBER 9

Faring | **Date: 09/26/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0		3-inch Asphalt over 4-inch Base
				1		FILL: Silty Sand to Sandy Silt, dark brown, moist, medium dense, stiff, fine grained
				2		
2.5	54	9.1	118.6			
				3		Silty Sand to Sand, dark and medium brown, moist, medium dense, fine grained
				4		
5	44	22.0	104.8	5		
				6		Silty Sand to Sandy Silt, dark and gray, moist, stiff, medium dense, fine grained, few brick and rock fragments
				7		
7.5	45	20.1	105.4			
				8		Clayey Silt to Silty Clay, dark gray, moist, stiff
				9		
10	36	20.6	106.5	10		
				11		
				12		
12.5	51	18.7	107.1			
				13	ML/CL	NATIVE SOILS: Clayey Silt to Silty Clay, dark brown, moist, stiff
				14		
15	72	17.6	116.0	15		
				16	SM/ML	Silty Sand to Sandy Silt, dark and gray, moist, dense, stiff, fine grained
				17		
				18		
				19		
20	52	23.4	97.0	20		
				21		Total Depth 20 feet No Water Fill to 12½ feet
				22		
				23		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual.
				24		
				25		Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 10

Faring **Date: 10/01/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		4-inch Asphalt over 4-inch Base
				-		
				1 --		FILL: Sandy to Clayey Silt, dark and gray, moist, stiff
				-		
				2 --		
2.5	21	16.4	112.9	-		
				3 --		
				-		
				4 --		
				-		
5	9	21.0	SPT	5 --		
				-		Clayey Silt to Silty Clay, gray to dark gray, moist, stiff
				6 --		
				-		
				7 --		
7.5	44	21.6	108.0	-		
				8 --		
				-		
				9 --		
				-		
10	12	15.3	SPT	10 --		
				-	CL	NATIVE SOILS: Sandy to Silty Clay, dark and yellowish brown, moist, stiff
				11 --		
				-		
				12 --		
12.5	58	17.1	116.8	-		
				13 --		
				-		
				14 --		
				-		
15	27	17.6	SPT	15 --		
				-		
				16 --		
				-		
				17 --		
17.5	72	20.4	107.6	-		
				18 --		
				-		
				19 --		
				-		
20	21	12.1	SPT	20 --		
				-	SM/ML	Silty Sand to Sandy Silt, dark brown and gray, moist, medium dense, stiff, fine grained
				21 --		
				-		
				22 --		
22.5	65 50/5"	19.0	106.1	-		
				23 --	SM	Silty Sand, dark brown and gray, moist, dense, fine grained
				-		
				24 --		
				-		
25	32	15.4	SPT	25 --		
				-		

BORING LOG NUMBER 10

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				26 --		
				27 --		
27.5	68	19.9	105.1	-		
				28 --	SM/SP	Silty Sand to Sand, dark brown and gray, moist, dense, fine grained
				29 --		
30	22	21.4	SPT	30 --		
				31 --	SM/ML	Silty Sand to Sandy Silt, dark brown and gray, moist, medium dense, stiff, fine grained
				32 --		
32.5	63	24.2	101.3	-		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual. Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted SPT=Standard Penetration Test
				33 --		
				34 --		
35	16	30.2	SPT	35 --		
				36 --		
				37 --		
37.5	78	24.1	104.7	-		
				38 --	ML	Sandy to Clayey Silt, dark brown and gray, moist, very stiff
				39 --		
40	20	26.7	SPT	40 --		
				41 --	CL	Silty Clay, dark brown, moist, stiff
				42 --		
42.5	80	17.6	113.5	-		
				43 --	SM/SP	Silty Sand to Sand, dark brown and gray, moist, dense, fine grained
				44 --		
45	22	23.4	SPT	45 --		
				46 --	ML/SP	Sandy Silt to Sand, dark brown and gray, moist to wet, medium dense, stiff, fine grained
				47 --		
47.5	75	20.7	107.5	-		
				48 --	SP	Sand, dark brown and gray, wet, dense, fine grained
				49 --		
50	34	17.3	SPT	50 --		
				-		Total Depth 50 feet Water at 31 feet Fill to 10 feet

BORING LOG NUMBER 11

Faring — **Date: 09/30/19**

File No. 21850 — **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		4-inch Asphalt over 5-inch Base
				-		
				1 --		FILL: Sandy Silt, dark and yellowish brown, moist, stiff
				-		
				2 --		
				-		
3	17	24.5	111.4	3 --		
				-		Silty Sand to Sandy Silt, dark gray to yellowish brown, moist,
				4 --		medium dense, stiff, fine grained
				-		
				5 --		
				-		
				6 --		
				-		
7	56	8.9	85.3	7 --		
				-		Clayey Silt to Silty Clay, dark gray and gray, moist, stiff, few
				8 --		rock fragments
				-		
				9 --		
				-		
10	50	21.9	Disturbed	10 --		
				-		
				11 --		
				-		
				12 --		
12.5	68	15.0	117.2	-		
				13 --	SM/ML	NATIVE SOILS: Silty Sand to Sandy Silt, dark brown and
				-		gray, moist, medium dense to dense, stiff, fine grained
				14 --		
				-		
15	63	20.0	108.4	15 --		
				-	ML	Sandy to Clayey Silt, dark and grayish brown, moist, stiff
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-	SM	Silty Sand, dark and gray, moist, medium dense, fine grained
20	52	14.8	114.4	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 12½ feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 12

Faring | **Date: 09/30/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		5-inch Asphalt, No Base
				-		
				1 --		FILL: Sandy Silt to Silty Clay, dark brown and yellowish brown, moist, stiff
				-		
				2 --		
2.5	21	19.7	105.7	-		
				3 --		Clayey Silt to Silty Clay, dark brown and gray
				-		
				4 --		
				-		
5	29	15.8	116.3	5 --		
				-		Silty Sand to Sandy Silt, gray to dark gray
				6 --		
				-		
				7 --		
				-		
				8 --		
				-		
				9 --		
				-		
10	44	16.8	115.7	10 --		
				-		Clayey Silt to Silty Clay
				11 --		
				-		
				12 --		
12.5	26	17.5	111.3	-		
				13 --		
				-		
				14 --		
				-		
15	58	17.2	108.5	15 --		
				-		few asphalt, brick and concrete fragments
				16 --		
				-		
				17 --		
17.5	78	14.7	109.9	-		
				18 --		Sandy Silt, dark gray, moist, very stiff, some brick and concrete fragments
				-		
				19 --		
				-		
20	100/4"	14.7	Disturbed	20 --		
				-		cobbles
				21 --		
				-		
				22 --		
				-		
				23 --		
				-		
				24 --		
				-		
25	57	15.7	113.8	25 --		
				-	SM	NATIVE SOILS: Silty Sand, dark and yellowish brown, moist, dense, fine grained

BORING LOG NUMBER 12

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				26 --		
				-		
				27 --		
27.5	77	6.7	98.4	-		
				28 --		
				-	SP	Sand, dark and gray, moist, dense, fine grained
				29 --		
				-		Total Depth 29 feet
				30 --		No Water
				-		Fill to 25 feet
				31 --		
				-		
				32 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				33 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				34 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted
				35 --		
				-		
				36 --		
				-		
				37 --		
				-		
				38 --		
				-		
				39 --		
				-		
				40 --		
				-		
				41 --		
				-		
				42 --		
				-		
				43 --		
				-		
				44 --		
				-		
				45 --		
				-		
				46 --		
				-		
				47 --		
				-		
				48 --		
				-		
				49 --		
				-		
				50 --		
				-		

BORING LOG NUMBER 13

Faring **Date: 09/27/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		3-inch Asphalt over 4-inch Base
				-		
				1 --		FILL: Sandy Silt to Silty Clay, dark brown, moist, stiff
				-		
				2 --		
2.5	19	22.8	101.8	-		
				3 --		Clayey Silt to Silty Clay, gray to dark gray
				-		
				4 --		
				-		
5	22	23.5	102.0	5 --		
				-		
				6 --		
				-		
				7 --		
				-		
				8 --		
				-		
				9 --		
				-		
10	23	41.6	92.6	10 --		
				-		
				11 --		
				-		
				12 --		
12.5	33	21.1	97.1	-		
				13 --		few brick fragments
				-		
				14 --		
				-		
15	34	35.5	87.5	15 --		
				-	CL	NATIVE SOILS: Silty Clay, gray, moist, stiff
				16 --		
				-		
17	28	39.4	80.7	17 --		
				-		
				18 --		
				-		
				19 --		
				-		
20	27	41.5	79.6	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 15 feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 14

Faring | **Date: 09/26/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		3-inch Asphalt over 3-inch Base
				-		
				1 --		FILL: Sandy Silt, dark and gray, moist, stiff
				-		
				2 --		
2.5	20	17.5	113.1	-		
				3 --		Silty Sand to Sandy Silt, medium dense, stiff
				-		
				4 --		
				-		
5	22	17.1	112.0	5 --		
				-		Sandy Silt to Silty Clay, gray to dark gray, stiff
				6 --		
				-		
				7 --		
7.5	46	20.5	98.2	-		
				8 --		Silty Sand to Sandy Silt, stiff, medium dense, fine grained
				-		
				9 --		
				-		
10	31	17.5	100.6	10 --		
				-		Clayey Silt to Silty Clay, few asphalt and brick fragments
				11 --		
				-		
				12 --		
12.5	33	20.8	109.0	-		
				13 --	CL	NATIVE SOILS: Silty Clay, gray to dark gray, moist, stiff
				-		
				14 --		
				-		
15	33	22.5	105.5	15 --		
				-		
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		Silty Sand to Sandy Silt, dark and gray, moist, medium dense,
				-	SM/ML	stiff, fine grained
20	39	21.6	107.4	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 12½ feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 15

Faring **Date: 10/01/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Parking
				0 --		3-inch Asphalt over 4-inch Base
				-		
				1 --		FILL: Clayey Silt to Silty clay, dark and gray, moist, stiff
				-		
				2 --		
				-		
3	21	27.1	99.3	3 --		
				-		
				4 --		
				-		
				5 --		
				-		
				6 --		
				-		
7	29	23.9	98.1	7 --		
				-		few asphalt fragments
				8 --		
				-		
				9 --		
				-		
10	27	18.3	110.2	10 --		
				-		gray to dark gray
				11 --		
				-		
				12 --		
12.5	24	19.8	109.3	-		
				13 --		yellowish brown and gray
				-		
				14 --		
				-		
15	28	19.1	110.5	15 --		
				-		
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-		
20	59	12.4	116.3	20 --		
				-		
				21 --		
				-		
				22 --		
				-		
				23 --		
				-		
				24 --		
				-		
25	30	12.9	121.5	25 --		
	50/5"			-		Sandy to Clayey Silt, dark gray, very stiff, few brick and asphalt fragments

BORING LOG NUMBER 15

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				26 --		
				-		
				27 --		
27.5	100/7"	16.5	104.1	-		
				28 --		
				-		
				29 --		
				-		
30	100/3"	No Recovery		30 --		
				-		
				31 --		
				-		
				32 --		
32.5	100/4"	15.2	94.8	-		
				33 --		
				-		
				34 --		
				-		
35	100/4"	16.0	105.4	35 --		
				-		Total Depth 35 feet by refusal
				36 --		No Water
				-		Fill to 35 feet
				37 --		
				-		
				38 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				39 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				40 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted
				41 --		
				-		
				42 --		
				-		
				43 --		
				-		
				44 --		
				-		
				45 --		
				-		
				46 --		
				-		
				47 --		
				-		
				48 --		
				-		
				49 --		
				-		
				50 --		
				-		

BORING LOG NUMBER 16

Faring **Date: 10/01/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

sm

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		4-inch Asphalt, No Base
				-		
				1 --		FILL: Clayey Silt to Silty Clay, dark brown and gray, moist, stiff
				-		
				2 --		
2.5	16	22.3	100.2	-		
				3 --		
				-		
				4 --		
				-		
5	29	20.3	111.4	5 --		
				-		Silty Clay, dark brown and gray
				6 --		
				-		
				7 --		
				-		
				8 --	ML	NATIVE SOILS: Sandy to Clayey Silt, dark brown and gray, moist, stiff
				-		
				9 --		
				-		
10	38	17.7	108.8	10 --		
				-	SM/ML	Silty Sand to Sandy Silt, dark brown and gray, moist, medium dense, stiff, fine grained
				11 --		
				-		
				12 --		
				-		
				13 --		
				-		
				14 --		
				-		
15	72	17.5	116.3	15 --		
				-	ML	Sandy Silt, dark brown and gray, moist, stiff
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		Silty Sand to Sandy Silt, dark and gray, moist, dense, stiff, fine grained
				-	SM/ML	
20	75	21.1	105.8	20 --		
				-		Total Depth 20 feet No Water Fill to 7.5 feet
				21 --		
				-		
				22 --		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual.
				-		
				23 --		
				-		
				24 --		Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted
				-		
				25 --		
				-		

BORING LOG NUMBER 17

Faring | **Date: 09/26/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

sm

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		4-inch Asphalt over 3-inch Base
				-		
				1 --		FILL: Sandy Silt, dark and gray, moist, stiff
				-		
				2 --		
2.5	27	26.3	94.9	-		NOTE: The stratification lines represent the approximate
				3 --		boundary between earth types; the transition may be gradual.
				-		
				4 --		Used 8-inch diameter Hollow-Stem Auger
				-		140-lb. Automatic Hammer, 30-inch drop
5	7	28.2	SPT	5 --		Modified California Sampler used unless otherwise noted
				-		
				6 --		SPT=Standard Penetration Test
				-		
				7 --		
7.5	26	29.7	94.2	-		
				8 --		few brick fragments
				-		
				9 --		
				-		
10	10	21.5	SPT	10 --		
				-		Clayey Silt to Silty Clay, gray to dark gray, few plastic
				11 --		fragments
				-		
				12 --		
12.5	29	33.3	87.3	-		
				13 --	ML/CL	NATIVE SOILS: Sandy Silt to Silty Clay, dark and gray, moist,
				-		stiff
				14 --		
				-		
15	13	31.9	SPT	15 --		
				-		
				16 --		
				-		
				17 --		
17.5	31	32.3	87.0	-		
				18 --	CL	Silty Clay, gray, moist, stiff
				-		
				19 --		
				-		
20	7	24.0	SPT	20 --		
				-	CL	Sandy Clay, dark gray brown, moist, stiff
				21 --		
				-		
				22 --		
22.5	33	17.4	107.2	-		
				23 --		
				-		
				24 --		
				-		
25	16	31.5	SPT	25 --		
				-		

BORING LOG NUMBER 17

Faring

File No. 21850

sm

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				26 --		
				27 --		
27.5	54	18.2	114.5			
				28 --		
				29 --		
30	23	22.9	SPT	30 --		
					SM/SP	Silty Sand to Sand, dark and gray, wet, medium dense, fine grained
				31 --		
				32 --		
32.5	52	23.5	99.3			
				33 --	SM/ML	Sandy Silt to Silty Sand, dark and gray, moist, stiff, medium dense, stiff, fine grained
				34 --		
35	24	21.9	SPT	35 --		
				36 --		
				37 --		
37.5	47	21.2	101.7			
				38 --	SM	Silty Sand, dark and gray, very moist, medium dense, fine grained
				39 --		
40	25	29.3	SPT	40 --		
						very moist to wet
				41 --		
				42 --		
42.5	61	19.3	110.4			
				43 --	SM/SP	Silty Sand to Sand, dark and gray, wet, medium dense to dense, fine grained
				44 --		
45	28	20.6	SPT	45 --		
					ML/CL	Clayey Silt to Silty Clay, dark brown, moist, stiff
				46 --		
				47 --		
47.5	62	22.8	107.5			
				48 --	CL	Sandy to Silty Clay, dark and gray, wet, stiff
				49 --		Silty Sand to Sand, dark and gray, wet, medium dense, fine grained
					SP/SM	
50	33	25.3	SPT	50 --		
						Total Depth 50 feet Water at 28 feet Fill to 12½ feet

BORING LOG NUMBER 18

Faring | **Date: 09/26/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		5-inch Asphalt over 6-inch Base
				-		
				1 --		
				-		FILL: Sandy Silt, dark and gray, moist, stiff
				2 --		
2.5	24	32.0	94.0	-		
				3 --		Silty Sand to Sandy Silt, dark brown and gray, moist, medium
				-		dense, stiff, fine grained
				4 --		
				-		
5	38	20.3	105.7	5 --		
				-		Sandy Silt to Silty Clay
				6 --		
				-		
				7 --		
				-		
				8 --		
				-		
				9 --		
				-		
10	36	17.3	112.4	10 --		
				-		gray to dark gray
				11 --		
				-		
				12 --		
12.5	43	19.7	108.4	-		
				13 --	ML/CL	NATIVE SOILS: Clayey Silt to Silty Clay, dark and yellowish
				-		brown, moist, stiff
				14 --		
				-		
15	55	16.5	113.0	15 --		
				-		
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-	SM	Silty Sand, dark and gray, moist, medium dense, fine grained
20	40	19.9	108.9	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 12½ feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 19

Faring | **Date: 09/26/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		4-inch Asphalt, No Base
				-		
				1 --		FILL: Sandy Silt, dark and gray, moist, stiff
				-		
				2 --		
2.5	49	20.0	108.6	-		
				3 --		few brick fragments
				-		
				4 --		
				-		
5	40	28.0	96.0	5 --		
				-		
				6 --		
				-		
				7 --		
7.5	33	18.1	105.7	-		
				8 --	ML/CL	NATIVE SOILS: Clayey Silt to Silty Clay, dark brown, moist, stiff
				-		
				9 --		
				-		
10	41	20.0	107.5	10 --		
				-		some caliche
				11 --		
				-		
				12 --		
				-		
				13 --		
				-		
				14 --		
				-		
15	49	20.7	110.5	15 --		
				-	SM/ML	Silty Sand to Sandy Silt, dark and yellowish brown, moist, medium dense, stiff, fine grained
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-	SP	Sand, dark and gray, moist, medium dense, fine grained
20	55	6.8	101.6	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 7½ feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 20

Faring **Date: 10/28/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt
				0 --		5-inch Asphalt, No Base
				-		
				1 --		FILL: Sandy Silt to Silty Clay, dark gray to gray, moist, stiff
				-		
				2 --		
				-		
				3 --		
				-		
				4 --		
				-		
5	11	23.6	SPT	5 --		
				-		Silty Sand to Silty Clay
				6 --		
				-		
				7 --		
7.5	38	22.2	105.8	-		
				8 --		
				-		
				9 --		
				-		
10	12	22.7	SPT	10 --		
				-	CL	NATIVE SOILS: Silty Clay, dark and gray, moist, stiff
				11 --		
				-		
				12 --		
12.5	68	16.4	115.5	-		
				13 --		
				-		
				14 --		
				-		
15	21	17.6	SPT	15 --		
				-		
				16 --		
				-		
				17 --		
17.5	55	21.3	106.1	-		
				18 --	ML	Sandy Silt, dark and yellowish brown, moist,
				-		stiff
				19 --		
				-		
20	22	20.6	SPT	20 --		
				-		
				21 --		
				-		
				22 --		
22.5	63	21.7	105.5	-		
				23 --	ML	Sandy Silt, dark brown and gray, moist, stiff
				-		
				24 --		
				-		
25	20	16.1	SPT	25 --		
				-	SM/ML	Silty Sand to Sandy Silt, dark and yellowish brown, moist, medium dense, stiff, fine grained

BORING LOG NUMBER 20

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				- 26 -- - 27 --		
27.5	56	19.8	108.5	- 28 -- - 29 -- -	SM/SP	Silty Sand to Sand, dark and yellowish brown, moist, dense, fine grained
30	23	22.8	SPT	30 -- - 31 -- - 32 --		- - - - - - - - - - - - wet
32.5	83	21.3	107.5	- 33 -- - 34 -- -		
35	17	31.6	SPT	35 -- - 36 -- - 37 --	CL	Silty Clay, dark and yellowish brown, wet, stiff
37.5	70	21.4	108.1	- 38 -- - 39 -- -	SM/ML	Silty Sand to Sandy Silt, dark and yellowish brown, wet, dense, stiff, fine grained
40	22	22.6	SPT	40 -- - 41 -- - 42 --		
42.5	79	15.6	113.1	- 43 -- - 44 -- -	SM/SP	Silty Sand to Sand, dark and gray, wet, very dense, fine grained
45	23	22.8	SPT	45 -- - 46 -- - 47 --		
47.5	82	23.8	103.6	- 48 -- - 49 -- -	SP	Sand, gray, wet, very dense, fine grained
50	34	29.4	SPT	50 -- -	SM/ML	Silty Sand to Clayey Silt, gray, wet, medium dense, stiff, fine grained

BORING LOG NUMBER 20

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				51 --		
				-		
				52 --		
52.5	45	26.3	102.8	-		
	50/5"			53 --	SM/SP	Silty Sand to Sand, dark brown and gray, wet, very dense, fine grained
				-		
				54 --		
				-		
55	54	24.5	SPT	55 --		
				-	SP	Sand, gray, wet, dense, fine grained, few shell fragments
				56 --		
				-		
				57 --		
57.5	95	24.6	99.9	-		
				58 --	ML	Sandy to Clayey Silt, gray to dark gray, moist, very stiff
				-		
				59 --		
				-		
60	16	46.2	SPT	60 --		
				-	CL	Silty Clay, gray to dark gray, moist, stiff
				61 --		
				-		
				62 --		
62.5	40	37.0	89.0	-		
	50/5"			63 --		
				-		
				64 --		
				-		
65	35	15.7	SPT	65 --		
				-	SM/ML	Silty Sand to Clayey Silt, gray to dark gray, moist, dense, stiff, fine grained
				66 --		
				-		
				67 --		
67.5	85	23.1	108.8	-		
				68 --	SC/CL	Clayey Sand to Clay, dark gray to dark brown, moist, dense, stiff, fine grained
				-		
				69 --		
				-	ML/CL	Clayey Silt to Silty Clay, dark and yellowish brown, moist, stiff
70	76	25.9	SPT	70 --		
				-		Total Depth 70 feet
				71 --		Water at 23½ feet
				-		Fill to 10 feet
				72 --		
				-		
				73 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				74 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				75 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted
						SPT=Standard Penetration Test

BORING LOG NUMBER 21

Faring | **Date: 10/02/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

sm

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Parking
				0 --		3-inch Asphalt over 7-inch Base
				-		
				1 --		FILL: Sandy Silt to Silty Clay, dark and gray, moist, stiff
				-		
				2 --		
2.5	15	26.6	95.1	-		
				3 --		
				-		
				4 --		
				-		
5	9	21.5	SPT	5 --		
				-		Silty Clay, gray to dark gray
				6 --		
				-		
				7 --		
7.5	52	20.5	108.9	-		
				8 --		Sandy Silt to Clay, dark gray to dark brown, few asphalt fragments
				-		
				9 --		
				-		
10	62	8.7	SPT	10 --		
				-		Silty Sand to Sandy Silt, dark gray to dark brown, moist, medium dense, stiff, fine grained, few wood and concrete fragments
				11 --		
				-		
				12 --		
12.5	30 50/5"	12.6	120.2	-		
				13 --		Silty Sand with brick fragments, dark gray, moist, very dense, fine grained
				-		
				14 --		
				-		
15	28	26.1	SPT	15 --		
				-		Silty Clay, dark brown, moist, stiff
				16 --		
				-	CL	NATIVE SOILS: Silty Clay, dark and yellow, yellowish brown, moist, stiff
				17 --		
17.5	25	20.1	106.9	-		
				18 --		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual.
				-		
				19 --		Used 8-inch diameter Hollow-Stem Auger
20	16	No Recovery	SPT	20 --		140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted
				-		
				21 --		SPT=Standard Penetration Test
				-		
				22 --		
22.5	30	21.3	106.6	-		
				23 --		dark brown and gray
				-		
				24 --		
				-		
25	14	21.8	SPT	25 --		
				-		

BORING LOG NUMBER 21

Faring

File No. 21850

sm

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				26 --		
				-		
				27 --		
27.5	46	21.5	105.2	-		
				28 --		
				-		
				29 --		
				-		
30	13	25.2	SPT	30 --		
				-	CL	Silty Clay, dark brown and gray, moist, stiff
				31 --		
				-		
				32 --		
32.5	63	21.1	107.7	-		
				33 --		
				-		
				34 --		
				-		
35	12	29.5	SPT	35 --		
				-	ML	Sandy Silt, dark brown and gray, moist, stiff
				36 --		
				-		
				37 --		
37.5	47	25.7	101.8	-		
				38 --	SM/ML	Silty Sand to Sandy Silt, dark brown and gray, moist, medium dense, stiff, fine grained
				-		
				39 --		
				-		
40	14	20.6	SPT	40 --		
				-	ML	Sandy to Clayey Silt, dark brown and gray, moist, stiff
				41 --		
				-		
				42 --		
42.5	43	17.5	111.5	-		
				43 --	SP	Sand, dark brown and gray, wet, medium dense, fine grained
				-		
				44 --		
				-		
45	31	18.5	SPT	45 --		
				-		
				46 --		
				-		
				47 --		
47.5	53	13.9	114.7	-		
				48 --		
				-		
				49 --		Sand to Sandy Silt, dark brown and gray, moist to wet, medium dense, stiff, fine grained
				-	SP/ML	
50	38	17.3	SPT	50 --		
				-		Total Depth 50 feet Water at 31 feet Fill to 16 feet

BORING LOG NUMBER 22

Faring **Date: 10/01/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Parking
				0 --		5-inch Asphalt over 4-inch Base
				-		
				1 --		FILL: Sandy to Clayey Silt, dark and gray, moist, stiff
				-		
				2 --		
2.5	14	38.1	80.3	-		
				3 --		Sandy Silt to Silty Clay, dark brown and gray
				-		
				4 --		
				-		
5	20	24.3	97.8	5 --		
				-		Silty Clay, gray
				6 --		
				-		
				7 --		
7.5	20	17.9	110.4	-		
				8 --		few gravel and asphalt fragments
				-		
				9 --		
				-		
10	18	22.3	104.1	10 --		
				-		minor brick fragments
				11 --		
				-		
				12 --		
12.5	28	18.1	110.6	-		
				13 --	ML	NATIVE SOILS: Sandy Silt, dark and yellowish brown, moist, stiff
				-		
				14 --		
				-		
15	66	16.8	114.8	15 --		
				-	SM/ML	Silty Sand to Sandy Silt, dark brown and gray, moist, dense, stiff, fine grained
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		Silty Sand, dark brown and gray, moist, medium dense, fine grained
				-	SM	
20	49	17.6	105.7	20 --		
				-		Total Depth 20 feet No Water Fill to 12½ feet
				21 --		
				-		
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual.
				-		
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted
				25 --		
				-		

BORING LOG NUMBER 23

Faring — **Date: 09/27/19**

File No. 21850 — **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		5-inch Asphalt, No Base
				-		
				1 --		FILL: Sandy to Clayey Silt, dark and gray, moist, stiff
				-		
				2 --		
2.5	5	21.4	110.6	-		
	50/3"			3 --		few rock fragments and asphalt fragments
				-		
				4 --		
				-		
5	49	18.7	98.1	5 --		
				-		Clayey Silt to Silty Clay, dark gray, few asphalt fragments
				6 --		
				-		
				7 --		
7.5	36	13.2	105.2	-		
				8 --		Sandy to Clayey Silt, gray to dark gray, few asphalt fragments asphalt fragments
				-		
				9 --		
				-		
10	35	26.5	97.9	10 --		
				-	ML/CL	NATIVE SOILS: Clayey Silt to Silty Clay, gray to dark gray, moist, stiff
				11 --		
				-		
				12 --		
12.5	24	26.5	98.9	-		
				13 --	SM/SP	Silty Sand to Sand, gray, moist, medium dense, fine grained
				-		
				14 --		
				-		
15	28	21.5	104.9	15 --		
				-	ML/CL	Clayey Silt to Silty Clay, dark gray, moist, stiff
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-	ML	Sandy Silt to Clayey Silt, dark gray, moist, stiff
20	46	19.4	109.3	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 10 feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 24

Faring | **Date: 09/27/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		5-inch Asphalt over 5-inch Base
				-		
				1 --		FILL: Sandy Silt to Silty clay, dark gray, moist, stiff
				-		
				2 --		
				-		
3	36	28.2	98.2	3 --		
				-		Clayey Silt to Silty Clay, gray to dark gray
				4 --		
				-		
				5 --		
				-		
				6 --		
				-		
				7 --		
7.5	26	11.2	118.0	-		Sandy Silt to Silty Clay, few asphalt and rock fragments
				8 --		
				-		
				9 --		
				-		
10	27	12.5	120.6	10 --		
				-		
				11 --		
				-		
				12 --		
12.5	19	20.8	106.4	-		
				13 --	CL	NATIVE SOILS: Silty Clay, gray to dark gray, moist, stiff
				-		
				14 --		
				-		
15	28	23.5	102.4	15 --		
				-		yellow and gray
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		Silty Sand to Sandy Silt, yellow and gray, moist, medium dense,
				-	SM/ML	stiff, fine grained
20	39	18.9	111.3	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 12½ feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 25

Faring | **Date: 09/27/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		4-inch Asphalt over 2-inch Base
				-		
				1 --		FILL: Sandy Silt, dark brown and gray, moist, stiff
				-		
				2 --		
				-		
3	68	14.7	119.5	3 --		
				-		Silty Sand to Sandy Silt, dark gray, moist, medium dense,
				4 --		stiff, fine grained
				-		
				5 --		
				-		
				6 --		
				-		
7	54	8.7	114.8	7 --		
				-		few rock fragments
				8 --		
				-		
				9 --		
				-		
10	47	22.7	101.0	10 --		
				-		
				11 --		
				-	CL	NATIVE SOILS: Silty Clay, gray, moist, stiff
				12 --		
12.5	33	19.5	108.5	-		
				13 --		
				-		
				14 --		
				-		
15	48	16.3	118.6	15 --		
				-	ML	Sandy to Clayey Silt, dark brown and gray, moist, stiff
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		Silty Sand to Sand, dark and grayish brown, moist, dense, fine
				-	SM/SP	grained
20	75	18.7	103.7	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 11 feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 26

Faring **Date: 10/02/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0		4½-inch Asphalt over 1½-inch Base
				1		FILL: Silty Sand to Sandy Silt, dark brown to dark gray, moist, medium dense, stiff, fine grained
				2		
2.5	28	13.7	121.4			
				3		
				4		
5	36	16.9	113.0	5		
						dark gray to gray
				6		
				7		
7.5	31	18.9	111.2			
				8		Silty Sand to Silty Clay
				9		
10	48	18.4	109.6	10		
				11		
					ML	NATIVE SOILS: Sandy Silt, dark gray to gray, moist, stiff
				12		
12.5	51	15.9	111.9			
				13	ML/CL	Clayey Silt to Silty Clay, dark brown and gray, moist, stiff
				14		
15	73	17.1	115.2	15		
					ML	Sandy Silt, dark and yellowish brown, moist, stiff
				16		
				17		
				18		
				19		
					SM	Silty Sand, dark brown and gray, moist, dense, fine grained
20	64	19.8	112.5	20		
						Total Depth 20 feet
				21		No Water
						Fill to 11 feet
				22		
				23		NOTE: The stratification lines represent the approximate
						boundary between earth types; the transition may be gradual.
				24		
						Used 8-inch diameter Hollow-Stem Auger
				25		140-lb. Automatic Hammer, 30-inch drop
						Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 27

Faring **Date: 10/30/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		4-inch Asphalt, No Base
				-		
				1 --		FILL: Sandy Silt, dark brown, moist, stiff
				-		
				2 --		
				-		yellowish brown
				3 --		
				-		
				4 --		
				-		
5	13	20.7	SPT	5 --		
				-		Sandy Silt to Silty Clay, dark gray, few brick and concrete fragments
				6 --		
				-		
				7 --		
7.5	43	16.3	117.4	-		
				8 --		Silty Sand to Sandy Silt, dark brown and dark grayish brown, few construction debris
				-		
				9 --		
				-		
10	14	20.3	SPT	10 --		
				-		Silty Sand to Silty Clay, dark gray to gray, few concrete fragments
				11 --		
				-		
				12 --		
12.5	36	36.5	80.4	-		
				13 --	CL	NATIVE SOILS: Silty Clay, gray, moist, stiff
				-		
				14 --		
				-		
15	15	41.5	SPT	15 --		
				-		minor caliche
				16 --		
				-		
				17 --		
17.5	43	37.0	82.4	-		
				18 --		
				-		
				19 --		
				-		
20	7	42.7	SPT	20 --		
				-		dark and yellowish brown
				21 --		
				-		
				22 --		
22.5	35	34.4	86.8	-		
				23 --		gray to dark gray
				-		
				24 --		
				-		
25	12	43.7	SPT	25 --		
				-		

BORING LOG NUMBER 27

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				26		
				27		
27.5	35	42.8	80.8			
				28		
				29		
30	9	35.1	SPT	30		
				31	CL	Silty Clay, dark brown, moist, stiff
				32		
32.5	52	24.5	102.4			
				33		
				34		
35	9	21.7	SPT	35		
				36		
				37		
37.5	49	25.4	99.6			
				38		
				39		
40	14	22.7	SPT	40		
				41		
				42		
42.5	48	23.7	105.8			
				43		dark and yellowish brown
				44		
45	9	24.3	SPT	45		
				46		
				47		
47.5	80	23.6	103.7			
				48	SM/SP	Silty Sand to Sand, dark and yellowish brown, moist to wet, medium dense, fine grained
				49		
50	19	28.8	SPT	50		

BORING LOG NUMBER 27

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				- 51 -- - 52 --		
52.5	40 50/5"	28.7	98.1	- 53 -- - 54 -- -	SP	Sand, dark and yellowish brown, wet, very dense, fine grained
55	58	28.6	SPT	55 -- - 56 -- - 57 --		
57.5	38 50/5"	33.0	92.1	- 58 -- - 59 -- -	ML/CL	Sandy Silt to Silty Clay, gray and yellowish brown, moist, very stiff, with shell fragments
60	44	33.6	SPT	60 -- - 61 -- - 62 --		
62.5	82	32.3	92.7	- 63 -- - 64 -- -	CL	Silty Clay, dark gray, moist, very stiff
65	37	29.6	SPT	65 -- - 66 -- - 67 --		
67.5	45 50/4"	23.2	103.4	- 68 -- - 69 --	SM/CL	Silty Sand to Silty Clay, dark and yellowish brown, moist, very dense, very stiff, fine grained
				-	ML/CL	Clayey Silt to Silty Clay, dark and yellowish brown, moist, stiff
70	43	22.5	SPT	70 -- - 71 -- - 72 -- - 73 -- - 74 -- - 75 -- -		Total Depth 70 feet Water at 25 feet Fill to 12½ feet NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual. Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted SPT=Standard Penetration Test

BORING LOG NUMBER 28

Faring **Date: 10/01/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

sm

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street or Driveway
				0 --		4-inch Asphalt over 5-inch Base
				-		
				1 --		FILL: Clayey Silt to Silty Clay, dark and gray, moist, stiff
				-		
				2 --		
				-		
3	19	19.9	109.0	3 --		
				-		
				4 --		
				-		
				5 --		
				-		
				6 --		
				-		
7	52	15.7	117.0	7 --		
				-		few brick and concrete fragments
				8 --		
				-		
				9 --		
				-		
10	40 50/5"	13.9	Disturbed	10 --		
				-		
				11 --		
				-		
12	27	34.3	84.8	12 --		
				-		
				13 --	ML/CL	NATIVE SOILS: Clayey Silt to Silty Clay, dark brown and gray, moist, stiff
				-		
				14 --		
				-		
15	28	35.0	83.5	15 --		
				-	CL	Silty Clay, dark gray, moist, stiff with caliche
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-		
20	26	34.4	82.2	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 12.5 feet
				22 --		
				-		NOTE: The stratification lines represent the approximate
				23 --		boundary between earth types; the transition may be gradual.
				-		
				24 --		Used 8-inch diameter Hollow-Stem Auger
				-		140-lb. Automatic Hammer, 30-inch drop
				25 --		Modified California Sampler used unless otherwise noted
				-		

BORING LOG NUMBER 29

Faring | **Date: 09/27/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

sm

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Parking
				0 --		3-inch Asphalt, No Base
				-		
				1 --		FILL: Sandy Silt, dark and yellowish brown, moist, stiff
				-		
				2 --		
2.5	33	21.6	105.2	-		
				3 --		Silty Clay to Clayey Silt, dark and gray
				-		
				4 --		
				-		
5	28	20.7	108.5	5 --		
				-		
				6 --		
				-		
				7 --		
7.5	44	21.5	107.5	-		
				8 --		few rock and asphalt fragments
				-		
				9 --		
				-		
10	29	12.5	116.5	10 --		
				-		Silty Sand to Sandy Silt, gray to dark gray, moist, medium dense, stiff, fine grained
				11 --		
				-		
				12 --		
12.5	41	16.7	114.9	-		
				13 --	ML/CL	NATIVE SOILS: Clayey Silt to Silty Clay, dark brown and gray, moist, stiff, few shell fragments
				-		
				14 --		
				-		
15	21	18.6	SPT	15 --		
				-	CL	Silty Clay, dark brown and gray, moist, stiff
				16 --		
				-		
				17 --		
17.5	38	22.5	105.4	-		
				18 --		
				-		
				19 --		
				-		
20	24	19.1	SPT	20 --		
				-	ML	Sandy to Clayey Silt, dark and yellowish brown, moist, stiff
				21 --		
				-		
				22 --		
22.5	44	26.5	100.2	-		
				23 --		Silty Sand, dark and gray, moist, medium dense, fine grained
				-		
				24 --		
				-		
25	33	20.5	SPT	25 --		
				-	SM/SP	Silty Sand to Sand, dark and gray, moist, medium dense, fine grained

BORING LOG NUMBER 29

Faring

File No. 21850

sm

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				26 --		
				-		
				27 --		
27.5	57	26.7	99.6	-		
				28 --		
				-		
				29 --		
				-		
30	19	29.6	SPT	30 --		
				-	ML	Clayey Silt to Sandy Silt, dark and yellowish brown, moist, stiff
				31 --		
				-		
				32 --		
32.5	31	22.8	104.2	-		
				33 --	SM/ML	Silty Sand to Sandy Silt, dark and gray, moist, medium dense, stiff, fine grained
				-		
				34 --		
				-		
35	19	24.5	SPT	35 --		
				-		
				36 --		
				-		
				37 --		
37.5	72	24.8	102.9	-		
				38 --		
				-		
				39 --		
				-		
40	38	25.9	SPT	40 --		
				-		
				41 --		
				-		
				42 --		
42.5	68	20.4	111.3	-		
				43 --	ML	Sandy to Clayey Silt, dark and gray, moist, stiff
				-		
				44 --		
				-		
45	17	19.8	SPT	45 --		
				-	SM	Silty Sand, dark and gray, moist, medium dense, fine grained
				46 --		
				-		
				47 --		
47.5	78	18.5	114.1	-		
				48 --		
				-		
				49 --		
				-		
50	28	25.7	SPT	50 --		
				-		

BORING LOG NUMBER 29

Faring

File No. 21850

sm

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				51 --		
				52 --		
52.5	90	25.1	101.4	53 --	SM/SP	Silty Sand to Sand, dark and greenish brown, wet, very dense, fine grained, few shell fragments
				54 --		
55	40	28.1	SPT	55 --		
				56 --		Sand, dark and gray, wet, medium dense to dense, fine grained
				57 --		
57.5	45 50/4"	27.2	95.7	58 --		Sand, greenish brown, wet, very dense, fine grained, few shell fragments
				59 --		
60	25	31.7	SPT	60 --	ML/CL	Clayey Silt to Silty Clay, grayish brown, moist, stiff
				61 --		
				62 --		
62.5	45 50/4"	34.0	88.2	63 --	ML/CL	Sandy Silt to Silty Clay, yellow and gray, moist to wet, very stiff
				64 --		
65	34	31.2	SPT	65 --	SM/CL	Silty Sand to Silty Clay
				66 --		
				67 --		
67.5	83	42.0	82.0	68 --	SM/ML	Silty Sand to Clayey Silt, gray to dark gray, moist, dense, fine grained, stiff
				69 --		
70	48	32.9	SPT	70 --		
				71 --		Total Depth 70 feet Water at 32½ feet Fill to 12½ feet
				72 --		
				73 --		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual.
				74 --		Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop
				75 --		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 30

Faring **Date: 10/02/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		3-inch Asphalt over 4-inch Base
				-		
				1 --		FILL: Clayey Silt to Silty Clay, dark brown and gray, moist,
				-		stiff
				2 --		
2.5	21	18.9	107.6	-		
				3 --		
				-		
				4 --		
				-		
5	23	34.0	89.7	5 --		
				-		gray to dark gray
				6 --		
				-		
				7 --		
				-		
				8 --		
				-		
				9 --		
				-		
10	72	No Recovery		10 --		
				-		cobbles
				11 --		
				-		
				12 --		
12.5	37	16.9	111.7	-		
				13 --	CL	NATIVE SOILS: Silty Clay, dark and yellowish brown, moist,
				-		stiff, minor caliche
				14 --		
				-		
15	34	18.1	109.7	15 --		
				-		
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-	ML	Sandy Silt, dark and yellowish brown, moist, stiff
20	38	19.5	113.0	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 12½ feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 31

Faring | **Date: 09/27/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Driveway
				0 --		3-inch Asphalt over 3-inch Base
				-		
				1 --		FILL: Clayey Silt to Silty Clay, dark brown and gray, moist, stiff
				2 --		
2.5	52	14.2	114.5	-		
				3 --		dark gray, few brick and asphalt fragments
				-		
				4 --		
				-		
5	17	15.4	SPT	5 --		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual. Used 8-inch diameter Hollow-Stem Auger 140-lb. Automatic Hammer, 30-inch drop Modified California Sampler used unless otherwise noted SPT=Standard Penetration Test
				-		
				6 --		
				-		
				7 --		
7.5	34	13.3	117.2	-		
				8 --		
				-		
				9 --		
				-		
10	16	28.4	SPT	10 --		
				-	CL	NATIVE SOILS: Silty Clay, gray, moist, stiff
				11 --		
				-		
				12 --		
12.5	25	22.9	99.7	-		
				13 --		
				-		
				14 --		
				-		
15	14	20.7	SPT	15 --		
				-		dark to dark gray
				16 --		
				-		
				17 --		
17.5	24	20.0	109.6	-		
				18 --		
				-		
				19 --		
				-		
20	11	19.6	SPT	20 --		
				-		
				21 --		
				-		
				22 --		
22.5	40	19.9	112.2	-		
				23 --		Sandy to Silty Clay, dark brown, moist, stiff
				-		
				24 --		
				-		
25	15	7.8	SPT	25 --		
				-	SP	Sand, dark and yellowish brown, moist, medium dense, fine grained

BORING LOG NUMBER 31

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				26 --		
				-		
				27 --		
27.5	72	18.6	113.7	-		
				28 --	SM	Silty Sand, dark and yellowish brown, moist, dense, fine grained
				-		
				29 --		
				-		
30	19	19.7	SPT	30 --		
				-	SM/SP	Silty Sand to Sand, dark and yellowish brown, moist to wet,
				31 --		medium dense, fine grained
				-		
				32 --		
32.5	72	24.4	101.5	-		
				33 --		
				-		
				34 --		
				-		
35	25	23.7	SPT	35 --		
				-	SM	Silty Sand, dark and yellowish brown, moist, dense, fine grained
				36 --		
				-		
				37 --		
37.5	52	32.5	92.2	-		
				38 --	SM/ML	Silty Sand to Sandy Silt, dark and yellowish brown, moist,
				-		medium dense, fine grained
				39 --		
				-		
40	20	22.9	SPT	40 --		
				-	CL	Sandy Clay, dark and yellowish brown, moist, stiff
				41 --		
				-		
				42 --		
42.5	53	17.7	113.0	-		
				43 --	SM	Silty Sand, dark and gray, moist, medium dense, fine grained
				-		
				44 --		
				-		
45	37	19.8	SPT	45 --		
				-	SM/ML	Silty Sand to Sandy Silt, dark and yellowish brown, moist,
				46 --		medium dense, stiff, fine grained
				-		
				47 --		
47.5	76	23.2	101.0	-		
				48 --	SM/SP	Silty Sand to Sand, dark and gray, wet, dense, fine grained
				-		
				49 --		
				-	SP	Sand, dark and gray, wet, medium dense, fine grained
50	40	25.4	SPT	50 --		
				-		Total Depth 50 feet
						Water at 30 feet
						Fill to 10½ feet

BORING LOG NUMBER 32

Faring — **Date: 09/27/19**

File No. 21850 — **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		3-inch Asphalt over 4-inch Base
				-		
				1 --		FILL: Clayey Silt to Silty Clay, dark brown and gray, moist, stiff
				-		
				2 --		
2.5	19	14.7	116.4	-		
				3 --		
				-		
				4 --		
				-		
5	23	13.9	105.1	5 --		
				-		
				6 --		
				-		
				7 --		
7.5	34	21.6	84.0	-		
				8 --		
				-		
				9 --		
				-		
10	25	19.2	107.0	10 --		
				-	ML/CL	NATIVE SOILS: Clayey Silt to Silty Clay, dark brown, moist, stiff
				11 --		
				-		
				12 --		
				-		
				13 --		
				-		
				14 --		
				-		
15	21	20.7	103.5	15 --		
				-	CL	Silty Clay, dark gray to gray, moist, stiff
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-		
20	25	17.4	110.9	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 10 feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 33

Faring **Date: 10/03/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		5-inch Asphalt over 2-inch Base
				-		
				1 --		FILL: Sandy Silt to Silty Clay, dark brown and gray, moist, stiff
				-		
				2 --		
2.5	33	12.3	120.8	-		
				3 --		Silty Sand to Sandy Silt, gray to dark gray, medium dense, fine grained
				-		
				4 --		
				-		
5	37	14.8	117.9	5 --		
				-		Silty Sand, dark brown and gray, few concrete fragments
				6 --		
				-		
				7 --		
7.5	32	15.6	110.1	-		
				8 --		Silty Sand to Sandy Silt, gray and dark gray
				-		
				9 --		
				-		
10	27	16.5	112.5	10 --		
				-	SM/ML	NATIVE SOILS: Silty Sand to Sandy Silt, gray, moist, medium dense, stiff, fine grained
				11 --		
				-		
				12 --		
12.5	23	30.2	96.7	-		
				13 --	CL	Silty Clay, gray, moist, stiff
				-		
				14 --		
				-		
15	21	37.9	83.5	15 --		
				-		
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-		
20	20	36.0	82.8	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 10 feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 34

Faring **Date: 10/02/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		6-inch Asphalt over 3-inch Base
				-		
				1 --		FILL: Clayey Silt to Silty Clay, dark brown and gray, moist, stiff
				-		
				2 --		
2.5	21	22.6	107.0	-		
				3 --		Silty Clay
				-		
				4 --		
				-		
5	41	20.7	108.4	5 --		
				-		
				6 --		
				-		
				7 --		
7.5	83	16.6	Disturbed	-		
				8 --		Clayey Silt to Silty Clay, some brick fragments
				-		
				9 --		
				-		
10	50/3"	32.5	87.4	10 --		
				-		
				11 --		
				-		
12	24	37.0	85.1	12 --		
				-	ML	NATIVE SOILS: Sandy to Clayey Silt, gray, moist, stiff
				13 --		
				-		
				14 --	CL	Silty Clay, dark and gray, moist, stiff
				-		
15	53	29.8	99.2	15 --		
				-		
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		Silty Sand to Sandy Silt, gray, moist, medium dense, stiff, fine grained
				-	SM/ML	
20	36	16.3	111.1	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 12 feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate boundary between earth types; the transition may be gradual.
				-		
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 35

Faring **Date: 10/03/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

sm

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		4-inch Asphalt over 4-inch Base
				-		
				1 --		FILL: Sandy Silt, dark brown, moist, stiff
				-		
				2 --		
2.5	22	17.3	110.0	-		
				3 --		Sandy to Clayey Silt, dark brown and dark gray, few brick asphalt and concrete fragments
				-		
				4 --		
				-		
5	29	17.6	114.2	5 --		
				-		Silty Sand, gray to dark gray, medium dense, fine grained
				6 --		
				-		
				7 --		
7.5	28	17.7	112.3	-		
				8 --		Sandy Silt to Silty Sand, few wood fragments
				-		
				9 --		
				-		
10	27	24.9	99.6	10 --		
				-		Clayey Silt to Silty Clay
				11 --		
				-		
				12 --		
12.5	38	36.3	84.8	-		
				13 --	ML/CL	NATIVE SOILS: Clayey Silt to Silty Clay, gray to dark gray, moist, stiff
				-		
				14 --		
				-		
15	28	33.3	85.6	15 --		
				-	CL	Silty Clay, gray, moist, stiff
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		Clayey Silt to Silty Clay, dark brown and gray, moist, stiff
				-	ML/CL	
20	35	21.2	104.6	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 12.5 feet
				22 --		
				-		NOTE: The stratification lines represent the approximate
				23 --		boundary between earth types; the transition may be gradual.
				-		
				24 --		Used 8-inch diameter Hollow-Stem Auger
				-		140-lb. Automatic Hammer, 30-inch drop
				25 --		Modified California Sampler used unless otherwise noted
				-		

BORING LOG NUMBER 36

Faring | **Date: 10/03/19**

File No. 21850 | **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		3½-inch Asphalt over 3½-inch Base
				-		
				1 --		FILL: Sandy Silt, dark brown and gray, moist, stiff
				-		
				2 --		
2.5	58	14.2	117.1	-		
				3 --		Sandy to Clayey Silt, dark gray and gray, moist, stiff, few construction debris
				-		
				4 --		
				-		
5	35	18.0	109.5	5 --		
				-		Silty Sand to Sandy Silt, medium dense, fine grained
				6 --		
				-		
				7 --		
7.5	36	20.8	105.7	-		
				8 --		Clayey Silt to Silty Clay
				-		
				9 --		
				-		
10	38	18.9	111.3	10 --		
				-		Silty Sand to Silty Clay, medium dense
				11 --		
				-		
				12 --		
12.5	32	No Recovery		-		
				13 --	ML/CL	NATIVE SOILS: Clayey Silt to Silty Clay, gray, moist, stiff
				-		
				14 --		
				-		
15	26	39.6	81.8	15 --		
				-		
				16 --		
				-		
				17 --		
				-		
				18 --		
				-		
				19 --		
				-	CL	Silty Clay, gray, moist, stiff
20	23	38.8	82.3	20 --		
				-		Total Depth 20 feet
				21 --		No Water
				-		Fill to 12½ feet
				22 --		
				-		
				23 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				24 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				25 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted

BORING LOG NUMBER 37

Faring **Date: 11/03/19**

File No. 21850 **Method: 8-inch diameter Hollow Stem Auger**

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description Surface Conditions: Asphalt for Street
				0 --		4-inch Asphalt over 4-inch Base
				-		
				1 --		FILL: Clayey Silt to Silty Clay, dark gray, moist, stiff
				-		
				2 --		
2.5	28	23.6	102.7	-		
				3 --		Silty Sand, gray to dark gray, medium dense, minor gravel
				-		
				4 --		
				-		
5	9	17.3	SPT	5 --		
				-		Silty Sand to Sandy Silt, stiff, few concrete fragments
				6 --		
				-		
				7 --		
7.5	34	16.2	111.3	-		
				8 --		Sandy Silt to Silty Clay
				-		
				9 --		
				-		
10	12	15.2	SPT	10 --		
				-	CL	NATIVE SOILS: Silty Clay, gray and dark brown, moist, stiff
				11 --		
				-		
				12 --		
12.5	47	15.6	118.7	-		
				13 --		
				-		
				14 --		
				-		
15	14	16.8	SPT	15 --		
				-	CL	Sandy Clay, dark brown and gray, moist, stiff
				16 --		
				-		
				17 --		
17.5	43	16.7	115.7	-		
				18 --		
				-		
				19 --		
				-		
20	15	11.5	SPT	20 --		
				-	SP	Sand, dark and yellowish brown, moist, medium dense, fine grained
				21 --		
				-		
				22 --		
22.5	72	21.4	100.5	-		
				23 --		dark brown and gray, very moist, medium dense to dense
				-		
				24 --		
				-		
25	21	17.8	SPT	25 --		
				-		wet, medium dense

BORING LOG NUMBER 37

Faring

File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				26 --		
				27 --		
27.5	72	22.9	98.2	-		
				28 --		dark brown, dense
				29 --		
30	36	21.7	SPT	30 --		
				-	SM/ML	Silty Sand to Sand, dark brown and gray, wet, medium dense, stiff, fine grained
				31 --		
				32 --		
32.5	48	6.5	115.5	-		
				33 --		
				34 --		
35	26	25.2	SPT	35 --		
				-	CL	Clayey Silt to Silty Clay, dark brown and gray, moist, stiff
				36 --		
				37 --		
37.5	48	20.2	110.3	-		
				38 --	SM/ML	Silty Sand to Sandy Silt, dark brown and gray, wet, medium dense, stiff, fine grained
				39 --		
40	23	No Recovery	SPT	40 --		
				41 --		
				42 --		
42.5	59	20.9	107.8	-		
				43 --	SM/SP	Silty Sand to Sand, dark brown and gray, wet, dense, fine grained
				44 --		
45	30	23.1	SPT	45 --		
				-	SM/ML	Silty Sand to Sandy Silt, dark brown and gray, moist to wet, medium dense, stiff, fine grained
				46 --		
				47 --		
47.5	50	25.2	101.2	-		
				48 --		
				49 --		
50	29	26.2	SPT	50 --		

BORING LOG NUMBER 37

Faring

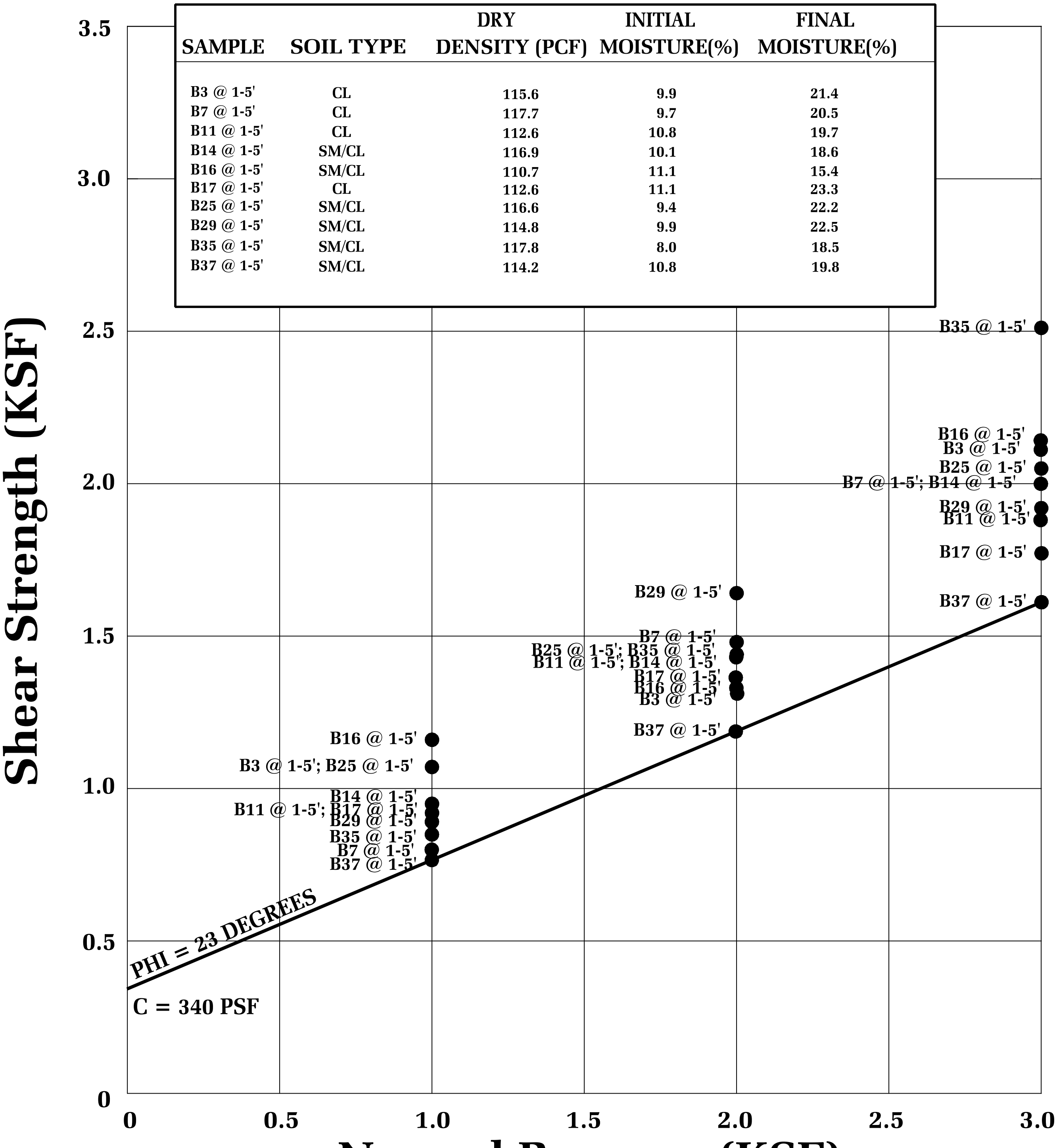
File No. 21850

km

Sample Depth ft.	Blows per ft.	Moisture content %	Dry Density p.c.f.	Depth in feet	USCS Class.	Description
				-		
				51 --		
				-		
				52 --		
52.5	45	37.1	87.5	-		
	50/5"			53 --	ML/CL	Clayey Silt to Silty Clay, gray, moist, very stiff
				-		
				54 --		
				-		
55	10	37.8	SPT	55 --		
				-	CL	Silty Clay, gray, moist, stiff
				56 --		
				-		
				57 --		
57.5	40	19.8	111.4	-		
	50/5"			58 --		
				-		
				59 --		
				-		
60	28	38.5	SPT	60 --		
				-	ML/CL	Clayey Silt to Silty Clay, gray, moist, stiff
				61 --		
				-		
				62 --		
62.5	83	45.2	76.3	-		
				63 --	CL	Silty Clay, gray, moist, stiff
				-		
				64 --		
				-		
65	30	18.0	SPT	65 --		
				-	SM/ML	Silty Sand to Sandy Silt, gray, moist, medium dense, stiff, fine
				66 --		grained
				-		
				67 --		
67.5	40	18.8	116.0	-		
	50/4"			68 --	CL	Silty Clay, dark and gray, moist, very stiff
				-		
				69 --		
				-		
70	35	17.2	SPT	70 --		
				-		Total Depth 70 feet
				71 --		Water at 26 feet
				-		Fill to 10 feet
				72 --		
				-		
				73 --		NOTE: The stratification lines represent the approximate
				-		boundary between earth types; the transition may be gradual.
				74 --		
				-		Used 8-inch diameter Hollow-Stem Auger
				75 --		140-lb. Automatic Hammer, 30-inch drop
				-		Modified California Sampler used unless otherwise noted
						SPT=Standard Penetration Test

BULK SAMPLE REMOLDED TO 90 PERCENT OF THE MAXIMUM LABORATORY DENSITY

SAMPLE	SOIL TYPE	DRY DENSITY (PCF)	INITIAL MOISTURE(%)	FINAL MOISTURE(%)
B3 @ 1-5'	CL	115.6	9.9	21.4
B7 @ 1-5'	CL	117.7	9.7	20.5
B11 @ 1-5'	CL	112.6	10.8	19.7
B14 @ 1-5'	SM/CL	116.9	10.1	18.6
B16 @ 1-5'	SM/CL	110.7	11.1	15.4
B17 @ 1-5'	CL	112.6	11.1	23.3
B25 @ 1-5'	SM/CL	116.6	9.4	22.2
B29 @ 1-5'	SM/CL	114.8	9.9	22.5
B35 @ 1-5'	SM/CL	117.8	8.0	18.5
B37 @ 1-5'	SM/CL	114.2	10.8	19.8



● Direct Shear, Saturated

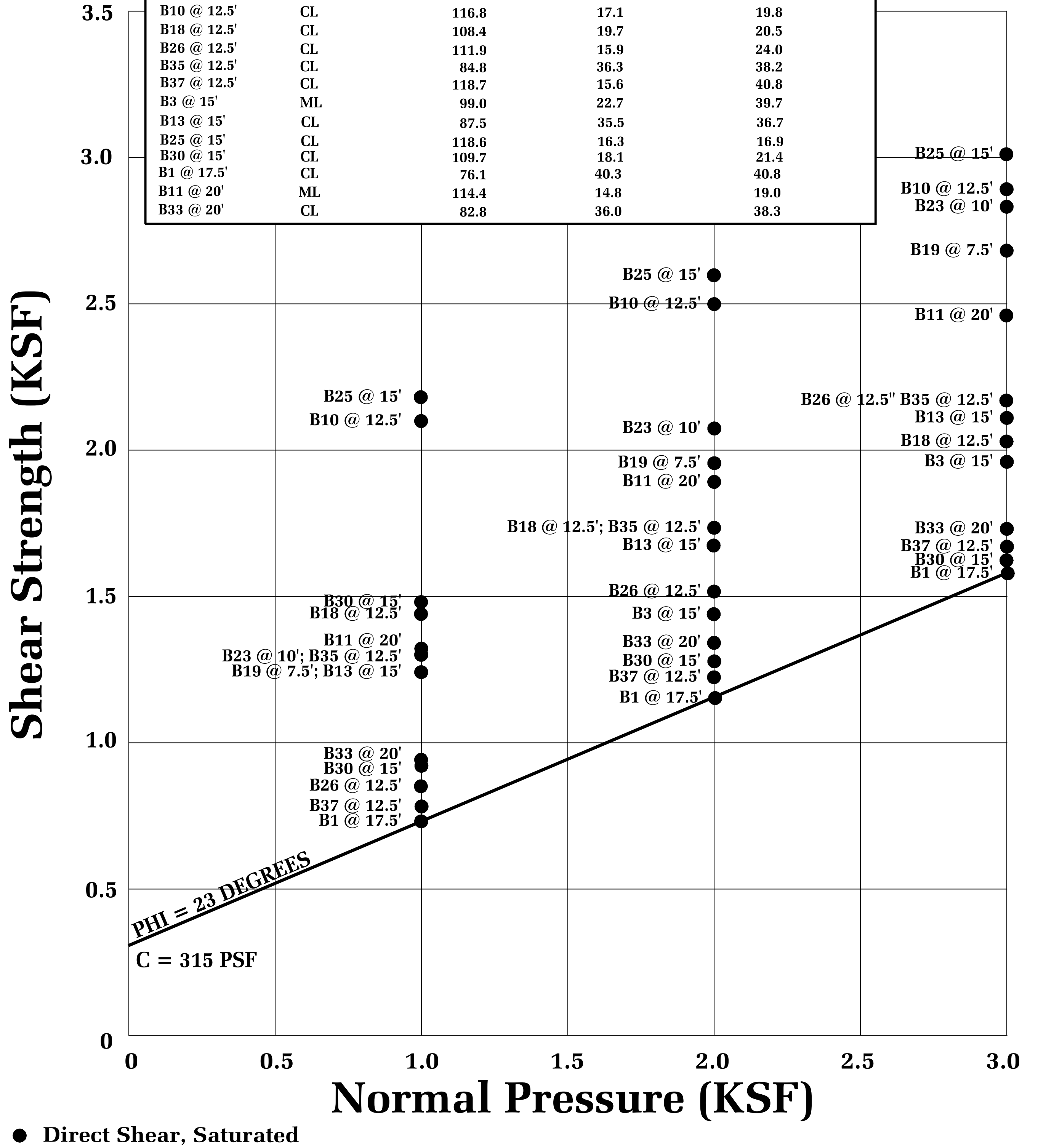
SHEAR TEST DIAGRAM

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | PLATE: B-1

SAMPLE	SOIL TYPE	DRY DENSITY (PCF)	INITIAL MOISTURE(%)	FINAL MOISTURE(%)
B19 @ 7.5'	CL	105.7	18.1	23.4
B23 @ 10'	CL	97.9	26.5	29.1
B10 @ 12.5'	CL	116.8	17.1	19.8
B18 @ 12.5'	CL	108.4	19.7	20.5
B26 @ 12.5'	CL	111.9	15.9	24.0
B35 @ 12.5'	CL	84.8	36.3	38.2
B37 @ 12.5'	CL	118.7	15.6	40.8
B3 @ 15'	ML	99.0	22.7	39.7
B13 @ 15'	CL	87.5	35.5	36.7
B25 @ 15'	CL	118.6	16.3	16.9
B30 @ 15'	CL	109.7	18.1	21.4
B1 @ 17.5'	CL	76.1	40.3	40.8
B11 @ 20'	ML	114.4	14.8	19.0
B33 @ 20'	CL	82.8	36.0	38.3



SHEAR TEST DIAGRAM

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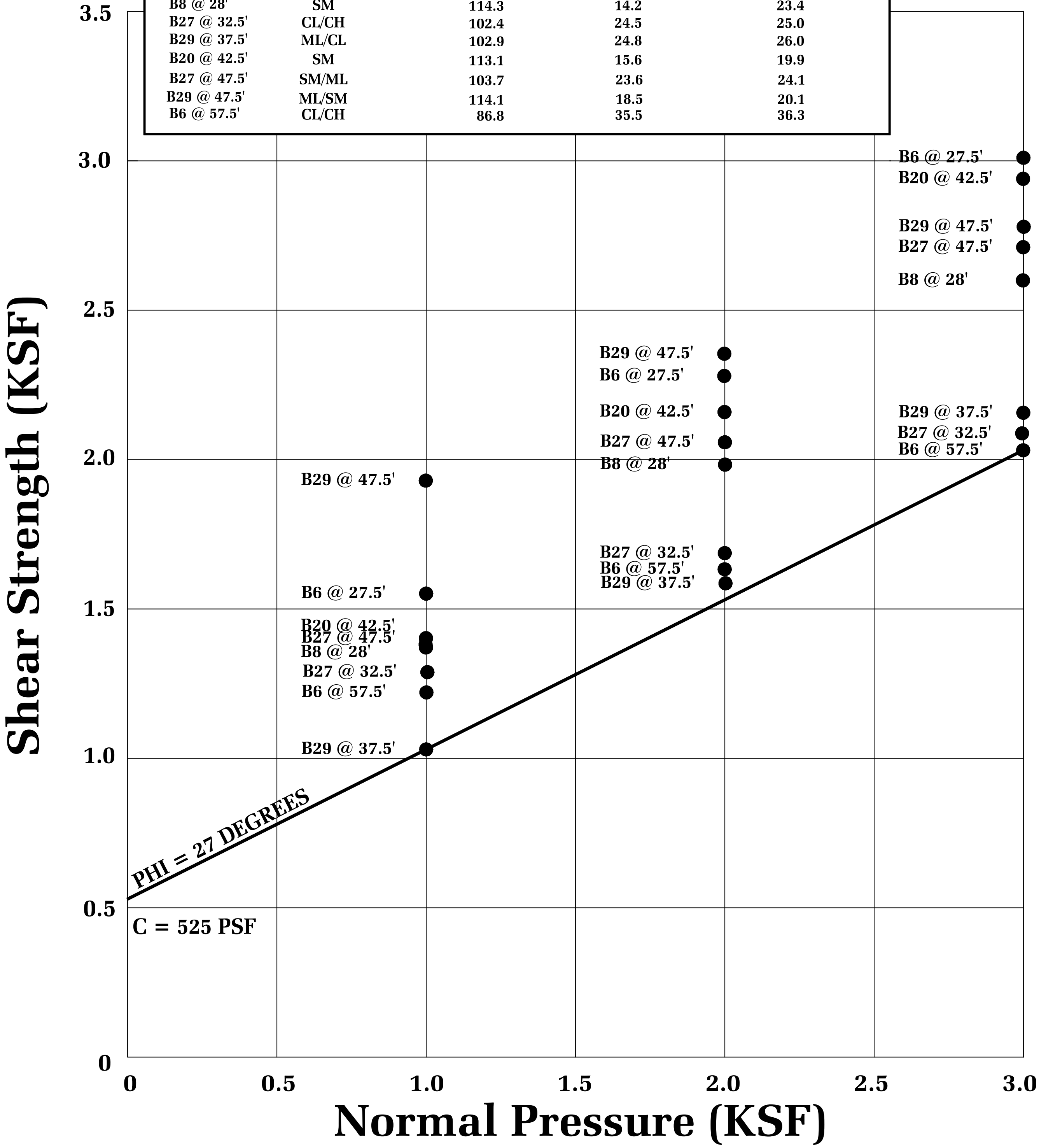
FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: B-2**

SAMPLE	SOIL TYPE	DRY DENSITY (PCF)	INITIAL MOISTURE(%)	FINAL MOISTURE(%)
B6 @ 27.5'	SM	115.1	16.5	16.7
B8 @ 28'	SM	114.3	14.2	23.4
B27 @ 32.5'	CL/CH	102.4	24.5	25.0
B29 @ 37.5'	ML/CL	102.9	24.8	26.0
B20 @ 42.5'	SM	113.1	15.6	19.9
B27 @ 47.5'	SM/ML	103.7	23.6	24.1
B29 @ 47.5'	ML/SM	114.1	18.5	20.1
B6 @ 57.5'	CL/CH	86.8	35.5	36.3



● Direct Shear, Saturated

SHEAR TEST DIAGRAM

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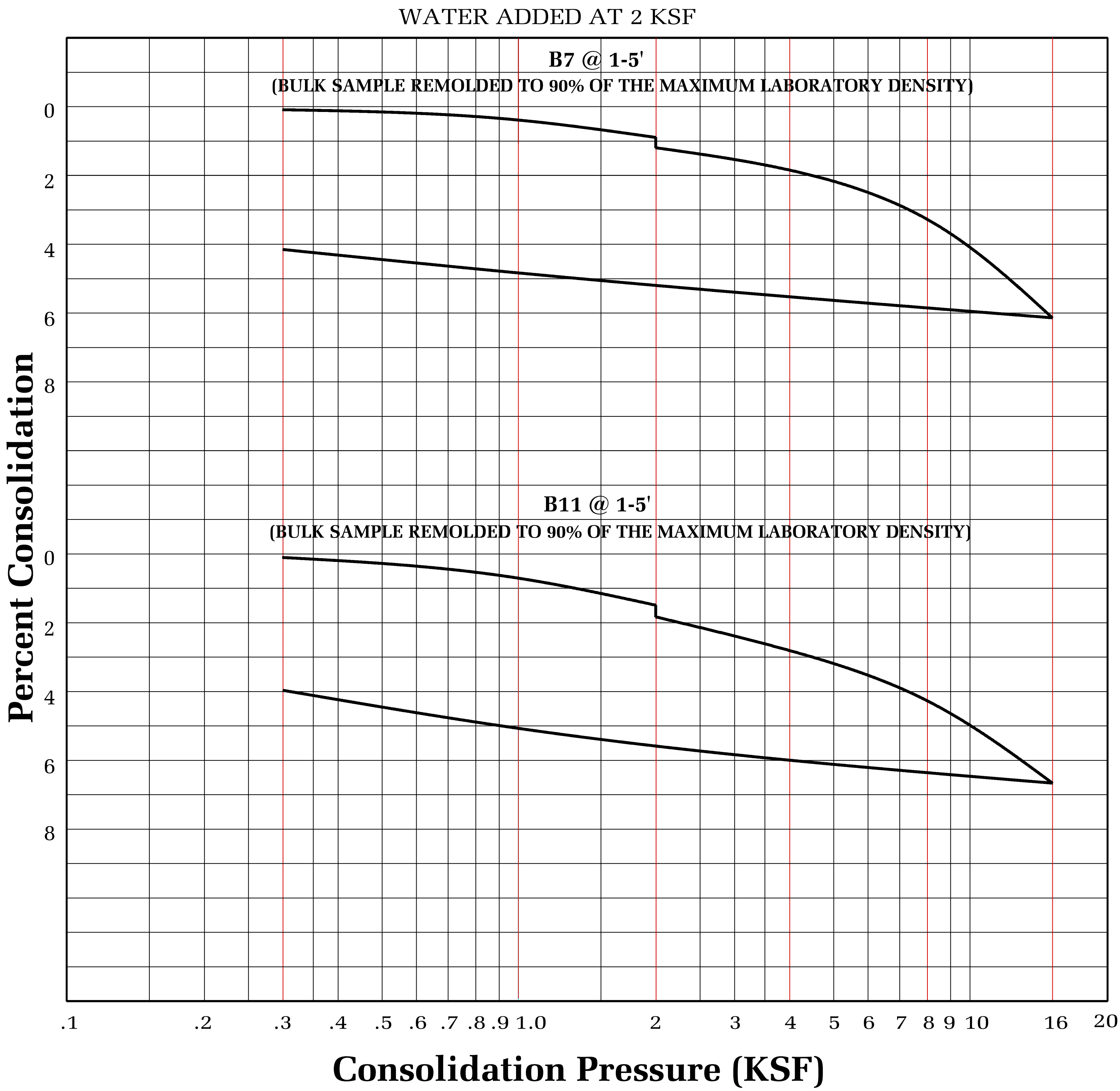
FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: B-3**



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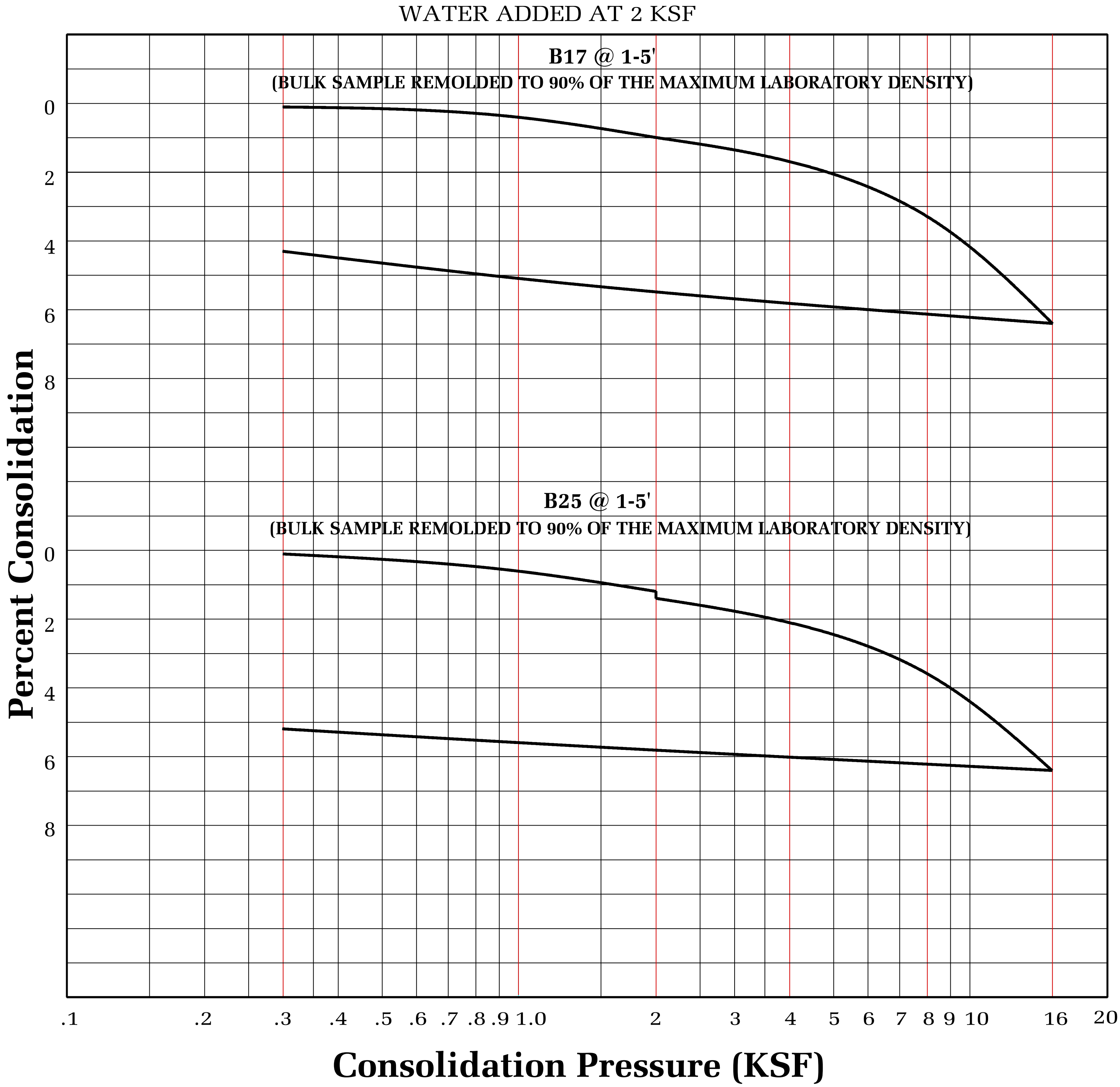
FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: C-1**



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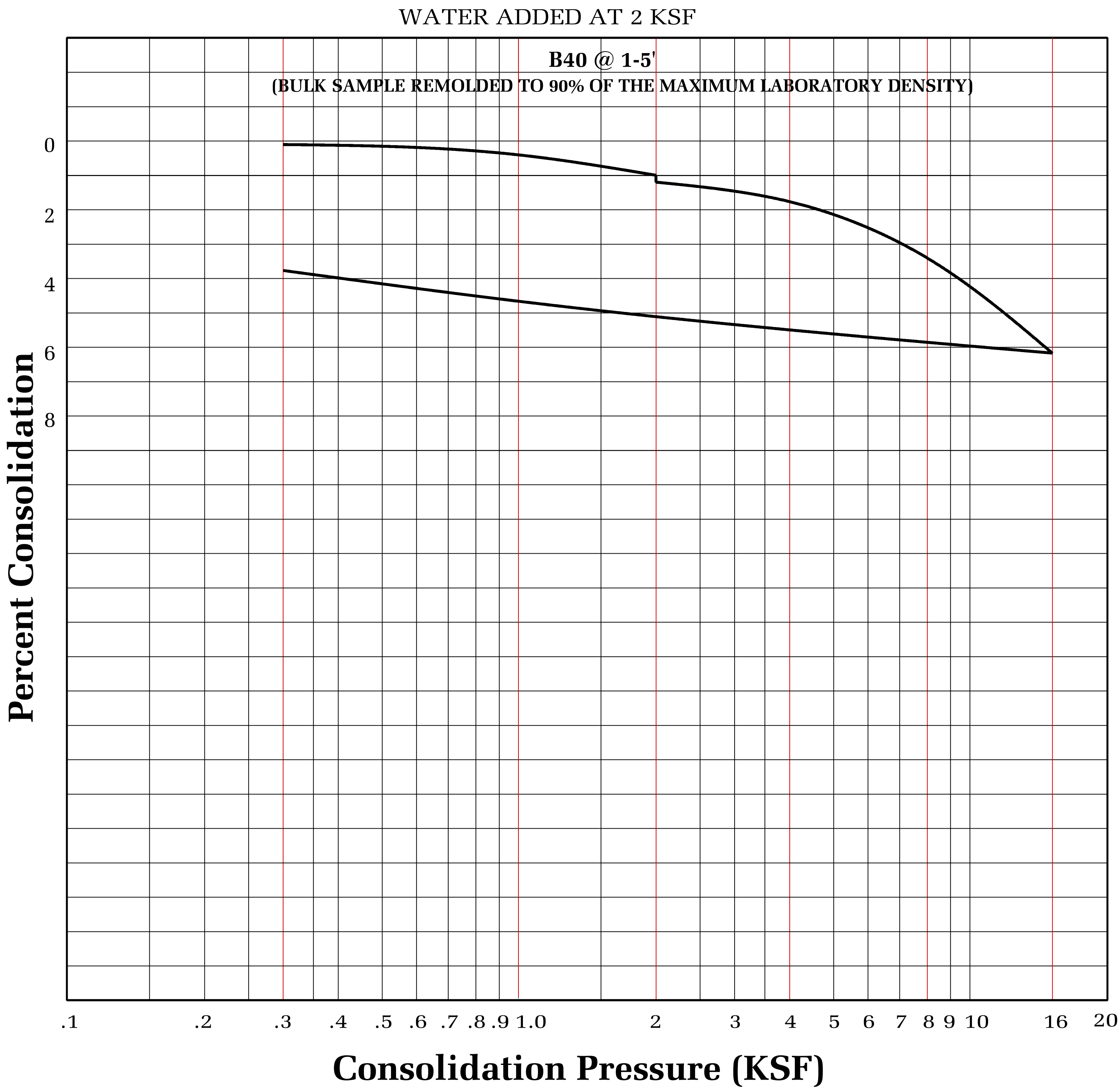
FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850	**PLATE: C-2**



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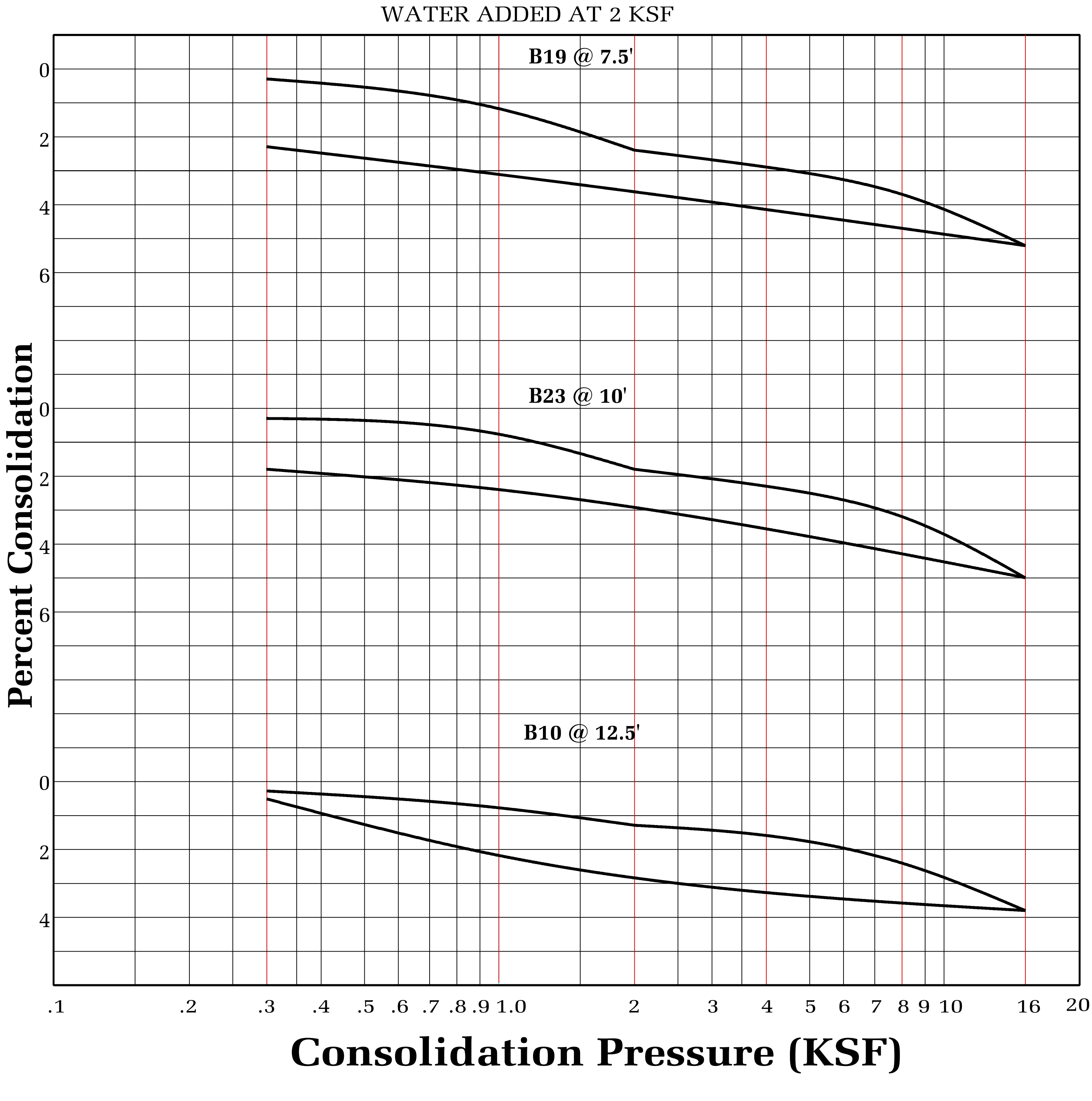
FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: C-3**



CONSOLIDATION TEST

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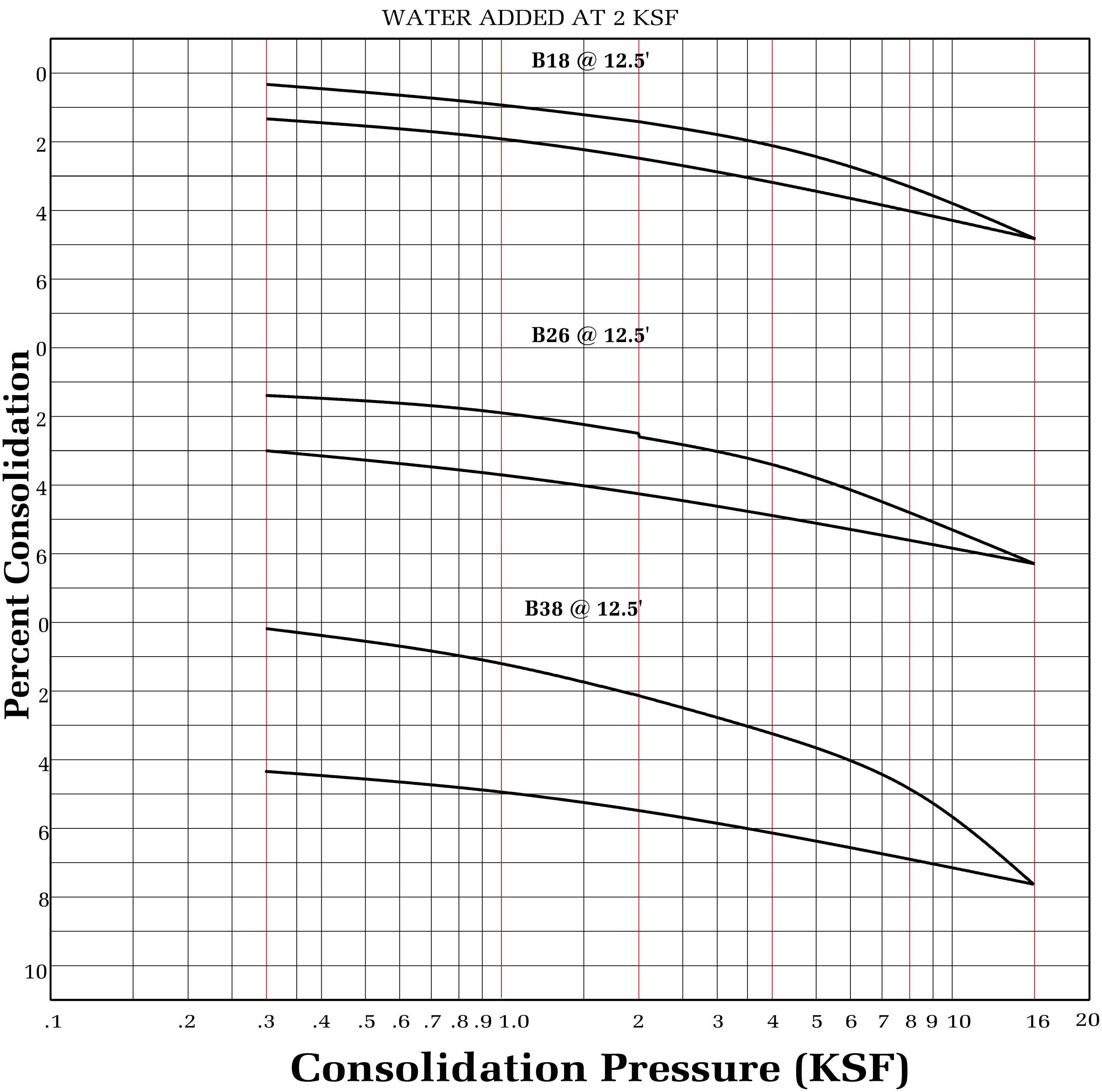
FARING

21207 AVALON BLVD., CARSON

FILE NO. 21850	PLATE: C-4



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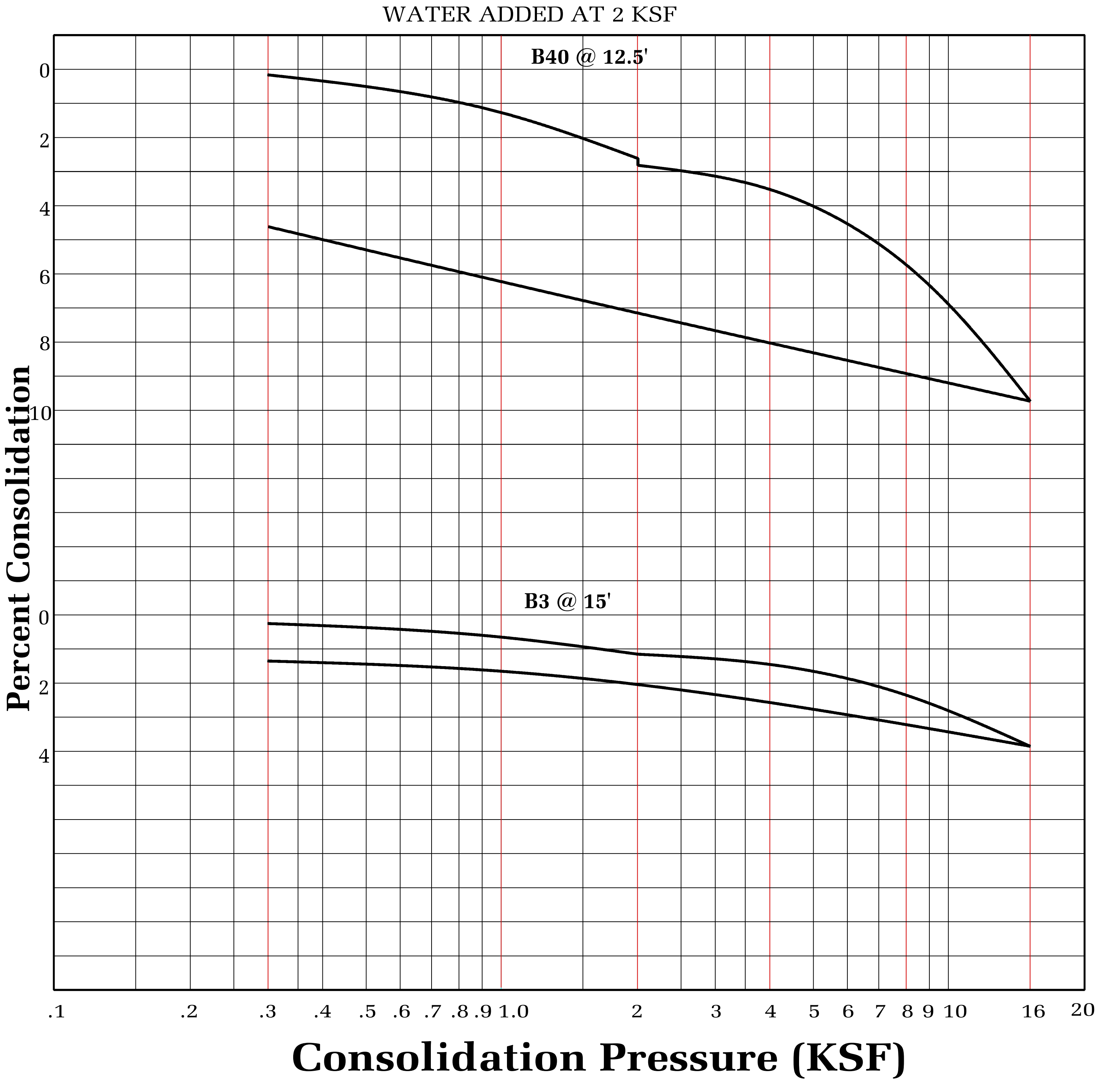
FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850	PLATE: C-5



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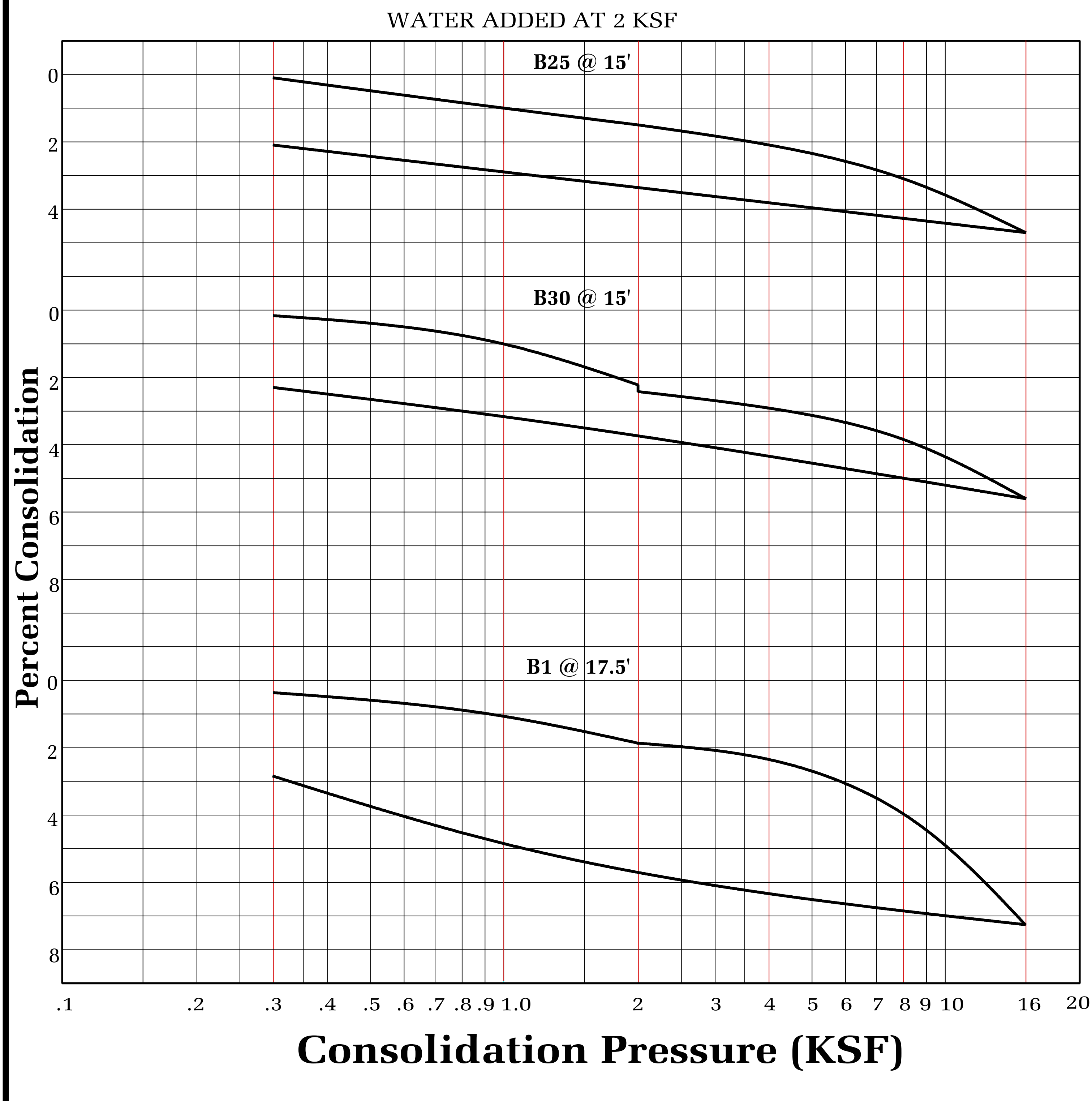
FARING 21207 AVALON BLVD., CARSON	
FILE NO. 21850	**PLATE: C-6**



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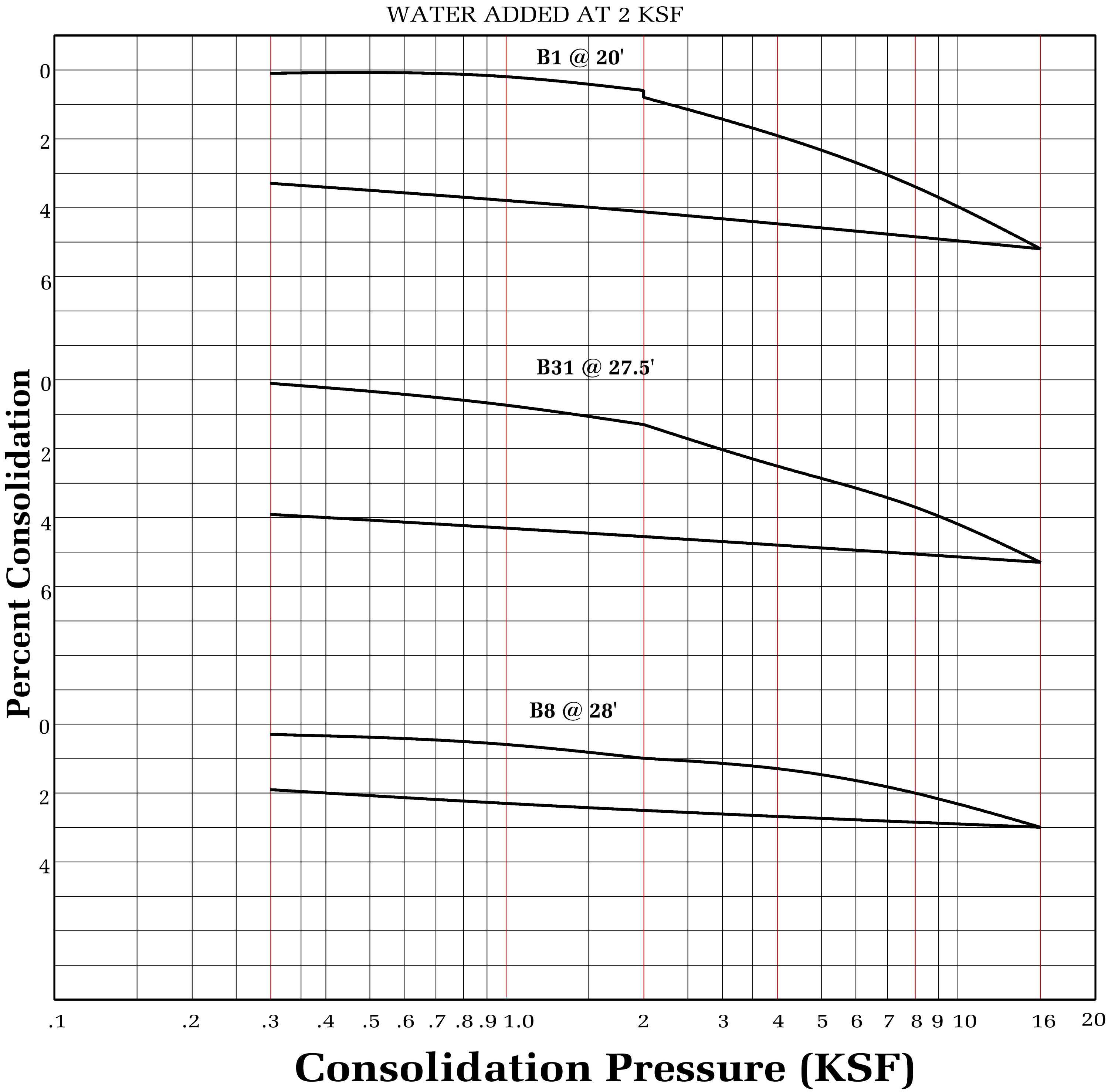
FARING 21207 AVALON BLVD., CARSON	
FILE NO. 21850	**PLATE: C-7**



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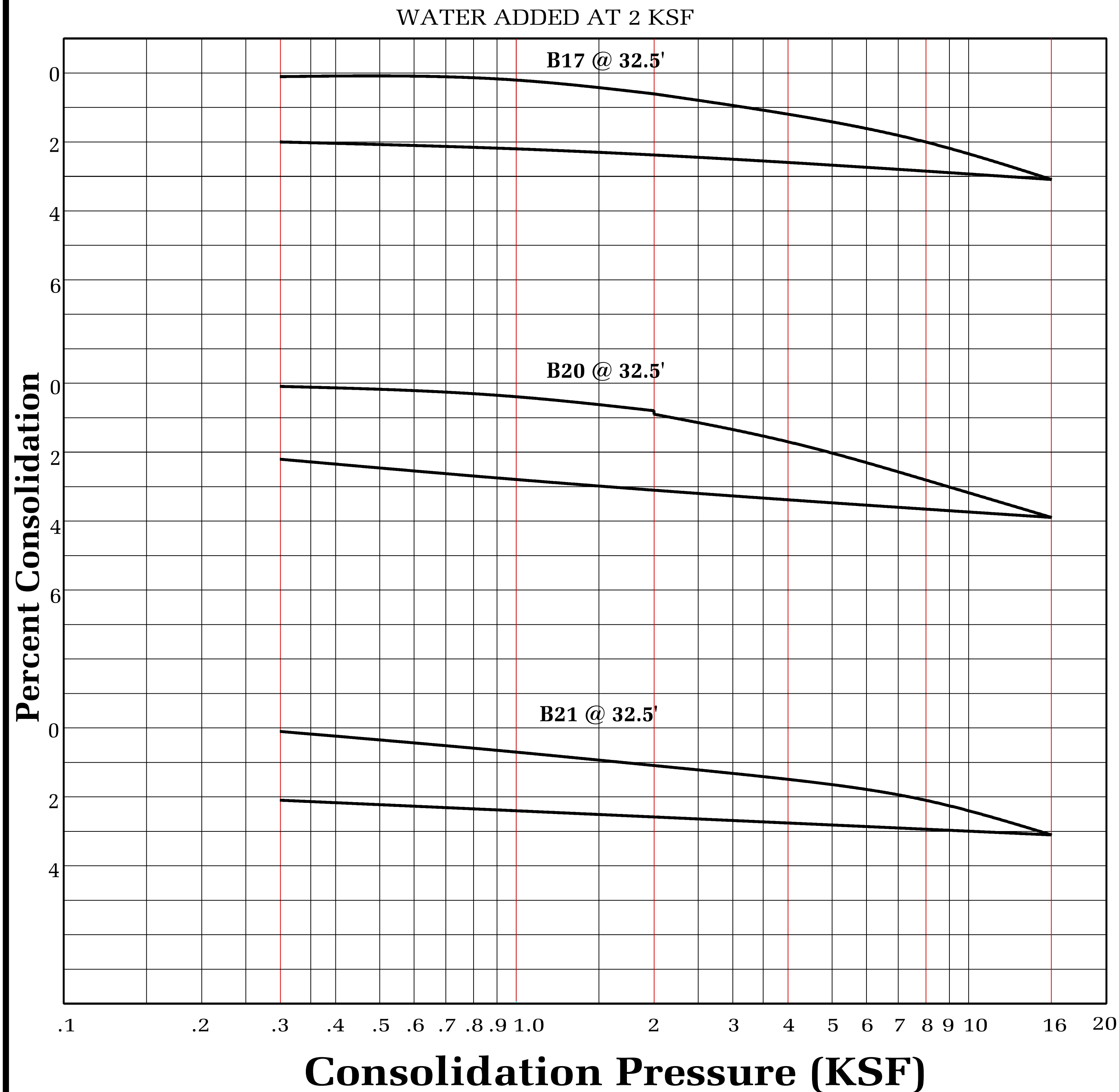
FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850	**PLATE: C-8**

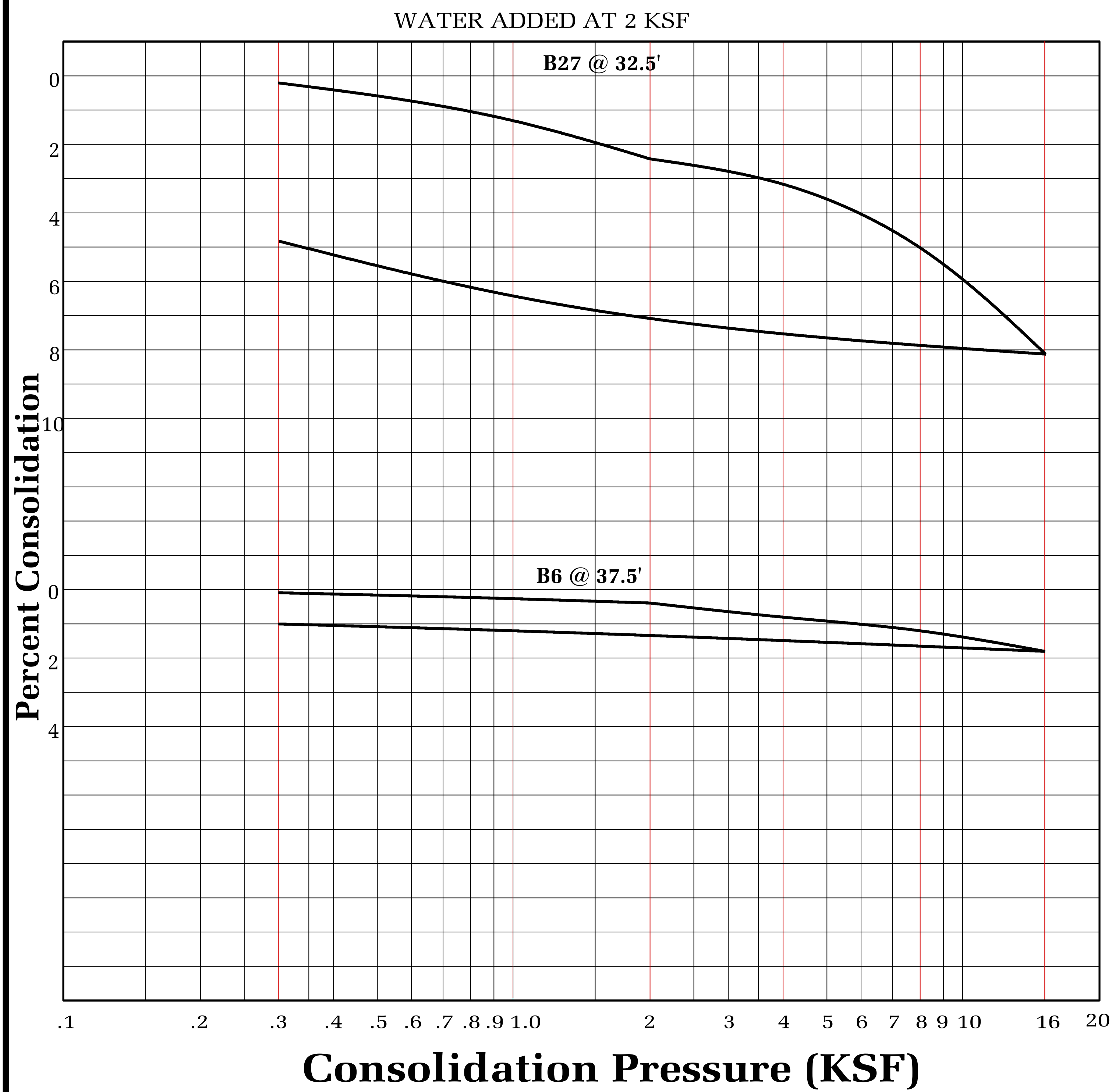


CONSOLIDATION TEST

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: C-9**

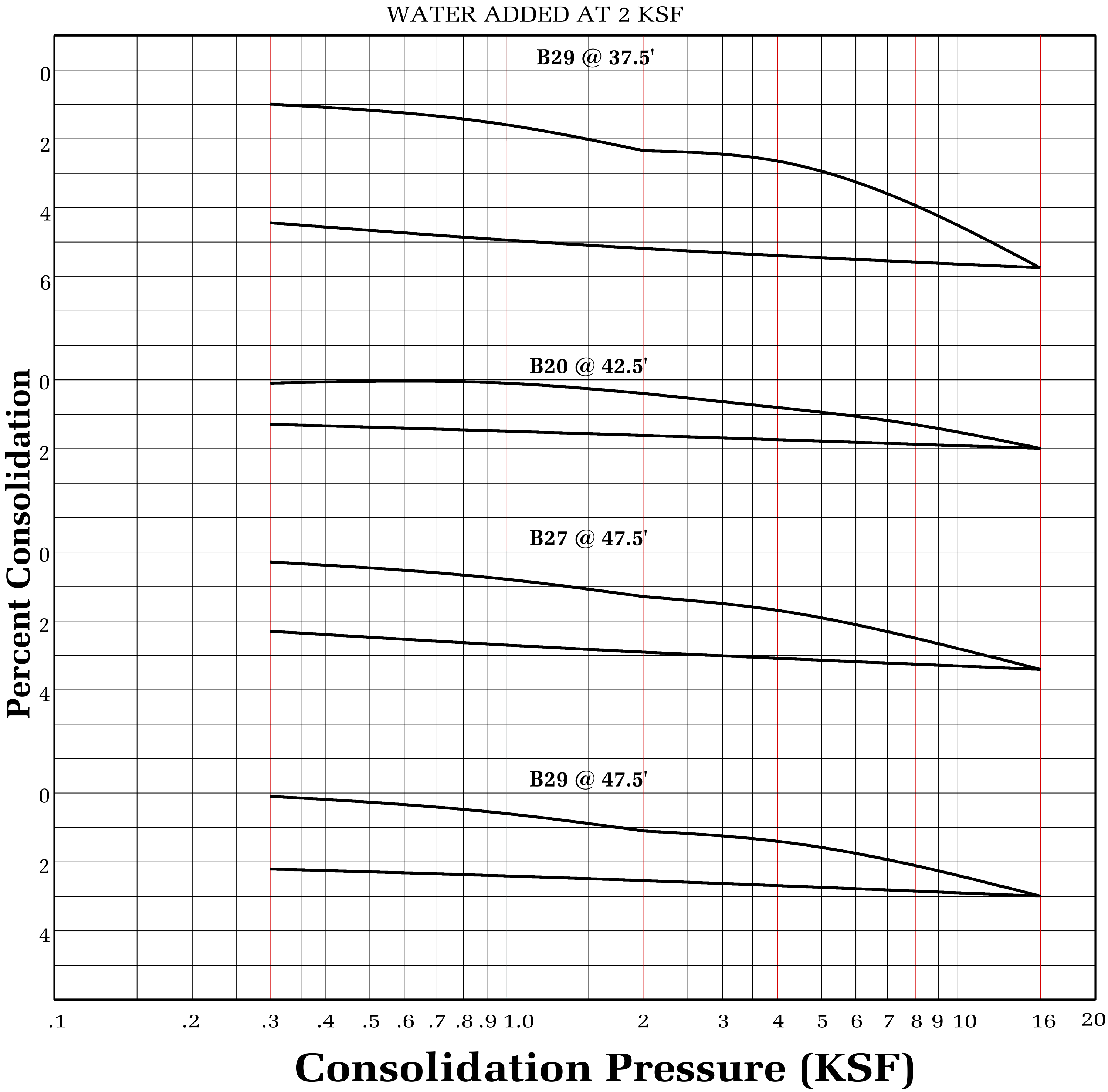


CONSOLIDATION TEST

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850	PLATE: C-10

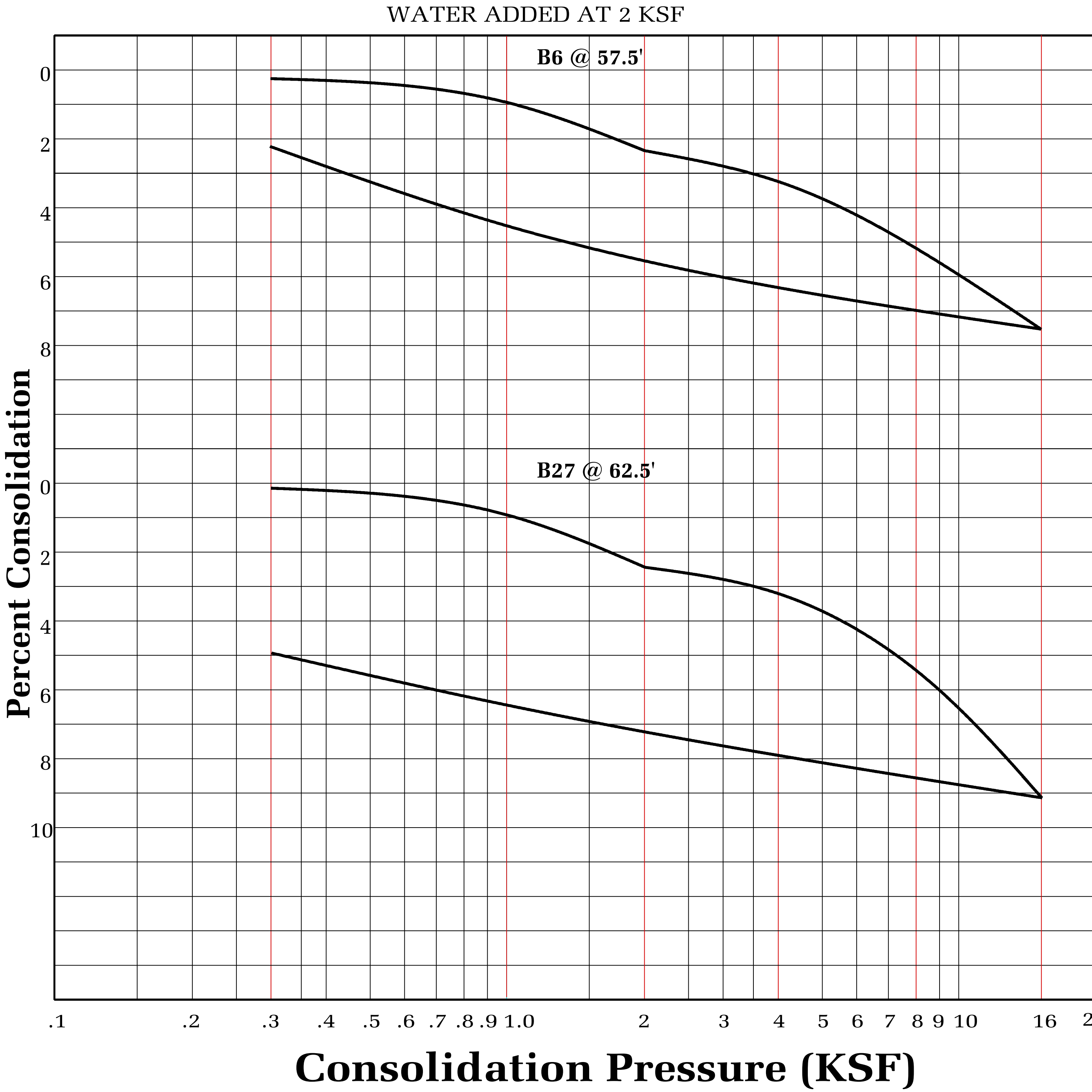


CONSOLIDATION TEST

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: C-11**

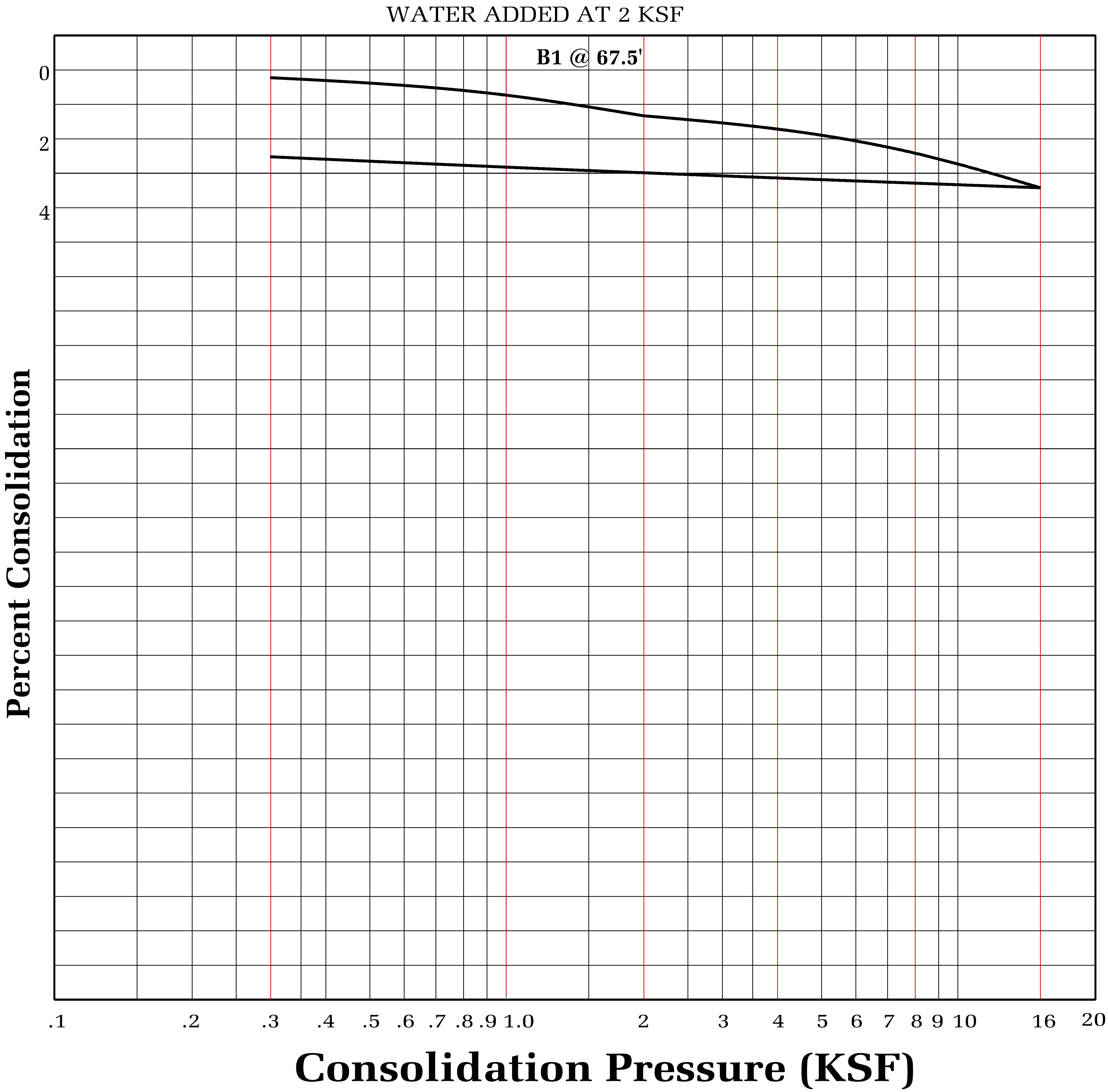


CONSOLIDATION TEST

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850	PLATE: C-12



CONSOLIDATION TEST

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING 21207 AVALON BLVD., CARSON	
FILE NO. 21850	**PLATE: C-13**

ASTM D 1557

SAMPLE	B3 @ 1- 5'	B7 @ 1-5'	B11 @ 1-5'	B14 @ 1-5'	B16 @ 1-5'
SOIL TYPE:	CL	CL	CL	SM/CL	SM/CL
MAXIMUM DENSITY pcf.	128.4	130.8	125.1	129.9	123.0
OPTIMUM MOISTURE %	9.9	9.7	10.8	10.1	11.1

SAMPLE	B17 @ 1- 5'	B25 @ 1-5'	B29 @ 1-5'	B35 @ 1-5'	B37 @ 1-5'
SOIL TYPE:	CL	SM/CL	SM/CL	SM/CL	SM/CL
MAXIMUM DENSITY pcf.	125.1	129.5	127.5	130.9	126.5
OPTIMUM MOISTURE %	11.1	9.4	9.9	8.0	10.8

ASTM D 4829

SAMPLE	B3 @ 1- 5'	B7 @ 1-5'	B11 @ 1-5'	B14 @ 1-5'	B16 @ 1-5'
SOIL TYPE:	CL	CL	CL	SM/CL	SM/CL
EXPANSION INDEX UBC STANDARD 18-2	66	76	69	63	56
EXPANSION CHARACTER	MODERATE	MODERATE	MODERATE	MODERATE	MODERATE

SAMPLE	B17 @ 1- 5'	B25 @ 1-5'	B29 @ 1-5'	B35 @ 1-5'	B37 @ 1-5'
SOIL TYPE:	CL	SM/CL	SM/CL	SM/CL	SM/CL
EXPANSION INDEX UBC STANDARD 18-2	43	58	102	56	75
EXPANSION CHARACTER	LOW	MODERATE	HIGH	MODERATE	MODERATE

SULFATE CONTENT

SAMPLE	B3 @ 1- 5'	B7 @ 1-5'	B11 @ 1-5'	B14 @ 1-5'	B16 @ 1-5'
SULFATE CONTENT: (percentage by weight)	< 0.10%	< 0.10%	< 0.10%	< 0.10%	< 0.20%

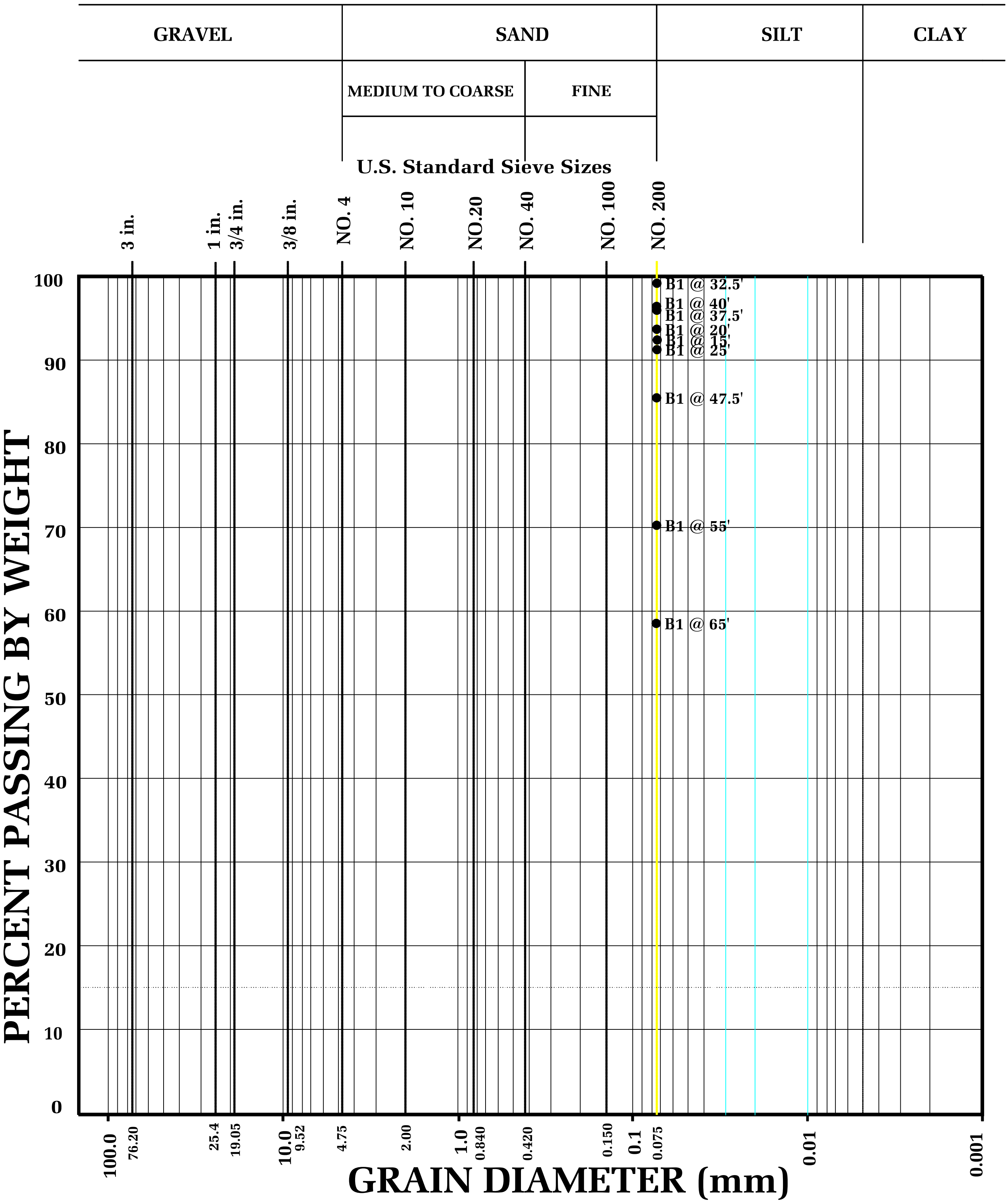
SAMPLE	B17 @ 1- 5'	B25 @ 1-5'	B29 @ 1-5'	B35 @ 1-5'	B37 @ 1-5'
SULFATE CONTENT: (percentage by weight)	< 0.20%	< 0.10%	< 0.10%	< 0.20%	< 0.10%

COMPACTION/EXPANSION DATA SHEET

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | PLATE: D

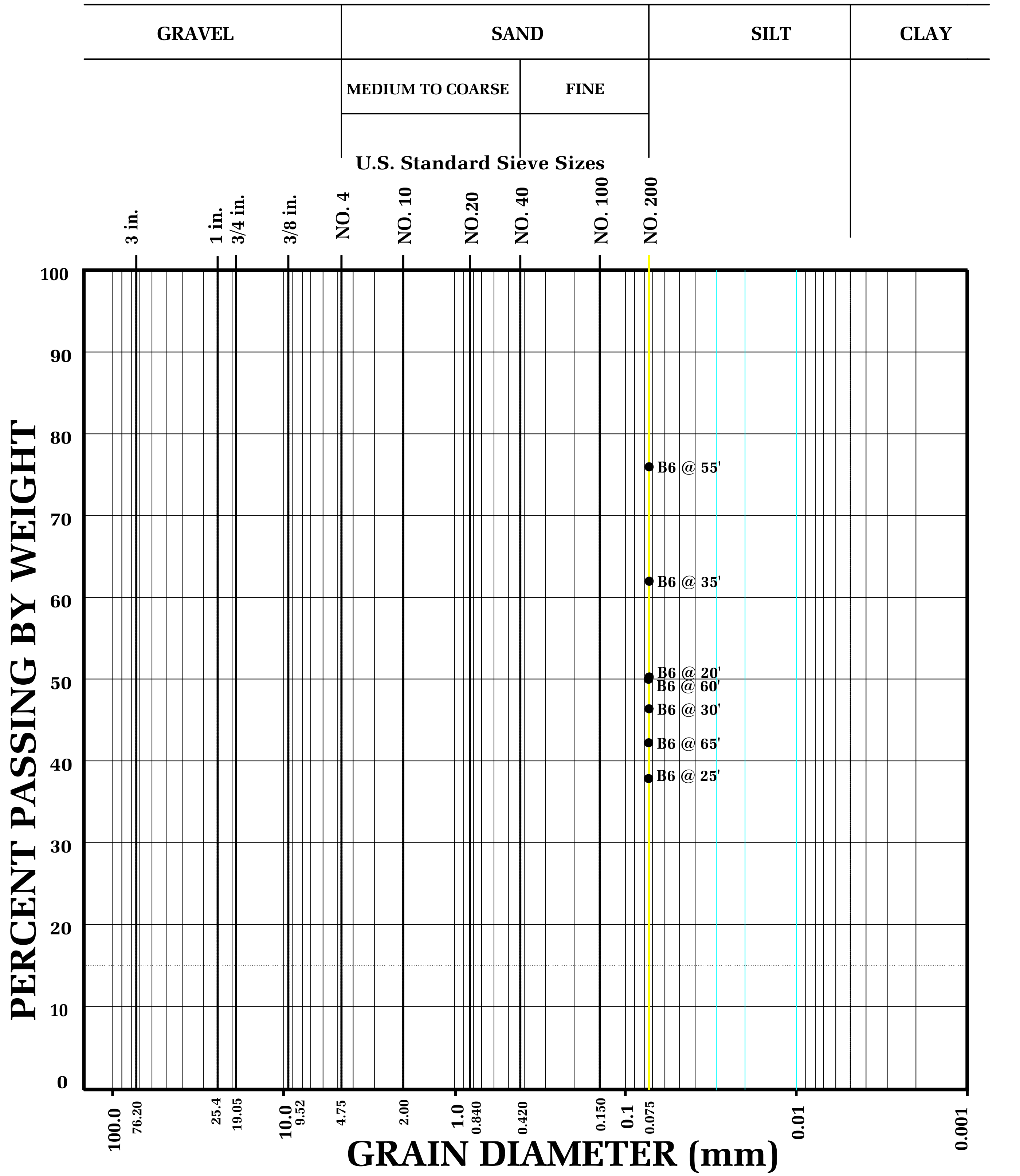


GRAIN SIZE DISTRIBUTION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: E-1**

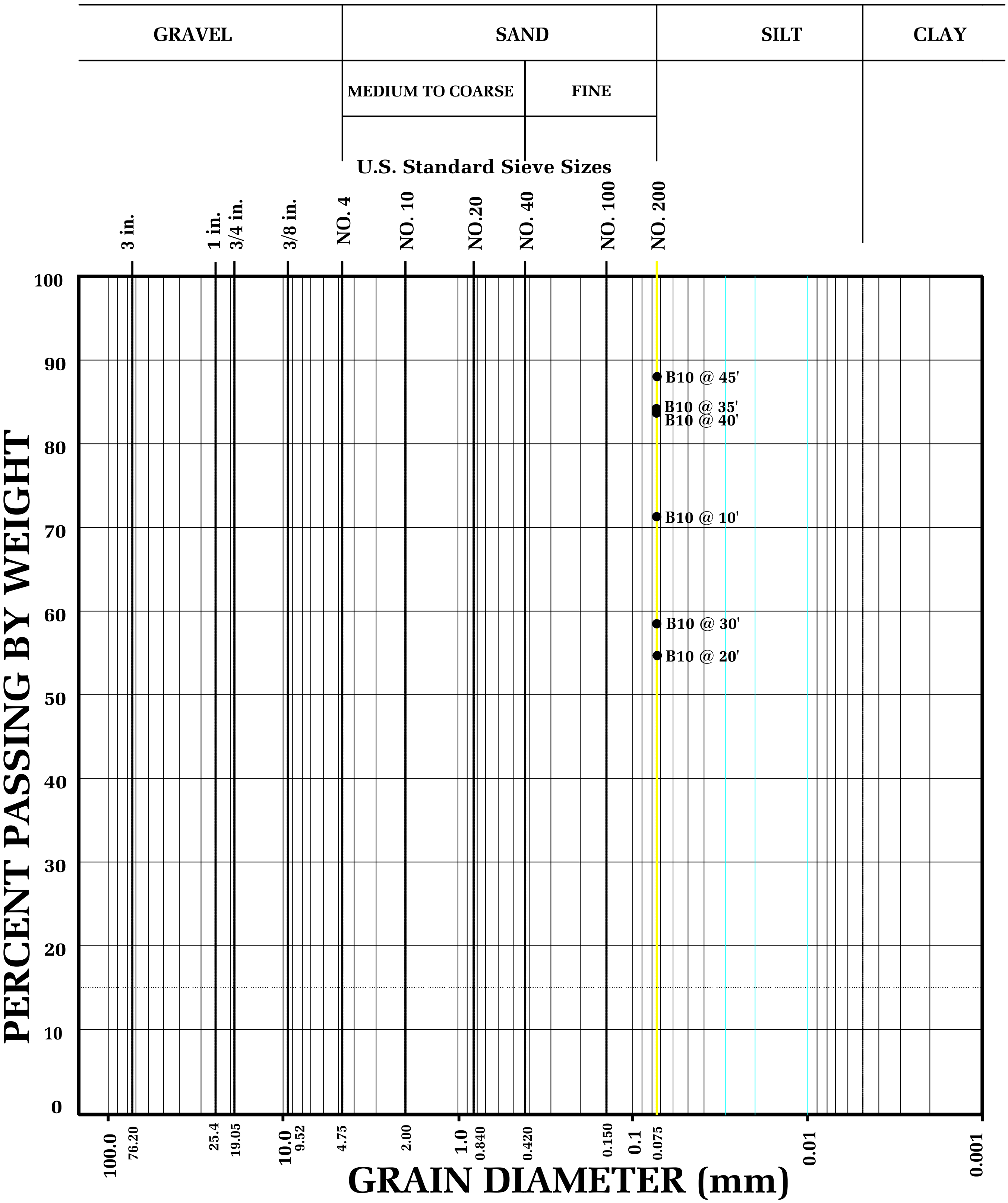


GRAIN SIZE DISTRIBUTION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850	PLATE: E-2

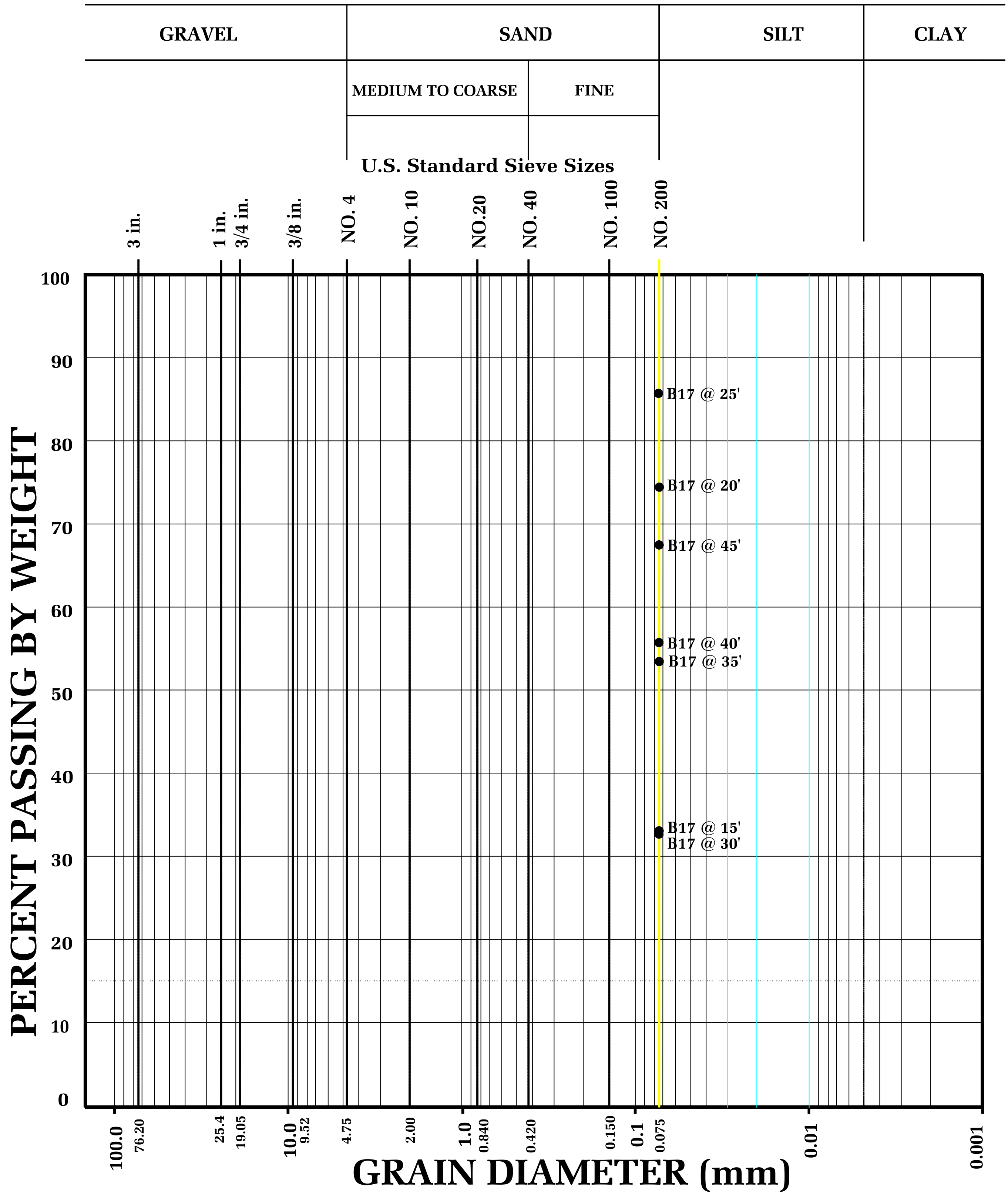


GRAIN SIZE DISTRIBUTION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: E-3**

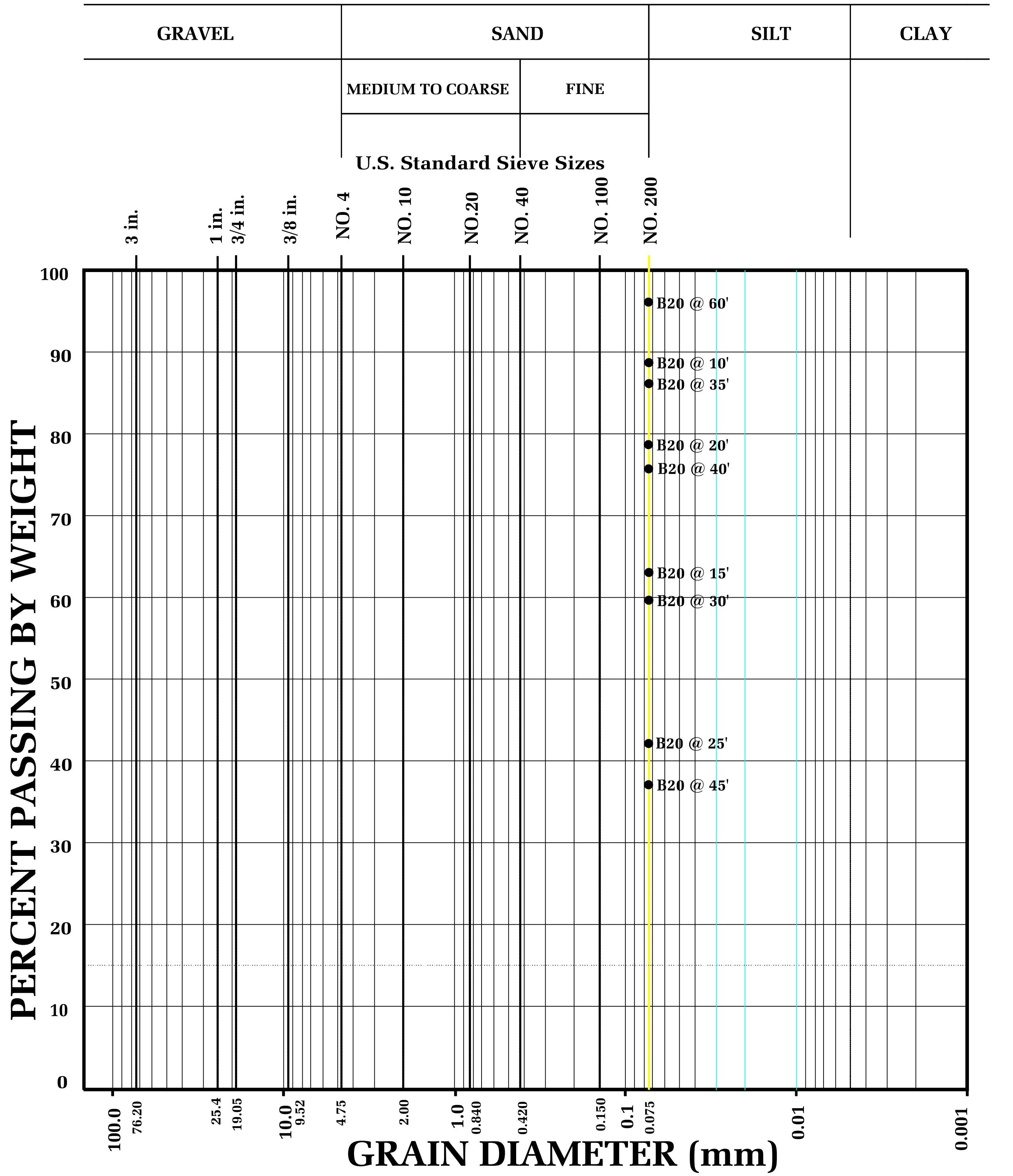


GRAIN SIZE DISTRIBUTION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | PLATE: E-4



GRAIN SIZE DISTRIBUTION

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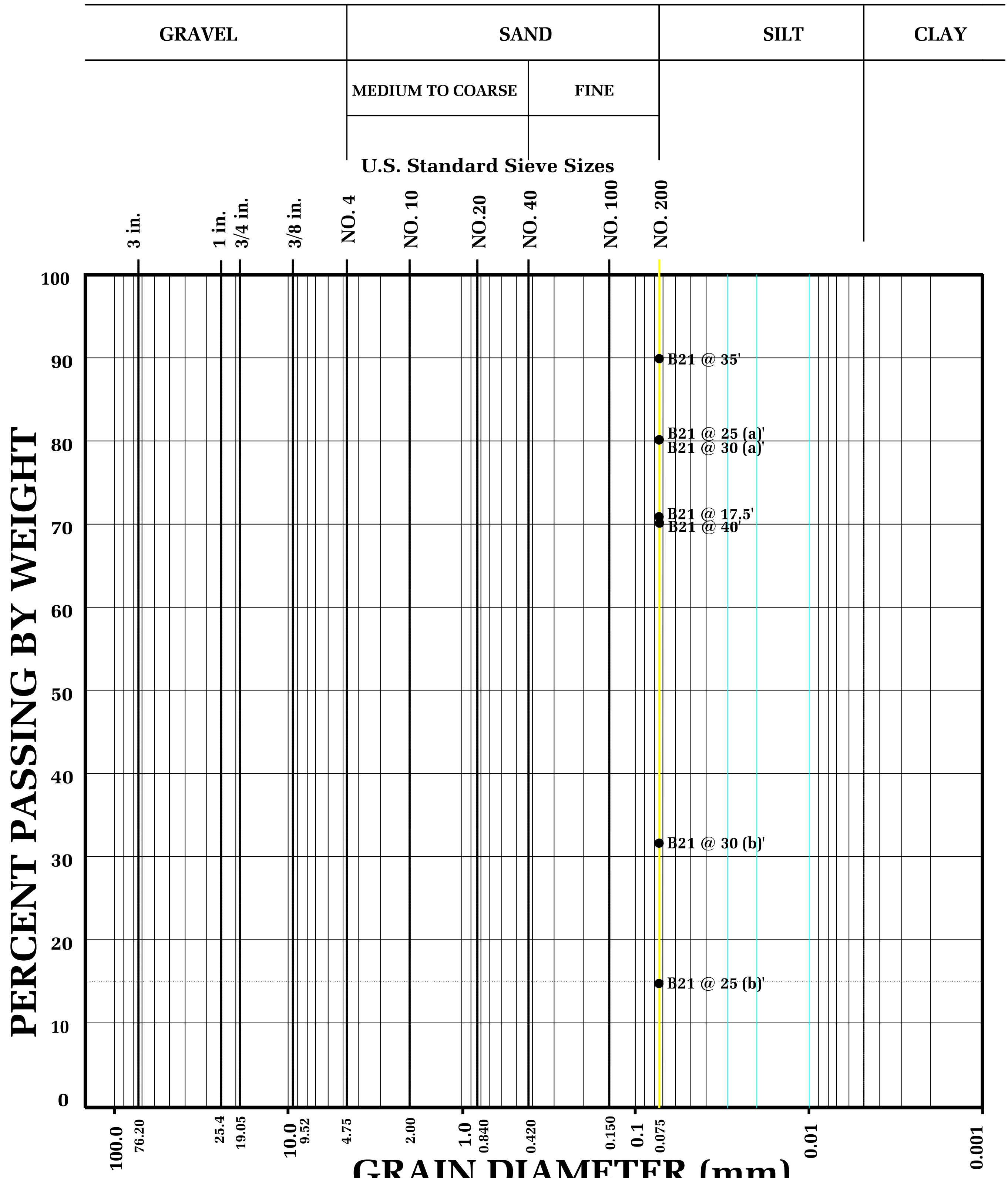
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: E-5**

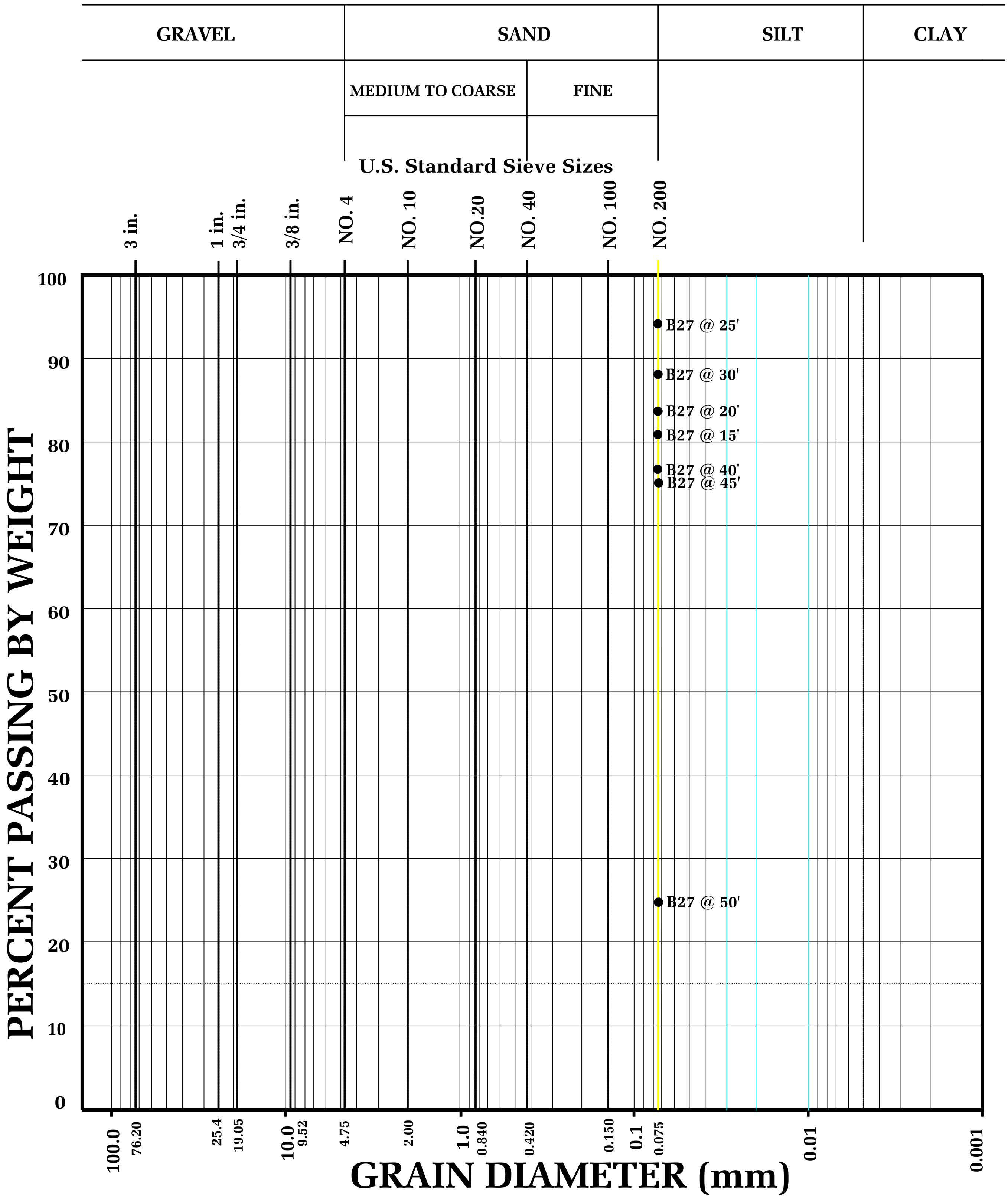


GRAIN SIZE DISTRIBUTION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850	PLATE: E-6

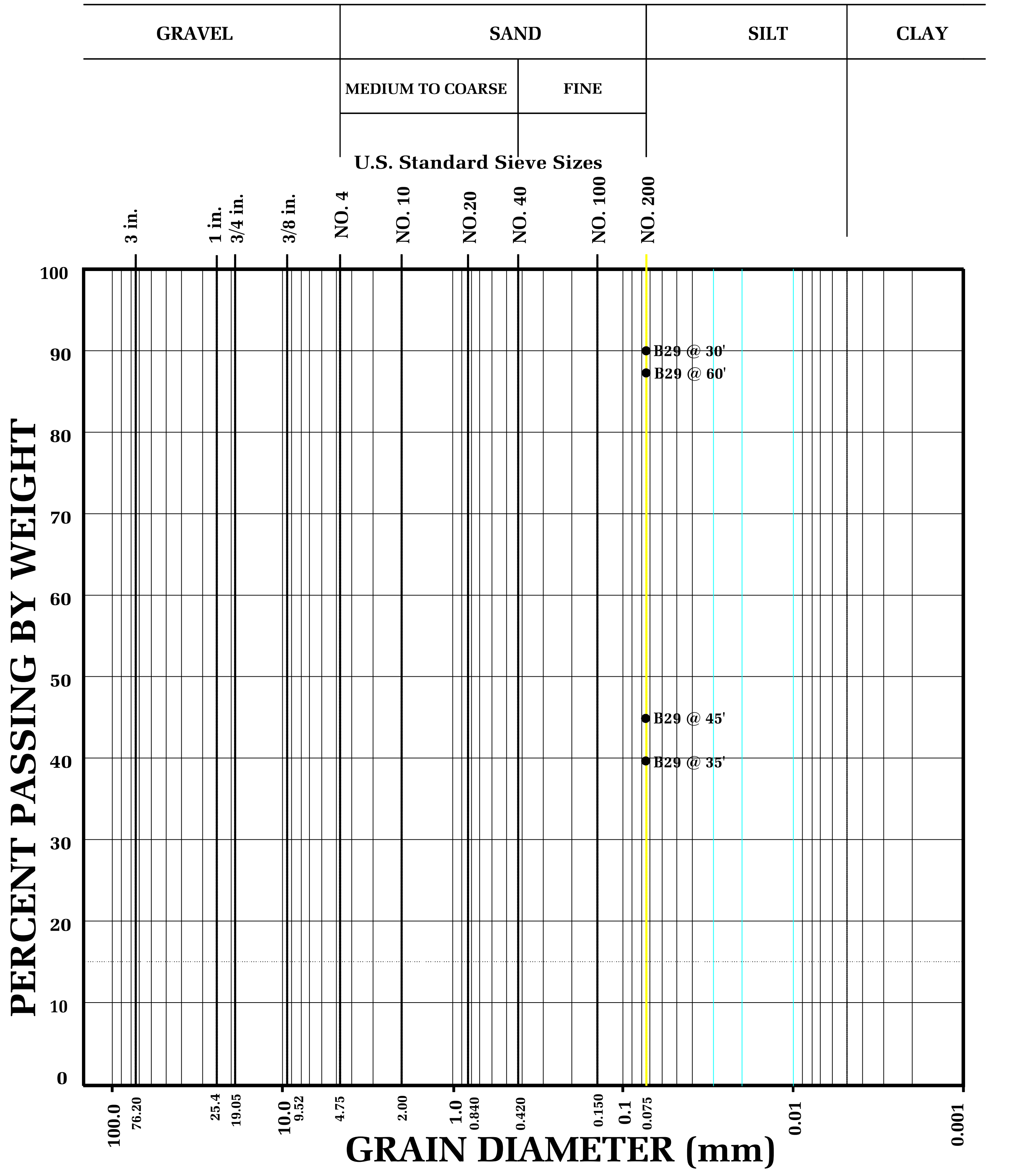


GRAIN SIZE DISTRIBUTION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: E-7**

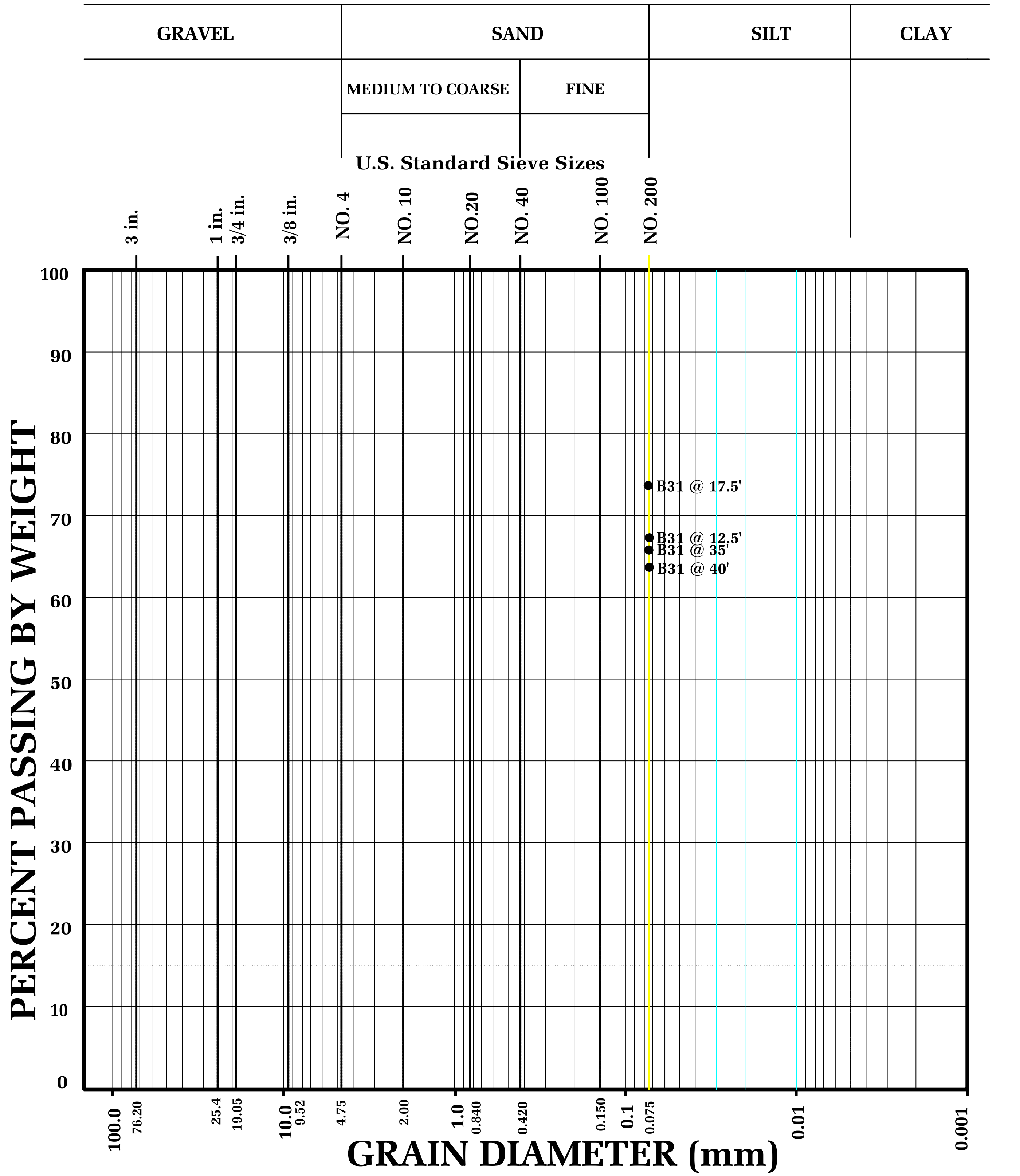


GRAIN SIZE DISTRIBUTION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: E-8**

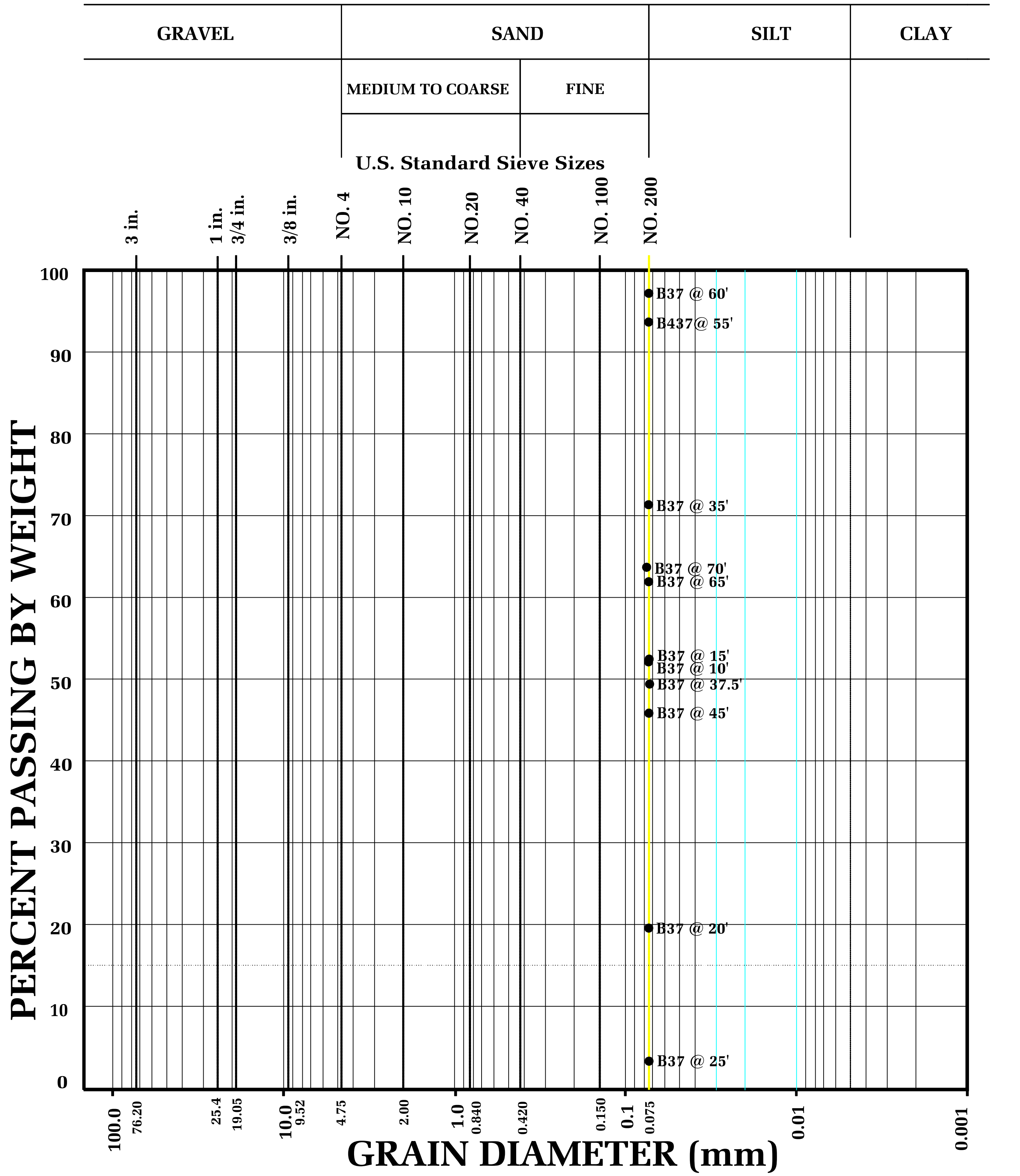


GRAIN SIZE DISTRIBUTION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: E-9**



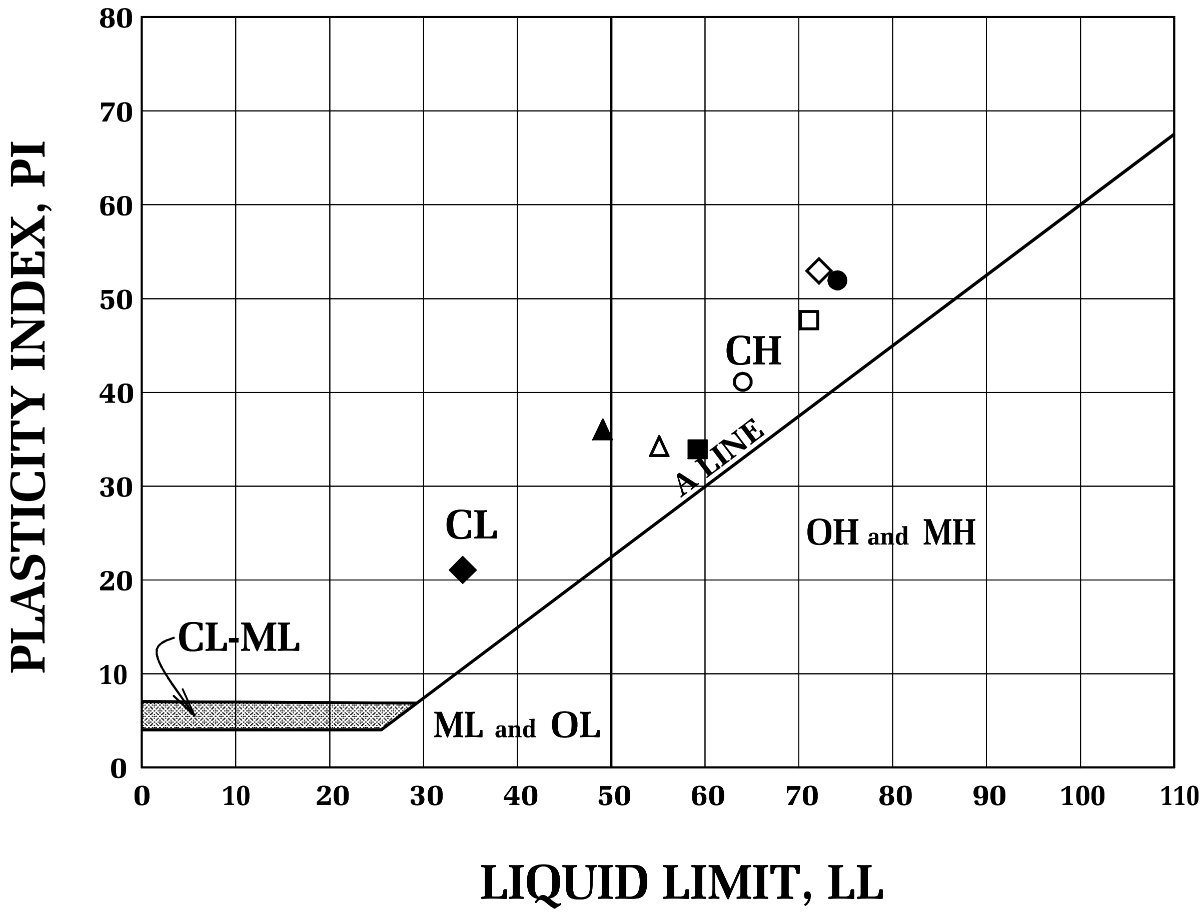
GRAIN SIZE DISTRIBUTION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: E-10**

ASTM D4318



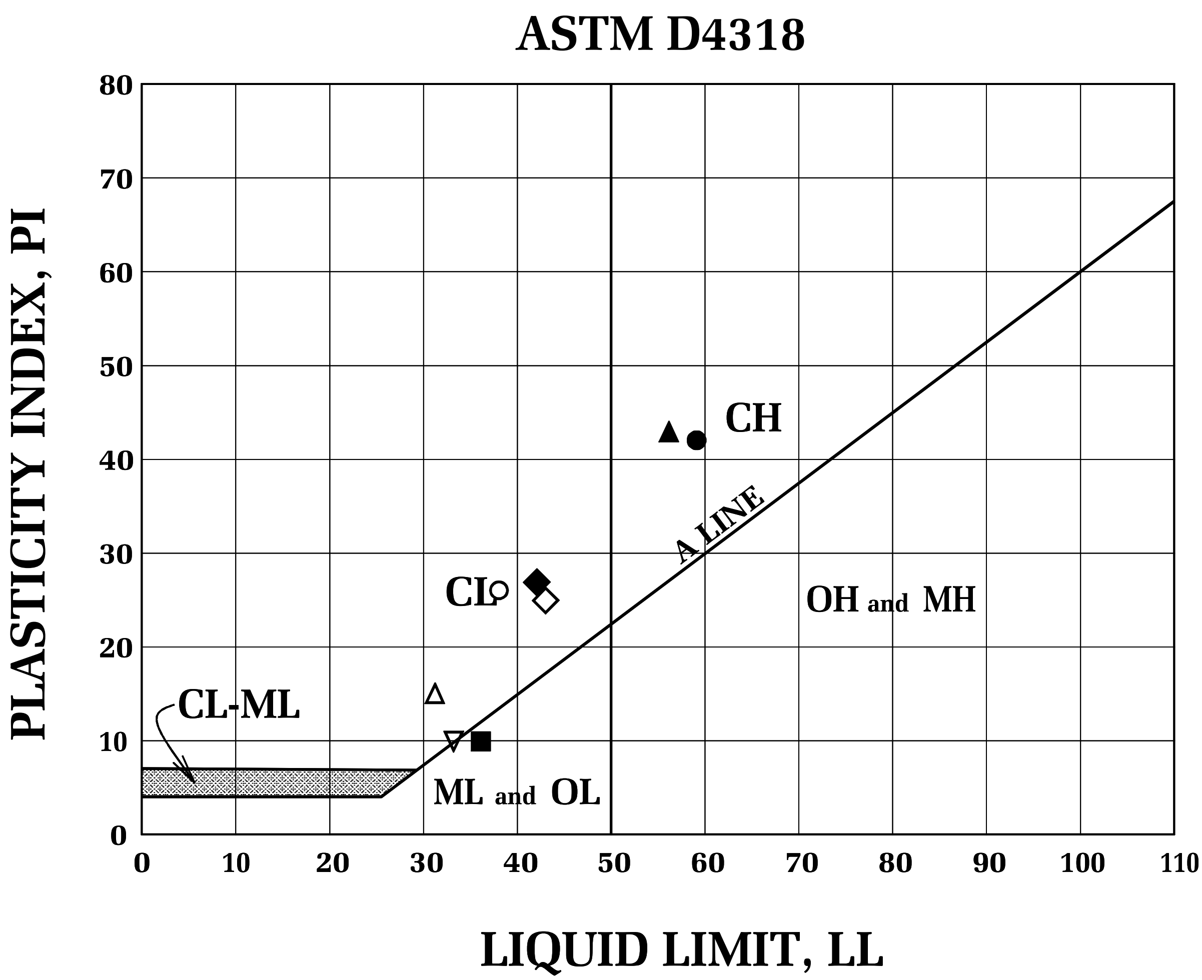
BORING NUMBER	DEPTH (FEET)	TEST SYMBOL	LL	PL	PI	DESCRIPTION
B1	15	○	64	23	41	CH
B1	20	●	74	22	52	CH
B1	25	△	55	21	34	CH
B1	32.5	▲	49	13	36	CL
B1	37.5	□	71	23	48	CH
B1	40	■	59	25	34	CH
B1	47.5	◇	72	19	53	CH
B1	55	◆	34	13	21	CL

ATTERBERG LIMITS DETERMINATION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 **PLATE: F-1**



BORING NUMBER	DEPTH (FEET)	TEST SYMBOL	LL	PL	PI	DESCRIPTION
B6	35	○	38	12	26	CL
B6	55	●	59	17	42	CH
B6	60	△	31	16	15	CL
B10	10	▲	56	13	43	CH
B10	35	■	36	26	10	ML
B10	40	◇	43	18	25	CH
B17	20	◆	42	15	27	CL
B17	25	▽	33	23	10	CL

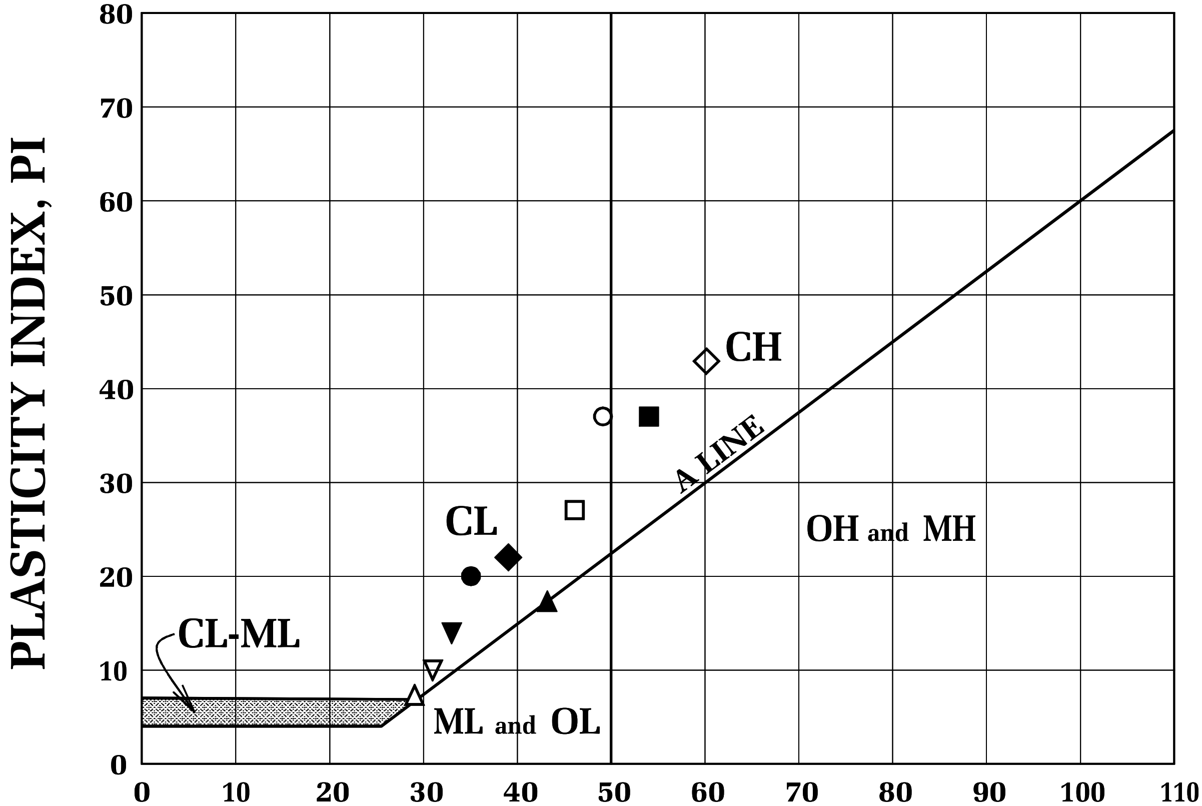
ATTERBERG LIMITS DETERMINATION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: F-2**

ASTM D4318



LIQUID LIMIT, LL

BORING NUMBER	DEPTH (FEET)	TEST SYMBOL	LL	PL	PI	DESCRIPTION
B20	10	○	49	12	37	CL
B20	15	●	35	15	20	CL
B20	20	△	29	22	07	CL/ML
B20	35	▲	43	26	17	CL
B20	60	□	46	19	27	CL
B21	17.5	■	54	17	37	CH
B21	25	◇	60	17	43	CH
B21	30	◆	39	17	22	CL
B21	35	▽	31	21	10	CL
B21	40	▼	33	19	14	CL

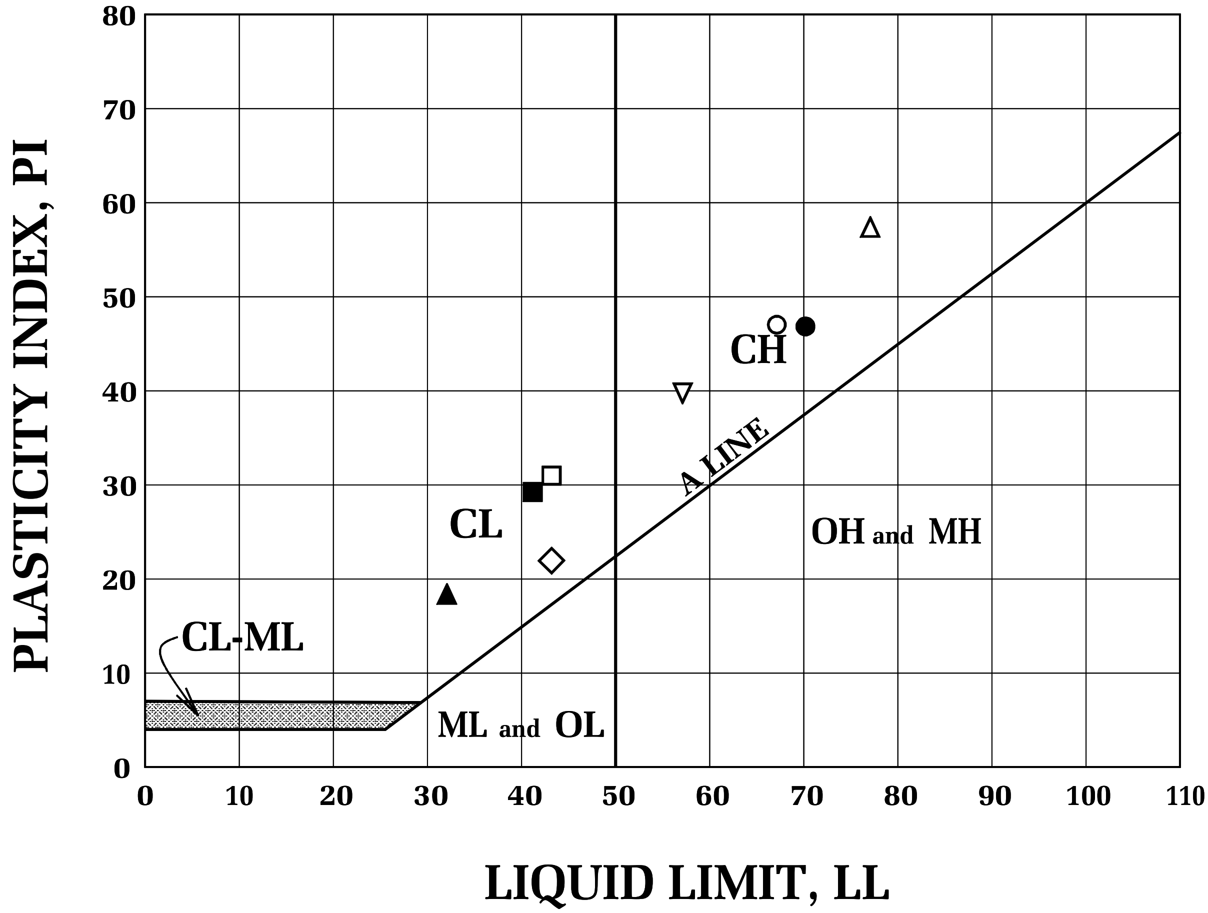
ATTERBERG LIMITS DETERMINATION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: F-3**

ASTM D4318



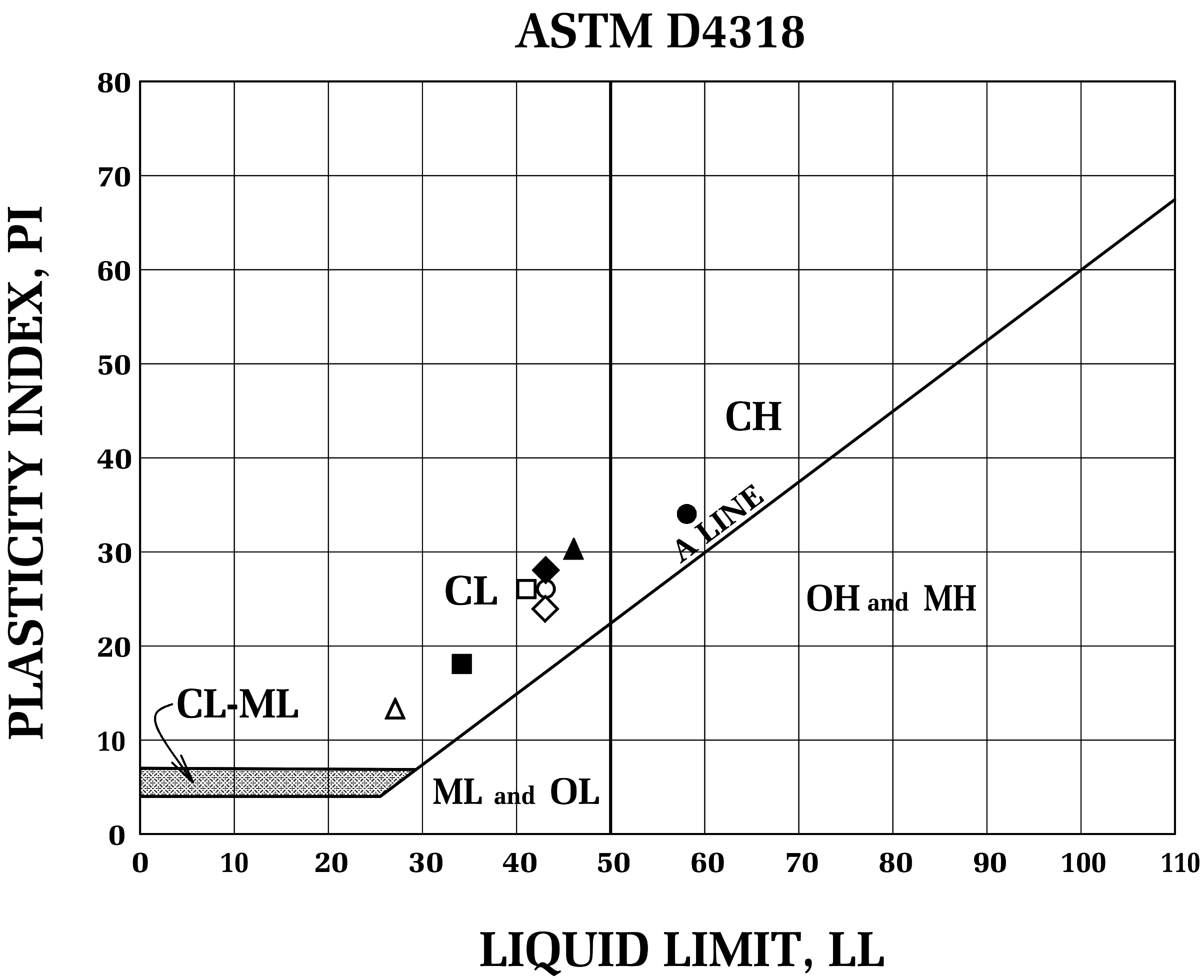
BORING NUMBER	DEPTH (FEET)	TEST SYMBOL	LL	PL	PI	DESCRIPTION
B27	15	○	67	20	47	CH
B27	20	●	70	23	47	CH
B27	25	△	77	20	57	CH
B27	30	▲	32	14	18	CL
B27	40	□	43	12	31	CL
B27	45	■	41	12	29	CL
B29	30	◇	43	21	22	CL
B29	60		57	17	40	CH

ATTERBERG LIMITS DETERMINATION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 PLATE: F-4



BORING NUMBER	DEPTH (FEET)	TEST SYMBOL	LL	PL	PI	DESCRIPTION
B31	12.5	○	43	17	26	CL
B31	17.5	●	58	24	34	CH
B31	40	△	27	14	13	CL
B37	10	▲	46	16	30	CL
B37	15	□	41	15	26	CL
B37	35	■	34	16	18	CL
B37	55	◇	43	19	24	CL
B37	70	◆	43	15	28	CL

ATTERBERG LIMITS DETERMINATION

Geotechnologies, Inc.
Consulting Geotechnical Engineers

FARING
21207 AVALON BLVD., CARSON

FILE NO. 21850 | **PLATE: F-5**

Geotechnologies, Inc.

Project: Faring - Carson
File No.: 21850
Description: Liquefaction Analysis
Boring No: 1

LIQUEFACTION EVALUATION (Idriss & Boulanger, EERI NO 12)

EARTHQUAKE INFORMATION:

Earthquake Magnitude (M):	6.8
Peak Ground Horizontal Acceleration, PGA (g):	0.83
Calculated Mag.Wtg.Factor:	1.218
GROUNDWATER INFORMATION:	
Current Groundwater Level (ft):	26.5
Historically Highest Groundwater Level* (ft):	15.0
Unit Weight of Water (pcf):	62.4

* Based on California Geological Survey Seismic Hazard Evaluation Report

BOREHOLE AND SAMPLER INFORMATION:

Borehole Diameter (inches):	8
SPT Sampler with room for Liner (Y/N):	Y
LIQUEFACTION BOUNDARY:	
Plastic Index Cut Off (PI):	18
Minimum Liquefaction FS:	1.3

Depth to Base Layer (feet)	Total Unit Weight (pcf)	Current Water Level (feet)	Historical Water Level (feet)	Field SPT Blowcount N	Depth of SPT Blowcount (feet)	Fines Content #200 Sieve (%)	Plastic Index (PI)	Vetical Stress σ_{vc}, (psf)	Effective Vert. Stress σ_{vc}', (psf)	Fines Corrected $(N_1)_{60-cs}$	Stress Reduction Coeff, r_d	Cyclic Shear Ratio CSR	Cyclic Resistance Ratio (CRR)	Factor of Safety CRR/CSR (F.S.)	Liquefaction Settlment ΔS_i (inches)
1	131.0	Unsaturated	Unsaturated	12	5	0.0	0	131.0	131.0	26.8	1.00	0.542	0.457	Non-Liq.	0.00
2	131.0	Unsaturated	Unsaturated	12	5	0.0	0	262.0	262.0	26.8	1.00	0.540	0.457	Non-Liq.	0.00
3	131.0	Unsaturated	Unsaturated	12	5	0.0	0	393.0	393.0	26.8	1.00	0.538	0.457	Non-Liq.	0.00
4	131.0	Unsaturated	Unsaturated	12	5	0.0	0	524.0	524.0	26.8	0.99	0.536	0.457	Non-Liq.	0.00
5	131.0	Unsaturated	Unsaturated	12	5	0.0	0	655.0	655.0	26.8	0.99	0.534	0.455	Non-Liq.	0.00
6	131.0	Unsaturated	Unsaturated	12	5	0.0	0	786.0	786.0	25.2	0.99	0.532	0.394	Non-Liq.	0.00
7	131.0	Unsaturated	Unsaturated	12	5	0.0	0	917.0	917.0	23.6	0.98	0.530	0.348	Non-Liq.	0.00
8	132.8	Unsaturated	Unsaturated	12	5	0.0	0	1049.8	1049.8	22.2	0.98	0.528	0.316	Non-Liq.	0.00
9	132.8	Unsaturated	Unsaturated	12	5	0.0	0	1182.6	1182.6	22.4	0.97	0.526	0.316	Non-Liq.	0.00
10	132.8	Unsaturated	Unsaturated	12	5	0.0	0	1315.4	1315.4	21.3	0.97	0.523	0.290	Non-Liq.	0.00
11	132.8	Unsaturated	Unsaturated	16	10	0.0	0	1448.2	1448.2	27.8	0.97	0.521	0.490	Non-Liq.	0.00
12	132.8	Unsaturated	Unsaturated	16	10	0.0	0	1581.0	1581.0	26.8	0.96	0.518	0.433	Non-Liq.	0.00
13	126.5	Unsaturated	Unsaturated	16	10	0.0	0	1707.5	1707.5	25.8	0.96	0.516	0.393	Non-Liq.	0.00
14	126.5	Unsaturated	Unsaturated	16	10	0.0	0	1834.0	1834.0	25.0	0.95	0.513	0.361	Non-Liq.	0.00
15	126.5	Unsaturated	Unsaturated	16	10	0.0	0	1960.5	1960.5	27.6	0.95	0.511	0.452	Non-Liq.	0.00
16	126.5	Unsaturated	Saturated	11	15	92.4	41	2087.0	2024.6	22.9	0.94	0.524	0.302	Non-Liq.	0.00
17	126.5	Unsaturated	Saturated	11	15	92.4	41	2213.5	2088.7	22.3	0.94	0.535	0.288	Non-Liq.	0.00
18	106.8	Unsaturated	Saturated	11	15	92.4	41	2320.3	2133.1	21.9	0.93	0.546	0.279	Non-Liq.	0.00
19	106.8	Unsaturated	Saturated	11	15	92.4	41	2427.1	2177.5	21.5	0.93	0.557	0.270	Non-Liq.	0.00
20	106.8	Unsaturated	Saturated	11	15	92.4	41	2533.9	2221.9	21.1	0.92	0.566	0.262	Non-Liq.	0.00
21	106.8	Unsaturated	Saturated	8	20	93.4	52	2640.7	2266.3	16.2	0.91	0.575	0.197	Non-Liq.	0.00
22	106.8	Unsaturated	Saturated	8	20	93.4	52	2747.5	2310.7	15.9	0.91	0.583	0.194	Non-Liq.	0.00
23	108.7	Unsaturated	Saturated	8	20	93.4	52	2856.2	2357.0	15.7	0.90	0.591	0.191	Non-Liq.	0.00
24	108.7	Unsaturated	Saturated	8	20	93.4	52	2964.9	2403.3	15.5	0.90	0.598	0.188	Non-Liq.	0.00
25	108.7	Unsaturated	Saturated	8	20	93.4	52	3073.6	2449.6	15.3	0.89	0.604	0.185	Non-Liq.	0.00
26	108.7	Unsaturated	Saturated	8	25	91.3	34	3182.3	2495.9	15.1	0.89	0.610	0.183	Non-Liq.	0.00
27	108.7	Saturated	Saturated	8	25	91.3	34	3291.0	2542.2	15.0	0.88	0.615	0.181	Non-Liq.	0.00
28	117.3	Saturated	Saturated	8	25	91.3	34	3408.3	2597.1	15.4	0.88	0.620	0.185	Non-Liq.	0.00
29	117.3	Saturated	Saturated	8	25	91.3	34	3525.6	2652.0	15.3	0.87	0.623	0.183	Non-Liq.	0.00
30	117.3	Saturated	Saturated	8	25	91.3	34	3642.9	2706.9	15.2	0.86	0.627	0.182	Non-Liq.	0.00
31	117.3	Saturated	Saturated	10	30	99.2	36	3760.2	2761.8	17.8	0.86	0.630	0.208	Non-Liq.	0.00
32	117.3	Saturated	Saturated	10	30	99.2	36	3877.5	2816.7	17.7	0.85	0.632	0.206	Non-Liq.	0.00
33	112.6	Saturated	Saturated	10	30	99.2	36	3990.1	2866.9	17.6	0.85	0.635	0.205	Non-Liq.	0.00
34	112.6	Saturated	Saturated	10	30	99.2	36	4102.7	2917.1	17.5	0.84	0.637	0.203	Non-Liq.	0.00
35	112.6	Saturated	Saturated	10	30	99.2	36	4215.3	2967.3	17.4	0.83	0.638	0.202	Non-Liq.	0.00
36	112.6	Saturated	Saturated	9	35	96.0	48	4327.9	3017.5	16.0	0.83	0.640	0.187	Non-Liq.	0.00
37	112.6	Saturated	Saturated	9	35	96.0	48	4440.5	3067.7	15.9	0.82	0.641	0.186	Non-Liq.	0.00
38	114.1	Saturated	Saturated	9	35	96.0	48	4554.6	3119.4	15.8	0.81	0.642	0.185	Non-Liq.	0.00
39	114.1	Saturated	Saturated	9	35	96.0	48	4668.7	3171.1	15.7	0.81	0.642	0.184	Non-Liq.	0.00
40	114.1	Saturated	Saturated	9	35	96.0	48	4782.8	3222.8	15.7	0.80	0.643	0.183	Non-Liq.	0.00
41	114.1	Saturated	Saturated	12	40	96.4	34	4896.9	3274.5	19.6	0.80	0.643	0.225	Non-Liq.	0.00
42	114.1	Saturated	Saturated	12	40	96.4	34	5011.0	3326.2	19.5	0.79	0.642	0.223	Non-Liq.	0.00
43	101.7	Saturated	Saturated	12	40	96.4	34	5112.7	3365.5	19.4	0.78	0.643	0.222	Non-Liq.	0.00
44	101.7	Saturated	Saturated	12	40	96.4	34	5214.4	3404.8	19.4	0.78	0.643	0.221	Non-Liq.	0.00
45	101.7	Saturated	Saturated	12	40	96.4	34	5316.1	3444.1	19.3	0.77	0.643	0.219	Non-Liq.	0.00
46	101.7	Saturated	Saturated	10	45	85.5	53	5417.8	3483.4	16.5	0.77	0.643	0.190	Non-Liq.	0.00
47	101.7	Saturated	Saturated	10	45	85.5	53	5519.5	3522.7	16.4	0.76	0.643	0.189	Non-Liq.	0.00
48	118.2	Saturated	Saturated	10	45	85.5	53	5637.7	3578.5	16.4	0.75	0.641	0.188	Non-Liq.	0.00
49	118.2	Saturated	Saturated	10	45	85.5	53	5755.9	3634.3	16.3	0.75	0.639	0.187	Non-Liq.	0.00
50	118.2	Saturated	Saturated	10	45	85.5	53	5874.1	3690.1	16.2	0.74	0.638	0.186	Non-Liq.	0.00
51	118.2	Saturated	Saturated	15	50	70.2	21	5992.3	3745.9	23.1	0.74	0.636	0.272	Non-Liq.	0.00
52	118.2	Saturated	Saturated	15	50	70.2	21	6110.5	3801.7	23.0	0.73	0.634	0.269	Non-Liq.	0.00
53	130.9	Saturated	Saturated	15	50	70.2	21	6241.4	3870.2	22.8	0.73	0.631	0.265	Non-Liq.	0.00
54	130.9	Saturated	Saturated	15	50	70.2	21	6372.3	3938.7	22.7	0.72	0.628	0.262	Non-Liq.	0.00
55	130.9	Saturated	Saturated	15	50	70.2	21	6503.2	4007.2	22.5	0.71	0.625	0.259	Non-Liq.	0.00
56	130.9	Saturated	Saturated	14	55	70.2	21	6634.1	4075.7	20.9	0.71	0.622	0.235	Non-Liq.	0.00
57	130.9	Saturated	Saturated	14	55	70.2	21	6765.0	4144.2	20.8	0.70	0.619	0.233	Non-Liq.	0.00
58	130.7	Saturated	Saturated	14	55	70.2	21	6895.7	4212.5	20.7	0.70	0.616	0.231	Non-Liq.	0.00
59	130.7	Saturated	Saturated	14	55	70.2	21	7026.4	4280.8	20.5	0.69	0.613	0.228	Non-Liq.	0.00
60	130.7	Saturated	Saturated	14	55	70.2	21	7157.1	4349.1	20.4	0.69	0.609	0.226	Non-Liq.	0.00
61	130.7	Saturated	Saturated	37	60	0.0	0	7287.8	4417.4	54.7	0.68	0.606	1.797	3.0	0.00
62	130.7	Saturated	Saturated	37	60	0.0	0	7418.5	4485.7	54.5	0.68	0.603	1.788	3.0	0.00
63	136.9	Saturated	Saturated	37	60	0.0	0	7555.4	4560.2	54.3	0.67	0.600	1.777	3.0	0.00
64	136.9	Saturated	Saturated	37	60	0.0	0	7692.3	4634.7	54.1	0.67	0.596	1.767	3.0	0.00
65	136.9	Saturated	Saturated	37	60	0.0	0	7829.2	4709.2	53.9	0.66	0.593	1.757	3.0	0.00
66	136.9	Saturated	Saturated	39	65	58.6	0	7966.1	4783.7	62.2	0.66	0.589	1.748	3.0	0.00
67	136.9	Saturated	Saturated	39	65	58.6	0	8103.0	4858.2	62.0	0.65	0.586	1.738	3.0	0.00
68	126.4	Saturated	Saturated	39	65	58.6	0	8229.4	4922.2	61.9	0.65	0.583	1.730	3.0	0.00
69	126.4	Saturated	Saturated	39	65	58.6	0	8355.8	4986.2	61.7	0.64	0.580	1.722	3.0	0.00
70	126.4	Saturated	Saturated	36	70	0.0	0	8482.2	5050.2	51.6	0.64	0.577	1.713	3.0	0.00

Total Liquefaction Settlement, S = 0.00 inches

Geotechnologies, Inc.

Project: Faring - Carson
File No.: 21850
Description: Liquefaction Analysis
Boring No: 6

LIQUEFACTION EVALUATION (Idriss & Boulanger, EERI NO 12)

EARTHQUAKE INFORMATION:

Earthquake Magnitude (M):	6.8
Peak Ground Horizontal Acceleration, PGA (g):	0.83
Calculated Mag.Wtg.Factor:	1.218

GROUNDWATER INFORMATION:

Current Groundwater Level (ft):	30.0
Historically Highest Groundwater Level* (ft):	15.0
Unit Weight of Water (pcf):	62.4

* Based on California Geological Survey Seismic Hazard Evaluation Report

BOREHOLE AND SAMPLER INFORMATION:

Borehole Diameter (inches):	8
SPT Sampler with room for Liner (Y/N):	Y

LIQUEFACTION BOUNDARY:

Plastic Index Cut Off (PI):	18
Minimum Liquefaction FS:	1.3

Depth to Base Layer (feet)	Total Unit Weight (pcf)	Current Water Level (feet)	Historical Water Level (feet)	Field SPT Blowcount N	Depth of SPT Blowcount (feet)	Fines Content #200 Sieve (%)	Plastic Index (PI)	Vetical Stress σ_{vc}, (psf)	Effective Vert. Stress σ_{vc}', (psf)	Fines Corrected $(N_1)_{60-cs}$	Stress Reduction Coeff, r_d	Cyclic Shear Ratio CSR	Cyclic Resistance Ratio (CRR)	Factor of Safety CRR/CSR (F.S.)	Liquefaction Settlment ΔS_i (inches)
1	137.2	Unsaturated	Unsaturated	14	5	0.0	0	137.2	137.2	32.2	1.00	0.542	0.897	Non-Liq.	0.00
2	137.2	Unsaturated	Unsaturated	14	5	0.0	0	274.4	274.4	32.2	1.00	0.540	0.897	Non-Liq.	0.00
3	137.2	Unsaturated	Unsaturated	14	5	0.0	0	411.6	411.6	32.2	1.00	0.538	0.897	Non-Liq.	0.00
4	137.2	Unsaturated	Unsaturated	14	5	0.0	0	548.8	548.8	30.7	0.99	0.536	0.716	Non-Liq.	0.00
5	137.2	Unsaturated	Unsaturated	14	5	0.0	0	686.0	686.0	30.7	0.99	0.534	0.711	Non-Liq.	0.00
6	137.2	Unsaturated	Unsaturated	14	5	0.0	0	823.2	823.2	28.7	0.99	0.532	0.557	Non-Liq.	0.00
7	137.2	Unsaturated	Unsaturated	14	5	0.0	0	960.4	960.4	27.0	0.98	0.530	0.464	Non-Liq.	0.00
8	125.7	Unsaturated	Unsaturated	14	5	0.0	0	1086.1	1086.1	25.6	0.98	0.528	0.409	Non-Liq.	0.00
9	125.7	Unsaturated	Unsaturated	14	5	0.0	0	1211.8	1211.8	26.0	0.97	0.526	0.423	Non-Liq.	0.00
10	125.7	Unsaturated	Unsaturated	14	5	0.0	0	1337.5	1337.5	24.9	0.97	0.523	0.377	Non-Liq.	0.00
11	125.7	Unsaturated	Unsaturated	22	10	0.0	0	1463.2	1463.2	39.1	0.97	0.521	2.000	Non-Liq.	0.00
12	125.7	Unsaturated	Unsaturated	22	10	0.0	0	1588.9	1588.9	38.2	0.96	0.518	2.000	Non-Liq.	0.00
13	132.4	Unsaturated	Unsaturated	22	10	0.0	0	1721.3	1721.3	37.1	0.96	0.516	2.000	Non-Liq.	0.00
14	132.4	Unsaturated	Unsaturated	22	10	0.0	0	1853.7	1853.7	36.0	0.95	0.513	1.734	Non-Liq.	0.00
15	132.4	Unsaturated	Unsaturated	22	10	0.0	0	1986.1	1986.1	39.8	0.95	0.511	2.000	Non-Liq.	0.00
16	132.4	Unsaturated	Saturated	78	15	0.0	0	2118.5	2056.1	138.3	0.94	0.523	2.000	3.8	0.00
17	132.4	Unsaturated	Saturated	78	15	0.0	0	2250.9	2126.1	136.1	0.94	0.535	2.000	3.7	0.00
18	132.4	Unsaturated	Saturated	78	15	0.0	0	2383.3	2196.1	134.1	0.93	0.545	2.000	3.7	0.00
19	132.4	Unsaturated	Saturated	78	15	0.0	0	2515.7	2266.1	132.2	0.93	0.554	2.000	3.6	0.00
20	132.4	Unsaturated	Saturated	78	15	0.0	0	2648.1	2336.1	130.4	0.92	0.563	2.000	3.6	0.00
21	132.4	Unsaturated	Saturated	20	20	50.3	0	2780.5	2406.1	36.3	0.91	0.570	1.673	2.9	0.00
22	132.4	Unsaturated	Saturated	20	20	50.3	0	2912.9	2476.1	35.7	0.91	0.577	1.420	2.5	0.00
23	134.5	Unsaturated	Saturated	20	20	50.3	0	3047.4	2548.2	35.0	0.90	0.583	1.224	2.1	0.00
24	134.5	Unsaturated	Saturated	20	20	50.3	0	3181.9	2620.3	34.4	0.90	0.588	1.071	1.8	0.00
25	134.5	Unsaturated	Saturated	20	20	50.3	0	3316.4	2692.4	33.8	0.89	0.593	0.949	1.6	0.00
26	134.5	Unsaturated	Saturated	28	25	37.8	0	3450.9	2764.5	48.9	0.89	0.597	2.000	3.3	0.00
27	134.5	Unsaturated	Saturated	28	25	37.8	0	3585.4	2836.6	48.4	0.88	0.601	2.000	3.3	0.00
28	134.0	Unsaturated	Saturated	28	25	37.8	0	3719.4	2908.2	50.5	0.88	0.604	2.000	3.3	0.00
29	134.0	Unsaturated	Saturated	28	25	37.8	0	3853.4	2979.8	50.0	0.87	0.606	2.000	3.3	0.00
30	134.0	Unsaturated	Saturated	28	25	37.8	0	3987.4	3051.4	49.5	0.86	0.609	1.979	3.3	0.00
31	134.0	Saturated	Saturated	21	30	46.4	0	4121.4	3123.0	34.7	0.86	0.610	1.056	1.7	0.00
32	134.0	Saturated	Saturated	21	30	46.4	0	4255.4	3194.6	34.4	0.85	0.612	0.999	1.6	0.00
33	131.7	Saturated	Saturated	19	35	62.0	26	4387.1	3263.9	30.5	0.85	0.613	0.539	Non-Liq.	0.00
34	131.7	Saturated	Saturated	19	35	62.0	26	4518.8	3333.2	30.3	0.84	0.614	0.522	Non-Liq.	0.00
35	131.7	Saturated	Saturated	19	35	62.0	26	4650.5	3402.5	30.0	0.83	0.614	0.506	Non-Liq.	0.00
36	131.7	Saturated	Saturated	19	35	62.0	26	4782.2	3471.8	29.8	0.83	0.614	0.492	Non-Liq.	0.00
37	131.7	Saturated	Saturated	19	35	62.0	26	4913.9	3541.1	29.6	0.82	0.614	0.478	Non-Liq.	0.00
38	129.6	Saturated	Saturated	19	35	62.0	26	5043.5	3608.3	29.4	0.81	0.614	0.466	Non-Liq.	0.00
39	129.6	Saturated	Saturated	19	35	62.0	26	5173.1	3675.5	29.2	0.81	0.614	0.454	Non-Liq.	0.00
40	129.6	Saturated	Saturated	19	35	62.0	26	5302.7	3742.7	29.0	0.80	0.613	0.443	Non-Liq.	0.00
41	129.6	Saturated	Saturated	33	40	0.0	0	5432.3	3809.9	49.8	0.80	0.613	1.854	3.0	0.00
42	129.6	Saturated	Saturated	33	40	0.0	0	5561.9	3877.1	49.6	0.79	0.612	1.844	3.0	0.00
43	112.3	Saturated	Saturated	33	40	0.0	0	5674.2	3927.0	49.5	0.78	0.611	1.836	3.0	0.00
44	112.3	Saturated	Saturated	33	40	0.0	0	5786.5	3976.9	49.4	0.78	0.611	1.829	3.0	0.00
45	112.3	Saturated	Saturated	33	40	0.0	0	5898.8	4026.8	49.2	0.77	0.610	1.822	3.0	0.00
46	112.3	Saturated	Saturated	33	45	0.0	0	6011.1	4076.7	49.1	0.77	0.609	1.814	3.0	0.00
47	112.3	Saturated	Saturated	33	45	0.0	0	6123.4	4126.6	49.0	0.76	0.609	1.807	3.0	0.00
48	132.0	Saturated	Saturated	33	45	0.0	0	6255.4	4196.2	48.8	0.75	0.607	1.797	3.0	0.00
49	132.0	Saturated	Saturated	33	45	0.0	0	6387.4	4265.8	48.6	0.75	0.605	1.788	3.0	0.00
50	132.0	Saturated	Saturated	33	45	0.0	0	6519.4	4335.4	48.5	0.74	0.602	1.778	3.0	0.00
51	132.0	Saturated	Saturated	39	50	0.0	0	6651.4	4405.0	57.1	0.74	0.600	1.769	2.9	0.00
52	132.0	Saturated	Saturated	39	50	0.0	0	6783.4	4474.6	56.9	0.73	0.598	1.759	2.9	0.00
53	131.7	Saturated	Saturated	39	50	0.0	0	6915.1	4543.9	56.7	0.73	0.595	1.750	2.9	0.00
54	131.7	Saturated	Saturated	39	50	0.0	0	7046.8	4613.2	56.5	0.72	0.593	1.741	2.9	0.00
55	131.7	Saturated	Saturated	39	50	0.0	0	7178.5	4682.5	56.3	0.71	0.590	1.732	2.9	0.00
56	131.7	Saturated	Saturated	11	55	76.0	42	7310.2	4751.8	15.7	0.71	0.588	0.176	Non-Liq.	0.00
57	131.7	Saturated	Saturated	11	55	76.0	42	7441.9	4821.1	15.7	0.70	0.585	0.175	Non-Liq.	0.00
58	117.7	Saturated	Saturated	11	55	76.0	42	7559.6	4876.4	15.6	0.70	0.583	0.174	Non-Liq.	0.00
59	117.7	Saturated	Saturated	11	55	76.0	42	7677.3	4931.7	15.6	0.69	0.581	0.173	Non-Liq.	0.00
60	117.7	Saturated	Saturated	11	55	76.0	42	7795.0	4987.0	15.5	0.69	0.579	0.173	Non-Liq.	0.00
61	117.7	Saturated	Saturated	14	60	50.0	15	7912.7	5042.3	19.0	0.68	0.577	0.205	0.4	0.29
62	117.7	Saturated	Saturated	14	60	50.0	15	8030.4	5097.6	18.9	0.68	0.574	0.203	0.4	0.29
63	128.0	Saturated	Saturated	16	65	42.2	0	8158.4	5163.2	21.3	0.67	0.572	0.232	0.4	0.26
64	128.0	Saturated	Saturated	16	65	42.2	0	8286.4	5228.8	21.2	0.67	0.569	0.230	0.4	0.26
65	128.0	Saturated	Saturated	16	65	42.2	0	8414.4	5294.4	21.1	0.66	0.566	0.228	0.4	0.26
66	128.0	Saturated	Saturated	16	65	42.2	0	8542.4	5360.0	21.0	0.66	0.564	0.226	0.4	0.27
67	128.0	Saturated	Saturated	16	65	42.2	0	8670.4	5425.6	20.9	0.65	0.561	0.225	0.4	0.27
68	132.5	Saturated	Saturated	55	70	0.0	0	8802.9	5495.7	76.7	0.65	0.558	1.635	2.9	0.00
69	132.5	Saturated	Saturated	55	70	0.0	0	8935.4	5565.8	76.4	0.64	0.555	1.627	2.9	0.00
70	132.5	Saturated	Saturated	55	70	0.0	0	9067.9	5635.9	76.2	0.64	0.553	1.620	2.9	0.00
												Total Liquefaction Settlement, S =		1.90 inches	

Geotechnologies, Inc.

Project: Faring - Carson
File No.: 21850
Description: Liquefaction Analysis
Boring No: 10

LIQUEFACTION EVALUATION (Idriss & Boulanger, EERI NO 12)

EARTHQUAKE INFORMATION:

Earthquake Magnitude (M):	6.8
Peak Ground Horizontal Acceleration, PGA (g):	0.83
Calculated Mag.Wtg.Factor:	1.218

GROUNDWATER INFORMATION:

Current Groundwater Level (ft):	31.0
Historically Highest Groundwater Level* (ft):	15.0
Unit Weight of Water (pcf):	62.4

* Based on California Geological Survey Seismic Hazard Evaluation Report

BOREHOLE AND SAMPLER INFORMATION:

Borehole Diameter (inches):	8
SPT Sampler with room for Liner (Y/N):	Y

LIQUEFACTION BOUNDARY:

Plastic Index Cut Off (PI):	18
Minimum Liquefaction FS:	1.3

Depth to Base Layer (feet)	Total Unit Weight (pcf)	Current Water Level (feet)	Historical Water Level (feet)	Field SPT Blowcount N	Depth of SPT Blowcount (feet)	Fines Content #200 Sieve (%)	Plastic Index (PI)	Vetical Stress σ_{vc}, (psf)	Effective Vert. Stress σ_{vc}', (psf)	Fines Corrected $(N_1)_{60\text{-}cs}$	Stress Reduction Coeff, r_d	Cyclic Shear Ratio CSR	Cyclic Resistance Ratio (CRR)	Factor of Safety CRR/CSR (F.S.)	Liquefaction Settlment ΔS_i (inches)
1	131.5	Unsaturated	Unsaturated	9	5	0.0	0	131.5	131.5	19.2	1.00	0.542	0.264	Non-Liq.	0.00
2	131.5	Unsaturated	Unsaturated	9	5	0.0	0	263.0	263.0	19.2	1.00	0.540	0.264	Non-Liq.	0.00
3	131.5	Unsaturated	Unsaturated	9	5	0.0	0	394.5	394.5	19.2	1.00	0.538	0.264	Non-Liq.	0.00
4	131.5	Unsaturated	Unsaturated	9	5	0.0	0	526.0	526.0	19.2	0.99	0.536	0.264	Non-Liq.	0.00
5	131.5	Unsaturated	Unsaturated	9	5	0.0	0	657.5	657.5	20.3	0.99	0.534	0.281	Non-Liq.	0.00
6	131.5	Unsaturated	Unsaturated	9	5	0.0	0	789.0	789.0	18.9	0.99	0.532	0.260	Non-Liq.	0.00
7	131.5	Unsaturated	Unsaturated	9	5	0.0	0	920.5	920.5	17.7	0.98	0.530	0.242	Non-Liq.	0.00
8	131.3	Unsaturated	Unsaturated	9	5	0.0	0	1051.8	1051.8	16.6	0.98	0.528	0.224	Non-Liq.	0.00
9	131.3	Unsaturated	Unsaturated	9	5	0.0	0	1183.1	1183.1	16.6	0.97	0.526	0.222	Non-Liq.	0.00
10	131.3	Unsaturated	Unsaturated	9	5	0.0	0	1314.4	1314.4	15.8	0.97	0.523	0.209	Non-Liq.	0.00
11	131.3	Unsaturated	Unsaturated	12	10	71.3	43	1445.7	1445.7	26.0	0.97	0.521	0.408	Non-Liq.	0.00
12	131.3	Unsaturated	Unsaturated	12	10	71.3	43	1577.0	1577.0	25.1	0.96	0.518	0.373	Non-Liq.	0.00
13	136.8	Unsaturated	Unsaturated	12	10	71.3	43	1713.8	1713.8	24.3	0.96	0.516	0.345	Non-Liq.	0.00
14	136.8	Unsaturated	Unsaturated	12	10	71.3	43	1850.6	1850.6	23.6	0.95	0.513	0.323	Non-Liq.	0.00
15	136.8	Unsaturated	Unsaturated	12	10	71.3	43	1987.4	1987.4	25.2	0.95	0.511	0.364	Non-Liq.	0.00
16	136.8	Unsaturated	Saturated	27	15	0.0	0	2124.2	2061.8	47.8	0.94	0.523	2.000	3.8	0.00
17	136.8	Unsaturated	Saturated	27	15	0.0	0	2261.0	2136.2	47.1	0.94	0.535	2.000	3.7	0.00
18	129.9	Unsaturated	Saturated	27	15	0.0	0	2390.9	2203.7	46.4	0.93	0.545	2.000	3.7	0.00
19	129.9	Unsaturated	Saturated	27	15	0.0	0	2520.8	2271.2	45.7	0.93	0.554	2.000	3.6	0.00
20	129.9	Unsaturated	Saturated	27	15	0.0	0	2650.7	2338.7	45.1	0.92	0.563	2.000	3.6	0.00
21	129.9	Unsaturated	Saturated	21	20	54.8	0	2780.6	2406.2	38.3	0.91	0.570	2.000	3.5	0.00
22	129.9	Unsaturated	Saturated	21	20	54.8	0	2910.5	2473.7	37.6	0.91	0.577	2.000	3.5	0.00
23	126.2	Unsaturated	Saturated	32	25	0.0	0	3036.7	2537.5	51.6	0.90	0.584	2.000	3.4	0.00
24	126.2	Unsaturated	Saturated	32	25	0.0	0	3162.9	2601.3	51.1	0.90	0.589	2.000	3.4	0.00
25	126.2	Unsaturated	Saturated	32	25	0.0	0	3289.1	2665.1	50.5	0.89	0.594	2.000	3.4	0.00
26	126.2	Unsaturated	Saturated	32	25	0.0	0	3415.3	2728.9	50.0	0.89	0.599	2.000	3.3	0.00
27	126.2	Unsaturated	Saturated	32	25	0.0	0	3541.5	2792.7	49.6	0.88	0.603	2.000	3.3	0.00
28	126.0	Unsaturated	Saturated	32	25	0.0	0	3667.5	2856.3	51.7	0.88	0.606	2.000	3.3	0.00
29	126.0	Unsaturated	Saturated	32	25	0.0	0	3793.5	2919.9	51.2	0.87	0.609	2.000	3.3	0.00
30	126.0	Unsaturated	Saturated	32	25	0.0	0	3919.5	2983.5	50.8	0.86	0.612	1.991	3.3	0.00
31	126.0	Unsaturated	Saturated	22	30	58.5	0	4045.5	3047.1	36.7	0.86	0.614	1.611	2.6	0.00
32	126.0	Saturated	Saturated	22	30	58.5	0	4171.5	3110.7	36.5	0.85	0.616	1.515	2.5	0.00
33	125.9	Saturated	Saturated	22	30	58.5	0	4297.4	3174.2	36.2	0.85	0.617	1.429	2.3	0.00
34	125.9	Saturated	Saturated	22	30	58.5	0	4423.3	3237.7	36.0	0.84	0.618	1.350	2.2	0.00
35	125.9	Saturated	Saturated	22	30	58.5	0	4549.2	3301.2	35.8	0.83	0.619	1.278	2.1	0.00
36	125.9	Saturated	Saturated	16	35	84.2	10	4675.1	3364.7	24.9	0.83	0.620	0.308	0.5	0.23
37	125.9	Saturated	Saturated	16	35	84.2	10	4801.0	3428.2	24.7	0.82	0.620	0.304	0.5	0.23
38	130.0	Saturated	Saturated	16	35	84.2	10	4931.0	3495.8	24.5	0.81	0.620	0.299	0.5	0.23
39	130.0	Saturated	Saturated	16	35	84.2	10	5061.0	3563.4	24.4	0.81	0.620	0.295	0.5	0.23
40	130.0	Saturated	Saturated	16	35	84.2	10	5191.0	3631.0	24.2	0.80	0.619	0.291	0.5	0.23
41	130.0	Saturated	Saturated	20	40	83.7	25	5321.0	3698.6	30.6	0.80	0.618	0.536	Non-Liq.	0.00
42	130.0	Saturated	Saturated	20	40	83.7	25	5451.0	3766.2	30.4	0.79	0.617	0.520	Non-Liq.	0.00
43	133.4	Saturated	Saturated	20	40	83.7	25	5584.4	3837.2	30.2	0.78	0.616	0.505	Non-Liq.	0.00
44	133.4	Saturated	Saturated	20	40	83.7	25	5717.8	3908.2	30.0	0.78	0.614	0.491	Non-Liq.	0.00
45	133.4	Saturated	Saturated	20	40	83.7	25	5851.2	3979.2	29.8	0.77	0.613	0.478	Non-Liq.	0.00
46	133.4	Saturated	Saturated	22	45	88.1	27	5984.6	4050.2	33.2	0.77	0.611	0.756	Non-Liq.	0.00
47	133.4	Saturated	Saturated	22	45	88.1	27	6118.0	4121.2	33.0	0.76	0.609	0.727	Non-Liq.	0.00
48	129.7	Saturated	Saturated	34	50	0.0	0	6247.7	4188.5	50.1	0.75	0.607	1.790	2.9	0.00
49	129.7	Saturated	Saturated	34	50	0.0	0	6377.4	4255.8	50.0	0.75	0.605	1.781	2.9	0.00
50	129.7	Saturated	Saturated	34	50	0.0	0	6507.1	4323.1	49.8	0.74	0.603	1.771	2.9	0.00
											Total Liquefaction Settlement, S =			1.16 inches	

Geotechnologies, Inc.

Project: Faring - Carson
File No.: 21850
Description: Liquefaction Analysis
Boring No: 17

LIQUEFACTION EVALUATION (Idriss & Boulanger, EERI NO 12)

EARTHQUAKE INFORMATION:

Earthquake Magnitude (M):	6.8
Peak Ground Horizontal Acceleration, PGA (g):	0.83
Calculated Mag.Wtg.Factor:	1.218

GROUNDWATER INFORMATION:

Current Groundwater Level (ft):	28.0
Historically Highest Groundwater Level* (ft):	15.0
Unit Weight of Water (pcf):	62.4

* Based on California Geological Survey Seismic Hazard Evaluation Report

BOREHOLE AND SAMPLER INFORMATION:

Borehole Diameter (inches):	8
SPT Sampler with room for Liner (Y/N):	Y

LIQUEFACTION BOUNDARY:

Plastic Index Cut Off (PI):	18
Minimum Liquefaction FS:	1.3

Depth to Base Layer (feet)	Total Unit Weight (pcf)	Current Water Level (feet)	Historical Water Level (feet)	Field SPT Blowcount N	Depth of SPT Blowcount (feet)	Fines Content #200 Sieve (%)	Plastic Index (PI)	Vetical Stress σ_{vc}, (psf)	Effective Vert. Stress σ_{vc}', (psf)	Fines Corrected $(N_1)_{60-cs}$	Stress Reduction Coeff, r_d	Cyclic Shear Ratio CSR	Cyclic Resistance Ratio (CRR)	Factor of Safety CRR/CSR (F.S.)	Liquefaction Settlment ΔS_i (inches)
1	119.8	Unsaturated	Unsaturated	7	5	0	0	119.8	119.8	14.5	1.00	0.542	0.203	Non-Liq.	0.00
2	119.8	Unsaturated	Unsaturated	7	5	0	0	239.6	239.6	14.5	1.00	0.540	0.203	Non-Liq.	0.00
3	119.8	Unsaturated	Unsaturated	7	5	0	0	359.4	359.4	14.5	1.00	0.538	0.203	Non-Liq.	0.00
4	119.8	Unsaturated	Unsaturated	7	5	0	0	479.2	479.2	14.5	0.99	0.536	0.203	Non-Liq.	0.00
5	119.8	Unsaturated	Unsaturated	7	5	0	0	599.0	599.0	15.6	0.99	0.534	0.216	Non-Liq.	0.00
6	119.8	Unsaturated	Unsaturated	7	5	0	0	718.8	718.8	15.4	0.99	0.532	0.214	Non-Liq.	0.00
7	119.8	Unsaturated	Unsaturated	7	5	0	0	838.6	838.6	14.4	0.98	0.530	0.203	Non-Liq.	0.00
8	122.2	Unsaturated	Unsaturated	7	5	0	0	960.8	960.8	13.5	0.98	0.528	0.189	Non-Liq.	0.00
9	122.2	Unsaturated	Unsaturated	7	5	0	0	1083.0	1083.0	13.5	0.97	0.526	0.187	Non-Liq.	0.00
10	122.2	Unsaturated	Unsaturated	7	5	0	0	1205.2	1205.2	12.7	0.97	0.523	0.178	Non-Liq.	0.00
11	122.2	Unsaturated	Unsaturated	10	10	0	0	1327.4	1327.4	17.5	0.97	0.521	0.230	Non-Liq.	0.00
12	122.2	Unsaturated	Unsaturated	10	10	0	0	1449.6	1449.6	16.8	0.96	0.518	0.218	Non-Liq.	0.00
13	116.6	Unsaturated	Unsaturated	13	15	33	0	1566.2	1566.2	26.8	0.96	0.516	0.438	Non-Liq.	0.00
14	116.6	Unsaturated	Unsaturated	13	15	33	0	1682.8	1682.8	26.1	0.95	0.513	0.403	Non-Liq.	0.00
15	116.6	Unsaturated	Unsaturated	13	15	33	0	1799.4	1799.4	28.1	0.95	0.511	0.486	Non-Liq.	0.00
16	116.6	Unsaturated	Saturated	13	15	33	0	1916.0	1853.6	27.4	0.94	0.525	0.447	0.9	0.13
17	116.6	Unsaturated	Saturated	13	15	33	0	2032.6	1907.8	26.8	0.94	0.538	0.415	0.8	0.16
18	115.1	Unsaturated	Saturated	13	15	33	0	2147.7	1960.5	26.2	0.93	0.550	0.390	0.7	0.19
19	115.1	Unsaturated	Saturated	13	15	33	0	2262.8	2013.2	25.6	0.93	0.561	0.368	0.7	0.22
20	115.1	Unsaturated	Saturated	13	15	33	0	2377.9	2065.9	25.1	0.92	0.572	0.350	0.6	0.23
21	115.1	Unsaturated	Saturated	7	20	74.4	27	2493.0	2118.6	15.2	0.91	0.581	0.188	Non-Liq.	0.00
22	115.1	Unsaturated	Saturated	7	20	74.4	27	2608.1	2171.3	14.9	0.91	0.589	0.185	Non-Liq.	0.00
23	125.9	Unsaturated	Saturated	16	25	85.7	10	2734.0	2234.8	29.0	0.90	0.597	0.494	0.8	0.12
24	125.9	Unsaturated	Saturated	16	25	85.7	10	2859.9	2298.3	28.4	0.90	0.603	0.461	0.8	0.14
25	125.9	Unsaturated	Saturated	16	25	85.7	10	2985.8	2361.8	27.9	0.89	0.609	0.433	0.7	0.16
26	125.9	Unsaturated	Saturated	16	25	85.7	10	3111.7	2425.3	27.4	0.89	0.614	0.409	0.7	0.17
27	125.9	Unsaturated	Saturated	16	25	85.7	10	3237.6	2488.8	27.0	0.88	0.618	0.388	0.6	0.18
28	135.3	Unsaturated	Saturated	16	25	85.7	10	3372.9	2561.7	27.9	0.88	0.622	0.421	0.7	0.16
29	135.3	Saturated	Saturated	16	25	85.7	10	3508.2	2634.6	27.6	0.87	0.624	0.409	0.7	0.17
30	135.3	Saturated	Saturated	16	25	85.7	10	3643.5	2707.5	27.4	0.86	0.627	0.397	0.6	0.17
31	135.3	Saturated	Saturated	23	30	32.7	0	3778.8	2780.4	40.6	0.86	0.629	2.000	3.2	0.00
32	135.3	Saturated	Saturated	23	30	32.7	0	3914.1	2853.3	40.2	0.85	0.630	2.000	3.2	0.00
33	122.7	Saturated	Saturated	24	35	53.5	0	4036.8	2913.6	42.3	0.85	0.632	2.000	3.2	0.00
34	122.7	Saturated	Saturated	24	35	53.5	0	4159.5	2973.9	42.0	0.84	0.633	2.000	3.2	0.00
35	122.7	Saturated	Saturated	24	35	53.5	0	4282.2	3034.2	41.7	0.83	0.634	2.000	3.2	0.00
36	122.7	Saturated	Saturated	24	35	53.5	0	4404.9	3094.5	41.4	0.83	0.635	1.994	3.1	0.00
37	122.7	Saturated	Saturated	24	35	53.5	0	4527.6	3154.8	41.2	0.82	0.636	1.983	3.1	0.00
38	123.2	Saturated	Saturated	25	40	55.7	0	4650.8	3215.6	43.1	0.81	0.636	1.972	3.1	0.00
39	123.2	Saturated	Saturated	25	40	55.7	0	4774.0	3276.4	42.8	0.81	0.636	1.961	3.1	0.00
40	123.2	Saturated	Saturated	25	40	55.7	0	4897.2	3337.2	42.6	0.80	0.635	1.950	3.1	0.00
41	123.2	Saturated	Saturated	25	40	55.7	0	5020.4	3398.0	42.3	0.80	0.635	1.940	3.1	0.00
42	123.2	Saturated	Saturated	25	40	55.7	0	5143.6	3458.8	42.1	0.79	0.634	1.930	3.0	0.00
43	131.7	Saturated	Saturated	25	40	55.7	0	5275.3	3528.1	41.8	0.78	0.633	1.918	3.0	0.00
44	131.7	Saturated	Saturated	25	40	55.7	0	5407.0	3597.4	41.5	0.78	0.631	1.907	3.0	0.00
45	131.7	Saturated	Saturated	25	40	55.7	0	5538.7	3666.7	41.2	0.77	0.629	1.896	3.0	0.00
46	131.7	Saturated	Saturated	28	45	67.5	0	5670.4	3736.0	47.6	0.77	0.627	1.884	3.0	0.00
47	131.7	Saturated	Saturated	28	45	67.5	0	5802.1	3805.3	47.3	0.76	0.625	1.874	3.0	0.00
48	132.0	Saturated	Saturated	28	45	67.5	0	5934.1	3874.9	47.0	0.75	0.623	1.863	3.0	0.00
49	132.0	Saturated	Saturated	28	45	67.5	0	6066.1	3944.5	46.8	0.75	0.621	1.852	3.0	0.00
50	132.0	Saturated	Saturated	33	50	0.0	0	6198.1	4014.1	49.6	0.74	0.619	1.842	3.0	0.00
											Total Liquefaction Settlement, S =			2.19 inches	

Geotechnologies, Inc.

Project: Faring - Carson
File No.: 21850
Description: Liquefaction Analysis
Boring No: 20

LIQUEFACTION EVALUATION (Idriss & Boulanger, EERI NO 12)

EARTHQUAKE INFORMATION:

Earthquake Magnitude (M):	6.8
Peak Ground Horizontal Acceleration, PGA (g):	0.83
Calculated Mag.Wtg.Factor:	1.218

GROUNDWATER INFORMATION:

Current Groundwater Level (ft):	23.5
Historically Highest Groundwater Level* (ft):	15.0
Unit Weight of Water (pcf):	62.4

* Based on California Geological Survey Seismic Hazard Evaluation Report

BOREHOLE AND SAMPLER INFORMATION:

Borehole Diameter (inches):	8
SPT Sampler with room for Liner (Y/N):	Y

LIQUEFACTION BOUNDARY:

Plastic Index Cut Off (PI):	18
Minimum Liquefaction FS:	1.3

Depth to Base Layer (feet)	Total Unit Weight (pcf)	Current Water Level (feet)	Historical Water Level (feet)	Field SPT Blowcount N	Depth of SPT Blowcount (feet)	Fines Content #200 Sieve (%)	Plastic Index (PI)	Vetical Stress σ_{ve}, (psf)	Effective Vert. Stress σ_{ve}', (psf)	Fines Corrected $(N_1)_{60\text{-}cs}$	Stress Reduction Coeff, r_d	Cyclic Shear Ratio CSR	Cyclic Resistance Ratio (CRR)	Factor of Safety CRR/CSR (F.S.)	Liquefaction Settlment ΔS_i (inches)
1	129.3	Unsaturated	Unsaturated	11	5	0.0	0	129.3	129.3	24.2	1.00	0.542	0.366	Non-Liq.	0.00
2	129.3	Unsaturated	Unsaturated	11	5	0.0	0	258.6	258.6	24.2	1.00	0.540	0.366	Non-Liq.	0.00
3	129.3	Unsaturated	Unsaturated	11	5	0.0	0	387.9	387.9	24.2	1.00	0.538	0.366	Non-Liq.	0.00
4	129.3	Unsaturated	Unsaturated	11	5	0.0	0	517.2	517.2	24.2	0.99	0.536	0.366	Non-Liq.	0.00
5	129.3	Unsaturated	Unsaturated	11	5	0.0	0	646.5	646.5	24.7	0.99	0.534	0.380	Non-Liq.	0.00
6	129.3	Unsaturated	Unsaturated	11	5	0.0	0	775.8	775.8	23.2	0.99	0.532	0.340	Non-Liq.	0.00
7	129.3	Unsaturated	Unsaturated	11	5	0.0	0	905.1	905.1	21.7	0.98	0.530	0.307	Non-Liq.	0.00
8	129.3	Unsaturated	Unsaturated	11	5	0.0	0	1034.4	1034.4	20.5	0.98	0.528	0.283	Non-Liq.	0.00
9	129.3	Unsaturated	Unsaturated	11	5	0.0	0	1163.7	1163.7	20.6	0.97	0.526	0.281	Non-Liq.	0.00
10	129.3	Unsaturated	Unsaturated	11	5	0.0	0	1293.0	1293.0	19.6	0.97	0.523	0.261	Non-Liq.	0.00
11	129.3	Unsaturated	Unsaturated	12	10	88.7	37	1422.3	1422.3	26.1	0.97	0.521	0.413	Non-Liq.	0.00
12	129.3	Unsaturated	Unsaturated	12	10	88.7	37	1551.6	1551.6	25.2	0.96	0.518	0.378	Non-Liq.	0.00
13	134.9	Unsaturated	Unsaturated	21	15	88.7	20	1686.5	1686.5	40.9	0.96	0.516	2.000	Non-Liq.	0.00
14	134.9	Unsaturated	Unsaturated	21	15	88.7	20	1821.4	1821.4	39.8	0.95	0.513	2.000	Non-Liq.	0.00
15	134.9	Unsaturated	Unsaturated	21	15	63.0	20	1956.3	1956.3	43.6	0.95	0.511	2.000	Non-Liq.	0.00
16	134.9	Unsaturated	Saturated	21	15	63.0	20	2091.2	2028.8	42.6	0.94	0.524	2.000	Non-Liq.	0.00
17	134.9	Unsaturated	Saturated	21	15	63.0	20	2226.1	2101.3	41.7	0.94	0.535	2.000	Non-Liq.	0.00
18	128.7	Unsaturated	Saturated	22	20	78.7	7	2354.8	2167.6	42.9	0.93	0.546	2.000	3.7	0.00
19	128.7	Unsaturated	Saturated	22	20	78.7	7	2483.5	2233.9	42.1	0.93	0.555	2.000	3.6	0.00
20	128.7	Unsaturated	Saturated	22	20	78.7	7	2612.2	2300.2	41.3	0.92	0.564	2.000	3.5	0.00
21	128.7	Unsaturated	Saturated	22	20	78.7	7	2740.9	2366.5	40.5	0.91	0.572	2.000	3.5	0.00
22	128.7	Unsaturated	Saturated	22	20	78.7	7	2869.6	2432.8	39.8	0.91	0.579	2.000	3.5	0.00
23	128.4	Unsaturated	Saturated	22	20	78.7	7	2998.0	2498.8	39.1	0.90	0.585	2.000	3.4	0.00
24	128.4	Saturated	Saturated	22	20	78.7	7	3126.4	2564.8	38.6	0.90	0.591	2.000	3.4	0.00
25	128.4	Saturated	Saturated	22	20	78.7	7	3254.8	2630.8	38.3	0.89	0.596	2.000	3.4	0.00
26	128.4	Saturated	Saturated	20	25	42.1	0	3383.2	2696.8	34.2	0.89	0.600	1.022	1.7	0.00
27	128.4	Saturated	Saturated	20	25	42.1	0	3511.6	2762.8	33.9	0.88	0.604	0.965	1.6	0.00
28	130.0	Saturated	Saturated	23	30	59.7	0	3641.6	2830.4	41.8	0.88	0.607	2.000	3.3	0.00
29	130.0	Saturated	Saturated	23	30	59.7	0	3771.6	2898.0	41.5	0.87	0.610	2.000	3.3	0.00
30	130.0	Saturated	Saturated	23	30	59.7	0	3901.6	2965.6	41.2	0.86	0.613	2.000	3.3	0.00
31	130.0	Saturated	Saturated	23	30	59.7	0	4031.6	3033.2	40.8	0.86	0.615	2.000	3.3	0.00
32	130.0	Saturated	Saturated	23	30	59.7	0	4161.6	3100.8	40.5	0.85	0.616	2.000	3.2	0.00
33	130.4	Saturated	Saturated	23	30	59.7	0	4292.0	3168.8	40.2	0.85	0.618	2.000	3.2	0.00
34	130.4	Saturated	Saturated	23	30	59.7	0	4422.4	3236.8	39.9	0.84	0.618	2.000	3.2	0.00
35	130.4	Saturated	Saturated	23	30	59.7	0	4552.8	3304.8	39.6	0.83	0.619	2.000	3.2	0.00
36	130.4	Saturated	Saturated	17	35	86.2	17	4683.2	3372.8	27.8	0.83	0.619	0.408	0.7	0.16
37	130.4	Saturated	Saturated	17	35	86.2	17	4813.6	3440.8	27.6	0.82	0.619	0.398	0.6	0.17
38	131.3	Saturated	Saturated	22	40	75.8	17	4944.9	3509.7	36.7	0.81	0.619	1.602	2.6	0.00
39	131.3	Saturated	Saturated	22	40	75.8	17	5076.2	3578.6	36.4	0.81	0.619	1.499	2.4	0.00
40	131.3	Saturated	Saturated	22	40	75.8	17	5207.5	3647.5	36.2	0.80	0.618	1.407	2.3	0.00
41	131.3	Saturated	Saturated	22	40	75.8	17	5338.8	3716.4	35.9	0.80	0.617	1.324	2.1	0.00
42	131.3	Saturated	Saturated	22	40	75.8	17	5470.1	3785.3	35.6	0.79	0.616	1.249	2.0	0.00
43	130.7	Saturated	Saturated	23	45	37.1	0	5600.8	3853.6	37.4	0.78	0.615	1.832	3.0	0.00
44	130.7	Saturated	Saturated	23	45	37.1	0	5731.5	3921.9	37.1	0.78	0.614	1.708	2.8	0.00
45	130.7	Saturated	Saturated	23	45	37.1	0	5862.2	3990.2	36.9	0.77	0.612	1.600	2.6	0.00
46	130.7	Saturated	Saturated	23	45	37.1	0	5992.9	4058.5	36.6	0.77	0.610	1.506	2.5	0.00
47	130.7	Saturated	Saturated	23	45	37.1	0	6123.6	4126.8	36.4	0.76	0.609	1.420	2.3	0.00
48	128.2	Saturated	Saturated	23	45	37.1	0	6251.8	4192.6	36.1	0.75	0.607	1.345	2.2	0.00
49	128.2	Saturated	Saturated	23	45	37.1	0	6380.0	4258.4	35.9	0.75	0.605	1.276	2.1	0.00
50	128.2	Saturated	Saturated	23	45	37.1	0	6508.2	4324.2	35.7	0.74	0.603	1.213	2.0	0.00
51	128.2	Saturated	Saturated	34	50	0.0	0	6636.4	4390.0	50.8	0.74	0.601	1.828	3.0	0.00
52	128.2	Saturated	Saturated	34	50	0.0	0	6764.6	4455.8	50.7	0.73	0.599	1.818	3.0	0.00
53	129.9	Saturated	Saturated	34	50	0.0	0	6894.5	4523.3	50.5	0.73	0.596	1.809	3.0	0.00
54	129.9	Saturated	Saturated	34	50	0.0	0	7024.4	4590.8	50.3	0.72	0.594	1.799	3.0	0.00
55	129.9	Saturated	Saturated	34	50	0.0	0	7154.3	4658.3	50.1	0.71	0.591	1.790	3.0	0.00
56	129.9	Saturated	Saturated	54	55	0.0	0	7284.2	4725.8	79.4	0.71	0.589	1.780	3.0	0.00
57	129.9	Saturated	Saturated	54	55	0.0	0	7414.1	4793.3	79.1	0.70	0.586	1.771	3.0	0.00
58	129.5	Saturated	Saturated	54	55	0.0	0	7543.6	4860.4	78.8	0.70	0.584	1.762	3.0	0.00
59	129.5	Saturated	Saturated	54	55	0.0	0	7673.1	4927.5	78.6	0.69	0.581	1.753	3.0	0.00
60	129.5	Saturated	Saturated	54	55	0.0	0	7802.6	4994.6	78.3	0.69	0.578	1.744	3.0	0.00
61	129.5	Saturated	Saturated	16	60	96.1	27	7932.1	5061.7	22.1	0.68	0.576	0.246	Non-Liq.	0.00
62	129.5	Saturated	Saturated	16	60	96.1	27	8061.6	5128.8	22.0	0.68	0.573	0.244	Non-Liq.	0.00
63	122.0	Saturated	Saturated	35	65	0.0	0	8183.6	5188.4	50.3	0.67	0.571	1.720	3.0	0.00
64	122.0	Saturated	Saturated	35	65	0.0	0	8305.6	5248.0	50.2	0.67	0.568	1.712	3.0	0.00
65	122.0	Saturated	Saturated	35	65	0.0	0	8427.6	5307.6	50.0	0.66	0.566	1.705	3.0	0.00
66	122.0	Saturated	Saturated	35	65	0.0	0	8549.6	5367.2	49.9	0.66	0.563	1.697	3.0	0.00
67	122.0	Saturated	Saturated	35	65	0.0	0	8671.6	5426.8	49.8	0.65	0.561	1.690	3.0	0.00
68	133.9	Saturated	Saturated	35	65	0.0	0	8805.5	5498.3	49.6	0.65	0.558	1.682	3.0	0.00
69	133.9	Saturated	Saturated	35	65	0.0	0	8939.4	5569.8	49.5	0.64	0.555	1.673	3.0	0.00
70	133.9	Saturated	Saturated	120	70	0.0	0	9073.3	5641.3	169.1	0.64	0.552	1.665	3.0	0.00

Total Liquefaction Settlement, S = 0.32 inches

Geotechnologies, Inc.

Project: Faring - Carson
File No.: 21850
Description: Liquefaction Analysis
Boring No: 21

LIQUEFACTION EVALUATION (Idriss & Boulanger, EERI NO 12)

EARTHQUAKE INFORMATION:

Earthquake Magnitude (M):	6.8
Peak Ground Horizontal Acceleration, PGA (g):	0.83
Calculated Mag.Wtg.Factor:	1.218

GROUNDWATER INFORMATION:

Current Groundwater Level (ft):	31.0
Historically Highest Groundwater Level* (ft):	15.0
Unit Weight of Water (pcf):	62.4

* Based on California Geological Survey Seismic Hazard Evaluation Report

BOREHOLE AND SAMPLER INFORMATION:

Borehole Diameter (inches):	8
SPT Sampler with room for Liner (Y/N):	Y

LIQUEFACTION BOUNDARY:

Plastic Index Cut Off (PI):	18
Minimum Liquefaction FS:	1.3

Depth to Base Layer (feet)	Total Unit Weight (pcf)	Current Water Level (feet)	Historical Water Level (feet)	Field SPT Blowcount N	Depth of SPT Blowcount (feet)	Fines Content #200 Sieve (%)	Plastic Index (PI)	Vetical Stress σ_{vc}, (psf)	Effective Vert. Stress σ_{vc}', (psf)	Fines Corrected $(N_1)_{60-cs}$	Stress Reduction Coeff, r_d	Cyclic Shear Ratio CSR	Cyclic Resistance Ratio (CRR)	Factor of Safety CRR/CSR (F.S.)	Liquefaction Settlment ΔS_i (inches)
1	120.5	Unsaturated	Unsaturated	9	5	0.0	0	120.5	120.5	19.2	1.00	0.542	0.264	Non-Liq.	0.00
2	120.5	Unsaturated	Unsaturated	9	5	0.0	0	241.0	241.0	19.2	1.00	0.540	0.264	Non-Liq.	0.00
3	120.5	Unsaturated	Unsaturated	9	5	0.0	0	361.5	361.5	19.2	1.00	0.538	0.264	Non-Liq.	0.00
4	120.5	Unsaturated	Unsaturated	9	5	0.0	0	482.0	482.0	19.2	0.99	0.536	0.264	Non-Liq.	0.00
5	120.5	Unsaturated	Unsaturated	9	5	0.0	0	602.5	602.5	20.7	0.99	0.534	0.288	Non-Liq.	0.00
6	120.5	Unsaturated	Unsaturated	9	5	0.0	0	723.0	723.0	19.6	0.99	0.532	0.269	Non-Liq.	0.00
7	120.5	Unsaturated	Unsaturated	9	5	0.0	0	843.5	843.5	18.4	0.98	0.530	0.252	Non-Liq.	0.00
8	131.1	Unsaturated	Unsaturated	9	5	0.0	0	974.6	974.6	17.2	0.98	0.528	0.234	Non-Liq.	0.00
9	131.1	Unsaturated	Unsaturated	9	5	0.0	0	1105.7	1105.7	17.2	0.97	0.526	0.231	Non-Liq.	0.00
10	131.1	Unsaturated	Unsaturated	9	5	0.0	0	1236.8	1236.8	16.3	0.97	0.523	0.216	Non-Liq.	0.00
11	131.1	Unsaturated	Unsaturated	62	10	0.0	0	1367.9	1367.9	110.4	0.97	0.521	2.000	Non-Liq.	0.00
12	131.1	Unsaturated	Unsaturated	62	10	0.0	0	1499.0	1499.0	107.7	0.96	0.518	2.000	Non-Liq.	0.00
13	135.3	Unsaturated	Unsaturated	62	10	0.0	0	1634.3	1634.3	105.3	0.96	0.516	2.000	Non-Liq.	0.00
14	135.3	Unsaturated	Unsaturated	62	10	0.0	0	1769.6	1769.6	103.1	0.95	0.513	2.000	Non-Liq.	0.00
15	135.3	Unsaturated	Unsaturated	62	10	0.0	0	1904.9	1904.9	113.1	0.95	0.511	2.000	Non-Liq.	0.00
16	135.3	Unsaturated	Saturated	28	15	0.0	0	2040.2	1977.8	50.1	0.94	0.524	2.000	3.8	0.00
17	135.3	Unsaturated	Saturated	16	20	71.0	37	2175.5	2050.7	31.8	0.94	0.536	0.757	Non-Liq.	0.00
18	128.4	Unsaturated	Saturated	16	20	71.0	37	2303.9	2116.7	31.1	0.93	0.547	0.672	Non-Liq.	0.00
19	128.4	Unsaturated	Saturated	16	20	71.0	37	2432.3	2182.7	30.4	0.93	0.557	0.606	Non-Liq.	0.00
20	128.4	Unsaturated	Saturated	16	20	71.0	37	2560.7	2248.7	29.8	0.92	0.565	0.553	Non-Liq.	0.00
21	128.4	Unsaturated	Saturated	16	20	71.0	37	2689.1	2314.7	29.2	0.91	0.573	0.509	Non-Liq.	0.00
22	128.4	Unsaturated	Saturated	16	20	71.0	37	2817.5	2380.7	28.6	0.91	0.581	0.474	Non-Liq.	0.00
23	129.2	Unsaturated	Saturated	14	25	80.2	41	2946.7	2447.5	24.7	0.90	0.587	0.326	Non-Liq.	0.00
24	129.2	Unsaturated	Saturated	14	25	80.2	41	3075.9	2514.3	24.2	0.90	0.593	0.312	Non-Liq.	0.00
25	129.2	Unsaturated	Saturated	14	25	80.2	41	3205.1	2581.1	23.8	0.89	0.598	0.301	Non-Liq.	0.00
26	129.2	Unsaturated	Saturated	14	25	80.2	41	3334.3	2647.9	23.4	0.89	0.602	0.291	Non-Liq.	0.00
27	129.2	Unsaturated	Saturated	14	25	80.2	41	3463.5	2714.7	23.0	0.88	0.606	0.281	Non-Liq.	0.00
28	127.9	Unsaturated	Saturated	14	25	80.2	41	3591.4	2780.2	23.8	0.88	0.610	0.295	Non-Liq.	0.00
29	127.9	Unsaturated	Saturated	14	25	80.2	41	3719.3	2845.7	23.4	0.87	0.613	0.286	Non-Liq.	0.00
30	127.9	Unsaturated	Saturated	14	25	80.2	41	3847.2	2911.2	23.1	0.86	0.615	0.278	Non-Liq.	0.00
31	127.9	Unsaturated	Saturated	13	30	80.1	22	3975.1	2976.7	21.2	0.86	0.618	0.246	Non-Liq.	0.00
32	127.9	Saturated	Saturated	13	30	80.1	22	4103.0	3042.2	21.0	0.85	0.619	0.243	Non-Liq.	0.00
33	130.5	Saturated	Saturated	13	30	80.1	22	4233.5	3110.3	20.9	0.85	0.621	0.240	Non-Liq.	0.00
34	130.5	Saturated	Saturated	13	30	80.1	22	4364.0	3178.4	20.7	0.84	0.622	0.238	Non-Liq.	0.00
35	130.5	Saturated	Saturated	13	30	80.1	22	4494.5	3246.5	20.6	0.83	0.622	0.235	Non-Liq.	0.00
36	130.5	Saturated	Saturated	12	35	89.9	10	4625.0	3314.6	19.0	0.83	0.622	0.215	0.3	0.29
37	130.5	Saturated	Saturated	12	35	89.9	10	4755.5	3382.7	18.9	0.82	0.623	0.213	0.3	0.29
38	127.9	Saturated	Saturated	12	35	89.9	10	4883.4	3448.2	18.7	0.81	0.622	0.211	0.3	0.29
39	127.9	Saturated	Saturated	12	35	89.9	10	5011.3	3513.7	18.6	0.81	0.622	0.209	0.3	0.29
40	127.9	Saturated	Saturated	12	35	89.9	10	5139.2	3579.2	18.5	0.80	0.622	0.208	0.3	0.29
41	127.9	Saturated	Saturated	14	40	70.1	14	5267.1	3644.7	21.2	0.80	0.621	0.240	0.4	0.26
42	127.9	Saturated	Saturated	14	40	70.1	14	5395.0	3710.2	21.1	0.79	0.620	0.238	0.4	0.26
43	131.0	Saturated	Saturated	31	45	0.0	0	5526.0	3778.8	46.7	0.78	0.619	1.849	3.0	0.00
44	131.0	Saturated	Saturated	31	45	0.0	0	5657.0	3847.4	46.5	0.78	0.617	1.839	3.0	0.00
45	131.0	Saturated	Saturated	31	45	0.0	0	5788.0	3916.0	46.4	0.77	0.616	1.829	3.0	0.00
46	131.0	Saturated	Saturated	31	45	0.0	0	5919.0	3984.6	46.2	0.77	0.614	1.819	3.0	0.00
47	131.0	Saturated	Saturated	31	45	0.0	0	6050.0	4053.2	46.0	0.76	0.612	1.809	3.0	0.00
48	130.7	Saturated	Saturated	31	45	0.0	0	6180.7	4121.5	45.8	0.75	0.610	1.799	2.9	0.00
49	130.7	Saturated	Saturated	31	45	0.0	0	6311.4	4189.8	45.6	0.75	0.608	1.790	2.9	0.00
50	130.7	Saturated	Saturated	38	50	0.0	0	6442.1	4258.1	55.8	0.74	0.606	1.780	2.9	0.00

Total Liquefaction Settlement, S = 1.98 inches

Geotechnologies, Inc.
Project: Faring - Carson
File No.: 21850
Description: Liquefaction Analysis
Boring No: 27

LIQUEFACTION EVALUATION (Idriss & Boulanger, EERI NO 12)

EARTHQUAKE INFORMATION:

Earthquake Magnitude (M):	6.8
Peak Ground Horizontal Acceleration, PGA (g):	0.83
Calculated Mag.Wtg.Factor:	1.218

GROUNDWATER INFORMATION:

Current Groundwater Level (ft):	25.0
Historically Highest Groundwater Level* (ft):	15.0
Unit Weight of Water (pcf):	62.4

* Based on California Geological Survey Seismic Hazard Evaluation Report

BOREHOLE AND SAMPLER INFORMATION:

Borehole Diameter (inches):	8
SPT Sampler with room for Liner (Y/N):	Y

LIQUEFACTION BOUNDARY:

Plastic Index Cut Off (PI):	18
Minimum Liquefaction FS:	1.3

Depth to Base Layer (feet)	Total Unit Weight (pcf)	Current Water Level (feet)	Historical Water Level (feet)	Field SPT Blowcount N	Depth of SPT Blowcount (feet)	Fines Content #200 Sieve (%)	Plastic Index (PI)	Vetical Stress σ_{vc}, (psf)	Effective Vert. Stress σ_{vc}', (psf)	Fines Corrected $(N_1)_{60-cs}$	Stress Reduction Coeff, r_d	Cyclic Shear Ratio CSR	Cyclic Resistance Ratio (CRR)	Factor of Safety CRR/CSR (F.S.)	Liquefaction Settlment ΔS_i (inches)
1	136.6	Unsaturated	Unsaturated	13	5	0.0	0	136.6	136.6	29.5	1.00	0.542	0.611	Non-Liq.	0.00
2	136.6	Unsaturated	Unsaturated	13	5	0.0	0	273.2	273.2	29.5	1.00	0.540	0.611	Non-Liq.	0.00
3	136.6	Unsaturated	Unsaturated	13	5	0.0	0	409.8	409.8	29.5	1.00	0.538	0.611	Non-Liq.	0.00
4	136.6	Unsaturated	Unsaturated	13	5	0.0	0	546.4	546.4	28.7	0.99	0.536	0.556	Non-Liq.	0.00
5	136.6	Unsaturated	Unsaturated	13	5	0.0	0	683.0	683.0	28.6	0.99	0.534	0.547	Non-Liq.	0.00
6	136.6	Unsaturated	Unsaturated	13	5	0.0	0	819.6	819.6	26.8	0.99	0.532	0.453	Non-Liq.	0.00
7	136.6	Unsaturated	Unsaturated	13	5	0.0	0	956.2	956.2	25.1	0.98	0.530	0.391	Non-Liq.	0.00
8	136.6	Unsaturated	Unsaturated	13	5	0.0	0	1092.8	1092.8	23.7	0.98	0.528	0.351	Non-Liq.	0.00
9	136.6	Unsaturated	Unsaturated	13	5	0.0	0	1229.4	1229.4	23.9	0.97	0.526	0.352	Non-Liq.	0.00
10	136.6	Unsaturated	Unsaturated	13	5	0.0	0	1366.0	1366.0	22.8	0.97	0.523	0.319	Non-Liq.	0.00
11	136.6	Unsaturated	Unsaturated	14	10	0.0	0	1502.6	1502.6	23.6	0.97	0.521	0.335	Non-Liq.	0.00
12	136.6	Unsaturated	Unsaturated	14	10	0.0	0	1639.2	1639.2	22.7	0.96	0.518	0.309	Non-Liq.	0.00
13	109.8	Unsaturated	Unsaturated	14	10	0.0	0	1749.0	1749.0	22.0	0.96	0.516	0.292	Non-Liq.	0.00
14	109.8	Unsaturated	Unsaturated	14	10	0.0	0	1858.8	1858.8	21.4	0.95	0.513	0.277	Non-Liq.	0.00
15	109.8	Unsaturated	Unsaturated	14	10	0.0	0	1968.6	1968.6	23.6	0.95	0.511	0.320	Non-Liq.	0.00
16	109.8	Unsaturated	Saturated	15	15	80.9	47	2078.4	2016.0	30.4	0.94	0.524	0.625	Non-Liq.	0.00
17	109.8	Unsaturated	Saturated	15	15	80.9	47	2188.2	2063.4	29.8	0.94	0.536	0.571	Non-Liq.	0.00
18	112.8	Unsaturated	Saturated	15	15	80.9	47	2301.0	2113.8	29.2	0.93	0.547	0.525	Non-Liq.	0.00
19	112.8	Unsaturated	Saturated	15	15	80.9	47	2413.8	2164.2	28.6	0.93	0.557	0.488	Non-Liq.	0.00
20	112.8	Unsaturated	Saturated	15	15	80.9	47	2526.6	2214.6	28.1	0.92	0.567	0.456	Non-Liq.	0.00
21	112.8	Unsaturated	Saturated	7	20	83.7	47	2639.4	2265.0	14.8	0.91	0.575	0.184	Non-Liq.	0.00
22	112.8	Unsaturated	Saturated	7	20	83.7	47	2752.2	2315.4	14.6	0.91	0.583	0.181	Non-Liq.	0.00
23	116.6	Unsaturated	Saturated	7	20	83.7	47	2868.8	2369.6	14.4	0.90	0.590	0.178	Non-Liq.	0.00
24	116.6	Unsaturated	Saturated	7	20	83.7	47	2985.4	2423.8	14.2	0.90	0.597	0.175	Non-Liq.	0.00
25	116.6	Unsaturated	Saturated	7	20	83.7	47	3102.0	2478.0	14.0	0.89	0.603	0.173	Non-Liq.	0.00
26	116.6	Saturated	Saturated	12	25	94.2	57	3218.6	2532.2	20.8	0.89	0.608	0.248	Non-Liq.	0.00
27	116.6	Saturated	Saturated	12	25	94.2	57	3335.2	2586.4	20.6	0.88	0.613	0.246	Non-Liq.	0.00
28	115.5	Saturated	Saturated	12	25	94.2	57	3450.7	2639.5	21.4	0.88	0.617	0.257	Non-Liq.	0.00
29	115.5	Saturated	Saturated	12	25	94.2	57	3566.2	2692.6	21.3	0.87	0.621	0.254	Non-Liq.	0.00
30	115.5	Saturated	Saturated	12	25	94.2	57	3681.7	2745.7	21.1	0.86	0.624	0.251	Non-Liq.	0.00
31	115.5	Saturated	Saturated	9	30	88.1	19	3797.2	2798.8	16.5	0.86	0.627	0.195	Non-Liq.	0.00
32	115.5	Saturated	Saturated	9	30	88.1	19	3912.7	2851.9	16.4	0.85	0.630	0.194	Non-Liq.	0.00
33	127.5	Saturated	Saturated	9	30	88.1	19	4040.2	2917.0	16.3	0.85	0.632	0.192	Non-Liq.	0.00
34	127.5	Saturated	Saturated	9	30	88.1	19	4167.7	2982.1	16.2	0.84	0.633	0.190	Non-Liq.	0.00
35	127.5	Saturated	Saturated	9	30	88.1	19	4295.2	3047.2	16.1	0.83	0.633	0.189	Non-Liq.	0.00
36	127.5	Saturated	Saturated	9	35	88.1	19	4422.7	3112.3	16.0	0.83	0.634	0.188	Non-Liq.	0.00
37	127.5	Saturated	Saturated	9	35	88.1	19	4550.2	3177.4	15.9	0.82	0.634	0.186	Non-Liq.	0.00
38	124.9	Saturated	Saturated	9	35	88.1	19	4675.1	3239.9	15.8	0.81	0.634	0.185	Non-Liq.	0.00
39	124.9	Saturated	Saturated	9	35	88.1	19	4800.0	3302.4	15.7	0.81	0.634	0.184	Non-Liq.	0.00
40	124.9	Saturated	Saturated	9	35	88.1	19	4924.9	3364.9	15.6	0.80	0.634	0.182	Non-Liq.	0.00
41	124.9	Saturated	Saturated	14	40	76.7	31	5049.8	3427.4	22.5	0.80	0.633	0.266	Non-Liq.	0.00
42	124.9	Saturated	Saturated	14	40	76.7	31	5174.7	3489.9	22.4	0.79	0.632	0.263	Non-Liq.	0.00
43	130.9	Saturated	Saturated	14	40	76.7	31	5305.6	3558.4	22.2	0.78	0.631	0.260	Non-Liq.	0.00
44	130.9	Saturated	Saturated	14	40	76.7	31	5436.5	3626.9	22.1	0.78	0.629	0.256	Non-Liq.	0.00
45	130.9	Saturated	Saturated	14	40	76.7	31	5567.4	3695.4	21.9	0.77	0.628	0.253	Non-Liq.	0.00
46	130.9	Saturated	Saturated	9	45	75.1	29	5698.3	3763.9	15.1	0.77	0.626	0.176	Non-Liq.	0.00
47	130.9	Saturated	Saturated	9	45	75.1	29	5829.2	3832.4	15.0	0.76	0.624	0.174	Non-Liq.	0.00
48	128.2	Saturated	Saturated	19	50	24.8	0	5957.4	3898.2	28.9	0.75	0.622	0.442	0.7	0.13
49	128.2	Saturated	Saturated	19	50	24.8	0	6085.6	3964.0	28.7	0.75	0.620	0.432	0.7	0.14
50	128.2	Saturated	Saturated	19	50	24.8	0	6213.8	4029.8	28.5	0.74	0.618	0.422	0.7	0.14
51	128.2	Saturated	Saturated	19	50	24.8	0	6342.0	4095.6	28.4	0.74	0.615	0.412	0.7	0.15
52	128.2	Saturated	Saturated	19	50	24.8	0	6470.2	4161.4	28.2	0.73	0.613	0.404	0.7	0.15
53	126.3	Saturated	Saturated	58	55	0.0	0	6596.5	4225.3	87.1	0.73	0.611	1.838	3.0	0.00
54	126.3	Saturated	Saturated	58	55	0.0	0	6722.8	4289.2	86.8	0.72	0.608	1.829	3.0	0.00
55	126.3	Saturated	Saturated	58	55	0.0	0	6849.1	4353.1	86.5	0.71	0.606	1.820	3.0	0.00
56	126.3	Saturated	Saturated	58	55	0.0	0	6975.4	4417.0	86.2	0.71	0.603	1.810	3.0	0.00
57	126.3	Saturated	Saturated	58	55	0.0	0	7101.7	4480.9	85.9	0.70	0.601	1.801	3.0	0.00
58	122.5	Saturated	Saturated	44	60	0.0	0	7224.2	4541.0	65.0	0.70	0.598	1.793	3.0	0.00
59	122.5	Saturated	Saturated	44	60	0.0	0	7346.7	4601.1	64.8	0.69	0.596	1.785	3.0	0.00
60	122.5	Saturated	Saturated	44	60	0.0	0	7469.2	4661.2	64.6	0.69	0.593	1.776	3.0	0.00
61	122.5	Saturated	Saturated	44	60	0.0	0	7591.7	4721.3	64.4	0.68	0.591	1.768	3.0	0.00
62	122.5	Saturated	Saturated	44	60	0.0	0	7714.2	4781.4	64.2	0.68	0.588	1.760	3.0	0.00
63	122.6	Saturated	Saturated	37	65	0.0	0	7836.8	4841.6	53.8	0.67	0.586	1.752	3.0	0.00
64	122.6	Saturated	Saturated	37	65	0.0	0	7959.4	4901.8	53.7	0.67	0.583	1.744	3.0	0.00
65	122.6	Saturated	Saturated	37	65	0.0	0	8082.0	4962.0	53.5	0.66	0.580	1.737	3.0	0.00
66	122.6	Saturated	Saturated	37	65	0.0	0	8204.6	5022.2	53.4	0.66	0.578	1.729	3.0	0.00
67	122.6	Saturated	Saturated	37	65	0.0	0	8327.2	5082.4	53.2	0.65	0.575	1.721	3.0	0.00
68	127.4	Saturated	Saturated	37	65	0.0	0	8454.6	5147.4	53.1	0.65	0.572	1.713	3.0	0.00
69	127.4	Saturated	Saturated	37	65	0.0	0	8582.0	5212.4	52.9	0.64	0.570	1.705	3.0	0.00
70	127.4	Saturated	Saturated	43	70	0.0	0	8709.4	5277.4	61.3	0.64	0.567	1.697	3.0	0.00

Total Liquefaction Settlement, S = 0.71 inches

Geotechnologies, Inc.

Project: Faring
File No.: 21850
Description: Liquefaction Analysis
Boring No: 29

LIQUEFACTION EVALUATION (Idriss & Boulanger, EERI NO 12)

EARTHQUAKE INFORMATION:

Earthquake Magnitude (M):	6.8
Peak Ground Horizontal Acceleration, PGA (g):	0.83
Calculated Mag.Wtg.Factor:	1.218
GROUNDWATER INFORMATION:	
Current Groundwater Level (ft):	32.5
Historically Highest Groundwater Level* (ft):	15.0
Unit Weight of Water (pcf):	62.4

* Based on California Geological Survey Seismic Hazard Evaluation Report

BOREHOLE AND SAMPLER INFORMATION:

Borehole Diameter (inches):	8
SPT Sampler with room for Liner (Y/N):	Y
LIQUEFACTION BOUNDARY:	
Plastic Index Cut Off (PI):	18
Minimum Liquefaction FS:	1.3

Depth to Base Layer (feet)	Total Unit Weight (pcf)	Current Water Level (feet)	Historical Water Level (feet)	Field SPT Blowcount N	Depth of SPT Blowcount (feet)	Fines Content #200 Sieve (%)	Plastic Index (PI)	Vetical Stress σ_{vc}, (psf)	Effective Vert. Stress σ_{vc}', (psf)	Fines Corrected $(N_1)_{60-cs}$	Stress Reduction Coeff, r_d	Cyclic Shear Ratio CSR	Cyclic Resistance Ratio (CRR)	Factor of Safety CRR/CSR (F.S.)	Liquefaction Settlment ΔS_i (inches)
1	130.6	Unsaturated	Unsaturated	1	5	0.0	0	130.6	130.6	2.0	1.00	0.542	0.094	Non-Liq.	0.00
2	130.6	Unsaturated	Unsaturated	1	5	0.0	0	261.2	261.2	2.0	1.00	0.540	0.094	Non-Liq.	0.00
3	130.6	Unsaturated	Unsaturated	1	5	0.0	0	391.8	391.8	2.0	1.00	0.538	0.094	Non-Liq.	0.00
4	130.6	Unsaturated	Unsaturated	1	5	0.0	0	522.4	522.4	2.0	0.99	0.536	0.093	Non-Liq.	0.00
5	130.6	Unsaturated	Unsaturated	1	5	0.0	0	653.0	653.0	2.2	0.99	0.534	0.093	Non-Liq.	0.00
6	130.6	Unsaturated	Unsaturated	1	5	0.0	0	783.6	783.6	2.2	0.99	0.532	0.092	Non-Liq.	0.00
7	130.6	Unsaturated	Unsaturated	1	5	0.0	0	914.2	914.2	2.2	0.98	0.530	0.091	Non-Liq.	0.00
8	130.6	Unsaturated	Unsaturated	1	5	0.0	0	1044.8	1044.8	2.0	0.98	0.528	0.089	Non-Liq.	0.00
9	130.6	Unsaturated	Unsaturated	1	5	0.0	0	1175.4	1175.4	2.0	0.97	0.526	0.089	Non-Liq.	0.00
10	131.1	Unsaturated	Unsaturated	1	5	0.0	0	1306.5	1306.5	1.9	0.97	0.523	0.087	Non-Liq.	0.00
11	131.1	Unsaturated	Unsaturated	1	5	0.0	0	1437.6	1437.6	1.7	0.97	0.521	0.086	Non-Liq.	0.00
12	131.1	Unsaturated	Unsaturated	1	5	0.0	0	1568.7	1568.7	1.6	0.96	0.518	0.085	Non-Liq.	0.00
13	134.1	Unsaturated	Unsaturated	1	5	0.0	0	1702.8	1702.8	1.6	0.96	0.516	0.084	Non-Liq.	0.00
14	134.1	Unsaturated	Unsaturated	1	5	0.0	0	1836.9	1836.9	1.5	0.95	0.513	0.083	Non-Liq.	0.00
15	134.1	Unsaturated	Unsaturated	1	5	0.0	0	1971.0	1971.0	1.6	0.95	0.511	0.083	Non-Liq.	0.00
16	134.1	Unsaturated	Saturated	21	15	0.0	0	2105.1	2042.7	36.9	0.94	0.523	2.000	3.8	0.00
17	134.1	Unsaturated	Saturated	21	15	0.0	0	2239.2	2114.4	36.0	0.94	0.535	1.648	3.1	0.00
18	129.1	Unsaturated	Saturated	21	15	0.0	0	2368.3	2181.1	35.1	0.93	0.545	1.347	2.5	0.00
19	129.1	Unsaturated	Saturated	21	15	0.0	0	2497.4	2247.8	34.3	0.93	0.555	1.130	2.0	0.00
20	129.1	Unsaturated	Saturated	21	15	0.0	0	2626.5	2314.5	33.6	0.92	0.564	0.968	1.7	0.00
21	129.1	Unsaturated	Saturated	24	20	0.0	0	2755.6	2381.2	39.1	0.91	0.571	2.000	3.5	0.00
22	129.1	Unsaturated	Saturated	24	20	0.0	0	2884.7	2447.9	38.3	0.91	0.578	2.000	3.5	0.00
23	126.7	Unsaturated	Saturated	24	20	0.0	0	3011.4	2512.2	37.6	0.90	0.585	2.000	3.4	0.00
24	126.7	Unsaturated	Saturated	24	20	0.0	0	3138.1	2576.5	37.0	0.90	0.590	1.859	3.2	0.00
25	126.7	Unsaturated	Saturated	24	20	0.0	0	3264.8	2640.8	36.3	0.89	0.595	1.576	2.6	0.00
26	126.7	Unsaturated	Saturated	33	25	0.0	0	3391.5	2705.1	51.7	0.89	0.600	2.000	3.3	0.00
27	126.7	Unsaturated	Saturated	33	25	0.0	0	3518.2	2769.4	51.2	0.88	0.604	2.000	3.3	0.00
28	126.2	Unsaturated	Saturated	33	25	0.0	0	3644.4	2833.2	53.4	0.88	0.607	2.000	3.3	0.00
29	126.2	Unsaturated	Saturated	33	25	0.0	0	3770.6	2897.0	52.9	0.87	0.610	2.000	3.3	0.00
30	126.2	Unsaturated	Saturated	33	25	0.0	0	3896.8	2960.8	52.5	0.86	0.613	1.995	3.3	0.00
31	126.2	Unsaturated	Saturated	19	30	90.0	22	4023.0	3024.6	31.0	0.86	0.615	0.582	Non-Liq.	0.00
32	126.2	Unsaturated	Saturated	19	30	90.0	22	4149.2	3088.4	30.6	0.85	0.617	0.546	Non-Liq.	0.00
33	127.9	Saturated	Saturated	19	35	39.7	0	4277.1	3153.9	30.3	0.85	0.618	0.526	0.9	0.11
34	127.9	Saturated	Saturated	19	35	39.7	0	4405.0	3219.4	30.1	0.84	0.619	0.511	0.8	0.11
35	127.9	Saturated	Saturated	19	35	39.7	0	4532.9	3284.9	29.9	0.83	0.620	0.497	0.8	0.11
36	127.9	Saturated	Saturated	19	35	39.7	0	4660.8	3350.4	29.7	0.83	0.621	0.483	0.8	0.12
37	127.9	Saturated	Saturated	19	35	39.7	0	4788.7	3415.9	29.5	0.82	0.621	0.471	0.8	0.12
38	128.4	Saturated	Saturated	19	35	39.7	0	4917.1	3481.9	29.3	0.81	0.621	0.459	0.7	0.13
39	128.4	Saturated	Saturated	19	35	39.7	0	5045.5	3547.9	29.1	0.81	0.620	0.448	0.7	0.13
40	128.4	Saturated	Saturated	19	35	39.7	0	5173.9	3613.9	28.9	0.80	0.620	0.437	0.7	0.13
41	128.4	Saturated	Saturated	38	40	0.0	0	5302.3	3679.9	57.3	0.80	0.619	1.850	3.0	0.00
42	128.4	Saturated	Saturated	38	40	0.0	0	5430.7	3745.9	57.1	0.79	0.618	1.840	3.0	0.00
43	134.1	Saturated	Saturated	38	40	0.0	0	5564.8	3817.6	56.9	0.78	0.617	1.829	3.0	0.00
44	134.1	Saturated	Saturated	38	40	0.0	0	5698.9	3889.3	56.6	0.78	0.615	1.819	3.0	0.00
45	134.1	Saturated	Saturated	38	40	0.0	0	5833.0	3961.0	56.4	0.77	0.613	1.809	2.9	0.00
46	134.1	Saturated	Saturated	17	45	44.9	0	5967.1	4032.7	24.7	0.77	0.612	0.295	0.5	0.23
47	134.1	Saturated	Saturated	17	45	44.9	0	6101.2	4104.4	24.5	0.76	0.610	0.291	0.5	0.23
48	135.2	Saturated	Saturated	17	45	44.9	0	6236.4	4177.2	24.3	0.75	0.608	0.287	0.5	0.23
49	135.2	Saturated	Saturated	17	45	44.9	0	6371.6	4250.0	24.2	0.75	0.605	0.283	0.5	0.23
50	135.2	Saturated	Saturated	17	45	44.9	0	6506.8	4322.8	24.0	0.74	0.603	0.279	0.5	0.24
51	135.2	Saturated	Saturated	28	50	0.0	0	6642.0	4395.6	38.4	0.74	0.601	1.749	2.9	0.00
52	135.2	Saturated	Saturated	28	50	0.0	0	6777.2	4468.4	38.1	0.73	0.598	1.740	2.9	0.00
53	126.9	Saturated	Saturated	40	55	0.0	0	6904.1	4532.9	57.7	0.73	0.596	1.732	2.9	0.00
54	126.9	Saturated	Saturated	40	55	0.0	0	7031.0	4597.4	57.6	0.72	0.594	1.723	2.9	0.00
55	126.9	Saturated	Saturated	40	55	0.0	0	7157.9	4661.9	57.4	0.71	0.591	1.715	2.9	0.00
56	126.9	Saturated	Saturated	40	55	0.0	0	7284.8	4726.4	57.2	0.71	0.589	1.707	2.9	0.00
57	126.9	Saturated	Saturated	40	55	0.0	0	7411.7	4790.9	57.1	0.70	0.586	1.699	2.9	0.00
58	121.7	Saturated	Saturated	40	55	0.0	0	7533.4	4850.2	56.9	0.70	0.584	1.692	2.9	0.00
59	121.7	Saturated	Saturated	40	55	0.0	0	7655.1	4909.5	56.8	0.69	0.582	1.685	2.9	0.00
60	121.7	Saturated	Saturated	40	55	0.0	0	7776.8	4968.8	56.6	0.69	0.580	1.678	2.9	0.00
61	121.7	Saturated	Saturated	19	60	87.3	40	7898.5	5028.1	25.5	0.68	0.577	0.303	Non-Liq.	0.00
62	121.7	Saturated	Saturated	19	60	87.3	40	8020.2	5087.4	25.4	0.68	0.575	0.300	Non-Liq.	0.00
63	118.2	Saturated	Saturated	19	60	87.3	40	8138.4	5143.2	25.3	0.67	0.573	0.297	Non-Liq.	0.00
64	118.2	Saturated	Saturated	19	60	87.3	40	8256.6	5199.0	25.2	0.67	0.570	0.294	Non-Liq.	0.00
65	118.2	Saturated	Saturated	19	60	87.3	40	8374.8	5254.8	25.0	0.66	0.568	0.291	Non-Liq.	0.00
66	118.2	Saturated	Saturated	34	65	0.0	0	8493.0	5310.6	47.4	0.66	0.566	1.638	2.9	0.00
67	118.2	Saturated	Saturated	34	65	0.0	0	8611.2	5366.4	47.3	0.65	0.563	1.632	2.9	0.00
68	116.4	Saturated	Saturated	34	65	0.0	0	8727.6	5420.4	47.2	0.65	0.561	1.626	2.9	0.00
69	116.4	Saturated	Saturated	34	65	0.0	0	8844.0	5474.4	47.1	0.64	0.559	1.620	2.9	0.00
70	116.4	Saturated	Saturated	48	70	0.0	0	8960.4	5528.4	66.4	0.64	0.557	1.614	2.9	0.00
											Total Liquefaction Settlement, S =			**2.12 inches**	

Geotechnologies, Inc.

Project: Faring - Carson
File No.: 21850
Description: Liquefaction Analysis
Boring No: 31

LIQUEFACTION EVALUATION (Idriss & Boulanger, EERI NO 12)

EARTHQUAKE INFORMATION:

Earthquake Magnitude (M):	6.8
Peak Ground Horizontal Acceleration, PGA (g):	0.83
Calculated Mag.Wtg.Factor:	1.218

GROUNDWATER INFORMATION:

Current Groundwater Level (ft):	30.0
Historically Highest Groundwater Level* (ft):	15.0
Unit Weight of Water (pcf):	62.4

* Based on California Geological Survey Seismic Hazard Evaluation Report

BOREHOLE AND SAMPLER INFORMATION:

Borehole Diameter (inches):	8
SPT Sampler with room for Liner (Y/N):	Y

LIQUEFACTION BOUNDARY:

Plastic Index Cut Off (PI):	18
Minimum Liquefaction FS:	1.3

Depth to Base Layer (feet)	Total Unit Weight (pcf)	Current Water Level (feet)	Historical Water Level (feet)	Field SPT Blowcount N	Depth of SPT Blowcount (feet)	Fines Content #200 Sieve (%)	Plastic Index (PI)	Vetical Stress σ_{vc}, (psf)	Effective Vert. Stress σ_{vc}', (psf)	Fines Corrected $(N_1)_{60-cs}$	Stress Reduction Coeff, r_d	Cyclic Shear Ratio CSR	Cyclic Resistance Ratio (CRR)	Factor of Safety CRR/CSR (F.S.)	Liquefaction Settlment ΔS_i (inches)
1	130.7	Unsaturated	Unsaturated	17	5	0.0	0	130.7	130.7	40.5	1.00	0.542	2.000	Non-Liq.	0.00
2	130.7	Unsaturated	Unsaturated	17	5	0.0	0	261.4	261.4	40.5	1.00	0.540	2.000	Non-Liq.	0.00
3	130.7	Unsaturated	Unsaturated	17	5	0.0	0	392.1	392.1	39.5	1.00	0.538	2.000	Non-Liq.	0.00
4	130.7	Unsaturated	Unsaturated	17	5	0.0	0	522.8	522.8	37.1	0.99	0.536	2.000	Non-Liq.	0.00
5	130.7	Unsaturated	Unsaturated	17	5	0.0	0	653.5	653.5	36.9	0.99	0.534	2.000	Non-Liq.	0.00
6	130.7	Unsaturated	Unsaturated	17	5	0.0	0	784.2	784.2	35.2	0.99	0.532	1.541	Non-Liq.	0.00
7	130.7	Unsaturated	Unsaturated	17	5	0.0	0	914.9	914.9	33.5	0.98	0.530	1.104	Non-Liq.	0.00
8	132.8	Unsaturated	Unsaturated	17	5	0.0	0	1047.7	1047.7	31.8	0.98	0.528	0.834	Non-Liq.	0.00
9	132.8	Unsaturated	Unsaturated	17	5	0.0	0	1180.5	1180.5	32.3	0.97	0.526	0.910	Non-Liq.	0.00
10	132.8	Unsaturated	Unsaturated	17	5	0.0	0	1313.3	1313.3	31.0	0.97	0.523	0.741	Non-Liq.	0.00
11	132.8	Unsaturated	Unsaturated	16	10	67.3	26	1446.1	1446.1	33.4	0.97	0.521	1.085	Non-Liq.	0.00
12	132.8	Unsaturated	Unsaturated	16	10	67.3	26	1578.9	1578.9	32.4	0.96	0.518	0.886	Non-Liq.	0.00
13	122.5	Unsaturated	Unsaturated	16	10	67.3	26	1701.4	1701.4	31.5	0.96	0.516	0.757	Non-Liq.	0.00
14	122.5	Unsaturated	Unsaturated	16	10	67.3	26	1823.9	1823.9	30.6	0.95	0.513	0.663	Non-Liq.	0.00
15	122.5	Unsaturated	Unsaturated	16	10	67.3	26	1946.4	1946.4	33.2	0.95	0.511	0.980	Non-Liq.	0.00
16	122.5	Unsaturated	Saturated	14	15	73.7	34	2068.9	2006.5	28.6	0.94	0.524	0.499	Non-Liq.	0.00
17	122.5	Unsaturated	Saturated	14	15	73.7	34	2191.4	2066.6	27.9	0.94	0.536	0.460	Non-Liq.	0.00
18	131.6	Unsaturated	Saturated	14	15	73.7	34	2323.0	2135.8	27.3	0.93	0.546	0.425	Non-Liq.	0.00
19	131.6	Unsaturated	Saturated	14	15	73.7	34	2454.6	2205.0	26.6	0.93	0.556	0.397	Non-Liq.	0.00
20	131.6	Unsaturated	Saturated	14	15	73.7	34	2586.2	2274.2	26.1	0.92	0.565	0.374	Non-Liq.	0.00
21	131.6	Unsaturated	Saturated	11	20	73.7	34	2717.8	2343.4	20.6	0.91	0.572	0.251	Non-Liq.	0.00
22	131.6	Unsaturated	Saturated	11	20	73.7	34	2849.4	2412.6	20.2	0.91	0.579	0.243	Non-Liq.	0.00
23	134.5	Unsaturated	Saturated	11	20	73.7	34	2983.9	2484.7	19.8	0.90	0.586	0.237	Non-Liq.	0.00
24	134.5	Unsaturated	Saturated	11	20	73.7	34	3118.4	2556.8	19.4	0.90	0.591	0.230	Non-Liq.	0.00
25	134.5	Unsaturated	Saturated	11	20	73.7	34	3252.9	2628.9	19.1	0.89	0.596	0.225	Non-Liq.	0.00
26	134.5	Unsaturated	Saturated	15	25	14.7	0	3387.4	2701.0	22.4	0.89	0.600	0.272	0.5	0.25
27	134.5	Unsaturated	Saturated	15	25	14.7	0	3521.9	2773.1	22.0	0.88	0.604	0.263	0.4	0.25
28	134.9	Unsaturated	Saturated	15	25	14.7	0	3656.8	2845.6	22.8	0.88	0.607	0.276	0.5	0.25
29	134.9	Unsaturated	Saturated	15	25	14.7	0	3791.7	2918.1	22.4	0.87	0.609	0.267	0.4	0.25
30	134.9	Unsaturated	Saturated	15	25	14.7	0	3926.6	2990.6	22.1	0.86	0.611	0.259	0.4	0.25
31	134.9	Saturated	Saturated	19	30	31.6	0	4061.5	3063.1	31.0	0.86	0.613	0.582	0.9	0.09
32	134.9	Saturated	Saturated	19	30	31.6	0	4196.4	3135.6	30.7	0.85	0.615	0.561	0.9	0.10
33	126.3	Saturated	Saturated	19	30	31.6	0	4322.7	3199.5	30.5	0.85	0.616	0.543	0.9	0.10
34	126.3	Saturated	Saturated	19	30	31.6	0	4449.0	3263.4	30.3	0.84	0.617	0.527	0.9	0.11
35	126.3	Saturated	Saturated	19	30	31.6	0	4575.3	3327.3	30.1	0.83	0.618	0.512	0.8	0.11
36	126.3	Saturated	Saturated	25	35	65.8	0	4701.6	3391.2	41.8	0.83	0.618	1.920	3.1	0.00
37	126.3	Saturated	Saturated	25	35	65.8	0	4827.9	3455.1	41.5	0.82	0.619	1.910	3.1	0.00
38	122.1	Saturated	Saturated	25	35	65.8	0	4950.0	3514.8	41.3	0.81	0.619	1.900	3.1	0.00
39	122.1	Saturated	Saturated	25	35	65.8	0	5072.1	3574.5	41.1	0.81	0.619	1.890	3.1	0.00
40	122.1	Saturated	Saturated	25	35	65.8	0	5194.2	3634.2	40.8	0.80	0.619	1.881	3.0	0.00
41	122.1	Saturated	Saturated	20	40	63.7	13	5316.3	3693.9	30.9	0.80	0.618	0.556	0.9	0.09
42	122.1	Saturated	Saturated	20	40	63.7	13	5438.4	3753.6	30.7	0.79	0.618	0.541	0.9	0.10
43	133.1	Saturated	Saturated	20	40	63.7	13	5571.5	3824.3	30.5	0.78	0.616	0.525	0.9	0.10
44	133.1	Saturated	Saturated	20	40	63.7	13	5704.6	3895.0	30.3	0.78	0.615	0.510	0.8	0.11
45	133.1	Saturated	Saturated	20	40	63.7	13	5837.7	3965.7	30.1	0.77	0.613	0.496	0.8	0.11
46	133.1	Saturated	Saturated	37	45	0.0	0	5970.8	4036.4	55.2	0.77	0.611	1.820	3.0	0.00
47	133.1	Saturated	Saturated	37	45	0.0	0	6103.9	4107.1	55.0	0.76	0.610	1.810	3.0	0.00
48	124.4	Saturated	Saturated	37	45	0.0	0	6228.3	4169.1	54.8	0.75	0.608	1.801	3.0	0.00
49	124.4	Saturated	Saturated	37	45	0.0	0	6352.7	4231.1	54.6	0.75	0.606	1.793	3.0	0.00
50	124.4	Saturated	Saturated	40	50	0.0	0	6477.1	4293.1	58.9	0.74	0.604	1.784	3.0	0.00

Total Liquefaction Settlement, S = 2.27 inches

Geotechnologies, Inc.

Project: Faring - Carson
File No.: 21850
Description: Liquefaction Analysis
Boring No: 37

LIQUEFACTION EVALUATION (Idriss & Boulanger, EERI NO 12)

EARTHQUAKE INFORMATION:

Earthquake Magnitude (M):	6.8
Peak Ground Horizontal Acceleration, PGA (g):	0.83
Calculated Mag.Wtg.Factor:	1.218

GROUNDWATER INFORMATION:

Current Groundwater Level (ft):	26.0
Historically Highest Groundwater Level* (ft):	15.0
Unit Weight of Water (pcf):	62.4

* Based on California Geological Survey Seismic Hazard Evaluation Report

BOREHOLE AND SAMPLER INFORMATION:

Borehole Diameter (inches):	8
SPT Sampler with room for Liner (Y/N):	Y

LIQUEFACTION BOUNDARY:

Plastic Index Cut Off (PI):	18
Minimum Liquefaction FS:	1.3

Depth to Base Layer (feet)	Total Unit Weight (pcf)	Current Water Level (feet)	Historical Water Level (feet)	Field SPT Blowcount N	Depth of SPT Blowcount (feet)	Fines Content #200 Sieve (%)	Plastic Index (PI)	Vetical Stress σ_{vc}, (psf)	Effective Vert. Stress σ_{vc}', (psf)	Fines Corrected $(N_1)_{60-cs}$	Stress Reduction Coeff, r_d	Cyclic Shear Ratio CSR	Cyclic Resistance Ratio (CRR)	Factor of Safety CRR/CSR (F.S.)	Liquefaction Settlment ΔS_i (inches)
1	127.0	Unsaturated	Unsaturated	9	5	0.0	0	127.0	127.0	19.2	1.00	0.542	0.264	Non-Liq.	0.00
2	127.0	Unsaturated	Unsaturated	9	5	0.0	0	254.0	254.0	19.2	1.00	0.540	0.264	Non-Liq.	0.00
3	127.0	Unsaturated	Unsaturated	9	5	0.0	0	381.0	381.0	19.2	1.00	0.538	0.264	Non-Liq.	0.00
4	127.0	Unsaturated	Unsaturated	9	5	0.0	0	508.0	508.0	19.2	0.99	0.536	0.264	Non-Liq.	0.00
5	127.0	Unsaturated	Unsaturated	9	5	0.0	0	635.0	635.0	20.5	0.99	0.534	0.285	Non-Liq.	0.00
6	127.0	Unsaturated	Unsaturated	9	5	0.0	0	762.0	762.0	19.2	0.99	0.532	0.263	Non-Liq.	0.00
7	127.0	Unsaturated	Unsaturated	9	5	0.0	0	889.0	889.0	18.0	0.98	0.530	0.246	Non-Liq.	0.00
8	129.3	Unsaturated	Unsaturated	9	5	0.0	0	1018.3	1018.3	16.8	0.98	0.528	0.228	Non-Liq.	0.00
9	129.3	Unsaturated	Unsaturated	9	5	0.0	0	1147.6	1147.6	16.9	0.97	0.526	0.226	Non-Liq.	0.00
10	129.3	Unsaturated	Unsaturated	9	5	0.0	0	1276.9	1276.9	16.0	0.97	0.523	0.212	Non-Liq.	0.00
11	129.3	Unsaturated	Unsaturated	12	10	52.1	30	1406.2	1406.2	26.3	0.97	0.521	0.422	Non-Liq.	0.00
12	129.3	Unsaturated	Unsaturated	12	10	52.1	30	1535.5	1535.5	25.4	0.96	0.518	0.385	Non-Liq.	0.00
13	137.2	Unsaturated	Unsaturated	12	10	52.1	30	1672.7	1672.7	24.6	0.96	0.516	0.354	Non-Liq.	0.00
14	137.2	Unsaturated	Unsaturated	12	10	52.1	30	1809.9	1809.9	23.8	0.95	0.513	0.330	Non-Liq.	0.00
15	137.2	Unsaturated	Unsaturated	12	10	52.1	30	1947.1	1947.1	25.5	0.95	0.511	0.373	Non-Liq.	0.00
16	137.2	Unsaturated	Saturated	14	15	52.5	26	2084.3	2021.9	28.5	0.94	0.524	0.496	Non-Liq.	0.00
17	137.2	Unsaturated	Saturated	14	15	52.5	26	2221.5	2096.7	27.8	0.94	0.535	0.454	Non-Liq.	0.00
18	135.0	Unsaturated	Saturated	14	15	52.5	26	2356.5	2169.3	27.1	0.93	0.546	0.420	Non-Liq.	0.00
19	135.0	Unsaturated	Saturated	14	15	52.5	26	2491.5	2241.9	26.5	0.93	0.555	0.392	Non-Liq.	0.00
20	135.0	Unsaturated	Saturated	14	15	52.5	26	2626.5	2314.5	26.0	0.92	0.564	0.369	Non-Liq.	0.00
21	135.0	Unsaturated	Saturated	15	20	19.6	0	2761.5	2387.1	25.9	0.91	0.571	0.365	0.6	0.22
22	135.0	Unsaturated	Saturated	15	20	19.6	0	2896.5	2459.7	25.4	0.91	0.578	0.346	0.6	0.22
23	122.0	Unsaturated	Saturated	15	20	19.6	0	3018.5	2519.3	24.9	0.90	0.584	0.331	0.6	0.23
24	122.0	Unsaturated	Saturated	15	20	19.6	0	3140.5	2578.9	24.5	0.90	0.590	0.318	0.5	0.23
25	122.0	Unsaturated	Saturated	15	20	19.6	0	3262.5	2638.5	24.1	0.89	0.595	0.306	0.5	0.24
26	122.0	Unsaturated	Saturated	21	25	3.3	0	3384.5	2698.1	29.8	0.89	0.600	0.520	0.9	0.11
27	122.0	Saturated	Saturated	21	25	3.3	0	3506.5	2757.7	29.5	0.88	0.604	0.502	0.8	0.12
28	120.8	Saturated	Saturated	21	25	3.3	0	3627.3	2816.1	31.3	0.88	0.608	0.633	1.0	0.07
29	120.8	Saturated	Saturated	21	25	3.3	0	3748.1	2874.5	31.1	0.87	0.611	0.608	1.0	0.08
30	120.8	Saturated	Saturated	21	25	3.3	0	3868.9	2932.9	30.8	0.86	0.614	0.586	1.0	0.09
31	120.8	Saturated	Saturated	36	30	0.0	0	3989.7	2991.3	58.1	0.86	0.617	2.000	3.2	0.00
32	120.8	Saturated	Saturated	36	30	0.0	0	4110.5	3049.7	57.9	0.85	0.619	2.000	3.2	0.00
33	123.0	Saturated	Saturated	36	30	0.0	0	4233.5	3110.3	57.6	0.85	0.621	2.000	3.2	0.00
34	123.0	Saturated	Saturated	36	30	0.0	0	4356.5	3170.9	57.4	0.84	0.622	2.000	3.2	0.00
35	123.0	Saturated	Saturated	36	30	0.0	0	4479.5	3231.5	57.2	0.83	0.623	1.992	3.2	0.00
36	123.0	Saturated	Saturated	26	35	71.4	0	4602.5	3292.1	45.5	0.83	0.624	1.981	3.2	0.00
37	123.0	Saturated	Saturated	26	35	71.4	0	4725.5	3352.7	45.2	0.82	0.624	1.970	3.2	0.00
38	132.6	Saturated	Saturated	23	40	49.4	0	4858.1	3422.9	38.5	0.81	0.624	1.957	3.1	0.00
39	132.6	Saturated	Saturated	23	40	49.4	0	4990.7	3493.1	38.2	0.81	0.623	1.945	3.1	0.00
40	132.6	Saturated	Saturated	23	40	49.4	0	5123.3	3563.3	37.9	0.80	0.622	1.933	3.1	0.00
41	132.6	Saturated	Saturated	23	40	49.4	0	5255.9	3633.5	37.7	0.80	0.622	1.921	3.1	0.00
42	132.6	Saturated	Saturated	23	40	49.4	0	5388.5	3703.7	37.4	0.79	0.620	1.855	3.0	0.00
43	130.3	Saturated	Saturated	23	40	49.4	0	5518.8	3771.6	37.2	0.78	0.619	1.729	2.8	0.00
44	130.3	Saturated	Saturated	23	40	49.4	0	5649.1	3839.5	36.9	0.78	0.618	1.619	2.6	0.00
45	130.3	Saturated	Saturated	23	40	49.4	0	5779.4	3907.4	36.7	0.77	0.616	1.524	2.5	0.00
46	130.3	Saturated	Saturated	30	45	45.8	0	5909.7	3975.3	51.0	0.77	0.614	1.867	3.0	0.00
47	130.3	Saturated	Saturated	30	45	45.8	0	6040.0	4043.2	50.8	0.76	0.613	1.856	3.0	0.00
48	126.7	Saturated	Saturated	30	45	45.8	0	6166.7	4107.5	50.6	0.75	0.611	1.846	3.0	0.00
49	126.7	Saturated	Saturated	30	45	45.8	0	6293.4	4171.8	50.4	0.75	0.609	1.837	3.0	0.00
50	126.7	Saturated	Saturated	30	45	45.8	0	6420.1	4236.1	50.2	0.74	0.607	1.827	3.0	0.00
51	126.7	Saturated	Saturated	29	50	0.0	0	6546.8	4300.4	42.5	0.74	0.605	1.818	3.0	0.00
52	126.7	Saturated	Saturated	29	50	0.0	0	6673.5	4364.7	42.3	0.73	0.603	1.809	3.0	0.00
53	119.9	Saturated	Saturated	29	50	0.0	0	6793.4	4422.2	42.1	0.73	0.601	1.801	3.0	0.00
54	119.9	Saturated	Saturated	29	50	0.0	0	6913.3	4479.7	41.9	0.72	0.599	1.793	3.0	0.00
55	119.9	Saturated	Saturated	29	50	0.0	0	7033.2	4537.2	41.7	0.71	0.597	1.785	3.0	0.00
56	119.9	Saturated	Saturated	10	55	93.7	24	7153.1	4594.7	15.1	0.71	0.595	0.172	Non-Liq.	0.00
57	119.9	Saturated	Saturated	10	55	93.7	24	7273.0	4652.2	15.0	0.70	0.593	0.171	Non-Liq.	0.00
58	133.5	Saturated	Saturated	10	55	93.7	24	7406.5	4723.3	14.9	0.70	0.590	0.170	Non-Liq.	0.00
59	133.5	Saturated	Saturated	10	55	93.7	24	7540.0	4794.4	14.9	0.69	0.587	0.169	Non-Liq.	0.00
60	133.5	Saturated	Saturated	10	55	93.7	24	7673.5	4865.5	14.8	0.69	0.584	0.168	Non-Liq.	0.00
61	133.5	Saturated	Saturated	28	60	97.2	0	7807.0	4936.6	43.4	0.68	0.581	1.732	3.0	0.00
62	133.5	Saturated	Saturated	28	60	97.2	0	7940.5	5007.7	43.2	0.68	0.578	1.723	3.0	0.00
63	110.7	Saturated	Saturated	28	60	97.2	0	8051.2	5056.0	43.0	0.67	0.576	1.717	3.0	0.00
64	110.7	Saturated	Saturated	28	60	97.2	0	8161.9	5104.3	42.8	0.67	0.574	1.711	3.0	0.00
65	110.7	Saturated	Saturated	28	60	97.2	0	8272.6	5152.6	42.7	0.66	0.572	1.705	3.0	0.00
66	110.7	Saturated	Saturated	30	65	61.9	0	8383.3	5200.9	47.2	0.66	0.570	1.699	3.0	0.00
67	110.7	Saturated	Saturated	30	65	61.9	0	8494.0	5249.2	47.0	0.65	0.568	1.693	3.0	0.00
68	137.9	Saturated	Saturated	30	65	61.9	0	8631.9	5324.7	46.8	0.65	0.565	1.684	3.0	0.00
69	137.9	Saturated	Saturated	30	65	61.9	0	8769.8	5400.2	46.5	0.64	0.562	1.675	3.0	0.00
70	137.9	Saturated	Saturated	35	70	63.7	28	8907.7	5475.7	54.9	0.64	0.559	1.666	Non-Liq.	0.00
											Total Liquefaction Settlement, S =			1.61 inches	

Soil Corrosivity Evaluation Report for Faring

November 25, 2019

Prepared for:

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Project X Job #: S191119G
Client Job or PO #: 21850

Contents

1 Executive Summary

A corrosion evaluation of the soils at Faring was performed to provide corrosion control recommendations for general construction materials. The site is located at 21207 Avalon Boulevard, Carson, CA (33.8387, -118.2667). Ten (10) samples were tested to a depth of 22.5 ft. Site ground water and topography information was provided by Geotechnologies, Inc. Groundwater depth was determined to be 26.5 feet below finished grade.

Every material has its weakness. Aluminums, galvanized/zinc coatings, and coppers do not survive well in very alkaline or very acidic pH environments. Copper and brasses do not survive well in high nitrate or ammonia environments. Steels and irons do not survive well in low soil resistivity and high chloride environments. High chloride environments can even overcome and attack steel encased in normally protective concrete. Concrete does not survive well in high sulfate environments. And nothing survives well in high sulfide and low redox potential environments with corrosive bacteria. This is why Project X tests for these 8 factors to determine a soil's corrosivity towards various construction materials. **Depending solely on soil resistivity or Caltrans corrosion guidelines, which over-simplify descriptions as corrosive or non-corrosive, will not detect these other factors because it is possible to have bad levels of corrosive ions and still have greater than 1,100 ohm-cm soil resistivity. We have observed this fact on thousands of soil samples tested in our laboratory.**

It should not be forgotten that import soil also be tested for all factors to avoid making your site more corrosive than it was to begin with.

The recommendations outlined herein are not a substitute for any design documents previously prepared for the purpose of construction and apply only to the depth of samples collected.

Soil samples were tested for minimum resistivity, pH, chlorides, sulfates, ammonia, nitrates, sulfides and redox.

As-Received soil resistivities ranged between 389 ohm-cm and 2,278 ohm-cm. This data would be similar to a Wenner 4 pin test in the field and used in the design of a cathodic protection or grounding bed system. This resistivity can change seasonally depending on the weather and moisture in the ground. This reading alone can be misleading because condensation or minor water leaks will occur underground along pipe surfaces creating a saturated soil environment in the trench along infrastructure surfaces which is why minimum or saturated soil resistivity measurements are more important than as-received resistivities.

Saturated soil resistivities ranged between 221 ohm-cm to 1,541 ohm-cm.

The worst of these values is considered to be severely corrosive to general metals.

PH levels ranged between 8.2 to 9.2 pH. The average pH of these samples is alkaline and can cause accelerated corrosion of copper and aluminum alloys.

Chlorides ranged between 14 mg/kg to 1,874 mg/kg.

Chloride levels in most of these samples are low and may cause insignificant corrosion of metals except for soil around Sample B16 at 10ft depth which had extremely high levels of chlorides. It would be best to remove and discard this soil.

Chloride levels at sample B16 at 10ft depth are enough to cause significant corrosion in metals in soil and in cement. Cement encased metals will require protection from chloride intrusion from soil.

Sulfates ranged between 48 mg/kg to 4,445 mg/kg.

For all locations except B16 and B20, sulfate levels are negligible for corrosion of metals and cement. Any type of cement can be used that does not contain encased metal except at sample sites B16 and B20.

Sulfate levels at B16 and B20 at depths 10 and 22 ft are severe for corrosion of metals and cement. Type V cement and coatings for metals should be used. If the B16 soil with high chlorides is not discarded, a chloride inhibitor such as DCI must be used to protect metal encased in concrete.

Ammonia ranged between 0.1 mg/kg to 5.0 mg/kg. Nitrates ranged between 0.2 mg/kg to 84.4 mg/kg. Concentrations of these elements were not high enough to cause accelerated corrosion of copper and copper alloys such as brass.

Sulfides presence was determined to be positive at only location B32 depth of 10 ft. REDOX ranged between + 149 mV to + 219 mV. Though sulfides were detected, the probability of corrosive bacteria was determined to be low due to very positive REDOX levels determined in these samples.

2 Corrosion Control Recommendations

The following recommendations are based upon the results of soil testing.

2.1 Cement

The highest reading for sulfates was 4,445 mg/kg or 0.4445 percent by weight.

For areas excluding sample sites B16 and B20: Per ACI 318-14, Table 19.3.1.1, sulfate levels in these samples categorized as S0 and are negligible for corrosion of metals and cement. Per ACI 318-14 Table 19.3.2.1 any type of cement not containing steel or other metal can be used.

Per ACI 318-14, Table 19.3.1.1, sulfate levels in these samples categorized as S1 and are moderate for corrosion of metals and cement. Per ACI 318-14 Table 19.3.2.1 Type II, IP(MS), IS(MS), IT(MS) cement should be used, with a maximum water/cement ratio of 0.50, and minimum strength of 4,000 psi per applicable code.

For sample sites B16 and B20: Per ACI 318-14, Table 19.3.1.1, sulfate levels in these samples categorized as S2 and are severe for corrosion of metals and cement. Type V, IP(HS), IS(HS), or IT(HS) cement should be used, with a maximum water/cement ratio of 0.45, and minimum strength of 4,500 psi per applicable code.

2.2 Steel Reinforced Cement/ Cement Mortar Lined & Coated (CML&C)

Chlorides in soil can overcome the corrosion inhibiting property of cement for steel, as it can also break through passivated surfaces of aluminum and stainless steels.[1,2] The highest concentration of chlorides was 1,874 mg/kg.

For areas excluding sample sites B16 and B20: Chloride levels in these samples are not significantly corrosive to metals not in tension. Standard cement cover may be used in these soils.

For sample sites B16 and B20: Chloride levels in these samples are enough to cause significant corrosion of metals in soil and in cement. Corrosion protection options can be one of the following:

1) Provide 3 inches minimum cement cover between soil and steel materials where cement will be placed in contact with onsite soils. Use Type V cement + Pozzolan or slag content per ACI 318-14 Table 19.3.2.1 to continue use of steel materials encased in cement[3], or
2) Provide waterproof coating with minimum 15 mil thickness to cement that is in contact with soil, or
3) Use epoxy coated steel such as Purple fusion bonded epoxy (FBE) (ASTM A934) or equivalent, or
4) Mix a chloride corrosion inhibitor such as DCI or equivalent into the cement with cement mix designed to protect embedded steel and iron that should be based on 1) Chloride content of 1,874 ppm in the soil, 2) desired service life, 3) cement cover. We defer to the manufacturer of the chloride inhibitor for determination of the proper admixture ratio to cement, or
5) Apply Cathodic Protection

Though soils at some locations are significantly corrosive to various metals, per ACI 318-14 Chapter 19 Table 19.3.1.1, these slab's exposure categories and class for **Corrosion Protection of Reinforcement (C) would be considered C1** as Concrete exposed to moisture (slab sides and bottom) but not to an external source of chlorides. Though there are chlorides in the soil, ACI 318's definition of "external source of chlorides" consists of deicing chemicals, salt, brackish water, seawater, or spray from these sources. The chloride levels in seawater are typically over 19,000 mg/L or 19,000 ppm.

When concrete is tested for water-soluble chloride ion content, the tests should be made at an age of 28 to 42 days. The limits in Table 5.3.2.1 are to be applied to chlorides contributed from the concrete ingredients, not those from the environment surrounding the concrete.[4]

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[1] Design Manual 303: Cement Cylinder Pipe. Ameron. p.65
[2] *Chapter 19, Table 1904.2.2(1), 2012 International Building Code*
[3] *Standard Requirements for Design of Shallow PT Cement foundations on Expansive soil*

[4] ACI 381-14., BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE (ACI 318-14) AND COMMENTARY (ACI 318R-14)

2.3 Stainless Steel Pipe/Conduit/Fittings

Stainless steels derive their corrosion resistance from their chromium content and oxide layer which needs oxygen to regenerate if damaged. Thus stainless steel is not good for deep soil applications where oxygen levels are extremely low. Stainless steels should not be installed deeper than a plant root zone. Stainless steels typically have the same nobility as copper on the galvanic series and can be connected to copper. If stainless steel must be used, it must be backfilled with soil having greater than 10,000 ohm-cm resistivity and excellent drainage. 304 Stainless steel will also corrode if in contact with carbon materials such as activated carbon. Stainless steel welds should be pickled.

The soil at this site has low probability for anaerobic corrosive bacteria and high chloride levels. Per Nickel Institute guidelines, Duplex Stainless steels should be used in these soils.

2.4 Steel Post Tensioning Systems

The proper sealing of stressing holes is of utmost importance in PT Systems. Cut off excess strand 1/2" to 3/4" back in the hole. Coat or paint exposed anchorage, grippers, and stub of strands with "Rust-o-leum" or equal. After tendons have been coated, the cement contractor shall dry pack blockouts within ten (10) days. A non-shrink, non-metallic, non-porous moisture-insensitive grout (Master EMACO S 488 or equivalent), or epoxy grout shall be used for this purpose. If an encapsulated post-tension system is used, regular non-shrink grout can be used.

For sample sites B16 and B20: Soil with high chloride levels is considered an aggressive environment for post-tensioning strands and anchors. Due to the high chloride levels determined on-site, implement all of the following measures:[5,6,7]

1) Completely encapsulate the tendon and anchor with polyethylene to create a watertight seal. Epoxy coated hardware would be equivalent to polyethylene coated and impermeable waterproofing system.
2) Add grease caps to the ends to provide extra protection against corrosion due to high chloride concentrations.
3) All components exposed to the job site should be protected within one working day after their exposure during installation.
4) Ensure the minimum cement cover over the tendon tail is 1-inch, or greater if required by the applicable building code.
5) Caps and sleeves should be installed within one working day after the cutting of the tendon tails and acceptance of the elongation records by the engineer.
6) Inspect the following to ensure the encapsulated system is completely watertight:
    a) Sheathing: Verify that all damaged areas, including pin-holes, are repaired.
    b) Stressing tails: After removal, ensure they are cut to a length for proper installation of P/T coating filled end caps.

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[5] *Post-Tensioning Manual, sixth edition. Post-Tensioning Institute (PTI), Phoenix, AZ, 2006.*
[6] *Specification for Unbonded Single Strand Tendons. Post-Tensioning Institute (PTI), Phoenix, AZ, 2000.*
[7] *ACI 423.6-01: Specification for Unbonded Single Strand Tendons. American Cement Institute (ACI), 2001*

c) End caps: Ensure proper installation before patching the pocket former recesses.

d) Patching: Ensure the patch is of an approved material and mix design, and installed void-free.

e) Limit the access of direct runoff onto the anchorage area by designing proper drainage.

f) Provide at least 2 inches of space between finish grade and the anchorage area, or more if required by applicable building codes.

For site excluding sample sites B16 and B20; due to chloride concentrations measured on samples obtained from these locations, post-tensioned slabs should be protected in accordance with soil considered normal (non-corrosive).[8,9]

2.5 Steel Piles

Steel piles are most susceptible to corrosion in disturbed soil where oxygen is available. Further, a dissimilar environment corrosion cell would exist between the steel embedded in cement, such as pile caps and the steel in the soil. In the cell, the steel in the soil is the anode (corroding metal), and the steel in cement is the cathode (protected metal). This cell can be minimized by coating the part of the steel piles that will be embedded in cement to prevent contact with cement and reinforcing steel.

Piles driven into soils without disturbing soils will avoid oxygen introduction and low corrosion rates unless there is a probability for corrosive anaerobic bacteria. Galvanized steel's zinc coating can provide significant protection for driven piles. In corrosive soils in which normal zinc coatings are not enough, the life of piles can be extended by increasing zinc coating thickness, using sacrificial metal, or providing a combination of epoxy coatings and cathodic protection. Corrosion has been observed to be extremely localized even at and below underground water tables. Pit depths of this magnitude do not have an appreciable effect on the strength or useful life of piling structures because the reduction in pile cross section is not significant.[10] Pitting is of more importance to pipes transporting liquids or gases which should not be leaked into the ground.

The following recommendations are recommended to achieve desired life. We defer to structural engineers to use our estimated corrosion rates and to choose from the corrosion control options listed below.

1) Sacrificial metal by use of thicker pile per disturbed soil corrosion rates, or

2) Sacrificial metal by use of thicker pile per non-disturbed soil corrosion rates and coat portion of piles that will be minimum 12 inches below grade and 12 inches above finished grade with abrasion resistant epoxy coating such as 3M Scotchkote 323, or PowercreteDD, or equivalent, or

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[8] *Post-Tensioning Manual, sixth edition. Post-Tensioning Institute (PTI), Phoenix, AZ, 2006.*
[9] *Specification for Unbonded Single Strand Tendons. Post-tensioning Institute (PTI), Phoenix, AZ, 2000.*

[10] Melvin Romanoff, Corrosion of Steel Pilings in Soils, National Bureau of Standards Monograph 58, pg 20.

3) Cement coated steel piles with minimum 3 inch cover of Type V cement + Pozzolan per 2012 IBC Table 1904.2.3, and 0.40 water-cement ratio by weight and 4,000 psi strength per 2012 IBC Table 1904.2.2(1) and ACI 318 Table 4.2.2 to prevent chloride intrusion from soil to encased steel; or mix chloride corrosion inhibitor such as DCI or equivalent into the cement with cement mix designed to protect embedded steel and iron that should be based on 1) Chloride content of 1,874 ppm in the soil, 2) desired service life, 3) cement cover. We defer to the manufacturer of the chloride inhibitor for determination of the proper admixture ratio to cement.

2.5.1 Expected Corrosion Rate of Steel and Zinc in disturbed soil

In general, the corrosion rate of metals in soil depends on the electrical resistivity, the elemental composition, and the oxygen content of the soil. Soils can vary greatly from one acre to the next, especially at earthquake faults. The better a soil is for farming; the easier it will be for corrosion to take place. Expansive soils will also be considered disturbed simply because of their nature from dry to wet seasons.

In Melvin Romanoff's NBS Circular 579, the corrosion rates of carbon steels and various metals was studied over long term periods. Various metals were placed in various soil types to gather corrosion rate data of all metals in all soil types. Samples were collected and material loss measured over the course of 20 years in some sites. The following corrosion rates were estimated by comparing the worst results of soils tested with similar soils in Romanoff's studies and Highway Research Board's publications.[11] The corrosion rate of zinc in disturbed soils is determined per Romanoff studies and King Nomograph.[12]

Expected Corrosion Rate for Steel = 3.87 mils/year for one sided attack

Expected Corrosion Rate for Zinc = 3.36 mils/year for one sided attack.

Note: 1 mil = 0.001 inch

In undisturbed soils, a corrosion rate of 1 mil/year for steel is expected with little change in the corrosion rate of zinc due to it's low nobility in the galvanic series.

Per CTM 643: Years to perforation of corrugated galvanized steel culverts

- 13.4 Years to Perforation for a 18 gage metal culvert
- 17.5 Years to Perforation for a 16 gage metal culvert
- 21.5 Years to Perforation for a 14 gage metal culvert
- 29.6 Years to Perforation for a 12 gage metal culvert
- 37.6 Years to Perforation for a 10 gage metal culvert
- 45.7 Years to Perforation for a 8 gage metal culvert

2.5.2 Expected Corrosion Rate of Steel and Zinc in Undisturbed soil

Expected Corrosion Rate for Steel = 1 mils/year for one sided attack

Expected Corrosion Rate for Zinc = 3.36 mils/year for one sided attack.

Note: 1 mil = 0.001 inch

[11] Field test for Estimating Service Life of Corrugated Metal Culverts, J.L. Beaton, Proc. Highway Research Board, Vol 41, P. 255, 1962
[12] King, R.A. 1977, Corrosion Nomograph, TRRC Supplementary Report, British Corrosion Journal

2.6 Steel Storage tanks

Underground fuel tanks must be constructed and protected in accordance with California Underground Storage Tank Regulations, CCR, Title 23, Division 3, Chapter 16. Metals should be protected with cathodic protection or isolated from backfill material with an epoxy coating.

2.7 Steel Pipelines

Though a site may not be corrosive in nature at the time of construction, **installation of corrosion test stations and electrical continuity joint bonding should be performed during construction** so that future corrosion inspections can be performed. If steel pipes with gasket joints or other possibly non-conductive type joints are installed, their joints should be bonded across by welding or pin brazing a #8 AWG copper strand bond cable. Electrical continuity is necessary for corrosion inspections and for cathodic protection.

Corrosion test stations should be installed every 1,000 feet of pipeline.

Test stations shall have two #8 HMWPE copper strand wire test leads welded or pin brazed to the underground pipe, brought up into the test station hand hole and marked CTS. Wires should be brought into test station hand hole at finished grade with 12 inches of wire coiled within test station.

At isolation joints and pipe casings, 4 wire test stations shall be installed using #8 HMWPE copper strand wire test leads. Use different color wires to distinguish which wires are bonded to one side of isolation joint or to casing. Wires should be brought into test station hand hole at finished grade with 12 inches of wire coiled within test station.

Prevent dissimilar metal corrosion cells per NACE SP0286:

1) Electrically isolate dissimilar metal connections
2) Electrically isolate dissimilar coatings (Epoxy vs CML&C) segments connections
3) Electrically isolate river crossing segments
4) Electrically isolate freeway crossing segments
5) Electrically isolate old existing pipelines from new pipelines
6) Electrically isolate aboveground and underground pipe segments with flange isolation joint kits. **These are especially important for fire risers.**

The corrosivity at this site is corrosive to steel. Any piping that must be jack bored should use abrasion resistant epoxy coating such as 3M Scotchkote 323, or PowercreteDD, or equivalent. The corrosion control options for this site are as follows:

1) Wax tape, or
2) Coal tar enamel, or
3) Fusion bonded epoxy
4) And install cathodic protection system per NACE SP0169.

   Or instead of CP and Dielectric coating

5) Apply 3 inch coating of Type V cement + mix chloride corrosion inhibitor such as DCI or equivalent into the cement with cement mix designed to protect embedded steel and iron that should be based on 1) Chloride content of 1,874 ppm in the soil, 2) desired service life, 3) cement cover. We defer to the manufacturer of the chloride inhibitor for determination of the proper admixture ratio to cement.

It is critical for the life of the pipe that the protective wrap contains no openings or holes. Prevent damage to the protective sleeve during backfilling of the pipe trench. Penetrations of any kind within these or other protective materials generally leads to accelerated corrosion failure due to the fact that the corrosion attack is concentrated at the location of these penetrations. Cathodic protection will protect these defects. The better the coating, the less expensive a cathodic protection system will be in anode material and power requirement if needed.

2.8 Steel Fittings

The corrosivity at this site is very corrosive to steel. The corrosion control options for this site are as follows:

1) Apply impermeable dielectric coating such as minimum 8 mil thick polyethylene, or
2) Tape coating system, or
3) Wax tape, or
4) Coal tar enamel, or
5) Fusion bonded epoxy, or
6) And install cathodic protection system per NACE SP0169.

Or instead of CP and Dielectric coating

7) Apply 3 inch coating of Type V cement + mix chloride corrosion inhibitor such as DCI or equivalent into the cement with cement mix designed to protect embedded steel and iron that should be based on 1) Chloride content of 1,874 ppm in the soil, 2) desired service life, 3) cement cover. We defer to the manufacturer of the chloride inhibitor for determination of the proper admixture ratio to cement.

It is critical for the life of the metal that the protective wrap contains no openings or holes. Prevent damage to the protective sleeve during backfilling of the pipe trench. Penetrations of any kind within these or other protective materials generally leads to accelerated corrosion failure due to the fact that the corrosion attack is concentrated at the location of these penetrations. Cathodic protection will protect these defects. The better the coating, the less expensive a cathodic protection system will be in anode material and power requirement if needed.

2.9 Ductile Iron (DI) Fittings

AWWA C105 developed a 10 point system to classify sites as aggressive or non-aggressive to ductile iron materials. The 10-point system does not, and was never intended to, quantify the corrosivity of a soil. It is a tool used to distinguish nonaggressive from aggressive soils relative to iron pipe. Soils <10 points are considered nonaggressive to iron pipe, whereas soils ≥10 points are considered aggressive. A 15 and a 20 point soil are both considered aggressive to iron pipe, however, because of the nature of the soil parameters measured, the 20 point soil may not necessarily be more aggressive than the 15 point soil. The criterion is based upon soil resistivities, soil drainage, pH, sulfide presence, and reduction-oxidation (REDOX) potential. The soil samples tested for this site resulted in a score of 17.5 out of 25.5. A score greater or equal to 10 points classifies soils as aggressive to iron materials.

The corrosivity at this site is very corrosive to iron. The corrosion control options for this site are as follows:

1) Apply impermeable dielectric coating such as minimum 8 mil thick polyethylene, or
2) Wax tape, or
3) Coal tar enamel, or
4) Fusion bonded epoxy, or
5) And install cathodic protection system per NACE SP0169.

   Or instead of CP and Dielectric coating

6) Apply 3 inch coating of Type V cement + mix chloride corrosion inhibitor such as DCI or equivalent into the cement with cement mix designed to protect embedded steel and iron that should be based on 1) Chloride content of 1,874 ppm in the soil, 2) desired service life, 3) cement cover. We defer to the manufacturer of the chloride inhibitor for determination of the proper admixture ratio to cement.

It is critical for the life of the metal that the protective wrap contains no openings or holes. Prevent damage to the protective sleeve during backfilling of the pipe trench. Penetrations of any kind within these or other protective materials generally leads to accelerated corrosion failure due to the fact that the corrosion attack is concentrated at the location of these penetrations. Cathodic protection will protect these defects. The better the coating, the less expensive a cathodic protection system will be in anode material and power requirement if needed.

2.10 Ductile Iron Pipe

AWWA C105 developed a 10 point system to classify sites as aggressive or non-aggressive to ductile iron materials. The 10-point system does not, and was never intended to, quantify the corrosivity of a soil. It is a tool used to distinguish nonaggressive from aggressive soils relative to iron pipe. Soils <10 points are considered nonaggressive to iron pipe, whereas soils ≥10 points are considered aggressive. A 15 and a 20 point soil are both considered aggressive to iron pipe, however, because of the nature of the soil parameters measured, the 20 point soil may not necessarily be more aggressive than the 15 point soil. The criterion is based upon soil resistivities, soil drainage, pH, sulfide presence, and reduction-oxidation (REDOX) potential. The soil samples tested for this site resulted in a score of 17.5 out of 25.5. A score greater or equal to 10 points classifies soils as aggressive to iron materials.

Though a site may not be corrosive in nature at the time of construction, **<u>installation of corrosion test stations and electrical continuity joint bonding should be performed during construction</u>** so that future corrosion inspections can be performed. If steel pipes with gasket joints or other possibly non-conductive type joints are installed, their joints should be bonded across by welding or pin brazing a #8 AWG copper strand bond cable. Electrical continuity is necessary for corrosion inspections and for cathodic protection.

Pea gravel is used by plumbers to lay pipes and establish slopes. If the gravel has more than 200 ppm chlorides or is not tested, a 25 mil plastic should be placed between the gravel and pipe to avoid corrosion.

Corrosion test stations should be installed every 1,000 feet of pipeline.

Test stations shall have two #8 HMWPE copper strand wire test leads welded or pin brazed to the underground pipe, brought up into the test station hand hole and marked CTS. Wires should be brought into test station hand hole at finished grade with 12 inches of wire coiled within test station.

At isolation joints and pipe casings, 4 wire test stations shall be installed using #8 HMWPE copper strand wire test leads. Use different color wires to distinguish which wires are bonded to one side of isolation joint or to casing. Wires should be brought into test station hand hole at finished grade with 12 inches of wire coiled within test station.

Prevent dissimilar metal corrosion cells per NACE SP0286:

1) Electrically isolate dissimilar metal connections
2) Electrically isolate dissimilar coatings (Epoxy vs CML&C) segments connections
3) Electrically isolate river crossing segments
4) Electrically isolate freeway crossing segments
5) Electrically isolate old existing pipelines from new pipelines
6) Electrically isolate aboveground and underground pipe segments with flange isolation joint kits**. These are especially important for fire risers.**

The corrosivity at this site is corrosive to iron. The corrosion control options for this site are as follows:

1) Apply impermeable dielectric coating such as minimum 8 mil thick polyethylene, or
2) Tape coating system, or
3) Wax tape, or
4) Coal tar enamel, or
5) Fusion bonded epoxy, or
6) And install cathodic protection system per NACE SP0169.

   Or instead of CP and Dielectric coating

7) Apply 3 inch coating of Type V cement + mix chloride corrosion inhibitor such as DCI or equivalent into the cement with cement mix designed to protect embedded steel and iron that should be based on 1) Chloride content of 1,874 ppm in the soil, 2) desired service life, 3) cement cover. We defer to the manufacturer of the chloride inhibitor for determination of the proper admixture ratio to cement.

It is critical for the life of the metal that the protective wrap contains no openings or holes. Prevent damage to the protective sleeve during backfilling of the pipe trench. Penetrations of any kind within these or other protective materials generally leads to accelerated corrosion failure due to the fact that the corrosion attack is concentrated at the location of these penetrations. Cathodic protection will protect these defects. The better the coating, the less expensive a cathodic protection system will be in anode material and power requirement if needed.

2.11 Copper Materials

Copper is an amphoteric material which is susceptible to corrosion at very high and very low pH. It is one of the most noble metals used in construction thus typically making it a cathode when connected to dissimilar metals. Copper's nobility can change with temperature, similar to the phenomenon in zinc. When zinc is at room temperature, it is less noble than steel and can provide cathodic protection to steel. But when zinc is at a temperature above 140F such as in a water heater, it becomes nobler than the steel and the steel becomes the sacrificial anode. This is why zinc is not used in steel water heaters or boilers. Copper when cold has one native potential, but when heated develops a more electronegative electro-potential. Thus hot and cold copper pipes should be electrically isolated from each other to avoid creation of a thermo-galvanic corrosion cell.

2.11.1 Copper Pipes

The lowest pH for this area was measured to be 8.2. Copper is greatly affected by pH, ammonia and nitrate concentrations[13]. The highest nitrate concentration was 84.4 mg/kg and the highest ammonia concentration was 5.0 mg/kg at this site.

These soils were determined mildly corrosive to copper and copper alloys such as brass as the high nitrate measurement was only found at one location of 22.5 ft depth.

Underground, aboveground, cold water, and hot water pipes should be electrically isolated from each other by use of dielectric unions and plastic in-wall pipe supports. The following are corrosion control options for underground copper water pipes.

1) Cover cold copper piping with minimum 8 mil polyethylene and backfill with clean sand with 2 inch minimum cover above and below tubing. Backfill should have a pH between 6 and 8 with minimum resistivity of 2,000 ohm-cm
2) Heat increases corrosion rates. Hot water pipes should be installed within PVC piping to prevent soil contact, or
3) Cover hot water pipes with minimum 10 mil polyethylene sleeve over a suitable primer

It is critical for the life of the metal that the protective wrap contains no openings or holes. Prevent damage to the protective sleeve during backfilling of the pipe trench. Penetrations of any kind within these or other protective materials generally leads to accelerated corrosion failure due to the fact that the corrosion attack is concentrated at the location of these penetrations. Cathodic protection will protect these defects. The better the coating, the less expensive a cathodic protection system will be in anode material and power requirement if needed.

[13] Corrosion Data Handbook, Table 6, Corrosion Resistance of copper alloys to various environments, 1995

2.11.2 Brass Fittings

Brass fittings should be electrically isolated from dissimilar metals by use of dielectric unions or isolation joint kits.

These soils were determined to be mildly corrosive to copper and copper alloys such as brass.

The following are corrosion control options for underground brass.

1) Cover with minimum 8 mil polyethylene or other impermeable coating and backfill with clean sand with 4 inch minimum cover above and below brass. Backfill should have a pH between 6 and 8 with minimum resistivity of 2,000 ohm-cm, or
2) Wrap fitting or valves in wax tape

It is critical for the life of the metal that the protective wrap contains no openings or holes. Prevent damage to the protective sleeve during backfilling of the pipe trench. Penetrations of any kind within these or other protective materials generally leads to accelerated corrosion failure due to the fact that the corrosion attack is concentrated at the location of these penetrations. Cathodic protection will protect these defects. The better the coating, the less expensive a cathodic protection system will be in anode material and power requirement if needed.

2.11.3 Bare Copper Grounding Wire

It is assumed that corrosion will occur at all sides of the bare wire, thus the corrosion rate is calculated as a two sided attack determining the time it takes for the corrosion from two sides to meet at the center of the wire. The estimated life of bare copper wire for this site is the following:[14]

Size (AWG)	**Diameter (mils)**	**Est. Time to penetration (Yrs)**
14	64.1	5.5
13	72	6.2
12	80.8	7.0
11	90.7	7.8
10	101.9	8.8
9	114.4	9.9
8	128.5	11.1
7	144.3	12.4
6	162	14.0
5	181.9	15.7
4	204.3	17.6
3	229.4	19.8
2	257.6	22.2
1	289.3	24.9

[14] Soil-Corrosion studies 1946 and 1948: Copper Alloys, Lead, and Zinc, Melvin Romanoff, National Bureau of Standards, Research Paper RP2077, 1950

If the bare copper wire is being used as a grounding wire connected to less noble metals such as galvanized steel or carbon steel, the less noble metals will provide additional cathodic protection to the copper reducing the corrosion rate of the copper.

It is recommended that a corrosion inhibiting and water-repelling coating such as Corrosion X Part No. 90102 by Corrosion Technologies (no affiliation to Project X) be applied to aboveground and belowground copper-to-dissimilar metal connections to reduce risk of dissimilar corrosion.

2.12 Aluminum Pipe/Conduit/Fittings

Aluminum is an amphoteric material prone to pitting corrosion in environments that are very acidic or very alkaline or high in chlorides.

Conditions at this site are unsafe for aluminum. Soils at this site were determined to be too alkaline for aluminum. Soil contact with aluminum alloys should be avoided at this site. This can be achieved with:

1) Impermeable minimum 20 mil polyethylene coatings, or
2) Epoxy coatings with minimum 20 mil thickness free of scratches and defects, or
3) Wax tape

Aluminum derives its corrosion resistance from its oxide layer which needs oxygen to regenerate if damaged, similar to stainless steels. Thus aluminum is not good for deep soil applications. Since aluminum corrodes at very alkaline environments, it cannot be encased or placed against cement or mortar such as brick wall mortar up against an aluminum window frame.

Aluminum is also very low on the galvanic series scale making it most likely to become a sacrificial anode when in contact with dissimilar metals in moist environments. Avoid electrical continuity with dissimilar metals by use of insulators, dielectric unions, or isolation joints. Pooling of water at post bottoms or surfaces should be avoided by integrating good drainage.

2.13 Carbon Fiber or Graphite Materials

Carbon fiber or other graphite materials are extremely noble on the galvanic series and should always be electrically isolated from dissimilar metals. They can conduct electricity and will create corrosion cells if placed in contact within a moist environment with any metal.

2.14 Plastic and Vitrified Clay Pipe

No special precautions are required for plastic and vitrified clay piping from a corrosion viewpoint.

Protect all metallic fittings and pipe restraining joints with wax tape per AWWA C217, cement if previously recommended, or epoxy.

3 CLOSURE

In addition to soils chemistry and resistivity, another contributing influence to the corrosion of buried metallic structures is stray electrical currents. These electrical currents flowing through the earth originate from buried electrical systems, grounding of electrical systems in residences, commercial buildings, and from high voltage overhead power grids. Therefore, it is imperative that the application of protective wraps and/or coatings and electrical isolation joints be properly applied and inspected.

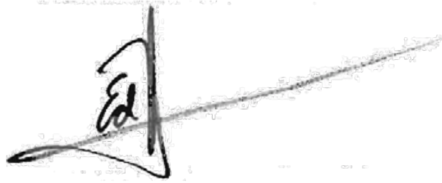
It is the responsibility of the builder and/or contractor to closely monitor the installation of such materials requiring protection in order to assure that the protective wraps or coatings are not damaged.

The recommendations outlined herein are in conformance with current accepted standards of practice that meet or exceed the provisions of the Uniform Building Code (UBC), the International Building Code (IBC), California Building Code (CBC), the American Cement Institute (ACI), Nickel Institute, National Association of Corrosion Engineers (NACE International), Post-Tensioning Institute Guide Specifications and State of California Department of Transportation, Standard Specifications, American Water Works Association (AWWA) and the Ductile Iron Pipe Research Association (DIPRA).

Our services have been performed with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended.

Please call if you have any questions.

Respectfully Submitted,



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4 SOIL ANALYSIS LAB RESULTS

Client: Geotechnologies, Inc.
Job Name: Faring
Client Job Number: 21850
Project X Job Number: S191119G
November 25, 2019

	Method	ASTM D4327		ASTM D4327		ASTM G187		ASTM G51	ASTM G200	SM 4500-S2-D	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327	ASTM D4327
Bore# / Description	**Depth**	**Sulfates** SO_4^{2-}		**Chlorides** Cl^-		**Resistivity** As Rec'd	Minimum	**pH**	**Redox**	**Sulfide** S^{2-}	**Nitrate** NO_3^-	**Ammonium** NH_4^+	**Lithium** Li^+	**Sodium** Na^+	**Potassium** K^+	**Magnesium** Mg^{2+}	**Calcium** Ca^{2+}	**Flouride** F_2^{--}	**Phosphate** PO_4^{3-}
	(ft)	(mg/kg)	(wt%)	(mg/kg)	(wt%)	(Ohm-cm)	(Ohm-cm)		(mV)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
B1	5.0	621.8	0.0622	93.3	0.0093	1,541	737	8.2	219.0	0.1	4.3	1.2	ND	634.1	0.6	9.3	16.0	4.5	0.4
B5	15.0	186.6	0.0187	73.7	0.0074	663	576	8.9	173.0	6.7	0.3	3.4	ND	501.8	ND	69.5	162.0	9.6	8.2
B9	10.0	335.3	0.0335	73.6	0.0074	570	529	8.9	174.0	0.1	0.6	ND	ND	622.1	ND	16.6	16.5	23.2	0.7
B13	5.0	48.2	0.0048	14.0	0.0014	1,340	1,340	8.6	172.0	0.9	0.2	0.1	ND	171.7	ND	20.8	99.0	5.6	1.9
B16	10.0	4,445.1	0.4445	1,873.6	0.1874	389	221	8.7	189.0	0.0	2.5	ND	ND	3,971.9	ND	76.4	53.7	11.4	3.6
B20	22.5	1,816.6	0.1817	269.3	0.0269	436	369	8.7	185.0	ND	84.4	ND	ND	1,483.5	6.4	39.2	30.8	2.1	3.9
B24	7.5	401.9	0.0402	96.1	0.0096	1,340	938	8.6	187.0	0.4	0.2	5.0	ND	436.2	23.6	17.3	35.4	6.4	0.5
B28	20.0	886.2	0.0886	22.5	0.0022	603	576	8.4	193.0	0.0	0.5	2.0	ND	369.5	6.6	48.6	79.3	7.4	1.9
B32	10.0	165.5	0.0166	89.4	0.0089	637	630	8.5	149.0	29.1	5.6	1.3	ND	906.1	6.0	89.8	136.1	9.7	27.3
B37	22.5	244.7	0.0245	76.6	0.0077	2,278	1,541	9.2	150.0	0.7	0.2	0.4	ND	377.5	0.3	10.2	12.2	3.5	2.2

Unk = Unknown
NT = Not Tested
ND = 0 = Not Detected
mg/kg = milligrams per kilogram (parts per million) of dry soil weight
Chemical Analysis performed on 1:3 Soil-To-Water extract
Anions and Cations tested via Ion Chromatograph except Sulfide.

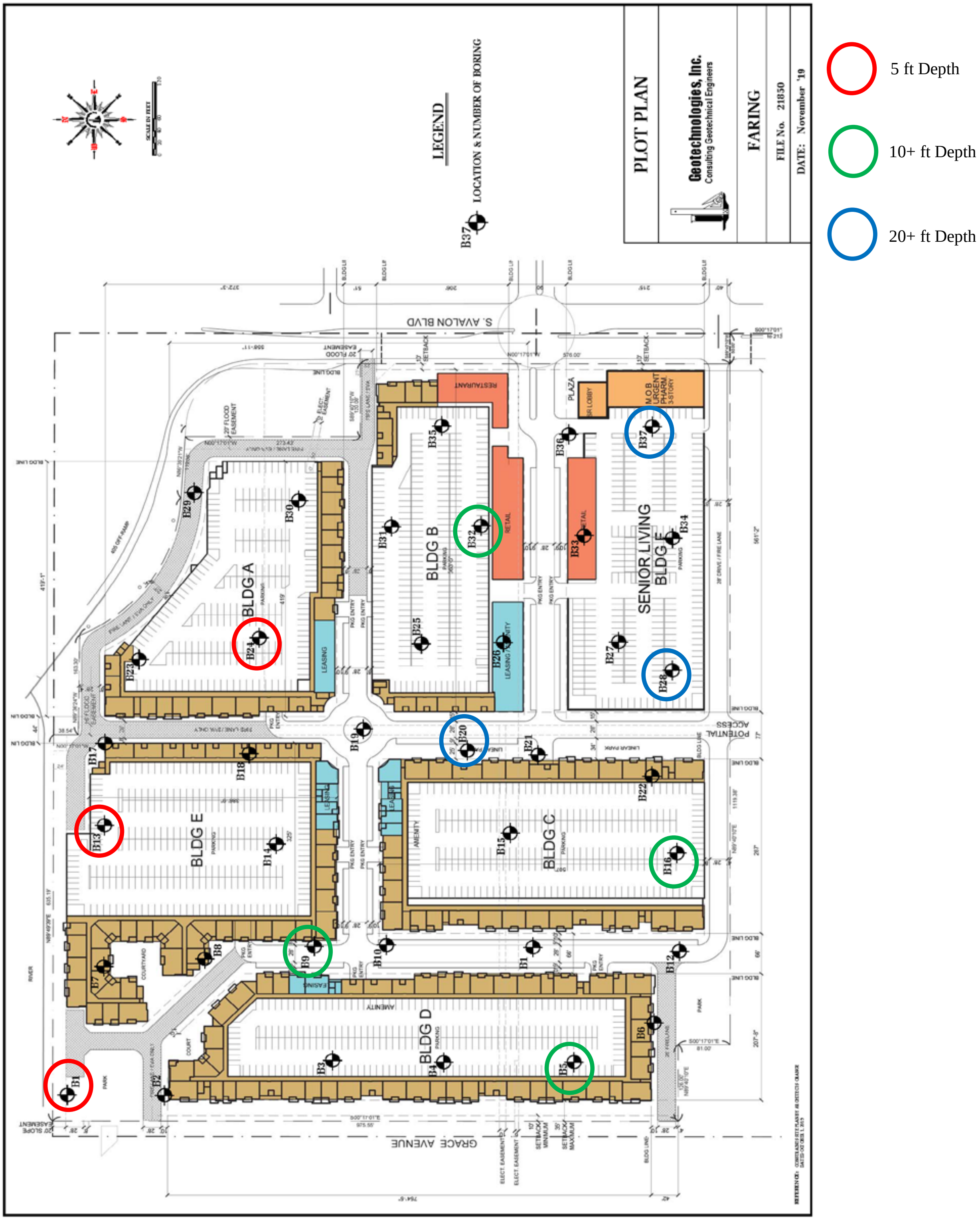


Figure 1 Soil Sample Locations, 21207 Avalon Boulevard, Carson, CA (33.8387, -118.2667)

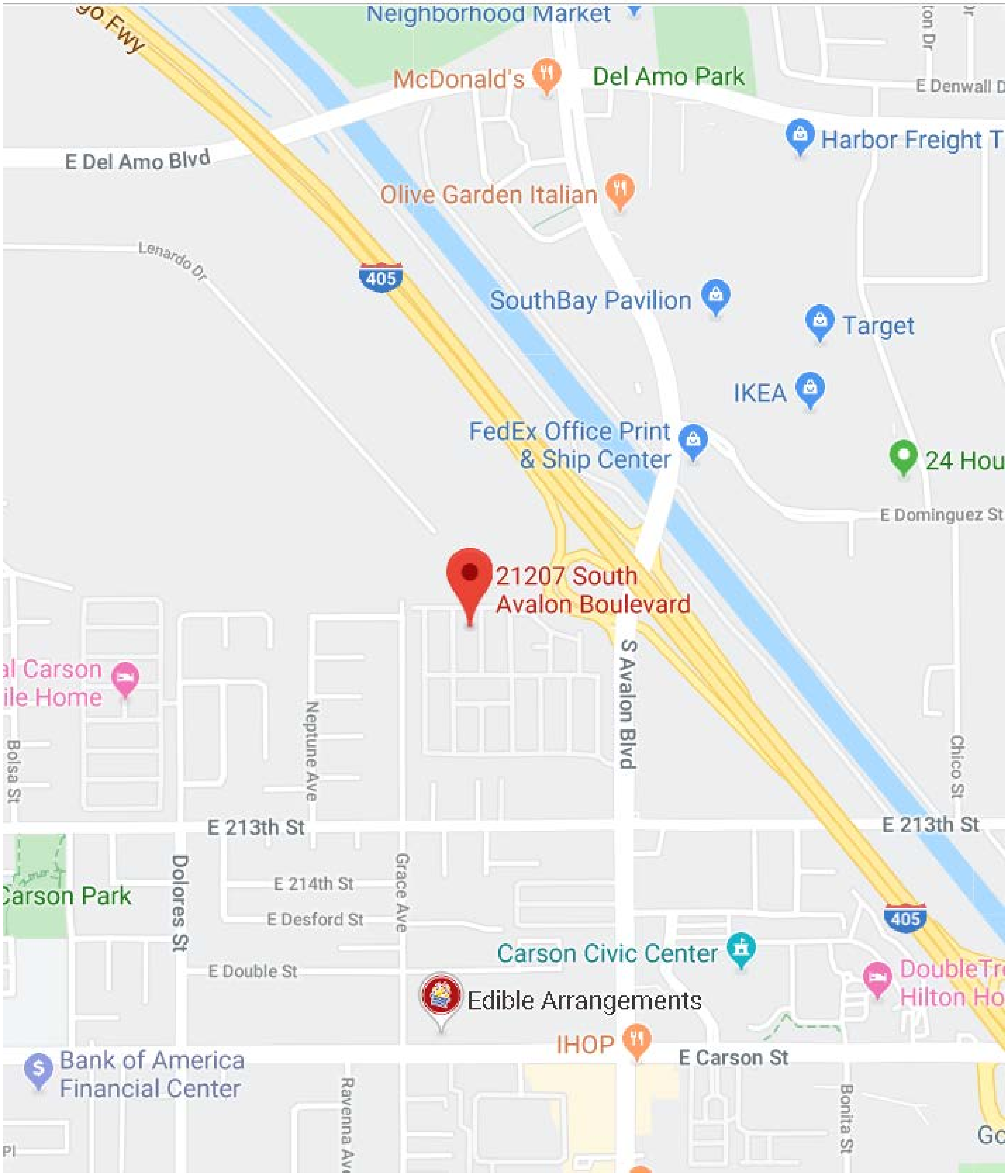


Figure 2 Vicinity Map, 21207 Avalon Boulevard, Carson, CA (33.8387, -118.2667)

5 Corrosion Basics

In general, the corrosion rate of metals in soil depends on the electrical resistivity, the elemental composition, and the oxygen content of the soil. Soils can vary greatly from one acre to the next, especially at earthquake faults. The better a soil is for farming; the easier it will be for corrosion to take place. Oxygen content in soil can be increased during construction. These soils are considered disturbed soils. When construction equipment at a site is simply driving piles into soil without digging into the soil, the activity can still disturb soil down to 3 feet. Expansive soils will also be considered disturbed simply because of their nature from dry to wet seasons.

5.1 Pourbaix Diagram – In regards to a material's environment

All metals are unique and have a weakness. Some metals do not like acidic (low pH) environments. Some metals do not like alkaline (high pH) environments. Some metals don't like either high or low pH environments such as aluminum. These are called amphoteric materials. Some metals become passivated and do not corrode at high pH environments such as steel. These characteristics are documented in Marcel Pourbaix's book "Atlas of electrochemical equilibria in aqueous solutions"

In the mid 1900's, Marcel Pourbaix developed the Pourbaix diagram which describes a metal's reaction to an environment dependent on pH and voltage conditions. It describes when a metal remains passive (non-corroding) and in which conditions metals become soluble (corrode). Steels are passive in pH over 12 such as the condition when it is encased in cement. If the cement were to carbonate and its pH reduce to below 12, the cement would no longer be able to act as a corrosion inhibitor and the steel will begin to corrode when moist.

Some metals such as aluminum are amphoteric, meaning that they react with acids and bases. They can corrode in low pH and in high pH conditions. Aluminum alloys are generally passive within a pH of 4 and 8.5 but will corrode outside of those ranges. This is why aluminum cannot be embedded in cement and why brick mortar should not be laid against an aluminum window frame without a protective barrier between them.

5.2 Galvanic Series – In regards to dissimilar metal connections

All metals have a natural electrical potential. This electrical potential is measured using a high impedance voltmeter connected to the metal being tested and with the common lead connected to a copper copper-sulfate reference electrode (CSE) in water or soil. There are many types of reference electrodes. In laboratory measurements, a Standard Hydrogen Electrode (SHE) is commonly used. When different metal alloys are tested they can be ranked into an order from most noble (less corrosion), to least noble (more active corrosion). When a more noble metal is connected to a less noble metal, the less noble metal will become an anode and sacrifice itself through corrosion providing corrosion protection to the more noble metal. This hierarchy is known as the galvanic series named after Luigi Galvani whose experiments with electricity and muscles led Alessandro Volta to discover the reactions between dissimilar metals leading to the early battery. The greater the voltage difference between two metals, the faster the corrosion rate will be.

Table 1- Dissimilar Metal Corrosion Risk

	Zinc	Galvanized Steel	Aluminum	Cast Iron	Lead	Mild Steel	Tin	Copper	Stainless Steel
Zinc	None	Low	Medium	High	High	High	High	High	High
Galvanized Steel	Low	None	Medium	Medium	Medium	High	High	High	High
Aluminum	Medium	Medium	None	Medium	Medium	Medium	Medium	High	High
Cast Iron	High	Medium	Medium	None	Low	Low	Low	Medium	Medium
Lead	High	Medium	Medium	Low	None	Low	Low	Medium	Medium
Mild Steel	High	High	Medium	Low	Low	None	Low	Medium	Medium
Tin	High	High	Medium	Low	Low	Low	None	Medium	Medium
Copper	High	High	High	Medium	Medium	Medium	Medium	None	Low
Stainless Steel	High	High	High	Medium	Medium	Medium	Medium	Low	None

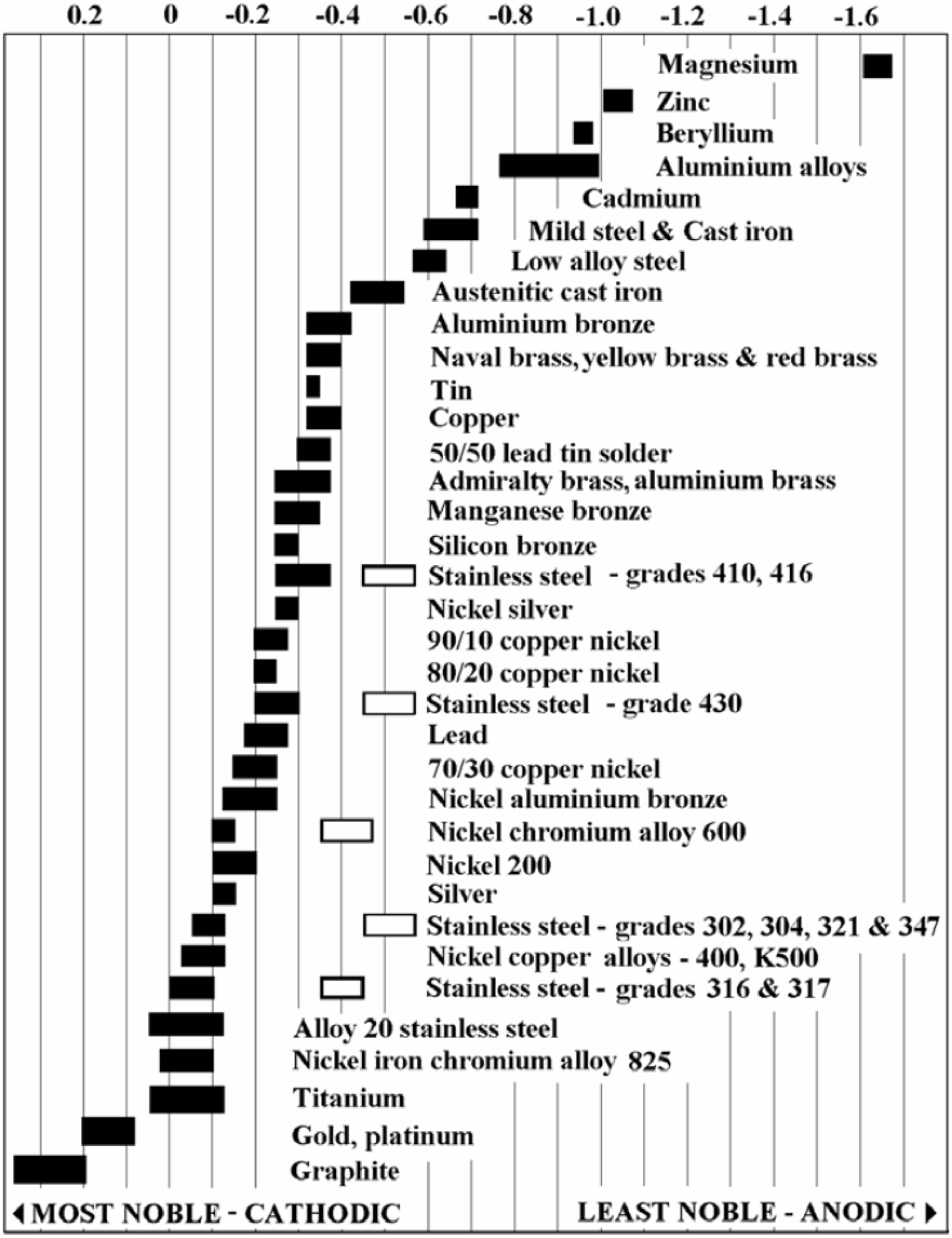
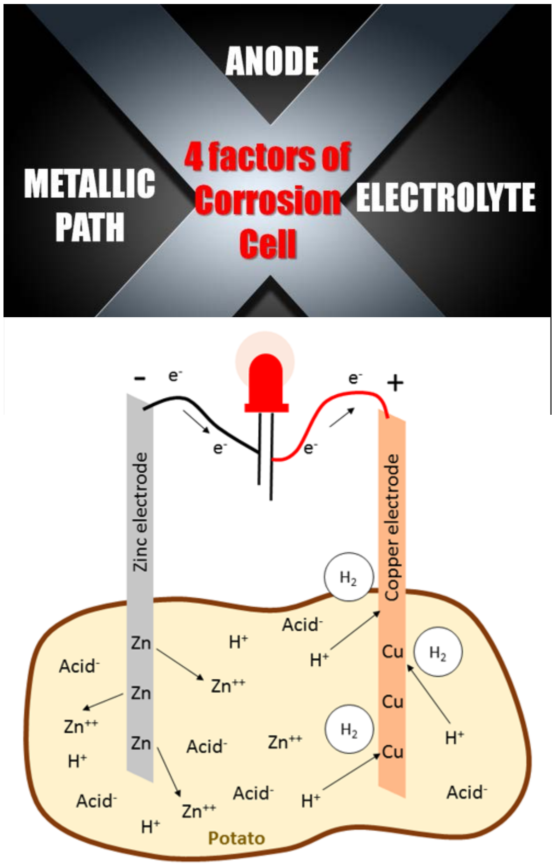


Figure 3 - Galvanic series of metals relative to CSE half cell.

5.3 Corrosion Cell

In order for corrosion to occur, four factors must be present. (1) The anode (2) the cathode (3) the electrolyte and (4) the metallic or conductive path joining the anode and the cathode. If any one of these is removed, corrosion activity will stop. This is how a simple battery produces electricity. An example of a non-metallic yet conductive material is graphite. Graphite is similar in nobility to gold. Do not connect graphite to anything in moist environments.



The anode is where the corrosion occurs, and the cathode is the corrosion free material. Sometimes the anode and cathode are different materials connected by a wire or union. Sometimes the anode and cathode are on the same pipe with one area of the pipe in a low oxygen zone while the other part of the pipe is in a high oxygen zone. A good example of this is a post in the ocean that is repeatedly splashed. Deep underwater, corrosion is minimal, but at the splash zone, the corrosion rate is greatest.

Low oxygen zones and crevices can also harbor corrosive bacteria which in moist environments will lead to corrosion. This is why pipes are laid on backfill instead of directly on native cut soil in a trench. Filling a trench slightly with backfill before installing pipe then finishing the backfill creates a uniform environment around the entire surface of the pipe.

The electrolyte is generally water, seawater, or moist soil which allows for the transfer of ions and electrical current. Pure water itself is not very conductive. It is when salts and minerals dissolve into pure water that it becomes a good conductor of electricity and chemical reactions. Metal ores are turned into metal alloys which we use in construction. They naturally want to return to their natural metal ore state but it requires energy to return to it. The corrosion cell, creates the energy needed to return a metal to its natural ore state.

The metallic or conductive path can be a wire or coupling. Examples are steel threaded into a copper joint, or an electrician grounding equipment to steel pipes inadvertently connecting electrical grid copper grounding systems to steel or iron underground pipes.

The ratio of surface area between the anode and the cathode is very important. If the anode is very large, and the cathode is very small, then the corrosion rate will be very small and the anode may live a long life. An example of this is when short copper laterals were connected to a large and long steel pipeline. The steel had plenty of surface area to spread the copper's attack, thus corrosion was not noticeable. But if the copper was the large pipe and the steel the short laterals, the steel would corrode at an amazing rate.

5.4 Design Considerations to Avoid Corrosion

The following recommendations are based upon typical observations and conclusions made by forensic engineers in construction defect lawsuits and NACE International (Corrosion Society) recommendations.

5.4.1 Testing Soil Factors (Resistivity, pH, REDOX, SO, CL, NO3, NH3)

As previously mentioned, different factors can cause corrosion. The most useful and common test for categorizing a soil's corrosivity has been the measure of soil resistivity which is typically measured in units of (ohm-cm) by corrosion engineers and geologists. Soil resistivity is the ability of soil to conduct or resist electrical currents and ion transfer. The lower the soil resistivity, the more conductive and corrosive it is. The following are "generally" accepted categories but keep in mind, the question is not "Is my soil corrosive?", the question should be, "What is my soil corrosive to?" and to answer that question, soil resistivity and chemistry must be tested. Though **soil resistivity is a good corrosivity indicator for steel materials, high chlorides or other corrosive elements do not always lower soil resistivity, thus if you don't test for chlorides and other water soluble salts, you can get an unpleasant surprise.** The largest contributing factor to a soil's electrical resistivity is its clay, mineral, metal, or sand make-up.

Table 2 - Corrosion Basics- An Introduction, NACE, 1984, pg 191

(Ohm-cm)	Corrosivity Description
0-500	Very Corrosive
500-1,000	Corrosive
1,000-2,000	Moderately Corrosive
2,000-10,000	Mildly Corrosive
Above 10,000	Progressively less corrosive

Testing a soil's pH provides information to reference the Pourbaix diagram of specific metals. Some elements such as ammonia and nitrates can create localized alkaline conditions which will greatly affect amphoteric materials such as aluminum and copper alloys.

Excess sulfates can break-down the structural integrity of cement and high concentrations of chlorides can overcome cement's corrosion inhibiting effect on encased ferrous metals and break down protective passivated surface layers on stainless steels and aluminum.

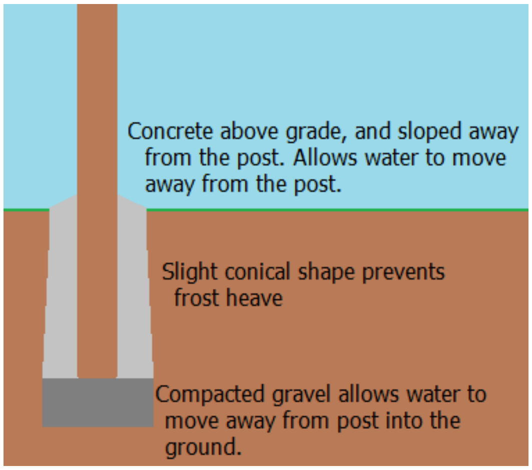
Corrosive bacteria are everywhere but can multiply significantly in anaerobic conditions with plentiful sulfates. The bacteria themselves do not eat the metal but their by-products can form corrosive sulfuric acids. The probability of corrosive bacteria is tested by measuring a soil's oxidation-reduction (REDOX) electro-potential and by testing for the presence of sulfides.

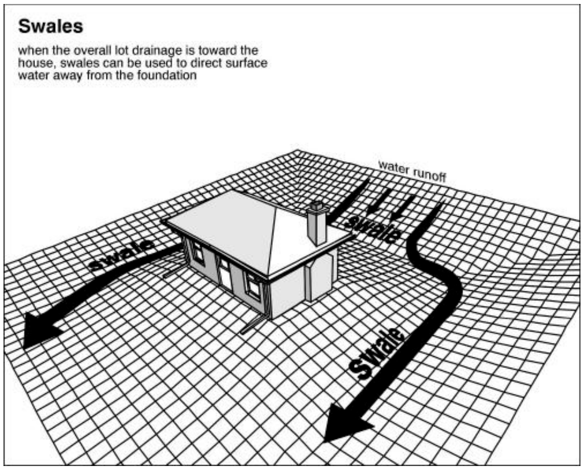
Only by testing a soil's chemistry for minimum resistivity, pH, chlorides, sulfates, sulfides, ammonia, nitrate, and redox potential can one have the information to evaluate the corrosion risk to construction materials such as steel, stainless steel, galvanized steel, iron, copper, brass, aluminum, and concrete.

5.4.2 Proper Drainage

It cannot be emphasized enough that pooled stagnant water on metals will eventually lead to corrosion. This stands for internal corrosion and external corrosion situations. In soils, providing good drainage will lower soil moisture content reducing corrosion rates. Attention to properly sealing polyethylene wraps around valves and piping will avoid water intrusion which would allow water to pool against metals. Above ground structures should not have cupped or flat surfaces that will pond water after rain or irrigation events.

Buildings typically are built on pads and have swales when constructed to drain water away from buildings directing it towards an acceptable exit point such as a driveway where it continues draining to a local storm drain. Many homeowners, landscapers and flatwork contractors appear to not be aware of this and destroy swales during remodeling. The majority of garage floor and finished grade elevations are governed by drainage during design. [15,16]



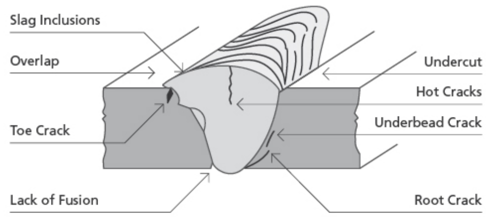


5.4.3 Avoiding Crevices

Crevices are excellent locations for oxygen differential induced corrosion cells to begin. Crevices can also harbor corrosive bacteria even in the most chemically treated waters. Crevices will also gather salts. If water's total alkalinity is low, its ability to maintain a stable pH can also become more difficult within a crevice allowing the pH to drop to acidic levels continuing a pitting process. Welds in extremely corrosive environments should be complete and well filleted without sharp edges to avoid crevices. Sharp edges should be avoided to allow uniform coating of protective epoxy. Detection of crevices in welds should be treated immediately. If pressures and loads are low, sanding and rewelding or epoxy patching can be suitable repairs. Damaged coatings can usually be repaired with Direct to Metal paints. **Scratches and crevice corrosion are like infections, they should not be left to fester or the infection will spread making things worse.**

[15] https://www.fencedaddy.com/blogs/tips-and-tricks/132606467-how-to-repair-a-broken-fence-post

[16] http://southdownstudio.co.uk/problme-drainage-maison.html



BAD **GOOD**

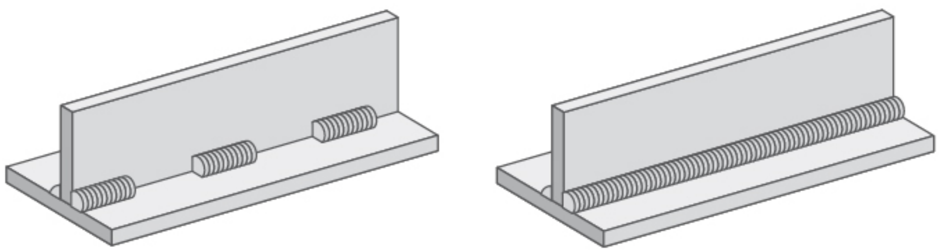


Figure 4 Defects which form weld crevices[17]

5.4.4 Coatings and Cathodic Protection

When faced with a corrosive environment, the best defense against corrosion is removing the electrolyte from the corrosion cell by applying coatings to separate the metal from the soil. During construction and installation, there is always some scratch or damage made to a coating. NACE training recommends that coatings be used as a first line of defense and that sacrificial or impressed current cathodic protection is used as a 2nd line of defense to protect the scratched areas. Use of a good coating dramatically reduces the amount of anodes a CP system would need. If CP is not installed as a 2nd line of defense in an extremely corrosive environment, the small scratched zones will suffer accelerated corrosion. CP details such as anode installation instructions must be designed by corrosion engineers or vessel manufacturers on a per project basis because it depends on electrolyte resistivity, surface area of infrastructure to be protected, and system geometry.

There are two types of cathodic protection systems, a Galvanic Anode Cathodic Protection (GACP) system and an Impressed Current Cathodic Protection (ICCP) system. A Galvanic Anode Cathodic Protection (GACP) system is simpler to install and maintain than an Impressed Current Cathodic Protection (ICCP) system. To protect the metals, they must all be electrically continuous to each other. In a GACP system, sacrificial zinc or magnesium anodes are then buried at locations per the CP design and connected by wire to a structure at various points in system. At the connection points, a wire connecting to the structure and the wire from the anode are joined in a Cathodic Protection Test Station hand hole which looks similar in size and shape to an irrigation valve pull box. By coating the underground structures, one can reduce the number of anodes needed to provide cathodic protection by 80% in many instances.

An ICCP system requires a power source, a rectifier, significantly more trenching, and more expensive type anodes. These systems are typically specified when bare metal is requiring protection

[17] http://www.daroproducts.co.uk/makes-good-weld/

in severely corrosive environments in which galvanic anodes do not provide enough power to polarize infrastructure to -850 mV structure-to-soil potential or be able to create a 100 mV potential shift as required by NACE SP169 to control corrosion. In severely corrosive environments, a GACP system simply may not last a required lifetime due to the high rate of consumption of the sacrificial anodes. ICCP system rectifiers must be inspected and adjusted quarterly or at a minimum bi-annually per NACE recommendations. Different anode installations may be possible but for large sites, anodes are placed evenly throughout the site and all anode wires must be trenched to the rectifier. For a large site, it may be beneficial to use two or more rectifiers to reduce wire lengths or trenching.

To simplify, a GACP system can be installed and practically forgotten with minor trenching because the anodes can be installed very close to the structures. An ICCP system must be inspected annually and anode wires run back to the rectifier which itself connects to the pile system. If any type of trenching or development is expected to occur at the site during the life of the site, it is a good idea to inspect the anode connections once a year to make sure wires are not cut and that the infrastructure is still being provided adequate protection. A common situation that occurs with ICCP systems is that a contractor accidently cuts the wires during construction then reconnects them incorrectly, turning the once cathode, into a sacrificing anode.

Design of a cathodic protection system protecting against soil side corrosion requires that Wenner Four Pin ground resistance measurements per ASTM G57 be performed by corrosion engineers at various locations of the site to determine the best depths and locations for anode installations. Ideally, a sample pile is installed and experiments determining current requirement are conducted. Using this data, the decision is made whether a GACP system is feasible or if an ICCP must be used.

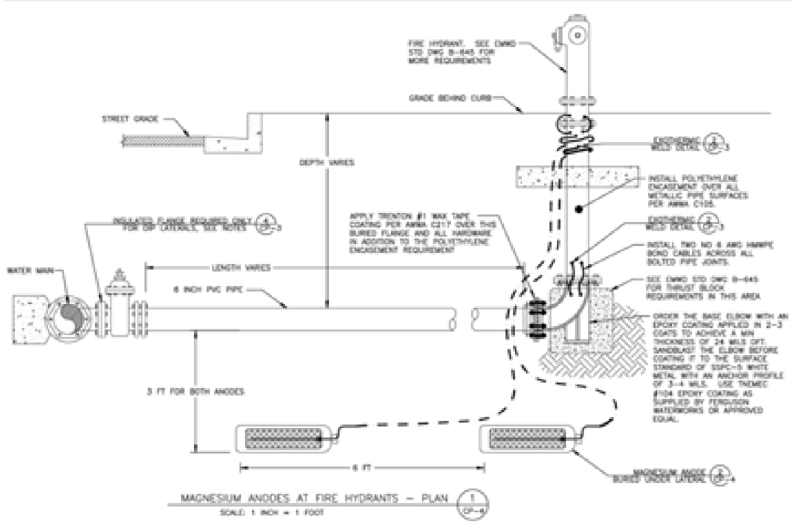


Figure 5 Sample anode design for fire hydrant underground piping

Vessels such as water tanks will have protective interior coatings and anodes to protect the interior surfaces. Anodes can also be buried on site and connected to system skid supports to protect the metal in contact with soil. A good example of a vessel cathodic protection system exists in all home water heaters which contain sacrificial aluminum or magnesium anodes. In environments that exceed 140F, zinc anodes cannot be used with carbon steel because they become the aggressor (Cathodic) to the steel instead of sacrificial (anodic). Anodes in vessels containing extremely brackish water with chloride levels over 2,000 ppm should inspect or change out their anodes every 6 months.

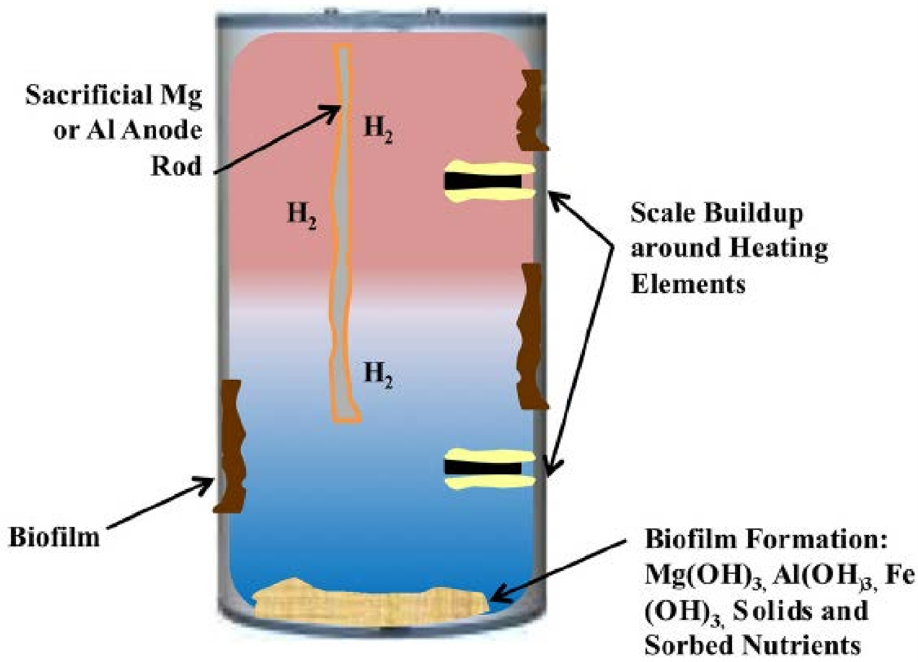


Figure 6 Cross section of boiler with anode

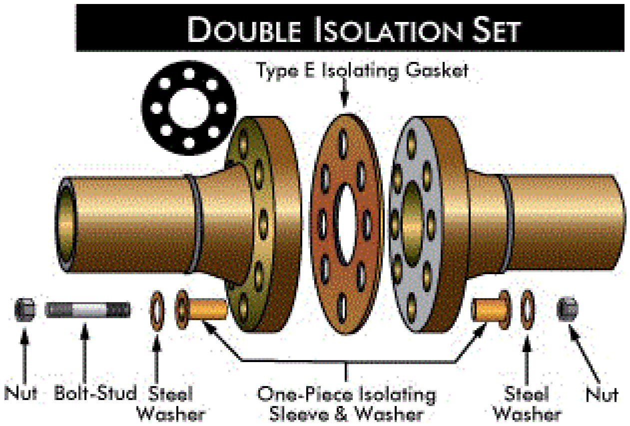
Cathodic protection can only protect a few diameters within a pipeline thus it is not recommended for small diameter pipelines and tubing internal corrosion protection. Anodes are like a lamp shining light in a room. They can only protect along their line of sight.

5.4.5 Good Electrical Continuity

In order for cathodic protection to protect a long pipeline or system of pipes from external soil side corrosion, they must all be electrically continuous to each other so that the electric current from the anode can travel along the pipes, then return through the earth to the anode. Electrical continuity is achieved by welding or pin brazing #8 AWG copper strand bond cable to the end of pipe sticks which have rubber gaskets at bell and spigots. If steel pipes are joined by full weld, bonding wires are not needed.

Electrical continuity between dissimilar metals is not desirable. Isolation joints or di-electric unions should be installed between dissimilar metals, such as steel pipes connecting to a brass valve. Bonding wires should then be welded onto the steel pipes by-passing the brass valve so that the cathodic protection system's current can continue to travel along the steel piping but isolate the brass valve from the steel pipeline. Another option would be to provide a separate cathodic protection system for steel pipes on both sides of the brass valve.

Typically, water heater inlets and outlets, gas meters and water meters have dielectric unions installed in them to separate utility property from homeowner property. This also protects them in the case that a home owner somehow electrically connects water pipes or gas pipes to a neighborhood electrical grounding system which can potentially have less noble steel in soil now connected to much more noble copper in soil which will then create a corrosion cell. This is exactly how a lemon powered clock works when a galvanized zinc nail and a steel nail are inserted into a lemon then connected to a clock. The clock is powered by the corrosion cell created.



5.4.6 Bad Electrical Continuity

Bad electrical continuity is when two different materials or systems are made electrically continuous (aka shorted) when they were not designed to be electrically continuous. Examples of this would be when gas lines are shorted to water lines or to electrical grounding beds. Very often, fire risers are shorted to electrical grounding systems, and water pipes at business parks. Since fire risers usually have a very short ductile iron pipe in the ground which connects to PVC pipe systems, they tend to experience leaks after 7 to 10 years of being attacked by underground copper systems.

It is absolutely imperative that any copper water piping or other metal conduits penetrating cement slab or footings, not come in contact with the reinforcing steel or post-tensioning tendons to avoid creation of galvanic corrosion cells.

5.4.7 Corrosion Test Stations

Corrosion test stations should be installed every 1,000 feet along pipelines in order to measure corrosion activity in the future. For a simple pipeline, two #8 AWG copper strand bond cable welded or pin brazed onto the pipeline are run up to finished grade and left in a hand hole. Corrosion test stations are used to measure pipe-to-soil electro potential relative to a copper copper-sulfate reference electrode to determine if the pipe is experiencing significant corrosion activity. By measuring test stations along a pipeline, hot spots can be determined, if any. The wires also allow for electrical continuity testing, condition assessment, and a multitude of other types of tests.

At isolation joints and pipe casings, two wires should be welded to either side of the isolation joint for a total of 4 wires to be brought up to the hand hole. This allows for future tests of the isolation joint, casing separation confirmation, and pipe-to-soil potential readings during corrosion surveys.

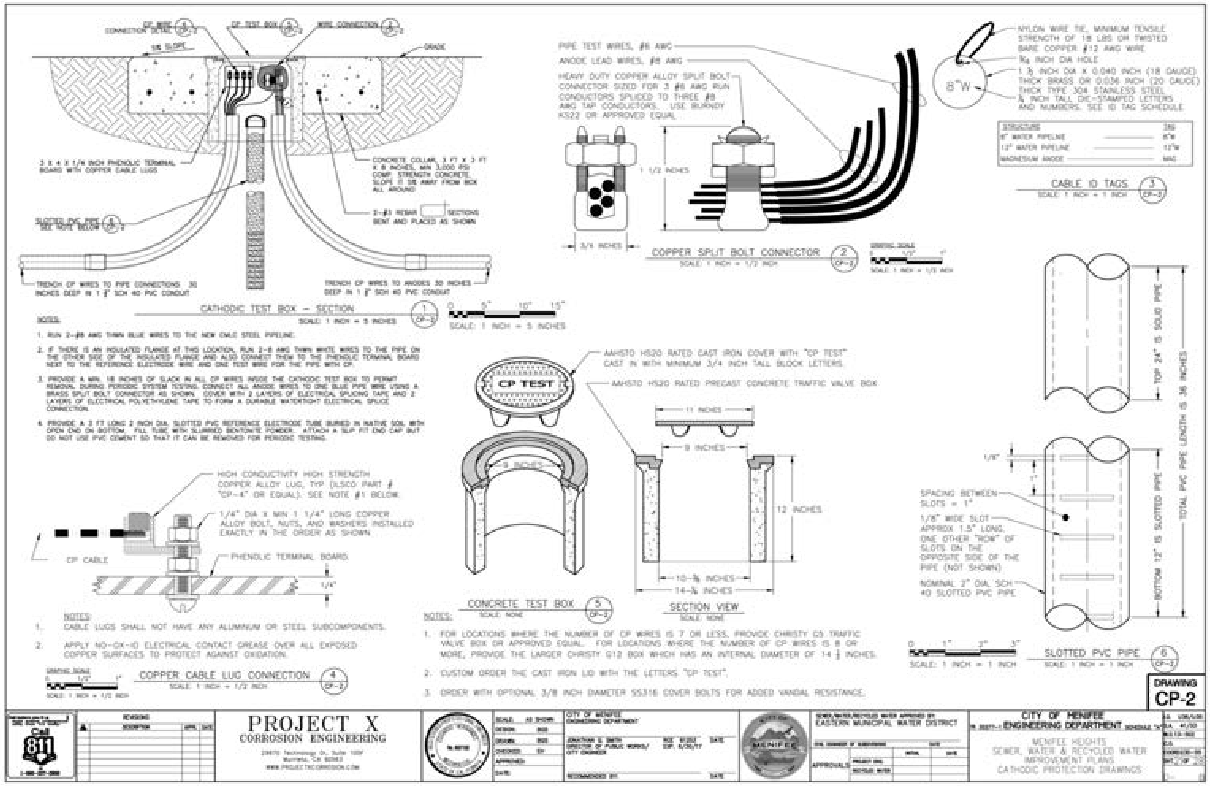


Figure 7 Sample of corrosion test station specification drawing

5.4.8 Excess Flux in Plumbing

Investigations of internal corrosion of domestic water plumbing systems almost always finds excess flux to be the cause of internal pitting of copper pipes. Some people believe that there is no such thing as too much flux. Flux runs have been observed to travel up to 20 feet with pitting occurring along the flux run. Flushing a soldered plumbing system with hot water for 15 minutes can remove significant amounts of excess flux left in the pipes. If a plumbing system is expected to be stagnant for some time, it should be drained to avoid stagnant water conditions that can lead to pitting and dezincification of yellow brasses.

5.4.9 Landscapers and Irrigation Sprinkler Systems

A significant amount of corrosion of fences is due to landscaper tools scratching fence coatings and irrigation sprinklers spraying these damaged fences. Recycled water typically has a higher salt content than potable drinking water, meaning that it is more corrosive than regular tap water. The same risk from damage and water spray exists for above ground pipe valves and backflow preventers. Fiber glass covers, cages, and cement footings have worked well to keep tools at an arm's length.

5.4.10 Roof Drainage splash zones

Unbelievably, even the location where your roof drain splashes down can matter. We have seen drainage from a home's roof valley fall directly down onto a gas meter causing it's piping to corrode at an accelerated rate reaching 50% wall thickness within 4 years. It is the same effect as a splash zone in the ocean or in a pool which has a lot of oxygen and agitation that can remove material as it corrodes.

5.4.11 Stray Current Sources

Stray currents which cause material loss when jumping off of metals may originate from direct-current distribution lines, substations, or street railway systems, etc., and flow into a pipe system or other steel structure. Alternating currents may occasionally cause corrosion. The corrosion resulting from stray currents (external sources) is similar to that from galvanic cells (which generate their own current) but different remedial measures may be indicated. In the electrolyte and at the metal-electrolyte interfaces, chemical and electrical reactions occur and are the same as those in the galvanic cell; specifically, the corroding metal is again considered to be the anode from which current leaves to flow to the cathode. Soil and water characteristics affect the corrosion rate in the same manner as with galvanic-type corrosion.

However, stray current strengths may be much higher than those produced by galvanic cells and, as a consequence, corrosion may be much more rapid. Another difference between galvanic-type currents and stray currents is that the latter are more likely to operate over long distances since the anode and cathode are more likely to be remotely separated from one another. Seeking the path of least resistance, the stray current from a foreign installation may travel along a pipeline causing severe corrosion where it leaves the line. Knowing when stray currents are present becomes highly important when remedial measures are undertaken since a simple sacrificial anode system is likely to be ineffectual in preventing corrosion under such circumstances.[18] Stray currents can be avoided by installing proper electrical shielding, installation of isolation joints, or installation of sacrificial jump off anodes at crossings near protected structures such as metal gas pipelines or electrical feeders.

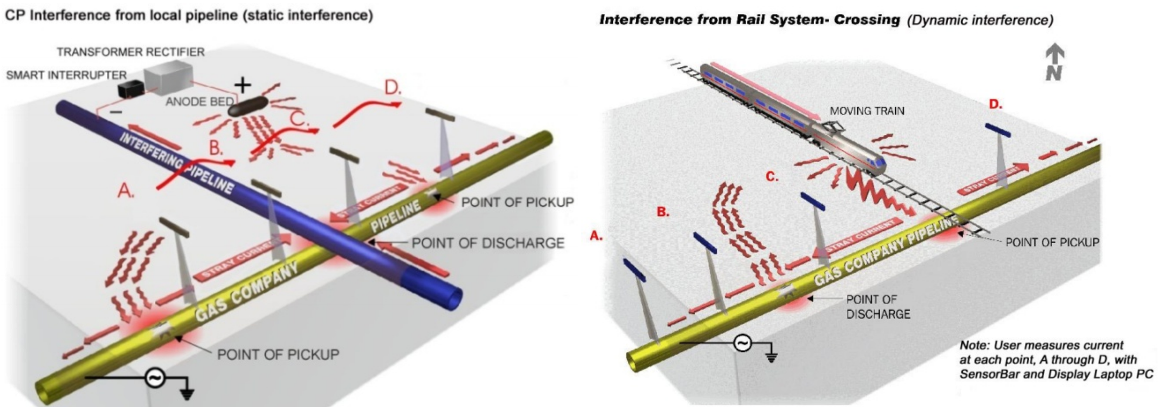


Figure 8 Examples of Stray Current[19]

[18] http://corrosion-doctors.org/StrayCurrent/Introduction.htm

[19] http://www.eastcomassoc.com/