GEOTECHNICAL INVESTIGATION

THOUSAND PALMS CHANNEL
COACHELLA VALLEY WATER DISTRICT
INDIO, CALIFORNIA

GEOCON
WEST, INC.

GEOTECHNICAL
ENVIRONMENTAL
MATERIALS

PREPARED FOR

Q_3 CONSULTING
FOOTHILL RANCH, CALIFORNIA

PROJECT NO. T2581-22-05
JUNE 7, 2022

GEOCON
WEST, INC.
GEOTECHNICAL ■ ENVIRONMENTAL ■ MATERIALS

Project No. T2581-22-05
June 7, 2022

Q3 Consulting
27042 Towne Centre Drive, Suite 110
Foothill Ranch, California 92610

Attention: Mr. John McCarthy

Subject: GEOTECHNICAL INVESTIGATION
THOUSAND PALMS CHANNEL
COACHELLA VALLEY WATER DISTRICT
INDIO, CALIFORNIA

Dear Mr. McCarthy:

In accordance with your authorization of our Proposal IE-2900, dated December 9, 2021, we have performed a geotechnical investigation for the proposed Thousand Palms Channel improvements that are part of the greater North Indio Regional Flood Control Channel system. The accompanying report presents the findings of our study and our preliminary conclusions and recommendations pertaining to the geotechnical aspects of the existing conditions.

If you have any questions regarding this report, or if we may be of further service, please contact the undersigned.

Very truly yours,

GEOCON WEST, INC.

PROFESSIONAL GEOLOGIST ★ LISA A. BATTIATO No. 2316 CERTIFIED ENGINEERING GEOLOGIST ★ STATE OF CALIFORNIA

Lisa A. Battiato
CEG 2316

REGISTERED PROFESSIONAL ENGINEER ★ ANDREW T. SHOASHEKAN No. 93940 CIVIL ★ STATE OF CALIFORNIA

Andrew Shoashekan
PE 93940

REGISTERED PROFESSIONAL ENGINEER ★ JOSEPH J. VETTEL No. 2401 GEOTECHNICAL ★ STATE OF CALIFORNIA

Joseph J. Vettel
GE 2401

LAB:ATS:JJV:hd

Distribution: Addressee (via email)

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GEOTECHNICAL INVESTIGATION

1. PURPOSE AND SCOPE

This report presents the results of a geotechnical investigation for the proposed Thousand Palms Channel improvements. The Thousand Palms Channel is part of the greater North Indio Regional Flood Control Channel system, located in the City of Indio, California (see *Vicinity Map*, Figure 1). The purpose of the investigation was to evaluate subsurface soil and geologic conditions underlying the channel and expected locations of proposed structures, and to provide conclusions and recommendations to aid in project design.

The scope of this investigation included a site reconnaissance, a field exploration program, laboratory testing, engineering analyses, and the preparation of this report. A previous site exploration was performed on October 5, 2020 and included drilling four small-diameter borings, and we recently drilled 11 additional borings on March 22 and 23, 2022. The borings were drilled utilizing a limited access track-mounted CME-75 hollow-stem auger drilling rig and were advanced to depths between approximately 31½ and 51 feet below the existing ground surface. The approximate locations of the borings are shown on the *Geologic Map*, Figure 2. A detailed discussion of the field investigations, including logs of borings, is presented in *Appendix A*.

Laboratory tests were performed on selected soil samples obtained during the investigation to evaluate pertinent physical and chemical soil properties. *Appendix B* presents the results of our laboratory testing program.

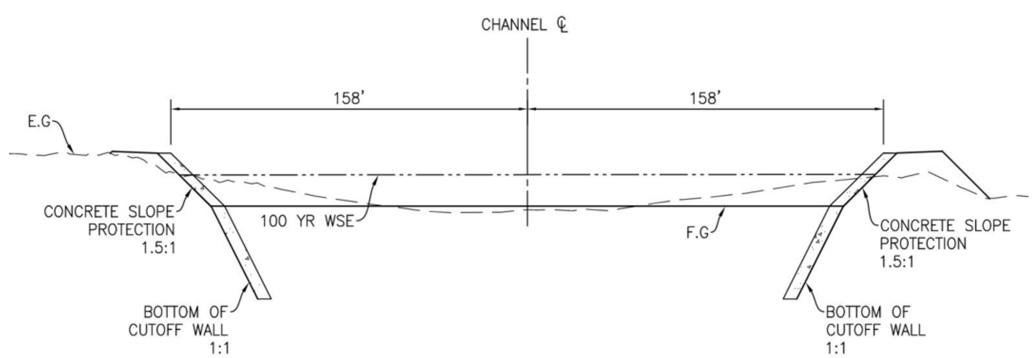
The recommendations presented herein are based on analyses of the data obtained during the geotechnical investigation and our experience with similar soil and geologic conditions. References reviewed to prepare this report are provided in the *List of References* section. If project details vary significantly from those described herein, Geocon should be contacted to determine the necessity for review and possible revision of this report.

2. PROJECT DESCRIPTION

The existing channel alignment begins on the west side of Madison Street at Sun City Shadow Hills senior living community (approximately 1,500 feet north of the intersection of Madison Street and Avenue 42), crosses and aligns parallel to the east side of Madison Street, where it then crosses Avenue 42 and begins curving to the southeast as it approaches Interstate 10 (I-10). The existing channel then crosses under the westbound and eastbound I-10 freeway bridges, and ties into the existing Coachella Valley Stormwater Channel (approximately 3,000 feet west of the intersection of Monroe Street and 43rd Avenue). The coordinates near the midpoint of the channel improvements are 33.7419 (latitude) and -116.2508 (longitude). The general alignment of the channel is depicted on the *Geologic Map*, Figure 2.

Based on project information provided by Q_3, major planned improvements (discussed in order from north to south) that are currently in design include the following:

- At the northern Sun City Shadow Hills senior living community, a 5-foot reinforced concrete drop structure is proposed that will tie into the existing channel at the Coachella Canal Siphon, and the existing concrete grade control structure will be extended for the new, lower profile channel.
- At Madison Avenue a concrete Arizona type crossing will be constructed.
- At Avenue 42, a 14-foot wide by 7-foot-high double culvert will be constructed resulting in the roadway being 2 feet above the channel bottom on the north side and 10 feet above the channel bottom on the south side. The channel improvements will be tied into the roadway improvements.
- Between I-10 and Indio Boulevard, a 20-foot drop structure will be constructed within the channel before the channel joins the Coachella Valley Storm Channel.
- Earthen channel levees are proposed upstream of Avenue 42, along the eastern channel boundary.
- Along the channel alignment, inside channel slopes are proposed to be concrete lined and constructed at slope ratios of 1.5:1 (horizontal to vertical) above the channel bottom, and at 1:1 (horizontal to vertical) below the channel bottom as a cut-off wall. Channel slopes above the cut-off wall are expected to be up to approximately 36 feet in height. The channel bottom will remain an earthen bottom. A depiction of a typical channel cross-section is shown below.



Typical Channel Cross-Section

Cuts and fills to achieve the new channel bottom elevations are expected to be up to approximately 35 and 5 feet, respectively. The approximate depths provided are exclusive of remedial grading.

Google Earth Pro (Google, 2022) and Historic Aerials (NETROnline, 2022) images indicate improvements to the channel area from 1953 to 1972 have included grading along various sections of the channel (what appears to be generally the channel boundaries), the construction of the westbound and eastbound I-10 bridge crossings, and the construction of the Avenue 42 crossing. The channel appears to have experienced heavy vegetative growth consisting of trees and shrubs along the eastern boundary beginning sometime prior to 1953, which have since been cleared between 2019 and 2021. The removal of vegetation appears to have left a high degree of organic debris in the undocumented fill along the eastern boundary. There are no indications of other channel improvements since the clearing of vegetation, as depicted by the latest available aerial photograph of the site taken in 2021.

The Thousand Palms Channel transmits water generally from the northwest to the southeast. Existing elevations along the planned improvement area at the northernmost end range between 22 and 24 feet above mean sea level (MSL), and elevations on the southernmost end range between 0 and 6 feet above MSL. Existing elevations range from 0 to 10 feet above MSL at the location where the channel ties into the Coachella Valley Stormwater Channel.

Although structural plans and loading information have not yet been provided for our review, we expect the concrete cut-off walls supporting channel liners and the channel drop structures will be supported on conventional shallow foundations.

3. GEOLOGIC SETTING

The site is approximately 19 miles north of the Salton Sea, within the Coachella Valley, a pull apart basin formed by extensional faulting and step-overs along the San Andreas fault zone. More than 3,000 feet of sediment have accumulated within the Coachella Valley in the last 0.5 million years since the extension began (Brothers, Et. Al, 2009). Quaternary age alluvial valley deposits underlie the site. The sediments consist of clays, silts, and sands which are derived from the Santa Rosa Mountains to the west and the Little San Bernardino Mountains to the northeast. The Coachella Valley is considered to be part of the Colorado Desert geomorphic province which is bounded on the west by the Santa Rosa Mountains and the Peninsular Ranges province, and the north by the Transverse Ranges. The Colorado Desert extends beyond California to the east and south. The San Andreas fault is geologically mapped approximately 2 miles northeast of the site. Geothermal resources associated with the pull-apart basin are present near the southern area of the Salton Sea.

4. GEOLOGIC MATERIALS

Based on our field exploration and published geologic maps of the area, the subsurface conditions along the channel alignment generally consists of alluvial sediments within the bottom of the channel and undocumented artificial fill along the channel embankments. Geologic units are described below with geologic nomenclature following that of T. W. Dibblee (2008). Detailed stratigraphic profiles are provided in the boring logs in *Appendix A*.

4.1 Undocumented Artificial Fill (afu)

Undocumented artificial fill was encountered to depths of 6 to 20 feet along the existing channel embankments. The undocumented fill encountered consists of loose to medium dense, dry, brownish gray to olive brown, silty sand to poorly graded sand, and silt with pin-hole voids. We expect portions of the fill will be removed to achieve proposed grades. Due to its low moisture content and loose nature, we expect the fill has a high potential to collapse upon wetting.

4.2 Alluvium (Qa)

Quaternary-age alluvium was encountered within the channel bottom and below the undocumented artificial fill within the existing channel embankments to the maximum depth explored of approximately 51 feet. The alluvium generally consists of poorly-graded sand with silt, silty sand, sandy silt, and sandy silt with clay, with a lesser extent of well-graded and poorly-graded sand, and sandy to silty clay. The frequency and thickness of the fine-grained units increases to the southeast. The alluvium was generally observed to be very loose to very dense, dry to moist, and varying in shades of grays, olives, yellows, whites, and browns. Pin-hole voids were encountered to depths of 35 feet. Based on the results of laboratory testing, the in-situ moisture content of several portions of the alluvium encountered is significantly lower than the optimum moisture content. The results of laboratory consolidation tests indicate the alluvium tested has a high potential to collapse upon wetting.

5. GROUNDWATER

Groundwater was not encountered during our field investigation to the maximum depth explored of approximately 51 feet beneath the existing ground surface. Based on the California Department of Water Resources, *Water Data Library (WDL) Station Map*, historic shallow groundwater depths can range between approximately 74 feet and 125 feet below the existing ground surface in wells located within approximately 2 miles of the channel.

Water will likely be present within the channel during and following times of significant precipitation. Fluctuations in groundwater level may occur due to infiltration of water during and after precipitation events or due to irrigation, variations in ground surface topography, subsurface geologic conditions and structure, rainfall, irrigation, and other factors.

6. SCOUR EVALUATION

The Thousand Palms Channel experiences sediment transport (general scour) relative to the volume and velocity of water present in the channel. Where structural improvements or constrictions are proposed, local scour can occur in foundation areas. Foundations should be properly protected against potential scour or extended below the zone affected by scour. The project hydraulic/hydrologic report prepared by the project Civil Engineer should be referenced for a detailed evaluation of scour, when available.

We performed grain size distribution analyses on samples obtained at various depths to provide information for a future scour evaluation. The particle size at which 30, 50, and 90 percent is passing (D_{30}, D_{50}, D_{90}) is presented in Table 6 below. Geocon should be contacted for additional parameters if needed.

TABLE 6
SOIL GRAIN SIZE DISTRIBUTION TEST RESULTS

Sample ID (Boring Number & Sample Depth)	D_{90} (mm)	D_{50} (mm)	D_{30} (mm)
B-1 @ 2.5’	0.21	0.082	~ 0.06
B-1 @ 10’	0.30	0.0037	< 0.001
B-2 @ 2.5’	0.46	0.16	0.12
B-2 @ 5’	0.13	0.074	0.051
B-3 @ 2.5’	0.29	0.13	0.083
B-3 @ 5’	0.22	0.087	0.032
B-4 @ 2.5’	0.28	~ 0.07	~ 0.05
B-4 @ 10’	0.11	0.017	0.0068
B-5 @ 5’	0.34	< 0.08	< 0.08
B-9 @ 25’	0.18	< 0.08	< 0.08
B-9 @ 35’	0.30	0.10	< 0.08
B-13 @ 40’	0.18	< 0.08	< 0.08

7. GEOLOGIC HAZARDS

A detailed summary of our evaluation of the geologic hazards that may affect the site is presented below.

7.1 Surface Fault Rupture

The numerous faults in southern California include active, potentially active, and inactive faults. The criteria for these major groups are based on criteria developed by the California Geological Survey (formerly known as California Division of Mines and Geology (CDMG) for the Alquist-Priolo Earthquake Fault Zone Program (Hart, 1999). By definition, an active fault is one that has had surface displacement within Holocene time (about the last 11,000 years). A potentially active fault has demonstrated surface displacement during Quaternary time (approximately the last 1.6 million years), but has had no known Holocene movement. Faults that have not moved in the last 1.6 million years are considered inactive.

There are no State of California or County of Riverside Fault Hazard Zones mapped within or projecting toward the site. The San Andreas fault zone is located in the Indio Hills, approximately 2 miles northeast of the site. Based on these considerations, the risk of surface ground rupture occurring at the subject site is relatively low. The site is located in the seismically active southern California region and could be subjected to moderate to strong ground shaking in the event of an earthquake on one of the many active southern California faults.

7.2 Liquefaction Potential and Seismic Settlement

Liquefaction is a phenomenon in which loose, saturated, relatively cohesionless soil deposits lose shear strength during strong ground motions. Primary factors controlling liquefaction include intensity and duration of ground motion, gradation characteristics of the subsurface soils, in-situ stress conditions, and the depth to groundwater. Additionally, seismically induced "dry-sand" settlement may occur whether the potential for liquefaction exists or not.

The current standard of practice as outlined in the *Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California* (SCEC, 1999) requires a liquefaction analysis to a depth of 50 feet below the lowest portion of the proposed structure. Liquefaction typically occurs in areas where the soils below the water table are composed of poorly consolidated, fine to medium-grained, primarily sandy soil. In addition to the requisite soil conditions, the ground acceleration and duration of the earthquake must also be enough to induce liquefaction.

According to the *Map My County* GIS system (RCIT), the channel is located within an area mapped as having a "low" to "moderate" potential for liquefaction.

Due to the lack of a permanent shallow groundwater table, it is our opinion that the potential for liquefaction at the site is negligible and is not a design consideration for the project. However, due to the dry and loose nature of the underlying fills and alluvium, and the site's proximity to the San Andreas Fault zone, we expect the potential for seismically induced "dry-sand" settlement at the site is high.

7.3 Subsidence

According to the Riverside County Information Technology public web data (2020) and the USGS (2013), the site is located within a region where subsidence is known to be occurring. The USGS began monitoring subsidence within Coachella Valley in the 1990's (USGS, 2013). They identified three areas of significant subsidence located in neighboring cities near the Santa Rosa Mountains; Palm Desert, Indian Wells, and La Quinta. The Coachella Valley Water District (CVWD) has embarked on a groundwater replenishment program which has slowed the rate of subsidence in the region. The settlement due to subsidence is expected to be on a regional scale at the subject site and occurs over a relatively large geographic area. Subsidence is not expected to cause differential settlement across the site; therefore, subsidence would not be a design consideration.

7.3 Expansive Soil

Based on laboratory testing of select soil samples collected during our field exploration, site soils along the channel have the potential to be expansive (Expansion Index [EI] of 21 to 50), as defined by the 2019 CBC Section 1803.5.3. Expansion Indexes ranged between 1 and 34 for the samples tested, which are classified as "very low" (EI between 0 and 20) to "low" (EI between 21 and 50), in accordance with ASTM D4829.

7.4 Hydrocompression

Hydrocompression is the tendency of unsaturated soil structure to collapse upon wetting resulting in the overall settlement of the affected soil and overlying foundations or improvements supported thereon. Potentially compressible soils underlying the site are typically removed and compacted during remedial site grading. However, if compressible soil is left in-place, a potential for settlement due to hydrocompression of the soil exists. The potential for hydrocompression can be mitigated by remedial grading or can accommodated with the use of stiffer foundation systems.

We performed three laboratory consolidation tests on samples of dry alluvium below the bottom of the existing channel within the upper 5 feet. The test results indicate the potential for hydrocomoression is up to approximately 3 percent when loaded to a pressure of 2,000 pounds per square foot (psf) and up to approximately 6.5 percent when loaded to a pressure of 4,000 psf. We expect the potential for hydrocompression extends to depths greater than 50 feet below grade due to the dry nature of the underlying alluvium. However, we do not anticipate the existing soils will be subjected to additional loads after construction of the channel. The existing underlying soils have also been subjected to wetting due to previous rain events, and we do not anticipate the wetting of the underlying the soils will increase subsequent to construction of the new channel. In addition, remedial grading will reduce the collapse/swell potential of near-surface soils. Therefore, we do not expect hydrocompression to be a design consideration for the project.

7.5 Slope Stability

We understand planned concrete-lined slopes with heights up to approximately 36 feet will be constructed along the sides of the channel alignment. Slope stability analyses for the proposed slopes with inclinations as steep as 1½:1 (horizontal:vertical) indicate a calculated factor of safety of at least 1.5 under static conditions for both deep-seated and surficial failure. Table 7.5.1 presents the slope stability analysis for the proposed sloping conditions.

TABLE 7.5.1
SLOPE STABILITY EVALUATION

Parameter	Value
Slope Height, H	36 Feet
Slope Inclination, I (Horizontal to Vertical)	1½:1
Total Soil Unit Weight, γ	125 pcf
Friction Angle, ϕ	32 Degrees
Cohesion, C	175 psf
Slope Factor $\gamma_{C\phi}$= (γHtanϕ)/C	16.1
N_{Cf} (From Chart)	37.5
Factor of Safety = (N_{Cf}C)/(γH)	1.5

Table 7.5.2 presents the surficial slope stability analysis for the proposed sloping conditions.

TABLE 7.5.2
SURFICIAL SLOPE STABILITY EVALUATION

Parameter	Value
Slope Height, H	∞
Vertical Depth of Saturation, Z	3 Feet
Slope Inclination, I (Horizontal to Vertical)	1½:1 (26.6 Degrees)
Total Soil Unit Weight, γ	125 pcf
Water Unit Weight, γ_W	62.4 pcf
Friction Angle, ϕ	32 Degrees
Cohesion, C	175 psf
Factor of Safety = (C+(γ+γ_W)Zcos^{2}I tanϕ)/(γZsinI cosI)	1.5

7.6 Dam Inundation / Seismic-Induced Flooding

Seismic-induced flooding is inundation caused by failure of dams or other water-retaining structures located upstream of the site due to a seismic event. There are no water retaining structures upstream of the site, therefore, seismic-induced flooding is not a design consideration for this project.

7.7 Tsunamis, Seiches and Flooding

The Coachella Valley is located more than 50 miles from the Pacific Ocean. The alignment is not downstream of any large bodies of water. Therefore, tsunamis and seiches are not a design consideration for this project.

According to the *Map My County* GIS system (RCIT), the Thousand Palms Channel is located in an area prone to flooding. The entire length of the channel and its embankments within the scope of the project are in a mapped flood zone.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1 General

8.1.1 We opine that neither soil nor geologic conditions at the site would preclude the construction of channel improvements that are proposed. Additional geotechnical analyses may be required once improvement plans are near completion.

8.1.2 Potential geologic hazards at the site include moderate to strong seismic shaking, regional subsidence, and seismically-induced “dry-sand” settlement.

8.1.3 Based on our investigation and available geologic information, active, potentially active, or inactive faults are not present on or trending toward the site.

8.1.4 The undocumented fill and upper portions of alluvium are not considered suitable for the support of engineered fill or settlement-sensitive improvements. Remedial grading of the surficial soil will be required as discussed herein. The site soils are suitable for re-use as engineered fill provided the recommendations in the *Grading* section of this report are followed.

8.1.5 Although groundwater was not encountered during our subsurface investigation, it is possible that perched water may be encountered during grading, particularly during the wet-weather season. Additionally, we expect water to be present within the channel during times of significant precipitation.

8.1.6 Soil samples of underlying alluvium tested for hydrocompression exhibit a collapse potential ranging from 2 to 6½ percent when subjected to loads of 2,000 or 4,000 psf, and we expect soils to depths below 51 feet may be prone to hydrocompression. However, we do not anticipate the existing soils will be subjected to additional loads after construction of the channel. The existing underlying soils have also been subjected to wetting due to previous rain events, and we do not anticipate the wetting of the underlying the soils will increase subsequent to construction of the new channel. In addition, remedial grading will reduce the collapse/swell potential of near-surface soils. Therefore, we opine settlement due to wetting is not a design consideration for the project.

8.1.7 During grading operations, undocumented fill and/or alluvium will be exposed at grade across the slope face of the proposed channel and cut-off wall. Prior to construction of the channel and cut-off wall, the undocumented fill and loose or soft alluvium should be over-excavated to expose competent alluvium prior to the placement of engineered fill.

8.1.8 Site soils should be considered to have a “very low” to “low” expansion potential. If moderate to highly expansive soils are encountered at the site, they should be exported from the site or selectively graded and placed in the deeper fill areas to allow for the placement of less expansive material at the finish pad grade.

8.1.9 Our slope stability evaluation indicates proposed concrete lined channel slopes are expected to have adequate factors of safety for global static (1.5 or greater) under typical dry conditions. The engineer responsible for the project’s hydraulic analysis should evaluate the duration of the design high water conditions to determine whether soils behind the liner will become saturated and if the need for a slope stability analysis under a rapid drawdown condition is warranted. For the purposes of this report, we have assumed that the soils behind the channel liner will not become saturated and therefore, hydrostatic pressures on the liner and rapid drawdown analysis will not be necessary. If, however, the hydraulic engineer anticipates the soils behind the channel liner will become saturated, Geocon should be contacted to evaluate slope stability of the concrete channel liner under a rapid drawdown condition.

8.1.10 Depending on the acceptable temporary slope inclination, a significant portion of the slope will have to be excavated to construct the proposed concrete cut-off wall. Therefore, consideration should be given to utilizing sheet pile as an alternative to a concrete cut-off wall.

8.1.11 Based on our experience, distress in concrete channel liners may occur as a result of soil loss through joints in the channel liner. Consideration should be given to the use of filter fabric between the soil slope and the channel liner at joint locations. The coefficient of friction in these areas will be lower than where concrete and soil are in contact.

8.1.12 In general, the in-situ moisture content of the channel soils are significantly lower than the laboratory tested optimum moisture content, with in-situ moisture content within 10 feet of the ground surface ranging between 1.3 and 8.2 percent, which could be as low as 4 to 12 percent below optimum moisture content. Significant moisture conditioning of the soils should be expected before they can be used as engineered fill.

8.1.13 Some of the site soils consist of sands with little or no cohesion that may be subject to caving in un-shored excavations. Preliminary excavation recommendations are provided in the *Temporary Excavations* section of this report.

8.1.14 Geocon should review the civil and structural plans with respect to this geotechnical report when they become available.

8.2 Soil and Excavation Characteristics

8.2.1 The undocumented fill and alluvium can be excavated with moderate effort using conventional earth-moving equipment in proper functioning order. Caving should be expected in unshored vertical excavations, especially where loose or cohesionless granular soils are encountered. Some possible construction methods may include pre-wetting of the soils to increase the apparent cohesion and allow for steeper excavations; utilizing localized sheet piles to protect utility poles or other structures within influence of the excavation; performing slot cutting excavation method; performing excavation and construction in rapid succession to reduce the amount of time the excavation is open; providing shoring or bracing against the excavated soil rather than leaving it exposed; and performing flash coating (thin application of shotcrete to prevent the excavated surface from raveling).

8.2.2 It is the responsibility of the contractor to ensure that excavations and trenches are properly shored and maintained in accordance with applicable OSHA rules and regulations in order to maintain safety and maintain the stability of existing adjacent/nearby improvements.

8.2.3 Onsite excavations must be conducted in such a manner that potential surcharges from existing structures, construction equipment, and vehicle loads are resisted. The surcharge area may be defined by a 1:1 projection down and away from the bottom of an existing foundation or vehicle load. Penetrations below this 1:1 projection will require special excavation measures such as sloping or shoring. Preliminary excavation recommendations are provided in the *Temporary Excavations* section of this report.

8.2.4 Based on the material classifications and laboratory testing performed, site material within the channel generally possess a “very low” (expansion index (EI) of 20 or less) to “low” (EI of 21 to 50) expansion potential, and are considered “non-expansive” and “expansive” as defined by 2019 CBC Section 1803.5.3. Table 8.2.4 presents material classifications based on the EI.

TABLE 8.2.4
SOIL CLASSIFICATION BASED ON EXPANSION INDEX

Expansion Index (EI)	Expansion Classification	2019 CBC Expansion Classification
0 – 20	**Very Low**	**Non-Expansive**
21 – 50	**Low**	**Expansive**
51 – 90	Medium	
91 – 130	High	
Greater Than 130	Very High	

8.3 Grading

8.3.1 Earthwork should be observed, and compacted fill tested by representatives of Geocon. The existing soils encountered during current and prior exploration are considered suitable for re-use as an engineered fill, provided oversize material (greater than 6 inches) trash, concrete, and deleterious debris are removed.

8.3.2 A preconstruction conference should be held at the site prior to the beginning of grading operations with a representative of CVWD, Contractor, Civil Engineer, and a representative of Geocon in attendance. Special soil handling requirements can be discussed at that time.

8.3.3 The recommendations in this report have been provided to assist the contractor in evaluating the appropriate means and methods needed to perform earthwork for the channel. Stability of the excavations and influence of the earthwork on the adjacent roadways and structures will depend on the contractor's procedures and the materials encountered during construction. Consideration should be given to performing the initial earthwork for the channel in an area relatively distant from existing improvements. This will allow the contractor to demonstrate that their means and methods in performing earthwork adequately address the existing geologic conditions.

8.3.4 Grading should commence with the removal of all existing vegetation and existing improvements from the area to be excavated. Once a clean excavation bottom has been established it must be observed and approved in writing by the Geotechnical Engineer (a representative of Geocon). Deleterious debris such as trash, wood, roots, and concrete should not be mixed with the fill soils. Existing underground improvements planned for removal should be excavated and the resulting depressions properly backfilled in accordance with the procedures described herein.

8.3.5 Undocumented fill and loose, soft, unsuitable alluvium should be removed until a competent alluvium bottom is exposed or stabilized as necessary as approved by Geocon's representative. Where channel improvements are planned, remedial removals are expected to range between 5 and 10 feet below existing grades, with lateral removals equal to the depth of the removal.

8.3.6 Excavation bottoms should be observed and approved in writing by a representative of Geocon, prior to the placement of engineered fill, stabilization materials, formwork, or construction materials.

8.3.7 Following removals, the bottom of excavations should be scarified at least 12 inches, moisture conditioned and compacted. Scarified excavation bottoms should be moisture conditioned at or slightly above optimum moisture content and compacted to at least 90 percent of the maximum dry density, as determined by ASTM D1557. Due to the relatively dry in-situ soil conditions at the time of this investigation, significant moisture conditioning will likely be required.

8.3.8 Fill soils should be thoroughly mixed, moisture conditioned, placed in horizontal loose layers not exceeding 8 inches thick, and properly compacted. Fill soils should be moisture conditioned at or slightly above optimum moisture content. Fill should be compacted to a minimum 90 percent of the maximum dry density as determined by ASTM D1557.

8.3.9 Remedial removals may be required adjacent to existing improvements, where large excavations may not be possible without damage to the improvements. Slot cutting may be necessary to perform the required removals. Where these areas are identified, Geocon should be contacted to review these excavation constraints and provide additional recommendations as needed.

8.3.10 Where relatively loose, soft, or wet soils are encountered in the site excavations, subgrade stabilization will be required prior to placing fill or installing utilities. Where required, subgrade stabilization can be achieved by various method selected by the contractor such as overexcavating the loose or soft materials and replacing with compacted fill; placing a reinforcing geogrid at the bottom of the excavation; placing 3-inch diameter rock in the soft bottom and working the rock into soil until it is stabilized; placing gravel wrapped in filter fabric at the bottom of the excavation; or other method approved by the engineering geologist or geotechnical engineer based on the conditions encountered. Recommendations for stabilizing excavation bottoms should be based on an evaluation in the field by a representative of Geocon at the time of construction.

8.3.11 The contractor should take precautionary measures not to cause damage to existing structures such as roadways, utility lines, residences, power poles, etc. The contractor may need to use localized sheet piles, slot cutting methods, and/or shoring/bracing against the excavated soil to protect the existing structures. The contractor should provide monitoring of the existing structures on the adjoining properties before, during, and after earthwork activities. If significant movement is observed, the earthwork procedures should be re-evaluated to reduce the potential for movement.

8.3.12 Excavations performed on a slope face that is at an inclination of 5:1 (horizontal to vertical) or steeper should be benched in accordance with *Section 4.4* of the *Recommended Grading Specifications.*

8.3.13 Where new paving is to be constructed (if planned), the upper twelve inches of fill or backfill should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557.

8.4 Earthwork Grading Factors

8.4.1 Estimates of shrinkage factors are based on empirical judgments comparing the material in its existing or natural state as encountered in the exploratory excavations to a compacted state. Variations in natural soil density and in compacted fill density render shrinkage value estimates highly approximate. As an example, the contractor can compact the fill to a dry density of 90 percent or higher of the laboratory maximum dry density. Thus, the contractor has an approximate 10 percent range of control over the fill volume. Due to the variations in the actual shrinkage/bulking factors, a balance area should be provided to accommodate variations.

8.5 Seismic Design Criteria

8.5.1 Table 8.5.1 summarizes summarizes site-specific design criteria obtained from the 2019 California Building Code (CBC; Based on the 2018 International Building Code [IBC] and ASCE 7-16), Chapter 16 Structural Design, Section 1613 Earthquake Loads. We used the computer program *U.S. Seismic Design Maps*, provided by the Structural Engineers Association (SEA) to calculate the seismic design parameters. The short spectral response uses a period of 0.2 second. We evaluated the Site Class based on the discussion in Section 1613.2.2 of the 2019 CBC and Table 20.3-1 of ASCE 7-16. The values presented herein are for the risk-targeted maximum considered earthquake (MCE_R). Sites designated as Site Class D, E and F may require additional analyses if requested by the project structural engineer and client.

TABLE 8.5.1
2019 CBC SEISMIC DESIGN PARAMETERS

Parameter	Value	2019 CBC Reference
Site Class	D	Section 1613.2.2
MCE_R Ground Motion Spectral Response Acceleration – Class B (short), S_S	2.177g	Figure 1613.2.1(1)
MCE_R Ground Motion Spectral Response Acceleration – Class B (1 sec), S_1	0.882g	Figure 1613.2.1(2)
Site Coefficient, F_A	1.000	Table 1613.2.3(1)
Site Coefficient, F_V	1.7*	Table 1613.2.3(2)
Site Class Modified MCE_R Spectral Response Acceleration (short), S_{MS}	2.177g	Section 1613.2.3 (Eqn 16-36)
Site Class Modified MCE_R Spectral Response Acceleration – (1 sec), S_{M1}	1.5g*	Section 1613.2.3 (Eqn 16-37)
5% Damped Design Spectral Response Acceleration (short), S_{DS}	1.451g	Section 1613.2.4 (Eqn 16-38)
5% Damped Design Spectral Response Acceleration (1 sec), S_{D1}	1.0g*	Section 1613.2.4 (Eqn 16-39)

*See following paragraph.

8.5.2 Using the code-based values presented in this Table 8.5.1, in lieu of a performing a ground motion hazard analysis, requires the exceptions outlined in ASCE 7-16 Section 11.4.8 be followed by the project structural engineer. Per Section 11.4.8 of ASCE/SEI 7-16, a ground motion hazard analysis should be performed for projects for Site Class "E" sites with Ss greater than or equal to 1.0g and for Site Class "D" and "E" sites with S1 greater than 0.2g. Section 11.4.8 also provides exceptions which indicates that the ground motion hazard analysis may be waived provided the exceptions are followed.

8.5.3 Table 8.5.3 presents the mapped maximum considered geometric mean (MCE_G) seismic design parameters for projects located in Seismic Design Categories of D through F in accordance with ASCE 7-16.

TABLE 8.5.3
ASCE 7-16 PEAK GROUND ACCELERATION

Parameter	Value	ASCE 7-16 Reference
Mapped MCE_G Peak Ground Acceleration, PGA	0.906g	Figure 22-9
Site Coefficient, F_{PGA}	1.100	Table 11.8-1
Site Class Modified MCE_G Peak Ground Acceleration, PGA_M	0.997g	Section 11.8.3 (Eqn 11.8-1)

8.5.4 Conformance to the criteria in Tables 8.5.1 and 8.5.3 for seismic design does not constitute any kind of guarantee or assurance that significant structural damage or ground failure will not occur in the event of a large earthquake. The primary goal of seismic design is to protect life, not to avoid all damage, since such design may be economically prohibitive.

8.5.5 The project structural engineer and architect should evaluate the appropriate Risk Category and Seismic Design Category for the planned structures. The values presented herein assume a Risk Category of IV and resulting in a Seismic Design Category D. Table 8.5.5 presents a summary of the risk categories in accordance with ASCE 7-16.

TABLE 8.5.5
ASCE 7-16 RISK CATEGORIES

Risk Category	Building Use	Examples
I	Low risk to Human Life at Failure	Barn, Storage Shelter
II	Nominal Risk to Human Life at Failure (Buildings Not Designated as I, III or IV)	Residential, Commercial and Industrial Buildings
III	Substantial Risk to Human Life at Failure	Theaters, Lecture Halls, Dining Halls, Schools, Prisons, Small Healthcare Facilities, Infrastructure Plants, Storage for Explosives/Toxins
IV	Essential Facilities	Hazardous Material Facilities, Hospitals, Fire and Rescue, Emergency Shelters, Police Stations, Power Stations, Aviation Control Facilities, National Defense, Water Storage

8.5.6 The Maximum Considered Earthquake Ground Motion (MCE) is the level of ground motion that has a 2 percent chance of exceedance in 50 years, with a statistical return period of 2,475 years. According to the 2019 California Building Code and ASCE 7-16, the MCE is to be utilized for the evaluation of liquefaction, lateral spreading, seismic settlements, and it is our understanding that the intent of the Building code is to maintain “Life Safety” during a MCE event. The Design Earthquake Ground Motion (DE) is the level of ground motion that has a 10 percent chance of exceedance in 50 years, with a statistical return period of 475 years.

8.5.7 Deaggregation of the MCE peak ground acceleration was performed using the USGS online Unified Hazard Tool, 2014 Conterminous U.S. Dynamic edition. The result of the deaggregation analysis indicates that the predominant earthquake contributing to the MCE peak ground acceleration is characterized as a 7.34 magnitude event occurring at a hypo central distance of 4.06 kilometers from the site.

8.5.8 Deaggregation was also performed for the Design Earthquake (DE) peak ground acceleration, and the result of the analysis indicates that the predominant earthquake contributing to the DE peak ground acceleration is characterized as a 7.34 magnitude occurring at a hypocentral distance of 4.11 kilometers from the site.

8.6 Cut-Off Wall/Channel Protection Bearing Capacity and Settlement

8.6.1 Based on the results of our investigation, it appears that site soils will provide adequate bearing capacity to support the proposed cut-off wall and channel slope protection. For design purposes, an allowable bearing capacity of 1,500 pounds per square foot may be utilized for design of the improvements.

8.6.2 If compressive loads from the channel liner will be imposed on a sheet pile, the portion of the sheet pile below scour elevation can be used to provide skin friction. An allowable skin friction of 300 pounds per square foot on both sides of the sheet pile can be used.

8.6.3 The pressure imposed by the proposed channel protection is expected to be about equal to the existing soils overburden pressure at the proposed channel invert depths. Therefore, static settlement is not a design consideration. Post-construction settlement in trench or channel access road areas should not affect proposed pavement improvements, provided the backfill is placed and compacted in accordance with the recommendations of this report.

8.7 Hydrostatic Uplift Pressure

8.7.1 For the purposes of this report, we have assumed that the soils behind the cut-off wall will become saturated but that soils behind the channel liner will not be saturated during and shortly after a rain event when water is present within the channel. Therefore, we have considered a high groundwater elevation of approximately the channel invert elevation.

8.7.2 Based on this consideration, we recommend that the portions of the proposed improvements (cut-off wall) which will be constructed below channel invert should be designed to resist hydrostatic pressure. In addition, the upward pressure of water on the cutoff wall footing should be taken as the full hydrostatic pressure on the base of the footing.

8.7.3 No hydrostatic pressures are assumed on the channel liner. If the hydraulic engineer determines that saturation will occur above the channel invert, Geocon should be contacted to provide additional recommendations.

8.8 Lateral Earth Pressures for Cutoff Walls and Channel Wall Lining

8.8.1 Cutoff walls and channel wall linings may be designed in accordance with the following recommendations. The recommendations presented below are based on the current proposed cutoff wall and channel wall lining design, and are applicable to a maximum height of 45 feet; from bottom of cutoff wall to the top of channel wall lining. In the event that walls/liners higher than 45 feet are planned, Geocon should be contacted for additional recommendations.

8.8.2 Cutoff walls at the toe of the channel linings should be designed utilizing the recommended parameters in the following table. The parameters presented in the following table include the active coefficient for level and 1½:1 (horizontal to vertical) backfill above the cutoff wall.

TABLE 8.8.2
RECOMMENDED LATERAL EARTH PRESSURE DESIGN PARAMETERS

Condition/Section	Retaining Wall Design Parameters			
	Soil Density (pcf)	Active Equiv Fluid Pressure - Level (psf/ft)	Active Equiv. Fluid Pressure – 1½:1 (psf/ft)	Passive Equiv. Fluid Pressure (psf/ft)
Hydrostatic Conditions	48	80*	112*	182*
No Groundwater	110	35	50	365

*Includes unit weight of water due to hydrostatic forces

8.8.3 Additional active pressure should be added for a surcharge condition due to vehicular traffic or adjacent structures and should be designed for each condition along the project alignment.

8.8.4 Lateral earth pressures are not assumed for the channel line since the planned 1½:1 slopes have adequate factors of safety for global slope stability.

8.8.5 A coefficient of friction between concrete and on-site soils can be taken as 0.35. If a geotextile fabric is used along joints to reduce loss of soil from behind the channel liner, a coefficient of friction between the geotextile and soil or concrete can be taken as 0.15 or as directed by the fabric manufacturer.

8.9 Dynamic (Seismic) Lateral Forces for Channel Slope Protection

8.9.1 Seismic lateral forces presented below should be incorporated into the design as necessary. The structural engineer should determine the seismic design category for the project in accordance with Section 1613.3.5 of the 2019 CBC or Section 11.6 of ASCE 7-10. If the project possesses a seismic design category of D, E, or F, retaining walls that support more than 6 feet of backfill should be designed with seismic lateral pressure in accordance with Section 1803.5.12 of the 2019 CBC. A seismic pressure of 25H psf is recommended. The seismic load is dependent on the retained height where H is the height of the wall, in feet, and the calculated loads result in pounds per square foot (psf) exerted at the base of the wall and zero at the top of the wall. We used the mean peak ground acceleration adjusted for Site Class effects (PGA_M) from ASCE 7-10 Section 11.8.3.

8.10 Exterior Concrete Flatwork

8.10.1 Exterior concrete flatwork not subject to vehicular traffic should be constructed in accordance with the recommendations presented in Table 8.10.1. The recommended reinforcing steel would help reduce the potential for crack displacements.

TABLE 8.10.1
MINIMUM CONCRETE FLATWORK RECOMMENDATIONS

Expansion Index, EI	Minimum Concrete Reinforcement* Options	Minimum Thickness
EI $\leq$ 90	6x6-W2.9/W2.9 (6x6-6/6) welded wire mesh	4 Inches
	No. 3 Bars 18 inches on center, Both Directions	

*In excess of 8 feet square.

8.10.2 The subgrade soil should be properly moisturized and compacted prior to the placement of steel and concrete. The subgrade soil should be compacted to a dry density of at least 90 percent of the laboratory maximum dry density near to slightly above optimum moisture content in accordance with ASTM D 1557.

8.10.3 Even with the incorporation of the recommendations of this report, the exterior concrete flatwork has a potential to experience some uplift due to expansive soil beneath grade. The reinforcing steel should overlap continuously in flatwork to reduce the potential for vertical offsets within flatwork. Additionally, flatwork should be structurally connected to the curbs, where possible, to reduce the potential for offsets between the curbs and the flatwork.

8.10.4 Concrete flatwork should be provided with crack control joints to reduce and/or control shrinkage cracking. Crack control spacing should be determined by the project structural engineer based upon the slab thickness and intended usage. Criteria of the American Concrete Institute (ACI) should be taken into consideration when establishing crack control spacing. Subgrade soil for exterior slabs not subjected to vehicle loads should be compacted in accordance with criteria presented in the grading section prior to concrete placement. Subgrade soil should be properly compacted and the moisture content of subgrade soil should be verified prior to placing concrete. Base materials will not be required below concrete improvements.

8.10.5 The recommendations presented herein are intended to reduce the potential for cracking of exterior slabs as a result of differential movement. However, even with the incorporation of the recommendations presented herein, slabs will still crack. The occurrence of concrete shrinkage cracks is independent of the soil supporting characteristics. Their occurrence may be reduced and/or controlled by limiting the slump of the concrete, the use of crack control joints and proper concrete placement and curing. Crack control joints should be spaced at intervals no greater than 12 feet. Literature provided by the Portland Concrete Association (PCA) and American Concrete Institute (ACI) present recommendations for proper concrete mix, construction, and curing practices, and should be incorporated into project construction.

8.11 Temporary Excavations

8.11.1 Excavations of up to 36 feet below the existing ground surface may be required for the construction of channel improvements.

8.11.2 Excavations are expected to expose alluvial soils that are suitable for vertical excavations of up to 5 feet where loose soils or caving sands are not present, and where not surcharged by adjacent traffic or structures.

8.11.3 Vertical excavations greater than 5 feet will require sloping measures in order to provide a stable excavation. Where sufficient space is available, temporary unsurcharged embankments should be designed by the contractor’s competent person in accordance with OSHA regulations.

8.11.4 Where there is insufficient space for sloped excavations, shoring or trench shields should be used to support excavations. Shoring may also be necessary where sloped excavation could remove vertical or lateral support of existing improvements, including existing utilities and adjacent/nearby structures. Recommendations for temporary shoring are provided in the following section.

8.11.5 Where sloped embankments are utilized, the top of the slope should be barricaded to prevent vehicles and storage loads at the top of the slope within a horizontal distance equal to the height of the slope. If the temporary construction embankments are to be maintained during the rainy season, berms are suggested along the tops of the slopes where necessary to prevent runoff water from entering the excavation and eroding the slope faces. The contractor’s competent person should inspect the soils exposed in the cut slopes during excavation in accordance with OSHA regulations so that modifications of the slopes can be made if variations in the soil conditions occur.

8.12 Temporary Shoring

8.12.1 Where there is insufficient space to safely perform sloped excavations, shoring should be implemented. We expect that braced shoring, such as conventionally braced shields or cross-braced hydraulic shoring, will be utilized; however, the selection of the shoring system is the responsibility of the contractor. Shoring systems should be designed by a California licensed civil or structural engineer with experience in designing shoring systems.

8.12.2 We recommend that an equivalent fluid pressure shown in Table 8.12.2 below be utilized for design of temporary shoring. These pressures are based on the assumption that there are no hydrostatic pressures above the bottom of the excavation.

TABLE 8.12.2
PRELIMINARY RECOMMENDED SHORING PRESSURES

HEIGHT OF SHORED EXCAVATION (FEET)	EQUIVALENT FLUID PRESSURE (Pounds Per Cubic Foot) (Active Pressure)	EQUIVALENT FLUID PRESSURE (Pounds Per Cubic Foot) (Active Pressure with 2:1 Slope)	EQUIVALENT FLUID PRESSURE (Pounds Per Cubic Foot) (AT-REST PRESSURE)
≤ 35	33	52	59

8.12.3 Active pressures can only be achieved when movement in the soil (earth wall) occurs. If movement in the soil is not acceptable, such as adjacent to an existing structure or where braced shoring will be utilized the at-rest pressure should be considered for design purposes.

8.12.4 Additional active pressure should be added for a surcharge condition due to sloping ground, construction equipment, vehicular traffic, or adjacent structures and should be designed for each condition as the project progresses.

8.12.5 In addition to the recommended earth pressure, shoring adjacent to roadways or driveway areas should be designed to resist a uniform lateral pressure of 100 psf, acting as a result of an assumed 300 psf surcharge behind the shoring due to normal street traffic. If the traffic is kept back at least 20 feet from the shoring, the traffic surcharge may be neglected. Higher surcharge loads may be required to account for construction equipment.

8.12.6 It is difficult to accurately predict the amount of deflection of a shored embankment, but some deflection will occur. We recommend that the deflection be minimized to prevent damage to existing structures and adjacent improvements. Where public right-of-ways are present or adjacent offsite structures do not surcharge the shoring excavation, the shoring deflection should be limited to less than 1 inch at the top of the shored embankment. Where offsite structures are within the shoring surcharge area it is recommended that the beam deflection be limited to less than ½ inch at the elevation of the adjacent offsite foundation, and no deflection at all if deflections will damage existing structures. The allowable deflection is dependent on many factors, such as the presence of structures and utilities near the top of the embankment and will be assessed and designed by the project shoring engineer.

8.13 Lateral Design

8.13.1 Table 8.13.1 should be used to help design the proposed structures and improvements to resist lateral loads for the design of footings or shear keys. The allowable passive pressure assumes a horizontal surface extending at least 5 feet, or three times the surface generating the passive pressure, whichever is greater. The upper 12 inches of material in areas not protected by floor slabs or pavement should not be included in design for passive resistance.

TABLE 8.13.1
SUMMARY OF LATERAL LOAD DESIGN RECOMMENDATIONS

Parameter	Value
Passive Pressure Fluid Density	365 pcf
Coefficient of Friction (Concrete and Soil)	0.35
Coefficient of Friction (Along Vapor Barrier)	0.2 to 0.25*

*Per manufacturer's recommendations.

8.13.2 The passive and frictional resistant loads can be combined for design purposes. The lateral passive pressures may be increased by one-third when considering transient loads due to wind or seismic forces.

8.14 Plan Review

8.14.1 Plans should be reviewed by the Geotechnical Engineer (a representative of Geocon), prior to finalization to verify that the plans have been prepared in substantial conformance with the recommendations of this report and to provide additional analyses or recommendations.

LIMITATIONS AND UNIFORMITY OF CONDITIONS

The recommendations of this report pertain only to the site investigated and are based upon the assumption that the soil conditions do not deviate from those disclosed in the investigation. If any variations or undesirable conditions are encountered during construction, or if the proposed construction will differ from that anticipated herein, Geocon should be notified so that supplemental recommendations can be given. The evaluation or identification of the potential presence of hazardous materials was not part of the scope of services provided by Geocon.

This report is issued with the understanding that it is the responsibility of the owner, or of their representative, to ensure that the information and recommendations contained herein are brought to the attention of the architect and engineer for the project and incorporated into the plans, and the necessary steps are taken to see that the contractor and subcontractors carry out such recommendations in the field.

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 our control. Therefore, this report is subject to review and should not be relied upon after a period of three years.

The firm that performed the geotechnical investigation for the project should be retained to provide testing and observation services during construction to provide continuity of geotechnical interpretation and to check that the recommendations presented for geotechnical aspects of site development are incorporated during site grading, construction of improvements, and excavation of foundations. If another geotechnical firm is selected to perform the testing and observation services during construction operations, that firm should prepare a letter indicating their intent to assume the responsibilities of project Geotechnical Engineer of Record. A copy of the letter should be provided to the regulatory agency for their records. In addition, that firm should provide revised recommendations concerning the geotechnical aspects of the proposed development, or a written acknowledgement of their concurrence with the recommendations presented in our report. They should also perform additional analyses deemed necessary to assume the role of Geotechnical Engineer of Record.

LIST OF REFERENCES

1. *2019 California Building Code, California Code of Regulations, Title 24, Part 2, based on the 2018 International Building Code*, prepared by California Building Standards Commission, dated July 2019.

2. American Society of Civil Engineers (ASCE), *ASCE 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, 2017.

3. California Building Standards Commission, 2019, *California Building Code (CBC)*, California Code of Regulations Title 24, Part 2.

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5. Coachella Valley Water District, 2020, Well Data Provided via Personal Communication.

6. Dibblee, T. W., Jr., 2008, *Geologic Map of the Palm Desert & Coachella 15 Minute Quadrangles*, Palm Desert and Coachella Map (DF-373).

7. Legg, M. R., J. C. Borrero, and C. E. Synolakis, *Evaluation of Tsunami Risk to Southern California Coastal Cities*, 2002 NEHRP Professional Fellowship Report, dated January 2003.

8. OSHPD Seismic Design Maps Web Application, https://seismicmaps.org/, accessed April 2022.

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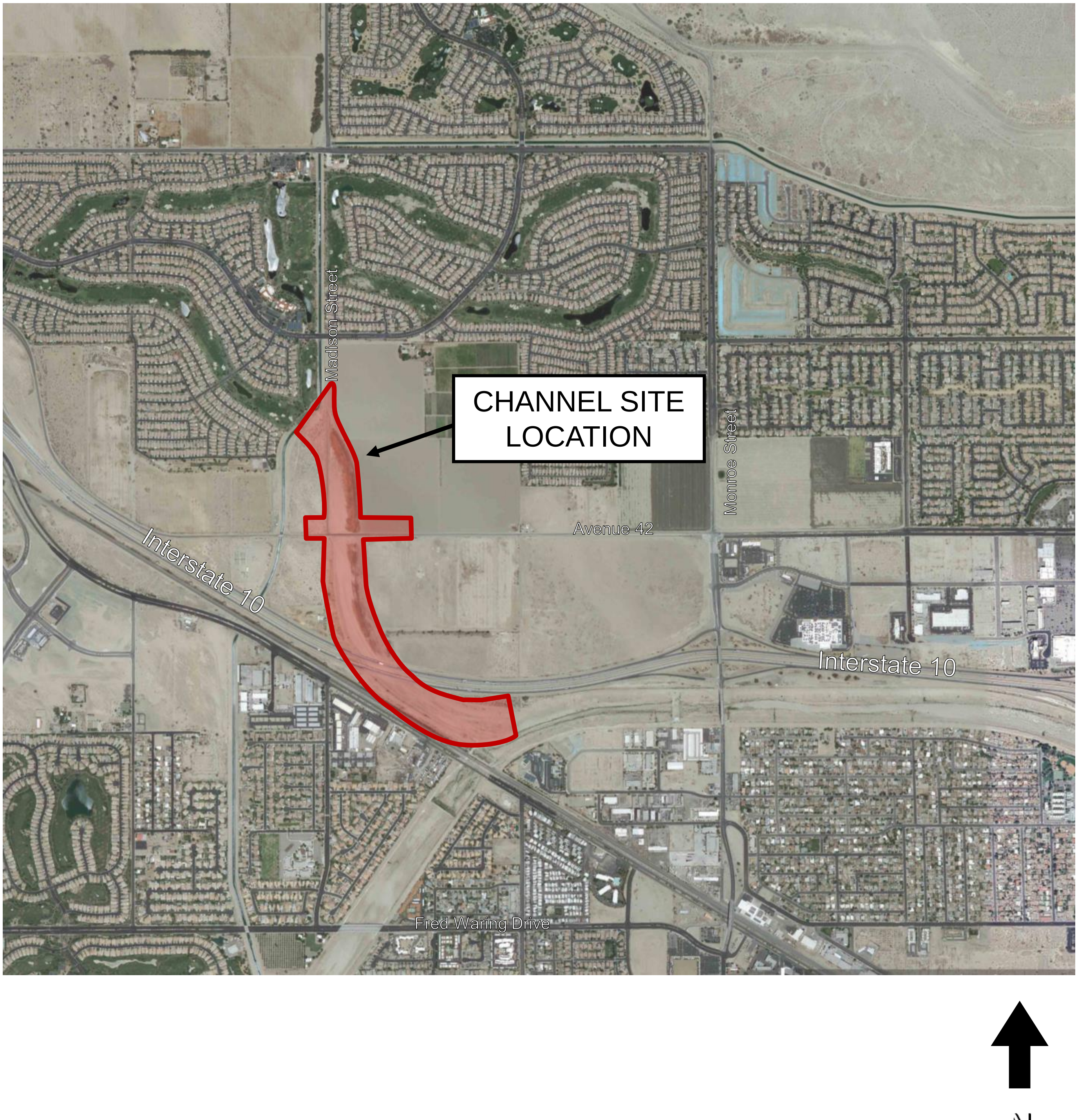
10. Riverside County Information System, *Map My County*, accessed April 2022.

11. US Geological Survey, 2013, *Detection and Measurement of Land Subsidence Using Global Positioning System Surveying and Interferometric Synthetic Aperture Radar, Coachella Valley, California 1996-2005*, Scientific Investigations Report 2007-5251, Version 2.0, dated month of June.



SOURCE: Google Earth Pro, 2022

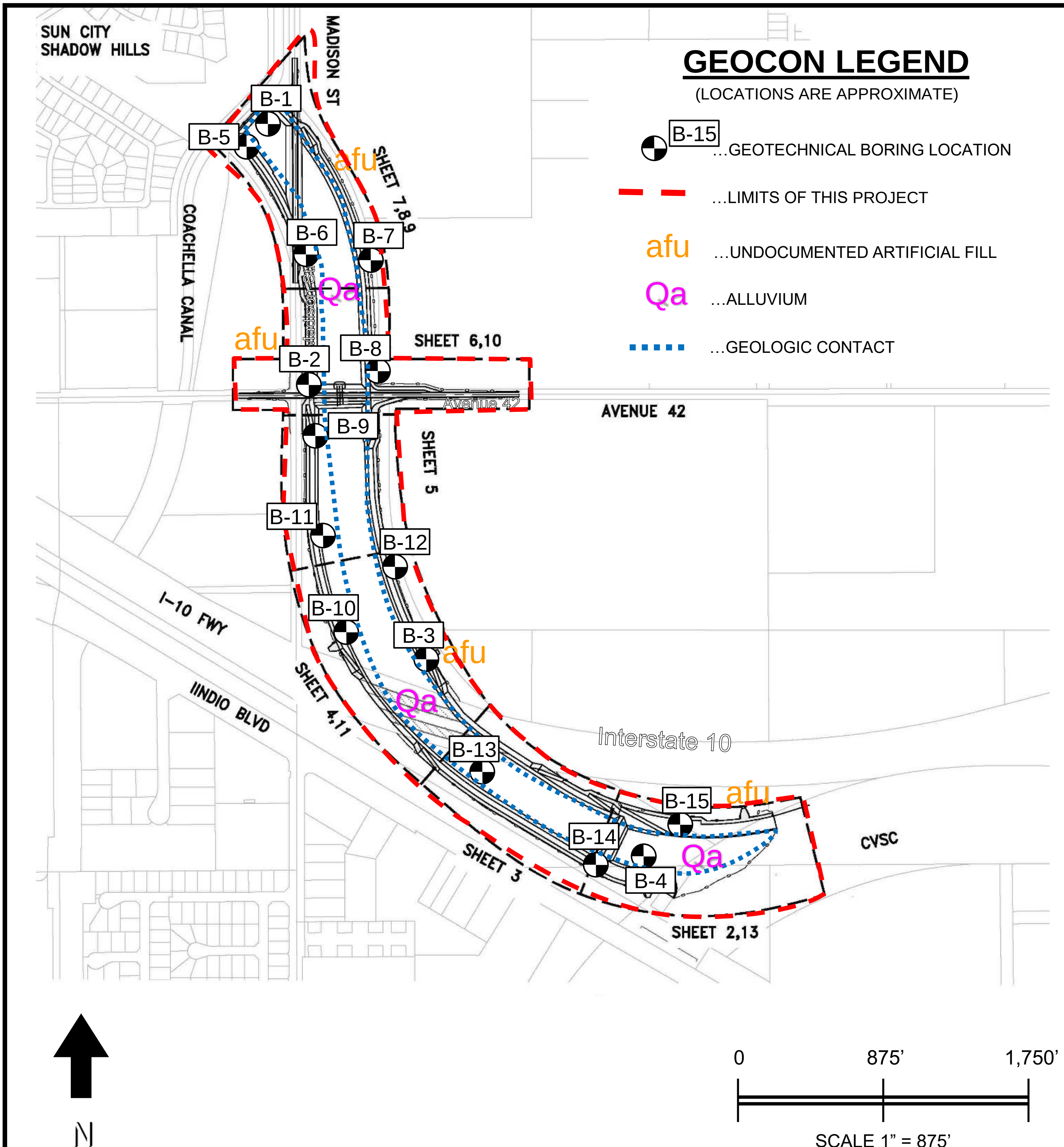
SCALE: 1" = 2,000'

VICINITY MAP

GEOCON WEST, INC.
GEOTECHNICAL CONSULTANTS
41571 CORNING PLACE SUITE 101 MURRIETA, CA 92562-7065
PHONE 951-304-2300 FAX 951-304-2392

THOUSAND PALMS CHANNEL
COACHELLA VALLEY WATER DISTRICT
INDIO, CALIFORNIA

ATS			JUNE 2022	PROJECT NO. T2581-22-05	FIG. 1



SOURCE: Albert A. Webb Associates, Thousand Palms Stormwater Channel, Sheet No. 1, July 2021 DRAFT

GEOLOGIC MAP

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WEST, INC.
GEOTECHNICAL CONSULTANTS
41571 CORNING PLACE SUITE 101 MURRIETA, CA 92562-7065
PHONE 951-304-2300 FAX 951-304-2392

HD

THOUSAND PALMS CHANNEL
COACHELLA VALLEY WATER DISTRICT
INDIO, CALIFORNIA

JUNE 2022 | PROJECT NO. T2581-22-05 | FIG. 2

APPENDIX A

APPENDIX A

FIELD INVESTIGATION

Geocon performed a preliminary field investigation on October 5, 2020, where we drilled Borings B-1 through B-4. Geocon performed an additional field investigation for this study on March 22 and 23, 2022 which included drilling Borings B-5 through B-15. In total, our work included drilling 15 8-inch diameter geotechnical borings (B-1 through B-15) to depths of up to approximately 51 feet below existing grades. The investigation was performed to observe the subsurface geological conditions at the site, collect relatively undisturbed in-situ and disturbed bulk samples for laboratory testing, and evaluate the depth to groundwater. The borings were drilled with a limited access track-mounted CME-75 drill rig equipped with hollow stem auger.

We collected disturbed bulk and relatively undisturbed soil samples from the borings by driving a 3-inch O. D., California Modified Sampler into the “undisturbed” soil mass with blows from a 140-pound hammer falling 30 inches. The California Modified Sampler was equipped with 1-inch high by 2$^{3}/_{8}$-inch inside diameter brass sampler rings to facilitate removal and testing. Relatively undisturbed samples and bulk samples of disturbed soils were transported to our laboratory for testing.

The soil conditions encountered in the borings were visually examined, classified and logged in general accordance with the Unified Soil Classification System (USCS). Logs of the borings are presented on Figures A-1 through A-15. The logs depict the soil and geologic conditions encountered and the depth at which samples were obtained. The approximate locations of the borings are depicted on the *Geologic Map*, Figure 2.

PROJECT NO. T2581-22-04

BORING B-1

ELEV. (MSL.) **17 ft** DATE COMPLETED **10/05/2020**

EQUIPMENT **CME-75** BY: **ATS**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0	B-1@0-5'			ML	**ALLUVIUM (Qa)** Sandy SILT, stiff, dry, light olive gray; fine sand			
2	B-1@2.5'			SM	Silty SAND, dense, damp, light olive gray; fine to medium sand; trace pores; shells	64	97.5	3.2
4								
6	B-1@5'			SP-SM	Poorly-graded SAND with silt, dense, moist, light olive gray; fine to medium sand; micaceous; trace calcium carbonate deposits	58	101.9	4.8
8								
10	B-1@10'			CL-ML	Sandy silty CLAY, very stiff, damp, light olive gray; fine sand; porous; calcium carbonate deposits	81		
12								
14								
16	B-1@15'			SP-SM	Poorly-graded SAND with silt, very dense, damp, light olive gray; fine to medium sand; trace mica	80-11"	99.9	4.9
				ML	Sandy SILT, very stiff, damp, light gray, white; fine sand			
18								
20	B-1@20'			SP	Poorly-graded SAND, very dense, damp, light grayish brown; fine sand	81	109.0	1.2
22								
24								
	B-1@25'					80	101.4	2.8
26				ML	SILT, very stiff, damp, light grayish brown; calcium carbonate deposits; trace pores			
28								

Figure A-1,
Log of Boring B-1, Page 1 of 2

T2581-22-04 BORING LOGS.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

BORING B-1

ELEV. (MSL.) **17 ft** DATE COMPLETED **10/05/2020**

EQUIPMENT **CME-75** BY: **ATS**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-1@30'			SP-SM	Poorly-graded SAND with silt, dense, damp, light grayish brown; fine sand; trace mica	70	98.7	1.6
					Total Depth = 31'-6" Groundwater not encountered Backfilled with cuttings on 10/05/2020			

Figure A-1,
Log of Boring B-1, Page 2 of 2

T2581-22-04 BORING LOGS.GPJ

SAMPLE SYMBOLS			
	☐ ... SAMPLING UNSUCCESSFUL	◧ ... STANDARD PENETRATION TEST	■ ... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	◪ ... CHUNK SAMPLE	▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

PROJECT NO. T2581-22-04

BORING B-2

ELEV. (MSL.) **19 ft** DATE COMPLETED **10/05/2020**

EQUIPMENT **CME-75** BY: **ATS**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SP-SM	**ALLUVIUM (Qa)** Poorly-graded SAND with silt, very loose, dry, light yellowish brown			
					- becomes loose			
2	B-2@2.5'				- becomes medium dense, moist, light grayish brown; fine to medium sand; trace mica	41		
4								
	B-2@5-10' B-2@5'			SM	Silty SAND, very dense, damp, light olive brown; fine sand; trace mica	81	102.4	2.2
6								
8								
10	B-2@10'				- becomes moist	50-6"	103.4	17.1
				ML	Sandy SILT, hard, moist, light grayish brown; fine sand			
12								
14								
	B-2@15'				- becomes damp, very stiff, light yellowish brown	66	96.2	5.7
16								
18								
20	B-2@20'			SP-SM	Poorly-graded SAND with silt, dense, damp, light grayish brown; fine sand	71	103.6	2.2
22								
24								
	B-2@25'			ML	Sandy SILT, hard, moist, light olive gray; fine sand; trace pores	50-6"	94.6	7.4
26								
28								

Figure A-2,
Log of Boring B-2, Page 1 of 2

T2581-22-04 BORING LOGS.GPJ

SAMPLE SYMBOLS			
	☐ ... SAMPLING UNSUCCESSFUL	◧ ... STANDARD PENETRATION TEST	■ ... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	◪ ... CHUNK SAMPLE	▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

BORING B-2

ELEV. (MSL.) **19 ft** DATE COMPLETED **10/05/2020**

EQUIPMENT **CME-75** BY: **ATS**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-2@30'			SP-SM	Poorly-graded SAND with silt, dense, damp, light gray; fine to medium sand; trace mica; silt lense	70		
					Total Depth = 31'-6" Groundwater not encountered Backfilled with cuttings on 10/05/2020			

Figure A-2,
Log of Boring B-2, Page 2 of 2

T2581-22-04 BORING LOGS.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. T2581-22-04

BORING B-3

ELEV. (MSL.) **12 ft** DATE COMPLETED **10/05/2020**

EQUIPMENT **CME-75** BY: **ATS**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SM	**ALLUVIUM (Qa)** Silty SAND, very loose, dry, light olive gray; fine to medium sand; trace mica			
2	B-3@2.5'				- becomes medium dense	39	106.9	1.3
4	B-3@5-10' B-3@5'				- becomes dense, damp, light gray; porous	70	87.3	2.7
6								
8								
10	B-3@10'			ML	Sandy SILT, hard, moist, light olive gray; fine sand	50-6"	104.6	8.6
12								
14	B-3@15'				- becomes dry	50-4"	100.6	1.8
16								
18								
20	B-3@20'				- becomes very stiff, damp, light olive gray, white	57	88.0	4.0
22								
24	B-3@25'				- becomse hard; fine to medium poorly-graded sand lense	50-5"		
26								
28								

Figure A-3,
Log of Boring B-3, Page 1 of 2

T2581-22-04 BORING LOGS.GPJ

SAMPLE SYMBOLS			
	☐ ... SAMPLING UNSUCCESSFUL	◧ ... STANDARD PENETRATION TEST	■ ... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	◪ ... CHUNK SAMPLE	▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

BORING B-3

ELEV. (MSL.) **12 ft** DATE COMPLETED **10/05/2020**

EQUIPMENT **CME-75** BY: **ATS**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-3@30'			SP-SM	Poorly-graded SAND with silt, very dense, moist, light gray; fine to medium sand; trace mica	50-6"	98.0	4.0
35	B-3@35'			SM	Silty SAND, very dense, moist, light gray; fine sand; trace mica	85		
40	B-3@40'				- becomes damp, gray	50-6"	96.1	2.6
45	B-3@45'			SW	Well-graded SAND, very dense, damp, yellowish brown; fine to coarse sand	50-5"		
50	B-3@50'			SP	Poorly-graded SAND, very dense, damp, light gray; medium sand	50-6"	103.8	1.4

Total Depth = 51'
Groundwater not encountered
Backfilled with cuttings on 10/05/2020

Figure A-3,
Log of Boring B-3, Page 2 of 2

T2581-22-04 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ☐ ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. T2581-22-04

BORING B-4

ELEV. (MSL.) **7 ft** DATE COMPLETED **10/05/2020**

EQUIPMENT **CME-75** BY: **ATS**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SM	**ALLUVIUM (Qa)** Silty SAND, loose, moist, brown; fine to medium sand			
2								
	B-4@2.5'			ML	Sandy SILT with clay, very stiff, moist, light gray, white; fine sand	64	103.5	8.2
4					- trace pores; shells			
	B-4@5'					61	88.2	6.1
6	B-4@0-5'				- becomes grayish brown; calcium carbonate stringers			
8								
10	B-4@10'				- becomes pale yellow	60	95.6	6.3
12								
14								
	B-4@15'				- becomes damp	60	96.6	3.1
16								
18								
20	B-4@20'				- becomes moist	59	85.6	16.0
22								
24								
	B-4@25'				- becomes hard; fine silty sand lense	50-6"		
26								
28								

Figure A-4,
Log of Boring B-4, Page 1 of 2

T2581-22-04 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	**BORING B-4** ELEV. (MSL.) **7 ft** DATE COMPLETED **10/05/2020** EQUIPMENT **CME-75** BY: **ATS**	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
					MATERIAL DESCRIPTION			
30	B-4@30'			ML	Sandy SILT with clay, very stiff, damp, light gray, white; fine sand; trace pores; shells	55	86.5	3.7
					Total Depth = 31'-6" Groundwater not encountered Backfilled with cuttings on 10/05/2020			

Figure A-4,
Log of Boring B-4, Page 2 of 2

T2581-22-04 BORING LOGS.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

BORING B-5

ELEV. (MSL.) 23 DATE COMPLETED 3/22/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				ML	**UNDOCUMENTED ARTIFICIAL FILL (afu)** Sandy SILT, stiff, slightly moist, light olive brown; fine sand			
5	B-5@5'				-Becomes dry; trace pores	18	97.8	1.8
7					-Becomes olive brown			
10	B-5@10'				-Becomes very stiff; porous	64	96.9	5.0
15	B-5@15'			SP	**ALLUVIUM (Qa)** Poorly-graded SAND, dense, slightly moist, olive brown to light yellow brown; fine sand	62	109.2	1.0
20	B-5@20'					54	100.6	5.3
20.5				ML	Sandy SILT, very stiff, dry, olive brown; fine sand; calcium carbonate deposits; porous			
25	B-5@25'			SP	Poory-graded SAND, dense, slightly moist, light olive brown; fine sand -Becomes yellowish brown; medium to coarse sand; SP lense; trace mottling	55	100.6	1.7

Figure A-5,
Log of Boring B-5, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	**BORING B-5** ELEV. (MSL.) **23** DATE COMPLETED **3/22/2022** EQUIPMENT **CME 75** BY: **A. Shoashekan**	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
		BULK / DR/SPT			MATERIAL DESCRIPTION			
30	B-5@30'					73	108.0	
32								
34								
	B-5@35'			MH	Elastic SILT, stiff, moist, olive to olive brown; trace pores	34	90.4	
36								
38								
40	B-5@40'			SP	Poorly-graded SAND, dense, moist, olive brown; fine sand	58	101.0	
42								
44								
	B-5@45'					53		
46								
					Total Depth = 46.5' feet No Groundwater encountered Penetration resistance for 140-lb hammer falling 30 inches by auto hammer Backfilled with cuttings 3/22/2022			

Figure A-5,
Log of Boring B-5, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

PROJECT NO. T2581-22-05

BORING B-6

ELEV. (MSL.) 24 DATE COMPLETED 3/22/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SP	**UNDOCUMENTED ARTIFICIAL FILL (afu)** Poorly-graded SAND, loose, moist, olive brown; fine sand			
5	B-6@5'					16		
6				ML	**ALLUVIUM (Qa)** Sandy SILT, stiff, slightly moist, light olive brown; fine sand			
10	B-6@10'				-Becomes dry	27	88.9	3.0
15	B-6@15'			SP	Poorly-graded SAND, slightly dense, moist, olive brown; fine sand; trace mica	49	96.5	1.7
20	B-6@20'			ML	Sandy SILT, very stiff, dry, olive brown; fine sand; trace mica	47	100.3	3.6
25	B-6@25'				-Becomes light olive brown; olive; fine sand; SP lense	60	107.5	2.9

Sampler columns: BULK, DR/SPT

Figure A-6,
Log of Boring B-6, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS

- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

GEOCON

PROJECT NO. T2581-22-05

BORING B-6

ELEV. (MSL.) 24 DATE COMPLETED 3/22/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-6@30'			SP	Poorly-graded SAND, dense, slightly moist, light yellowish brown; trace mica	57	100.6	1.4
35	B-6@35'			MH	Elastic SILT, very stiff, slightly moist, light olive to yellowish brown; trace pores	61	88.7	9.6
38.5				SP	Poorly-graded SAND, very dense, slightly moist, light olive brown; fine sand; trace mica			
40	B-6@40'					85-12"	104.1	1.4
45	B-6@45'			ML	Sandy SILT, very stiff, slightly moist, light olive to yellowish brown	68		

Total Depth = 46.5' feet
No Groundwater encountered
Penetration resistance for 140-lb hammer falling 30 inches by auto hammer
Backfilled with cuttings 3/22/2022

Figure A-6,
Log of Boring B-6, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

PROJECT NO. T2581-22-05

BORING B-7

ELEV. (MSL.) 29 DATE COMPLETED 3/22/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0		SM	**UNDOCUMENTED ARTIFICIAL FILL (afu)** SiltySAND, medium dense, moist, brown; fine sand; wood waste at surface			
5	B-7@5'			21	101.5	7.2
		SP	Poorly-graded SAND, medium dense, moist, light yellowish brown; fine sand; wood waste			
10	B-7@10'	SM	Silty SAND, medium dense, slightly moist, light olive brown; fine sand	17	108.0	2.7
15	B-7@15'	ML	**ALLUVIUM (Qa)** Sandy SILT, very stiff, slightly moist, light olive brown; fine sand; trace calcuim carbonate stringers	54	108.4	5.2
20	B-7@20'		-Increase calcium carbonate deposits	44	103.0	6.1
24		SP	Poorly-graded SAND, dense, moist, olive to yellowish brown; fine sand; trace mica			
25	B-7@25'			63	93.3	5.7
28		MH	Elastic SILT, very stiff, dry, light olive brown; fine sand; calcuim carbonate stringers			

Figure A-7,
Log of Boring B-7, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

BORING B-7

ELEV. (MSL.) 29 DATE COMPLETED 3/22/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-7@30'			SP	Poorly-graded SAND, dense, moist, light olive brown; fine sand	74	93.9	3.2
35	B-7@35'				-Becomes light yellowish brown	74	97.9	1.8
				ML	Sandy SILT, very stiff, dry, light yellowish brown; fine sand			
40	B-7@40'				-Becomes slightly moist; trace calcium carbonate deposits	63-11"	86.8	11.1
45	B-7@45'					62	101.8	7.4

Total Depth = 46.5' feet
No Groundwater encountered
Penetration resistance for 140-lb hammer falling 30 inches by auto hammer
Backfilled with cuttings 3/22/2022

Figure A-7,
Log of Boring B-7, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

PROJECT NO. T2581-22-05

BORING B-8

ELEV. (MSL.) 28 DATE COMPLETED 3/22/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SP	**UNDOCUMENTED ARTIFICIAL FILL (afu)** Poorly-graded SAND, loose, moist, brown; fine sand; trace mica; wood wast at surface			
2								
4								
6	B-8@5' B-8@5-10'				-Becomes slightly moist; wood waste	16	103.0	2.6
8								
10	B-8@10'				-Becomes medium dense, dry	32	104.9	0.8
12								
14								
16	B-8@15'			SP	**ALLUVIUM (Qa)** Poorly-graded SAND, dense, dry, olive to yellowish brown; fine sand; trace mica; yellowish brown ML lense	50	104.7	0.8
18								
20	B-8@20'			ML	Sandy SILT, very stiff, slightly moist, light olive brown; fine sand; trace pores; calcium carbonate deposits	62	103.2	5.0
22								
24								
26	B-8@25'					78		
28								

BULK DR/SPT

Figure A-8,
Log of Boring B-8, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS			
	☐ ... SAMPLING UNSUCCESSFUL	◧ ... STANDARD PENETRATION TEST	■ ... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	◪ ... CHUNK SAMPLE	▼ ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

BORING B-8

ELEV. (MSL.) 28 DATE COMPLETED 3/22/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-8@30'			SP	Poorly-graded SAND, dense, slightly moist, light yellowish brown; fine sand; trace mica	61	106.0	1.0
32								
34								
36	B-8@35'				-Yellowish brown ML lense with calcium carbonate stringers	75	99.8	1.3
38								
40	B-8@40'				-Yellowish brown ML lense	58	96.2	1.5
42								
44								
46	B-8@45'					57	95.9	1.6

Total Depth = 46.5' feet
No Groundwater encountered
Penetration resistance for 140-lb hammer falling 30 inches by auto hammer
Backfilled with cuttings 3/22/2022

Figure A-8,
Log of Boring B-8, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

PROJECT NO. T2581-22-05

BORING B-9

ELEV. (MSL.) **19** DATE COMPLETED **3/22/2022**

EQUIPMENT **CME 75** BY: **A. Shoashekan**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SP	**UNDOCUMENTED ARTIFICIAL FILL (afu)** Poorly-graded SAND, medium dense, moist, olive brown; fine sand; trace mica			
5	B-9@5'				-Becomes slightly moist	40	99.8	2.4
10	B-9@10'				-Becomes dense	50	91.8	15.9
				MH	**ALLUVIUM (Qa)** Elastic SILT, very stiff, moist, olive to yellowish brown; calcium carbonate deposits; trace pores			
15	B-9@15'				-Becomes dry; porous	41	97.7	3.4
20	B-9@20'			ML	Sandy SILT, very stiff, dry, light olive brown; fine sand; micaceous	47	97.5	2.5
25	B-9@25'				-Becomes light yellowish brown	60	95.0	2.6

Figure A-9,
Log of Boring B-9, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS

- ... SAMPLING UNSUCCESSFUL
- ... DISTURBED OR BAG SAMPLE
- ... STANDARD PENETRATION TEST
- ... CHUNK SAMPLE
- ... DRIVE SAMPLE (UNDISTURBED)
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

BORING B-9

ELEV. (MSL.) 19 DATE COMPLETED 3/22/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-9@30'			SP	Poorly-graded SAND, dense, slightly moist, light yellow to olive brown; fine sand; micaceous; yellowish brown ML lense	74	101.6	1.6
32								
34								
	B-9@35'					63	100.7	3.4
36					-Becomes moist			
38								
40	B-9@40'					67	86.8	15.3
				ML	Sandy SILT, very stiff, moist, light olive to yellowish brown; fine sand; trace pores; calcium carbonate stringers			
42								
44								
	B-9@45'				-Becomes hard	77-11"	86.7	13.1
46								

Total Depth = 46.5' feet
No Groundwater encountered
Penetration resistance for 140-lb hammer falling 30 inches by auto hammer
Backfilled with cuttings 3/22/2022

Figure A-9,
Log of Boring B-9, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS

- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

BORING B-10

ELEV. (MSL.) 25 DATE COMPLETED 3/23/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SP	**UNDOCUMENTED ARTIFICIAL FILL (afu)** Poorly-graded SAND with Silt, medium dense, dry, light olive brown; fine sand; micaceous; boulder encountered			
2								
4								
	B-10@5'				-Cobbles encountered. NO RECOVERY	27		
6								
					-Cobbles encountered			
8								
10	B-10@10'				-Becomes slightly moist	28	106.0	1.0
12								
14								
	B-10@15'				-Becomes dense, dry	55	100.9	0.9
16								
18								
20	B-10@20'			SP	**ALLUVIUM (Qa)** Poorly-graded SAND with Silt, dense, slightly moist, olive brown; fine sand; micaceous	75	105.6	3.0
22								
24								
	B-10@25'			ML	Sandy SILT, stiff, dry, olive brown; yellowish brown to olive brown MH in shoe	37	100.9	3.6
26								
28								

Figure A-10,
Log of Boring B-10, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

PROJECT NO. T2581-22-05

BORING B-10

ELEV. (MSL.) 25 DATE COMPLETED 3/23/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-10@30'				-Becomes very stiff, yellowish to olive brown; calcium carbonate deposits; trace mica	54	103.0	2.4
32								
34								
36	B-10@35'				-Becomes slightly moist, light olive brown	73	91.4	10.8
38								
40	B-10@40'				-Becomes dry; increase sand content	48	93.0	4.4
42								
44								
46	B-10@45'					64		
					Total Depth = 46.5' feet No Groundwater encountered Penetration resistance for 140-lb hammer falling 30 inches by auto hammer Backfilled with cuttings 3/23/2022			

Figure A-10,
Log of Boring B-10, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS

☐ ... SAMPLING UNSUCCESSFUL
◧ ... STANDARD PENETRATION TEST
■ ... DRIVE SAMPLE (UNDISTURBED)
⊠ ... DISTURBED OR BAG SAMPLE
◪ ... CHUNK SAMPLE
▼ ... WATER TABLE OR SEEPAGE

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GEOCON

BORING B-11

ELEV. (MSL.) 19 DATE COMPLETED 3/23/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SP	**UNDOCUMENTED ARTIFICIAL FILL (afu)** Poorly-graded SAND, medium dense, dry, light yellowish brown; fine sand with few medium and coarse sand; trace mica			
2								
4								
	B-11@5'				-Becomes slightly moist	11	95.9	1.0
6				SP	**ALLUVIUM (Qa)** Poorly-graded SAND, medium dense, slightly moist, light yellow to olive brown; fine sand; micaceous			
8								
10	B-11@10'			SP	Poorly-graded SAND with Silt, slightly moist, light olive brown; fine sand; micaceous	30	100.2	1.1
12								
14								
	B-11@15'					34	91.6	2.0
16								
18								
20	B-11@20'			ML	Sandy SILT, very stiff, dry, olive; fine sand; trace mica; trace pores; trace calcium carbonate deposits	57	99.7	3.0
22								
24								
	B-11@25'				-Decrease pores and sand	68	97.2	3.0
26								
28								

Figure A-11,
Log of Boring B-11, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

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BORING B-11

ELEV. (MSL.) 19 DATE COMPLETED 3/23/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-11@30'					72	98.5	4.2
32								
34								
	B-11@35'				-Becomes hard; trace pores	83-11"	100.3	4.6
36								
38								
40	B-11@40'			SP	Poorly-graded SAND, very dense, slightly moist, light olive brown; fine sand	79-11"	107.2	1.0
42								
44								
	B-11@45'			ML	Sandy SILT, hard, dry, light olive brown; fine sand	50-6"	87.0	2.9
46								

Total Depth = 46.5' feet
No Groundwater encountered
Penetration resistance for 140-lb hammer falling 30 inches by auto hammer
Backfilled with cuttings 3/23/2022

Figure A-11,
Log of Boring B-11, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
... SAMPLING UNSUCCESSFUL
... STANDARD PENETRATION TEST
... DRIVE SAMPLE (UNDISTURBED)
... DISTURBED OR BAG SAMPLE
... CHUNK SAMPLE
... WATER TABLE OR SEEPAGE

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PROJECT NO. T2581-22-05

BORING B-12

ELEV. (MSL.) 15 DATE COMPLETED 3/23/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0		SM	**UNDOCUMENTED ARTIFICIAL FILL (afu)** Silty SAND, loose, moist, brown; fine sand; trace mica; wood waste at surface			
4		SP	Poorly-graded SAND, meidium dense, moist, light olive brown; fine sand			
5	B-12@5'			29	100.2	1.6
6			-Becomes slightly moist			
10	B-12@10'	ML	Sandy SILT, stiff, slightly moist, light olive brown; fine sand; micaceous; porous	38	94.7	2.4
15	B-12@15'	ML	**ALLUVIUM (Qa)** Sandy SILT, very stiff, dry, olive brown; fine sand	66	101.5	2.8
20	B-12@20'			57	111.5	1.8
25	B-12@25'		-Becomes slightly moist	58	87.0	7.3

Figure A-12,
Log of Boring B-12, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

GEOCON

BORING B-12

ELEV. (MSL.) **15** DATE COMPLETED **3/23/2022**

EQUIPMENT **CME 75** BY: **A. Shoashekan**

DEPTH IN FEET	SAMPLE NO.	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-12@30'		-Becomes dry	57	95.0	4.9
32						
34						
	B-12@35'			85-11"	96.1	2.1
36		SP	Poorly-graded SAND, very dense, slightly moist, light yellow to olive brown; fine sand			
38						
40	B-12@40'	ML	Sandy SILT, very stiff, dry, light olive brown; fine sand; trace mica	74	99.2	2.5
42						
44						
	B-12@45'		-Becomes light olive gray	62	97.8	1.5
46						

Total Depth = 46.5' feet
No Groundwater encountered
Penetration resistance for 140-lb hammer falling 30 inches by auto hammer
Backfilled with cuttings 3/23/2022

Figure A-12,
Log of Boring B-12, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

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BORING B-13

ELEV. (MSL.) **10** DATE COMPLETED **3/23/2022**

EQUIPMENT **CME 75** BY: **A. Shoashekan**

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SP	**ALLUVIUM (Qa)** Poorly-graded SAND, meidium dense, dry, light olive brown; fine sand; trace mica			
5	B-13@5'			ML	Sandy SILT, very stiff, slightly moist, light yellow brown to olive brown; fine sand; calcium carbonate stringers	51	105.6	6.7
10	B-13@10'				-Becomes micaceous; trace oxidized staining	51		
15	B-13@15'					55	94.6	6.5
20	B-13@20'				-Becomes hard	62-11"		
25	B-13@25'			SP	Poorly-graded SAND, dense, dry, light yellow brown; fine sand	69	107.0	0.9

Figure A-13,
Log of Boring B-13, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS			
	☐ ... SAMPLING UNSUCCESSFUL	◧ ... STANDARD PENETRATION TEST	■ ... DRIVE SAMPLE (UNDISTURBED)
	⊠ ... DISTURBED OR BAG SAMPLE	◪ ... CHUNK SAMPLE	▼ ... WATER TABLE OR SEEPAGE

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PROJECT NO. T2581-22-05

BORING B-13

ELEV. (MSL.) 10 DATE COMPLETED 3/23/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-13@30'					65		
35	B-13@35'			ML	Sandy SILT, hard, slightly moist, light olive brown; fine sand	77-12"	90.6	6.0
40	B-13@40'					73-11"	93.6	6.9
45	B-13@45'					68		
					Total Depth = 46.5' feet No Groundwater encountered Penetration resistance for 140-lb hammer falling 30 inches by auto hammer Backfilled with cuttings 3/23/2022			

Figure A-13,
Log of Boring B-13, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

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GEOCON

BORING B-14

ELEV. (MSL.) 18 DATE COMPLETED 3/23/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				ML	**UNDOCUMENTED ARTIFICIAL FILL (afu)** Silty SAND, stiff, dry, light olive brown; fine sand			
5	B-14@5' B-14@5-10'			SP	Poorly-graded SAND with Silt, meidium dense, slightly moist, light olive brown; fine sand; trace mica	47	103.0	1.0
10	B-14@10'				-Becomes dense	52	98.1	12.8
11				SP	**ALLUVIUM (Qa)** Poorly-graded SAND with Silt, dense, moist, light olive brown; fine sand; micaceous			
15	B-14@15'				-Becomes medium dense, slightly moist	46	97.8	2.6
20	B-14@20'			ML	Sandy SILT, stiff, dry, light yellow brown; fine sand; trace mica	47	101.7	1.8
25	B-14@25'			SP	Poorly-graded SAND, dense, slightly moist, light yellow to olive brown; fine sand	56	98.9	1.2

Figure A-14,
Log of Boring B-14, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS			
	... SAMPLING UNSUCCESSFUL	... STANDARD PENETRATION TEST	... DRIVE SAMPLE (UNDISTURBED)
	... DISTURBED OR BAG SAMPLE	... CHUNK SAMPLE	... WATER TABLE OR SEEPAGE

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PROJECT NO. T2581-22-05

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	BORING B-14 ELEV. (MSL.) 18 DATE COMPLETED 3/23/2022 EQUIPMENT CME 75 BY: A. Shoashekan MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-14@30'			MH	Elastic SILT, hard, dry, light yellow to olive brown; trace pores	82-11"	91.6	4.6
32								
34								
	B-14@35'			SP	Poorly-graded SAND, dense, slightly moist, light yellow to olive brown; fine sand	70	97.8	1.1
36								
38								
40	B-14@40'			SP	Poorly-graded SAND with silt, dense, slightly moist, light olive brown; fine sand	65	97.7	1.7
42								
44								
	B-14@45'			ML	Sandy SILT, very stiff, slightly moist, yellow brown; fine sand	66		
46								

Total Depth = 46.5' feet
No Groundwater encountered
Penetration resistance for 140-lb hammer falling 30 inches by auto hammer
Backfilled with cuttings 3/23/2022

Figure A-14,
Log of Boring B-14, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

PROJECT NO. T2581-22-05

BORING B-15

ELEV. (MSL.) 21 DATE COMPLETED 3/23/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
0				SP	**UNDOCUMENTED ARTIFICIAL FILL (afu)** Poorly-graded SAND with Silt, medium dense, dry, light olive brown; fine sand			
5	B-15@5'				-Becomes slightly moist; trace mica	23	101.3	1.8
10	B-15@10'					18	99.4	1.2
15	B-15@15'			SP	Poorly-graded SAND, medium dense, slightly moist, light olive to grayish brown; fine sand; trace mica	37	103.9	1.0
20	B-15@20'			ML	**ALLUVIUM (Qa)** Sandy SILT, stiff, slightly moist, light yellow to olive brown; fine sand; trace mica; trace calcium deposits	30	87.1	9.4
25	B-15@25'				-Becomes moist; porous; decrease sand content	35	102.5	17.5

Figure A-15,
Log of Boring B-15, Page 1 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS

... SAMPLING UNSUCCESSFUL ... STANDARD PENETRATION TEST ... DRIVE SAMPLE (UNDISTURBED)

... DISTURBED OR BAG SAMPLE ... CHUNK SAMPLE ... WATER TABLE OR SEEPAGE

NOTE: THE LOG OF SUBSURFACE CONDITIONS SHOWN HEREON APPLIES ONLY AT THE SPECIFIC BORING OR TRENCH LOCATION AND AT THE DATE INDICATED. IT IS NOT WARRANTED TO BE REPRESENTATIVE OF SUBSURFACE CONDITIONS AT OTHER LOCATIONS AND TIMES.

GEOCON

BORING B-15

ELEV. (MSL.) 21 DATE COMPLETED 3/23/2022

EQUIPMENT CME 75 BY: A. Shoashekan

DEPTH IN FEET	SAMPLE NO.	LITHOLOGY	GROUNDWATER	SOIL CLASS (USCS)	MATERIAL DESCRIPTION	PENETRATION RESISTANCE (BLOWS/FT.)	DRY DENSITY (P.C.F.)	MOISTURE CONTENT (%)
30	B-15@30'				-Becomes light olive to grayish brown	36		
32								
34								
36	B-15@35'				-Becomes slightly moist	30	91.5	11.6
38								
40	B-15@40'				-Becomes moist, olive brown	39	85.1	16.3
42								
44								
46	B-15@45'					37		

Total Depth = 46.5' feet
No Groundwater encountered
Penetration resistance for 140-lb hammer falling 30 inches by auto hammer
Backfilled with cuttings 3/23/2022

Figure A-15,
Log of Boring B-15, Page 2 of 2

T2581-22-05 BORING LOGS.GPJ

SAMPLE SYMBOLS
- ... SAMPLING UNSUCCESSFUL
- ... STANDARD PENETRATION TEST
- ... DRIVE SAMPLE (UNDISTURBED)
- ... DISTURBED OR BAG SAMPLE
- ... CHUNK SAMPLE
- ... WATER TABLE OR SEEPAGE

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APPENDIX B

APPENDIX B

LABORATORY TESTING

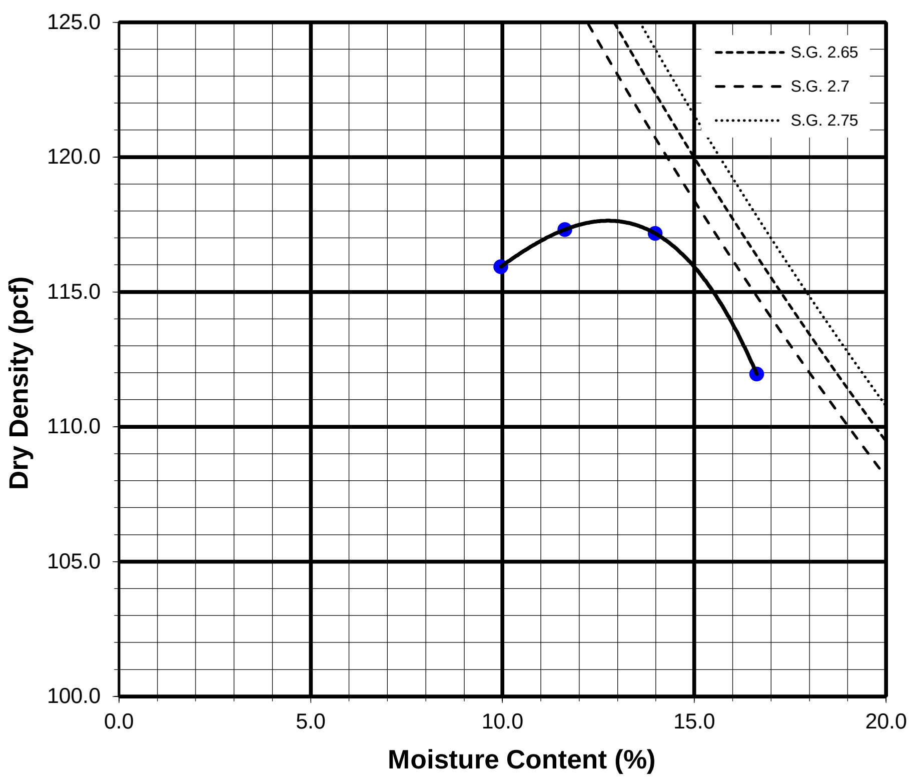
We performed laboratory testing in accordance with current, generally accepted test methods of ASTM International (ASTM) or other suggested procedures. We analyzed selected soil samples for in-situ density and moisture content, maximum dry density and optimum moisture content, expansion index, grain size distribution, consolidation characteristics, direct shear strength, and hydraulic conductivity. The results of the laboratory tests are presented on Figures B-1 through B-46. The in-place dry density and moisture content of the samples tested are presented on the boring logs in *Appendix A*.

Sample No:

B1@0-5'	Silty SAND (SM), olive gray

TEST NO.		1	2	3	4	5	6
Wt. Compacted Soil + Mold	(g)	6246	6200	6252	6291		
Weight of Mold	(g)	4274	4274	4274	4274		
Net Weight of Soil	(g)	1972	1926	1978	2017		
Wet Weight of Soil + Cont.	(g)	597.8	602.2	636.2	597.8		1257.5
Dry Weight of Soil + Cont.	(g)	549.1	570.8	596.7	556.3		1236.7
Weight of Container	(g)	256.2	255.5	257.0	259.4		254.5
Moisture Content	(%)	16.6	10.0	11.6	14.0		2.1
Wet Density	(pcf)	130.6	127.5	131.0	133.5		
Dry Density	(pcf)	112.0	115.9	117.3	117.2		0.0

Maximum Dry Density (pcf)	119.5	Optimum Moisture Content (%)	13.0



Preparation Method: A

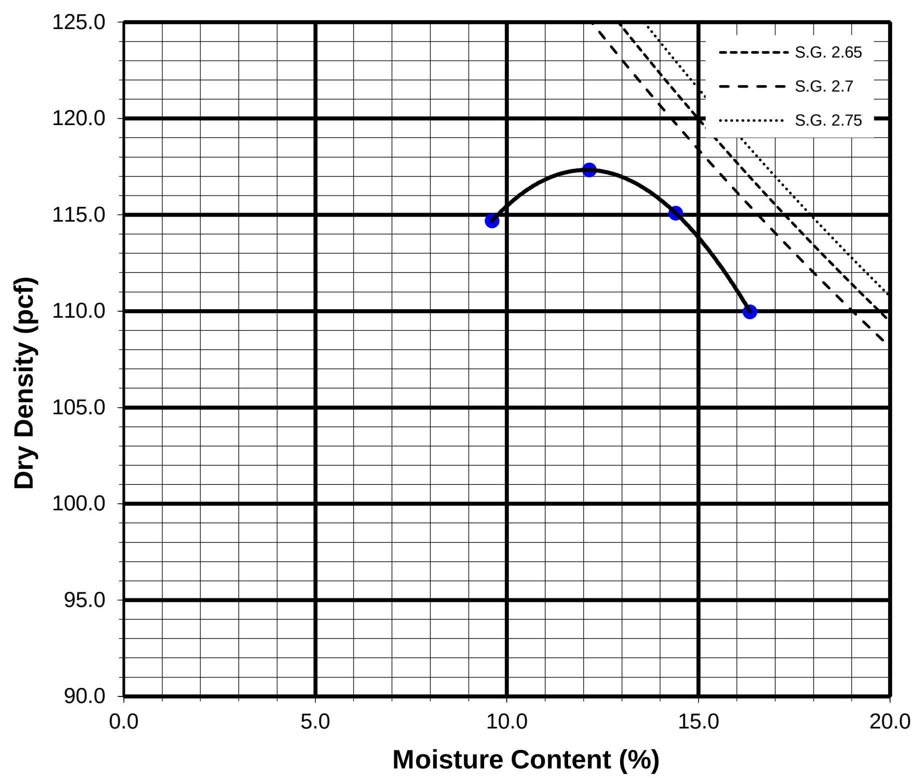
GEOCON	**MODIFIED COMPACTION TEST OF SOILS** ASTM D-1557	Project No.:	T2581-22-04
		Thousand Palms Channel Coachella Valley Water District Indio, California	
	Checked by: ATS	November 2020	Figure B-1

Sample No:

B3@5-10'	Silty SAND (SM), gray

TEST NO.		1	2	3	4	5	6
Wt. Compacted Soil + Mold	(g)	6207	6173	6263	6262		
Weight of Mold	(g)	4274	4274	4274	4274		
Net Weight of Soil	(g)	1933	1899	1989	1988		
Wet Weight of Soil + Cont.	(g)	620.0	585.7	642.9	651.1		1333.5
Dry Weight of Soil + Cont.	(g)	569.1	557.0	594.5	608.5		1310.7
Weight of Container	(g)	257.7	258.4	258.6	258.0		257.8
Moisture Content	(%)	16.3	9.6	14.4	12.2		2.2
Wet Density	(pcf)	127.9	125.7	131.7	131.6		
Dry Density	(pcf)	110.0	114.7	115.1	117.3		0.0

Maximum Dry Density (pcf)	118.0	Optimum Moisture Content (%)	13.0



Preparation Method: A

MODIFIED COMPACTION TEST OF SOILS

ASTM D-1557

Checked by: ATS

GEOCON

Project No.: T2581-22-04

Thousand Palms Channel
Coachella Valley Water District
Indio, California

November 2020

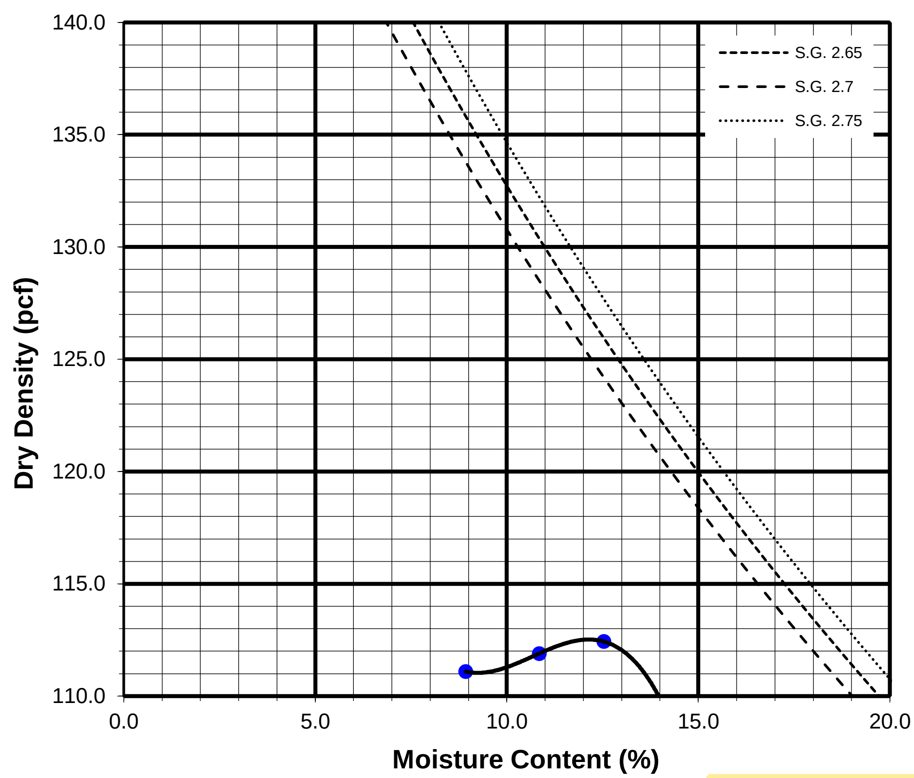
Figure B-2

Sample No:

B-8@5-10	Poorly Graded SAND (SP), light yellowish brown

TEST NO.		1	2	3	4	5	6
Wt. Compacted Soil + Mold	(g)	6130	6095	6141	6178		
Weight of Mold	(g)	4267	4267	4267	4267		
Net Weight of Soil	(g)	1863	1828	1874	1911		
Wet Weight of Soil + Cont.	(g)	699.0	708.4	702.4	704.0		1318.5
Dry Weight of Soil + Cont.	(g)	642.2	671.3	658.8	654.2		1308.2
Weight of Container	(g)	252.4	255.6	256.8	256.9		257.9
Moisture Content	(%)	14.6	8.9	10.8	12.5		1.0
Wet Density	(pcf)	123.3	121.0	124.0	126.5		
Dry Density	(pcf)	107.6	111.1	111.9	112.4		0.0

Maximum Dry Density (pcf)	113.0	Optimum Moisture Content (%)	12.0



NEED AXIS ADJUSTED

Preparation Method: A

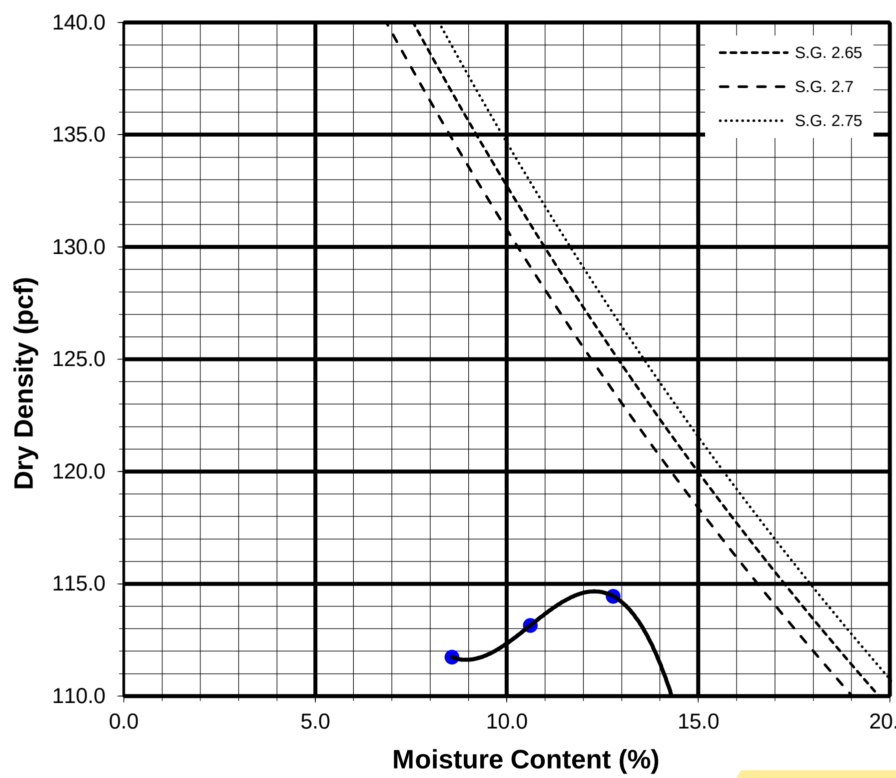
GEOCON	COMPACTION CHARACTERISTICS USING MODIFIED EFFORT TEST RESULTS ASTM D-1557 Checked by:	Project No.: T2581-22-05 Thousand Palms Channel Coachella Valley Water District Indio, California JUNE 2022 Figure B-3

Sample No:

B-14@5-10	Poorly Graded SAND with Silt (SP-SM), light gray

TEST NO.		1	2	3	4	5	6
Wt. Compacted Soil + Mold	(g)	6158	6217	6149	6100		
Weight of Mold	(g)	4267	4267	4267	4267		
Net Weight of Soil	(g)	1891	1950	1882	1832		
Wet Weight of Soil + Cont.	(g)	716.8	718.9	715.7	710.8		1278.0
Dry Weight of Soil + Cont.	(g)	672.8	666.7	657.3	674.8		1268.2
Weight of Container	(g)	258.3	258.1	255.2	254.5		258.3
Moisture Content	(%)	10.6	12.8	14.5	8.6		1.0
Wet Density	(pcf)	125.2	129.1	124.6	121.3		
Dry Density	(pcf)	113.1	114.4	108.8	111.7		0.0

Maximum Dry Density (pcf)	114.5	Optimum Moisture Content (%)	12.5



NEED AXIS ADJUSTED

Preparation Method: A

GEOCON

COMPACTION CHARACTERISTICS USING MODIFIED EFFORT TEST RESULTS

ASTM D-1557

Checked by:

Project No.: T2581-22-05

Thousand Palms Channel
Coachella Valley Water District
Indio, California

JUNE 2022

Figure B-4

B1@0-5'

MOLDED SPECIMEN		BEFORE TEST	AFTER TEST
Specimen Diameter	(in.)	4.0	4.0
Specimen Height	(in.)	1.0	1.0
Wt. Comp. Soil + Mold	(gm)	564.0	611.5
Wt. of Mold	(gm)	198.3	198.3
Specific Gravity	(Assumed)	2.7	2.7
Wet Wt. of Soil + Cont.	(gm)	554.5	611.5
Dry Wt. of Soil + Cont.	(gm)	520.0	323.6
Wt. of Container	(gm)	254.5	198.3
Moisture Content	(%)	13.0	27.7
Wet Density	(pcf)	110.3	124.5
Dry Density	(pcf)	97.6	97.5
Void Ratio		0.7	0.8
Total Porosity		0.4	0.4
Pore Volume	(cc)	87.1	94.1
Degree of Saturation	(%) [S_{meas}]	48.7	95.2

Date	Time	Pressure (psi)	Elapsed Time (min)	Dial Readings (in.)
10/12/2020	10:00	1.0	0	0.3376
10/12/2020	10:10	1.0	10	0.3365
Add Distilled Water to the Specimen				
10/13/2020	10:00	1.0	1430	0.3703
10/13/2020	11:00	1.0	1490	0.3703

Expansion Index (EI meas) =	33.8
Expansion Index (Report) =	**34**

Expansion Index, EI_{50}	CBC CLASSIFICATION *	UBC CLASSIFICATION **
0-20	Non-Expansive	Very Low
21-50	Expansive	Low
51-90	Expansive	Medium
91-130	Expansive	High
>130	Expansive	Very High

* Reference: 2019 California Building Code, Section 1803.5.3

** Reference: 1997 Uniform Building Code, Table 18-I-B.

GEOCON

EXPANSION INDEX TEST RESULTS

ASTM D-4829

Checked by: ATS

Project No.: T2581-22-04

Thousand Palms Channel
Coachella Valley Water District
Indio, California

November 2020

Figure B-5

B2@5-10'

MOLDED SPECIMEN		BEFORE TEST	AFTER TEST
Specimen Diameter	(in.)	4.0	4.0
Specimen Height	(in.)	1.0	1.0
Wt. Comp. Soil + Mold	(gm)	583.8	612.7
Wt. of Mold	(gm)	195.2	195.2
Specific Gravity	(Assumed)	2.7	2.7
Wet Wt. of Soil + Cont.	(gm)	558.6	612.7
Dry Wt. of Soil + Cont.	(gm)	528.9	350.1
Wt. of Container	(gm)	258.6	195.2
Moisture Content	(%)	11.0	19.3
Wet Density	(pcf)	117.2	125.8
Dry Density	(pcf)	105.6	105.5
Void Ratio		0.6	0.6
Total Porosity		0.4	0.4
Pore Volume	(cc)	77.3	77.6
Degree of Saturation	(%) [S_{meas}]	50.2	86.9

Date	Time	Pressure (psi)	Elapsed Time (min)	Dial Readings (in.)
10/12/2020	10:00	1.0	0	0.343
10/12/2020	10:10	1.0	10	0.3429
Add Distilled Water to the Specimen				
10/13/2020	10:00	1.0	1430	0.344
10/13/2020	11:00	1.0	1490	0.344

Expansion Index (EI meas) =	1.1
Expansion Index (Report) =	**1**

Expansion Index, EI_{50}	CBC CLASSIFICATION *	UBC CLASSIFICATION **
0-20	Non-Expansive	Very Low
21-50	Expansive	Low
51-90	Expansive	Medium
91-130	Expansive	High
>130	Expansive	Very High

* Reference: 2019 California Building Code, Section 1803.5.3

** Reference: 1997 Uniform Building Code, Table 18-I-B.

GEOCON

EXPANSION INDEX TEST RESULTS

ASTM D-4829

Checked by: ATS

Project No.: T2581-22-04

Thousand Palms Channel
Coachella Valley Water District
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Figure B-6

B3@5-10'

MOLDED SPECIMEN		BEFORE TEST	AFTER TEST
Specimen Diameter	(in.)	4.0	4.0
Specimen Height	(in.)	1.0	1.0
Wt. Comp. Soil + Mold	(gm)	579.7	611.9
Wt. of Mold	(gm)	196.7	196.7
Specific Gravity	(Assumed)	2.7	2.7
Wet Wt. of Soil + Cont.	(gm)	557.8	611.9
Dry Wt. of Soil + Cont.	(gm)	528.1	345.0
Wt. of Container	(gm)	257.8	196.7
Moisture Content	(%)	11.0	20.3
Wet Density	(pcf)	115.5	125.1
Dry Density	(pcf)	104.1	103.9
Void Ratio		0.6	0.6
Total Porosity		0.4	0.4
Pore Volume	(cc)	79.2	79.9
Degree of Saturation	(%) [S_{meas}]	48.3	87.8

Date	Time	Pressure (psi)	Elapsed Time (min)	Dial Readings (in.)
10/12/2020	10:00	1.0	0	0.3643
10/12/2020	10:10	1.0	10	0.3642
Add Distilled Water to the Specimen				
10/13/2020	10:00	1.0	1430	0.3675
10/13/2020	11:00	1.0	1490	0.3675

Expansion Index (EI meas) =	3.3
Expansion Index (Report) =	**3**

Expansion Index, EI_{50}	CBC CLASSIFICATION *	UBC CLASSIFICATION **
0-20	Non-Expansive	Very Low
21-50	Expansive	Low
51-90	Expansive	Medium
91-130	Expansive	High
>130	Expansive	Very High

* Reference: 2019 California Building Code, Section 1803.5.3

** Reference: 1997 Uniform Building Code, Table 18-I-B.

GEOCON

EXPANSION INDEX TEST RESULTS

ASTM D-4829

Checked by: ATS

Project No.: T2581-22-04

Thousand Palms Channel
Coachella Valley Water District
Indio, California

November 2020 Figure B-7

B4@0-5'

MOLDED SPECIMEN		BEFORE TEST	AFTER TEST
Specimen Diameter	(in.)	4.0	4.0
Specimen Height	(in.)	1.0	1.0
Wt. Comp. Soil + Mold	(gm)	579.7	607.2
Wt. of Mold	(gm)	196.7	196.7
Specific Gravity	(Assumed)	2.7	2.7
Wet Wt. of Soil + Cont.	(gm)	557.6	607.2
Dry Wt. of Soil + Cont.	(gm)	527.9	345.0
Wt. of Container	(gm)	257.6	196.7
Moisture Content	(%)	11.0	19.0
Wet Density	(pcf)	115.5	123.7
Dry Density	(pcf)	104.1	103.9
Void Ratio		0.6	0.6
Total Porosity		0.4	0.4
Pore Volume	(cc)	79.2	80.6
Degree of Saturation	(%) [S_{meas}]	48.3	81.2

Date	Time	Pressure (psi)	Elapsed Time (min)	Dial Readings (in.)
10/12/2020	10:00	1.0	0	0.3651
10/12/2020	10:10	1.0	10	0.365
Add Distilled Water to the Specimen				
10/13/2020	10:00	1.0	1430	0.3719
10/13/2020	11:00	1.0	1490	0.3719

Expansion Index (EI meas) =	6.9
Expansion Index (Report) =	**7**

Expansion Index, EI_{50}	CBC CLASSIFICATION *	UBC CLASSIFICATION **
0-20	Non-Expansive	Very Low
21-50	Expansive	Low
51-90	Expansive	Medium
91-130	Expansive	High
>130	Expansive	Very High

* Reference: 2019 California Building Code, Section 1803.5.3

** Reference: 1997 Uniform Building Code, Table 18-I-B.

GEOCON

EXPANSION INDEX TEST RESULTS

ASTM D-4829

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Project No.: T2581-22-04

Thousand Palms Channel
Coachella Valley Water District
Indio, California

November 2020

Figure B-8

B5@5-10

MOLDED SPECIMEN		BEFORE TEST	AFTER TEST
Specimen Diameter	(in.)	4.0	4.0
Specimen Height	(in.)	1.0	1.0
Wt. Comp. Soil + Mold	(gm)	566.6	603.8
Wt. of Mold	(gm)	196.5	196.5
Specific Gravity	(Assumed)	2.7	2.7
Wet Wt. of Soil + Cont.	(gm)	556.9	603.8
Dry Wt. of Soil + Cont.	(gm)	522.4	327.5
Wt. of Container	(gm)	256.9	196.5
Moisture Content	(%)	13.0	24.4
Wet Density	(pcf)	111.6	122.7
Dry Density	(pcf)	98.8	98.7
Void Ratio		0.7	0.8
Total Porosity		0.4	0.4
Pore Volume	(cc)	85.7	91.4
Degree of Saturation	(%) [S_{meas}]	50.1	87.3

Date	Time	Pressure (psi)	Elapsed Time (min)	Dial Readings (in.)
4/13/2022	10:00	1.0	0	0.3531
4/13/2022	10:10	1.0	10	0.3524
Add Distilled Water to the Specimen				
4/14/2022	10:00	1.0	1430	0.3798
4/14/2022	11:00	1.0	1490	0.3798

Expansion Index (EI meas) =	27.4
Expansion Index (Report) =	**27**

Expansion Index, EI_{50}	CBC CLASSIFICATION *	UBC CLASSIFICATION **
0-20	Non-Expansive	Very Low
21-50	Expansive	Low
51-90	Expansive	Medium
91-130	Expansive	High
>130	Expansive	Very High

* Reference: 2019 California Building Code, Section 1803.5.3

** Reference: 1997 Uniform Building Code, Table 18-I-B.

GEOCON

EXPANSION INDEX TEST RESULTS

ASTM D-4829

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Thousand Palms Channel
Coachella Valley Water District
Indio, California

JUNE 2022

Figure B-9

B13@5-10

MOLDED SPECIMEN		BEFORE TEST	AFTER TEST
Specimen Diameter	(in.)	4.0	4.0
Specimen Height	(in.)	1.0	1.0
Wt. Comp. Soil + Mold	(gm)	579.6	616.0
Wt. of Mold	(gm)	195.1	195.1
Specific Gravity	(Assumed)	2.7	2.7
Wet Wt. of Soil + Cont.	(gm)	557.9	616.0
Dry Wt. of Soil + Cont.	(gm)	525.8	343.3
Wt. of Container	(gm)	257.9	195.1
Moisture Content	(%)	12.0	22.6
Wet Density	(pcf)	116.0	126.8
Dry Density	(pcf)	103.6	103.4
Void Ratio		0.6	0.7
Total Porosity		0.4	0.4
Pore Volume	(cc)	79.8	84.5
Degree of Saturation	(%) [S_{meas}]	52.0	91.9

Date	Time	Pressure (psi)	Elapsed Time (min)	Dial Readings (in.)
4/13/2022	10:00	1.0	0	0.3431
4/13/2022	10:10	1.0	10	0.3429
Add Distilled Water to the Specimen				
4/14/2022	10:00	1.0	1430	0.3652
4/14/2022	11:00	1.0	1490	0.3652

Expansion Index (EI meas) =	22.3
Expansion Index (Report) =	**22**

Expansion Index, EI_{50}	CBC CLASSIFICATION *	UBC CLASSIFICATION **
0-20	Non-Expansive	Very Low
21-50	Expansive	Low
51-90	Expansive	Medium
91-130	Expansive	High
>130	Expansive	Very High

* Reference: 2019 California Building Code, Section 1803.5.3
** Reference: 1997 Uniform Building Code, Table 18-I-B.

GEOCON

EXPANSION INDEX TEST RESULTS

ASTM D-4829

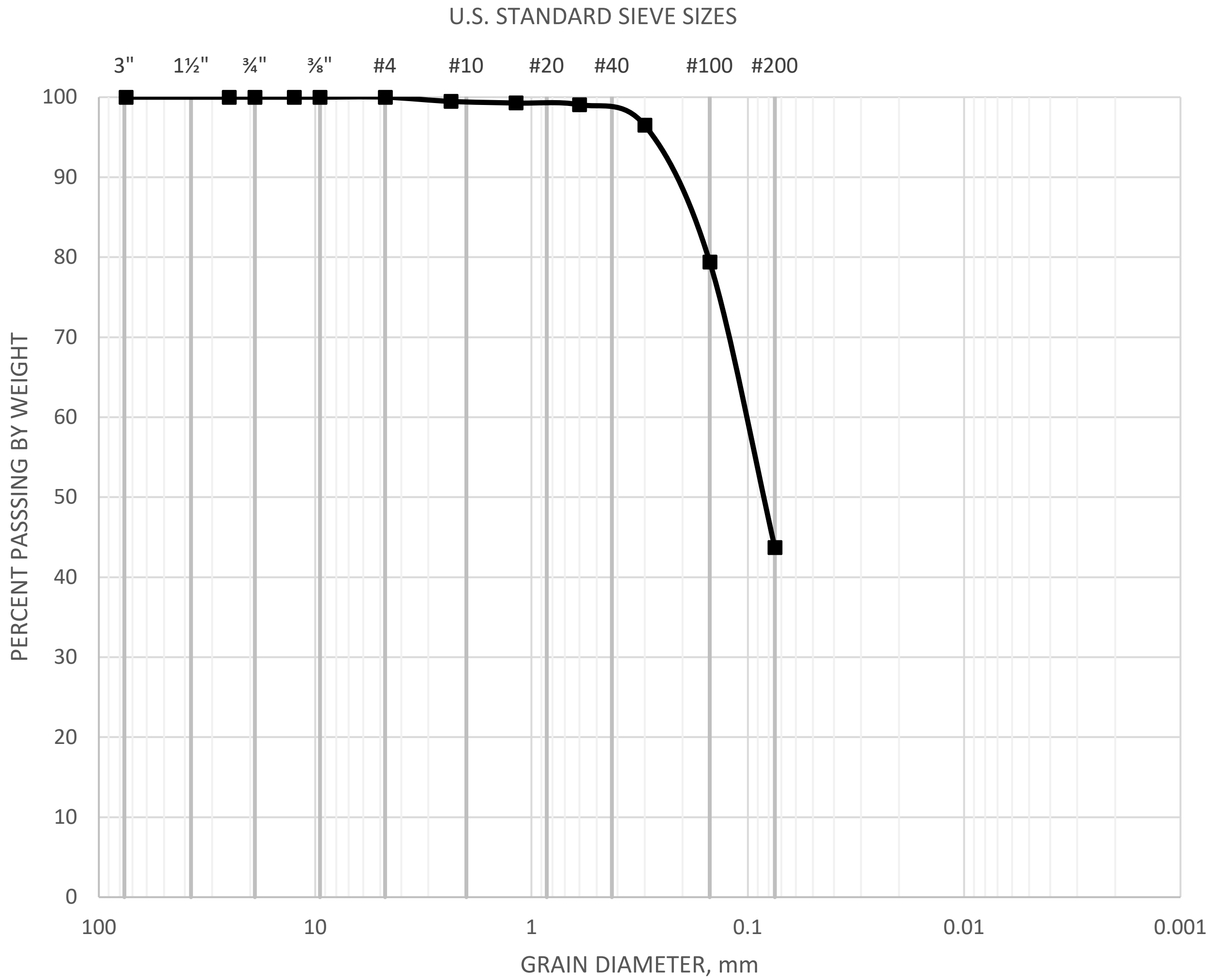
Checked by:

Project No.: T2581-22-05

Thousand Palms Channel
Coachella Valley Water District
Indio, California

JUNE 2022 Figure B-10

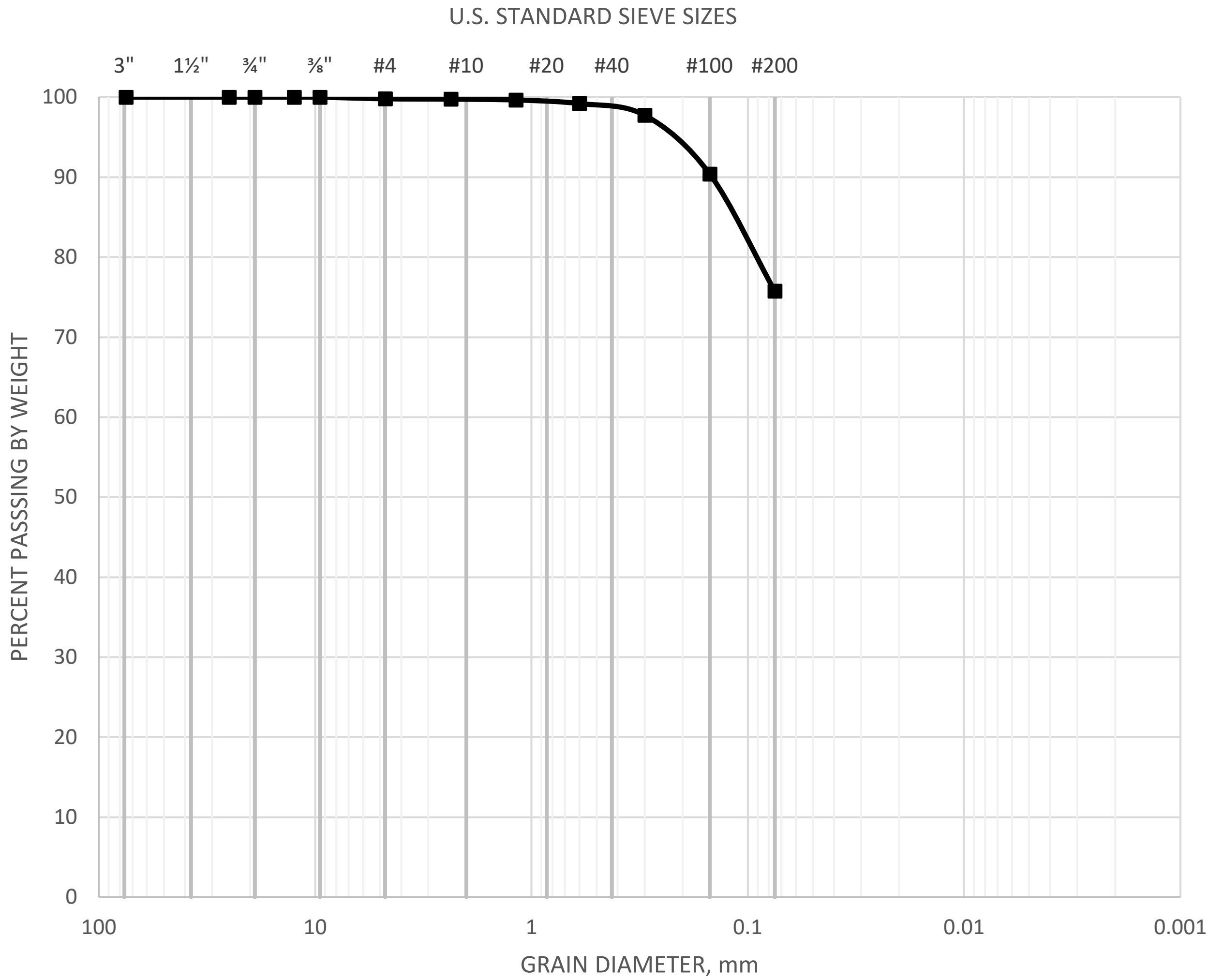
GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B1@2.5'	silty SAND (SM), olive gray			

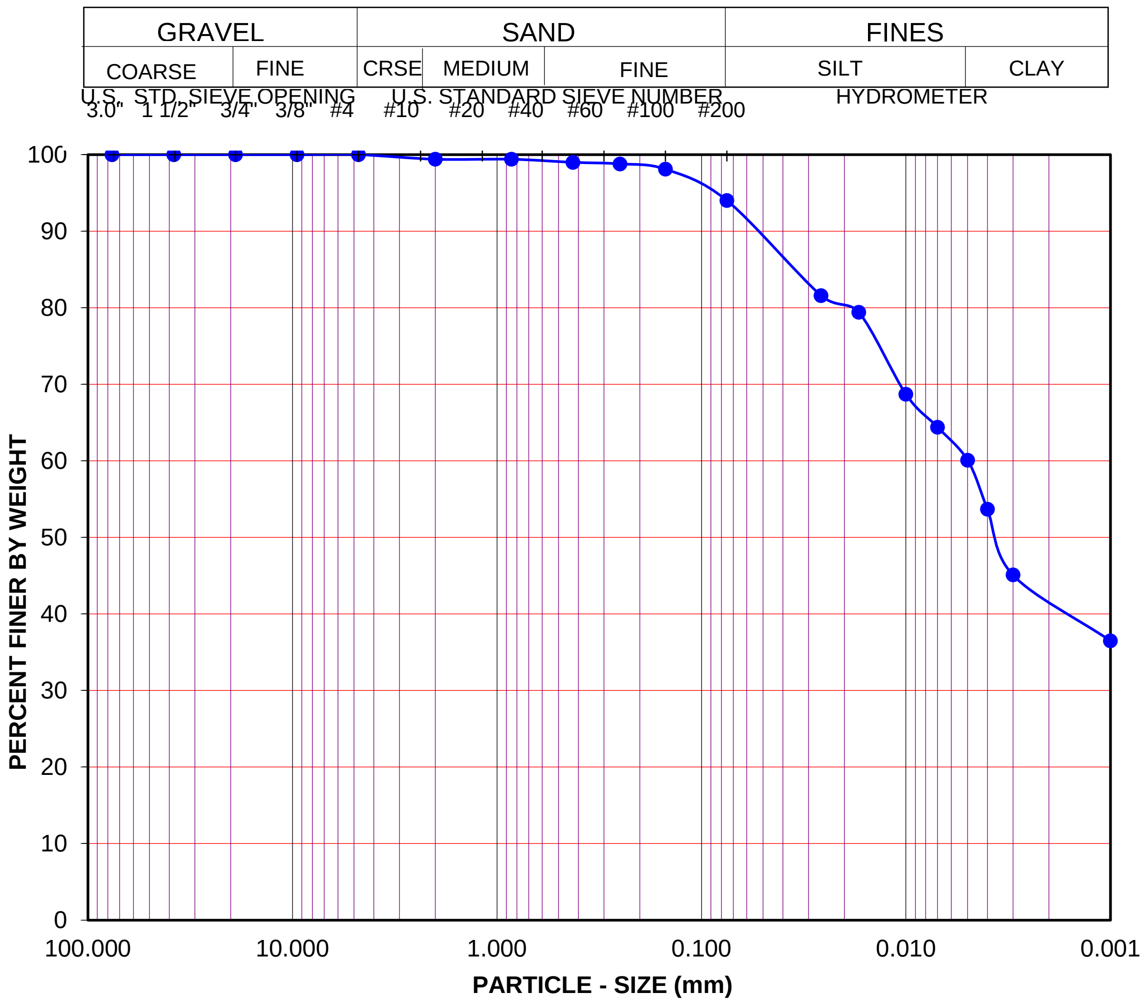
GEOCON	**GRAIN SIZE DISTRIBUTION** ASTM D-422 Checked by: ATS	Project No.: T2581-22-04 Thousand Palms Channel Coachella Valley Water District Indio, California November 2020 Figure B-11

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B1@10'	Sandy SILT (ML), olive gray			

GEOCON	**GRAIN SIZE DISTRIBUTION**	Project No.: T2581-22-04
	ASTM D-422	Thousand Palms Channel Coachella Valley Water District Indio, California
	Checked by: ATS	November 2020 Figure B-12



Boring No.	Sample No.	Depth (ft.)	Soil Type		
B1	B1@10'	10	CL-ML		

Sample Description:
Silty CLAY (CL-ML)

Project No.: T2581-22-04
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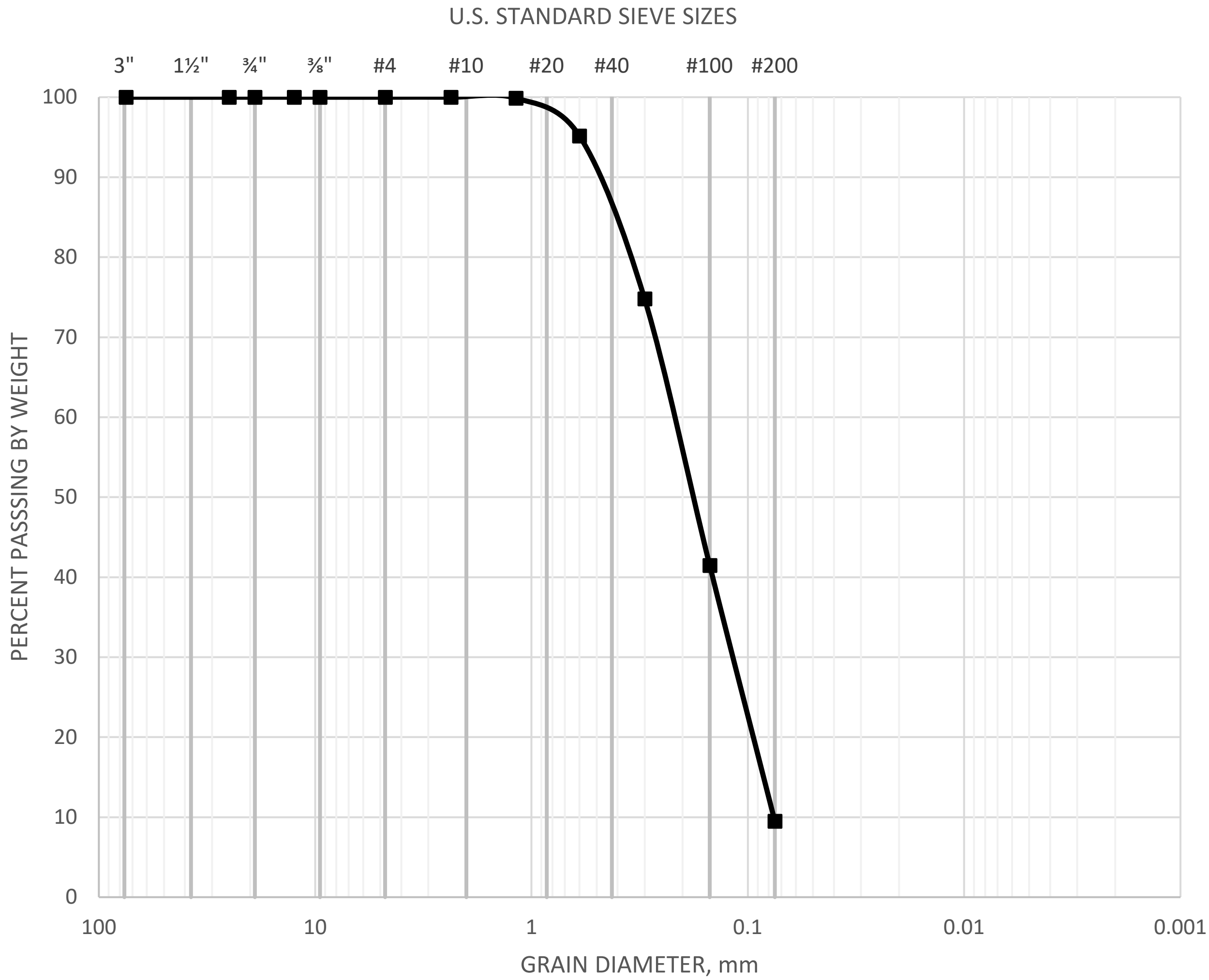
Indio, California

PARTICLE-SIZE CURVE (HYDROMETER)
ASTM D 4318, D 422

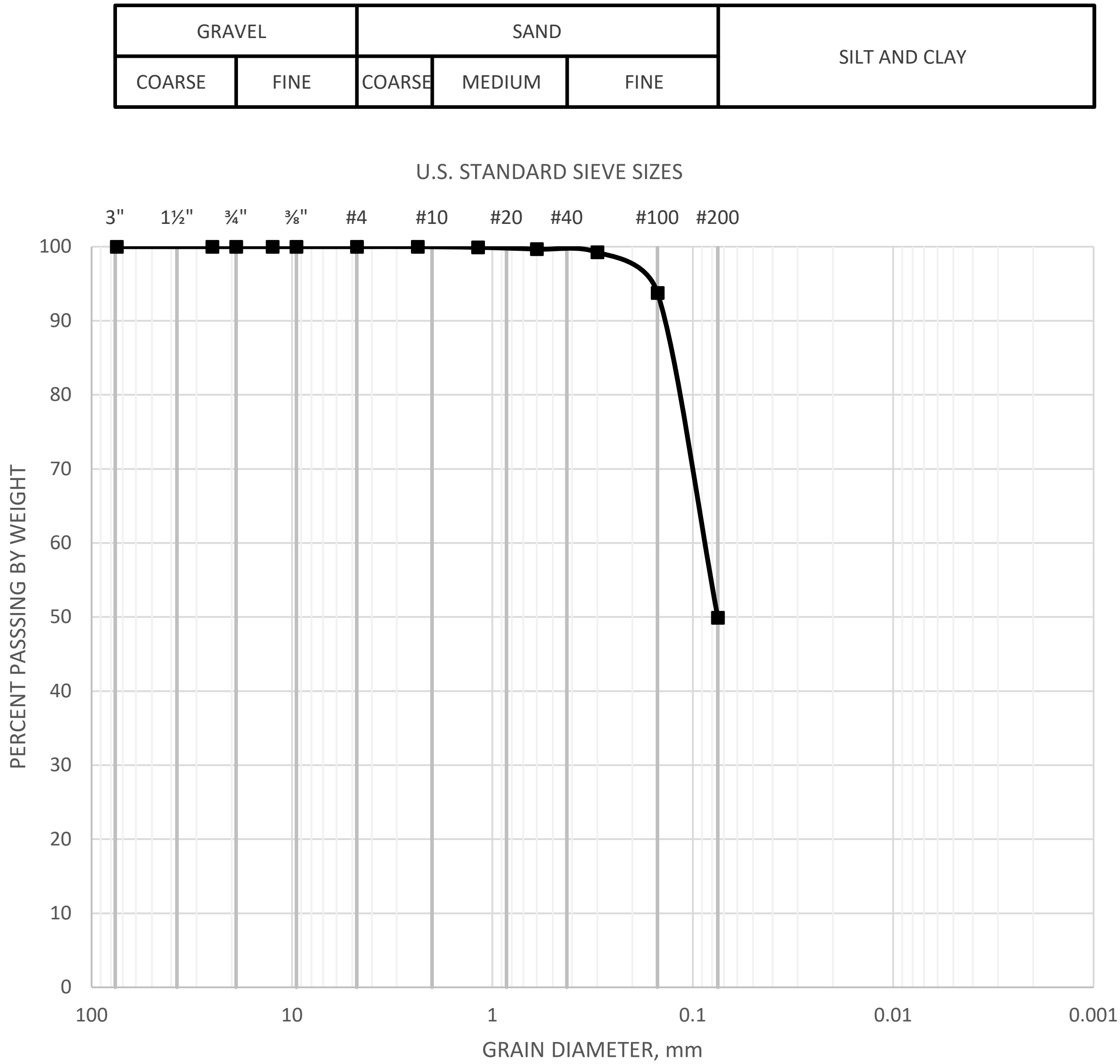
Figure B-13

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B2@2.5'	poorly-graded SAND with silt (SP-SM), grayish brown	0.22	0.12	0.075

GEOCON	**GRAIN SIZE DISTRIBUTION** ASTM D-422	Project No.: T2581-22-04
	Checked by: ATS	Thousand Palms Channel Coachella Valley Water District Indio, California
		November 2020 — Figure B-14



SAMPLE	CLASSIFICATION	D60	D30	D10
B2@5'	Silty SAND (SM), olive gray	0.09		

GEOCON

GRAIN SIZE DISTRIBUTION

ASTM D-422

Checked by: ATS

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Thousand Palms Channel
Coachella Valley Water District
Indio, California

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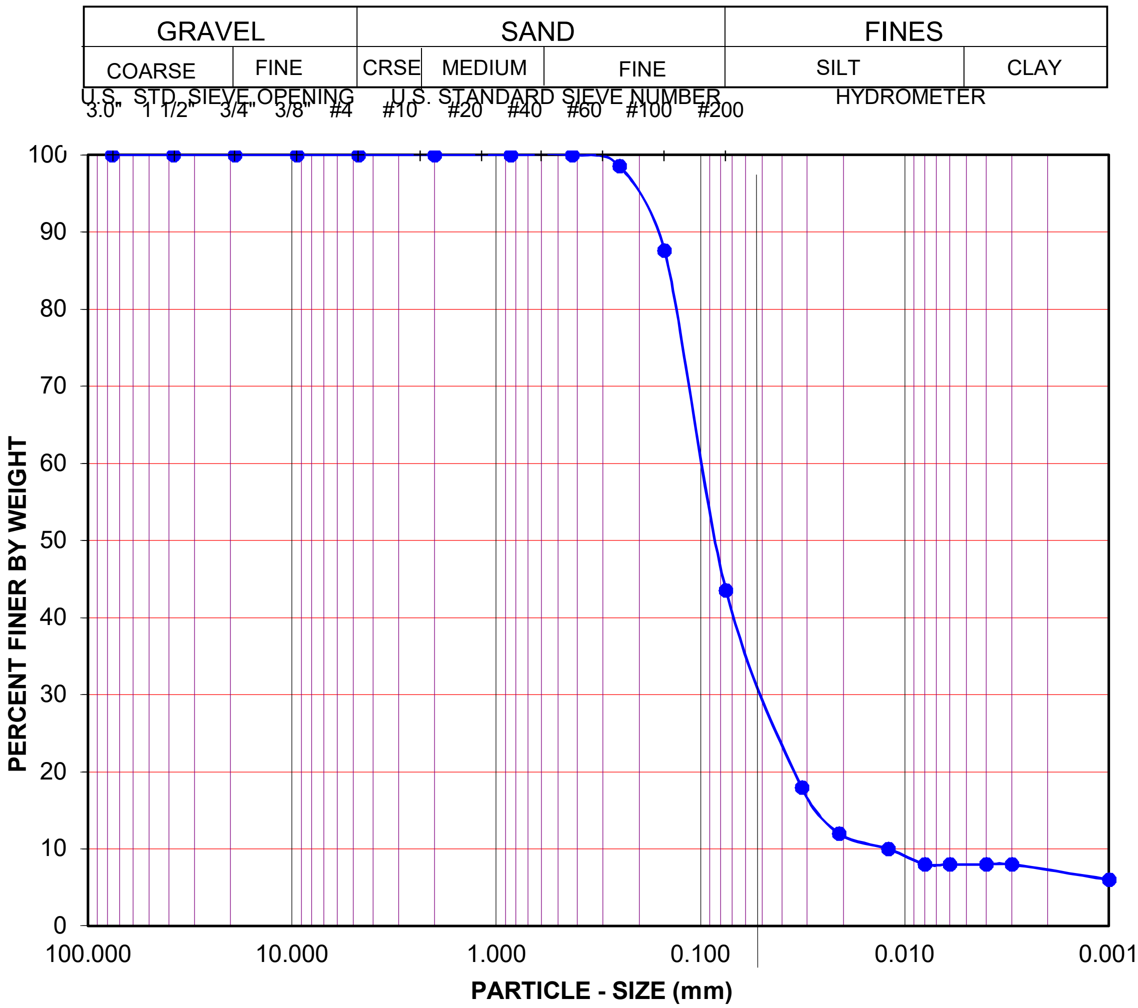
Figure B-15



Boring No.	Sample No.	Depth (ft.)	Soil Type		
B2	B2@5'	5'	SM		

Sample Description:
Silty SAND (SM)

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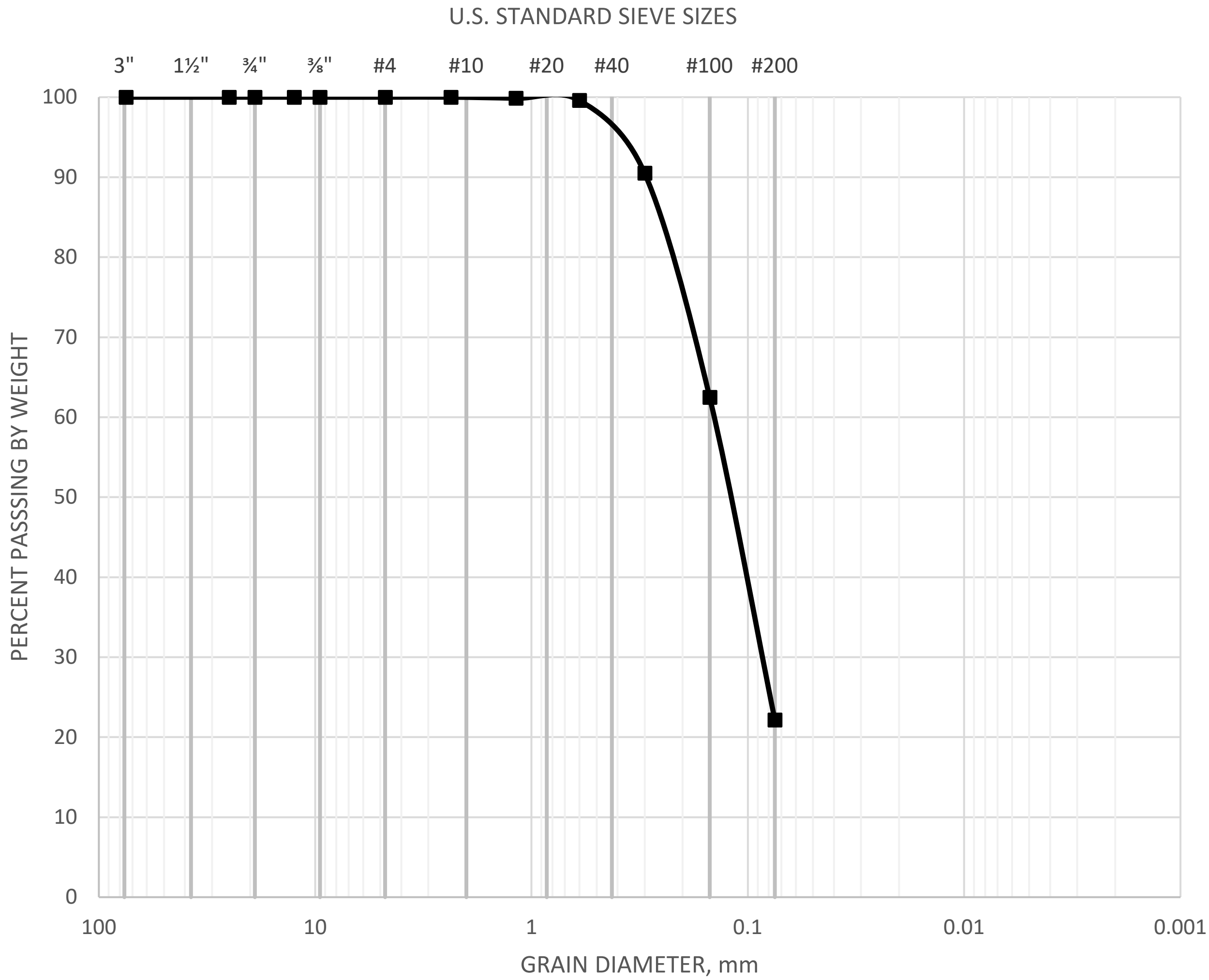
Indio, California

PARTICLE-SIZE CURVE (HYDROMETER)
ASTM D 4318, D 422

Figure B-16

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B3@2.5'	Silty SAND (SM), olive gray	0.13	0.083	

GEOCON

GRAIN SIZE DISTRIBUTION

ASTM D-422

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Coachella Valley Water District
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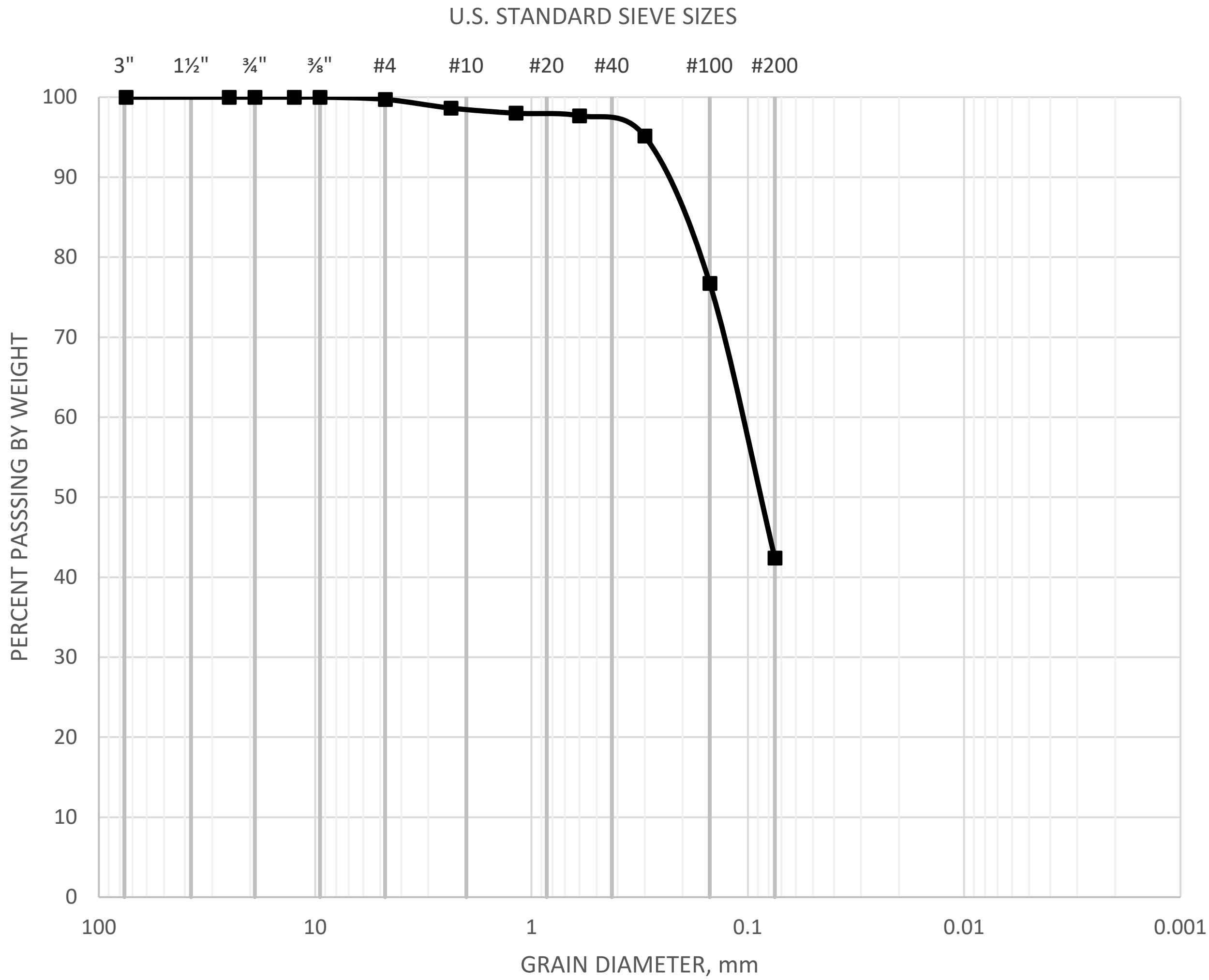
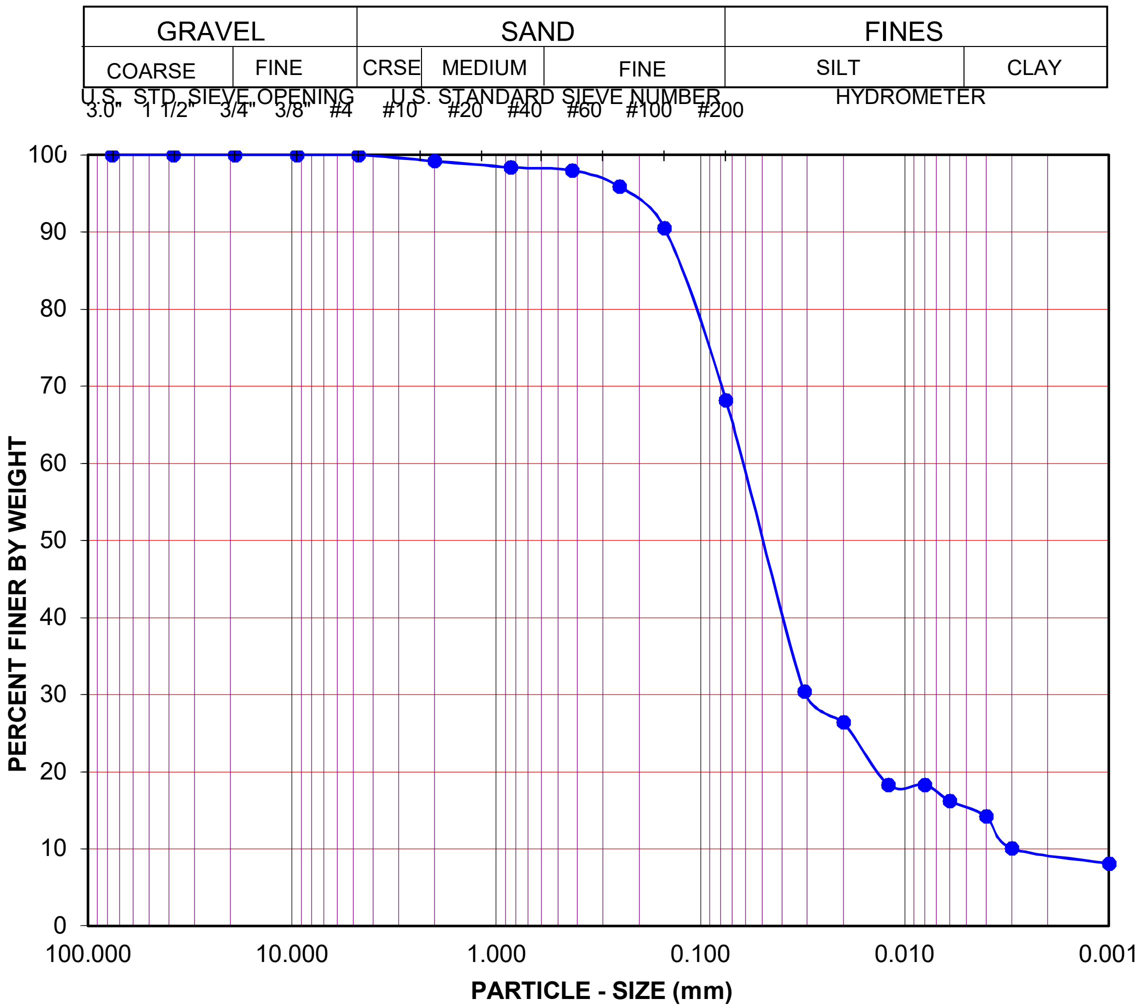
Figure B-17

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B3@5'	silty SAND (SM), gray	0.1		

GEOCON	**GRAIN SIZE DISTRIBUTION** ASTM D-422 Checked by: ATS	Project No.: T2581-22-04 Thousand Palms Channel Coachella Valley Water District Indio, California November 2020 Figure B-18



Boring No.	Sample No.	Depth (ft.)	Soil Type		
B3	B3@5'	5'	ML		

Sample Description:
Sandy SILT (ML)

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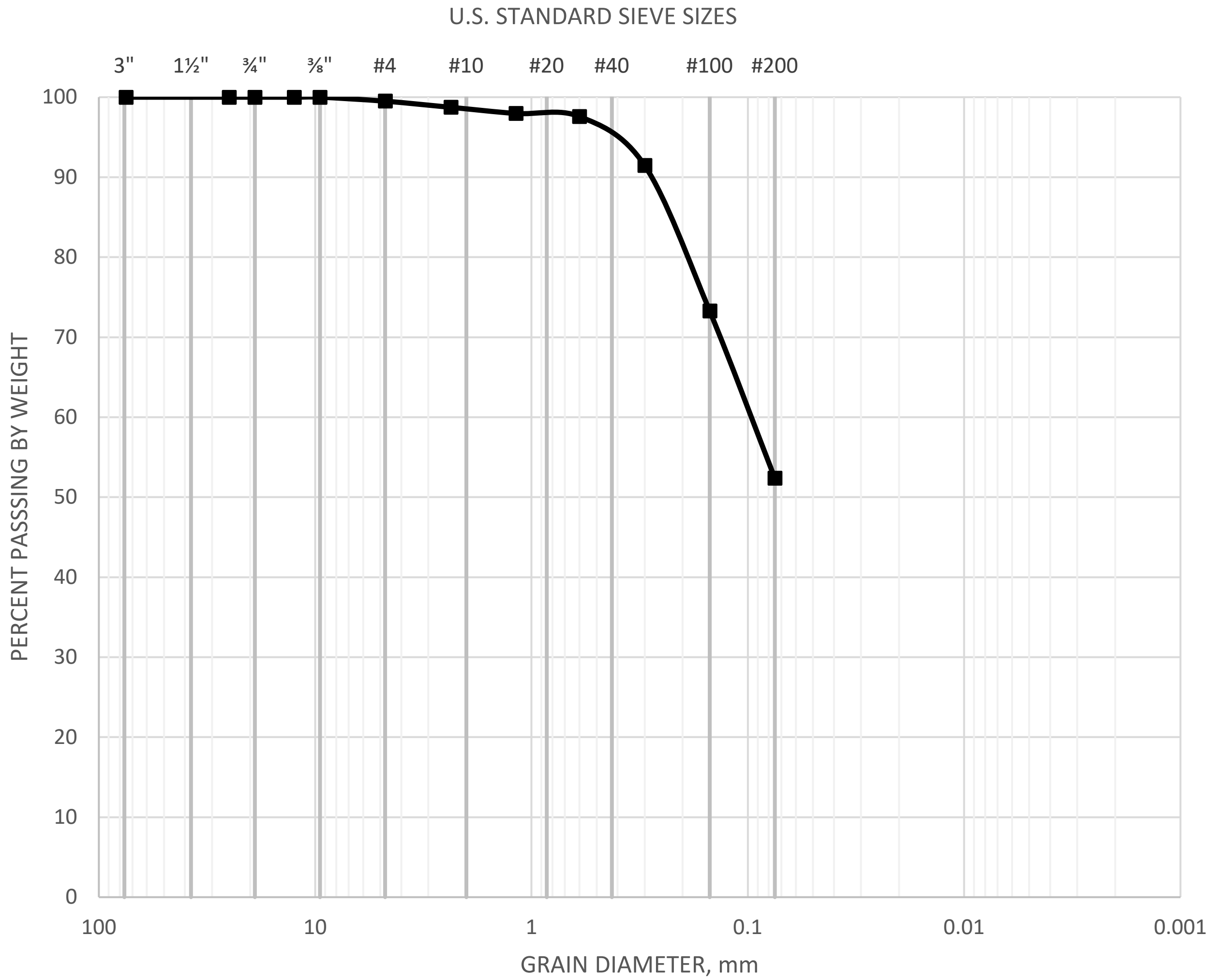
Indio, California

PARTICLE-SIZE CURVE (HYDROMETER)
ASTM D 4318, D 422

Figure B-19

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B4@2.5'	Sandy SILT (ML), gray	0.1		

GEOCON

GRAIN SIZE DISTRIBUTION

ASTM D-422

Checked by: ATS

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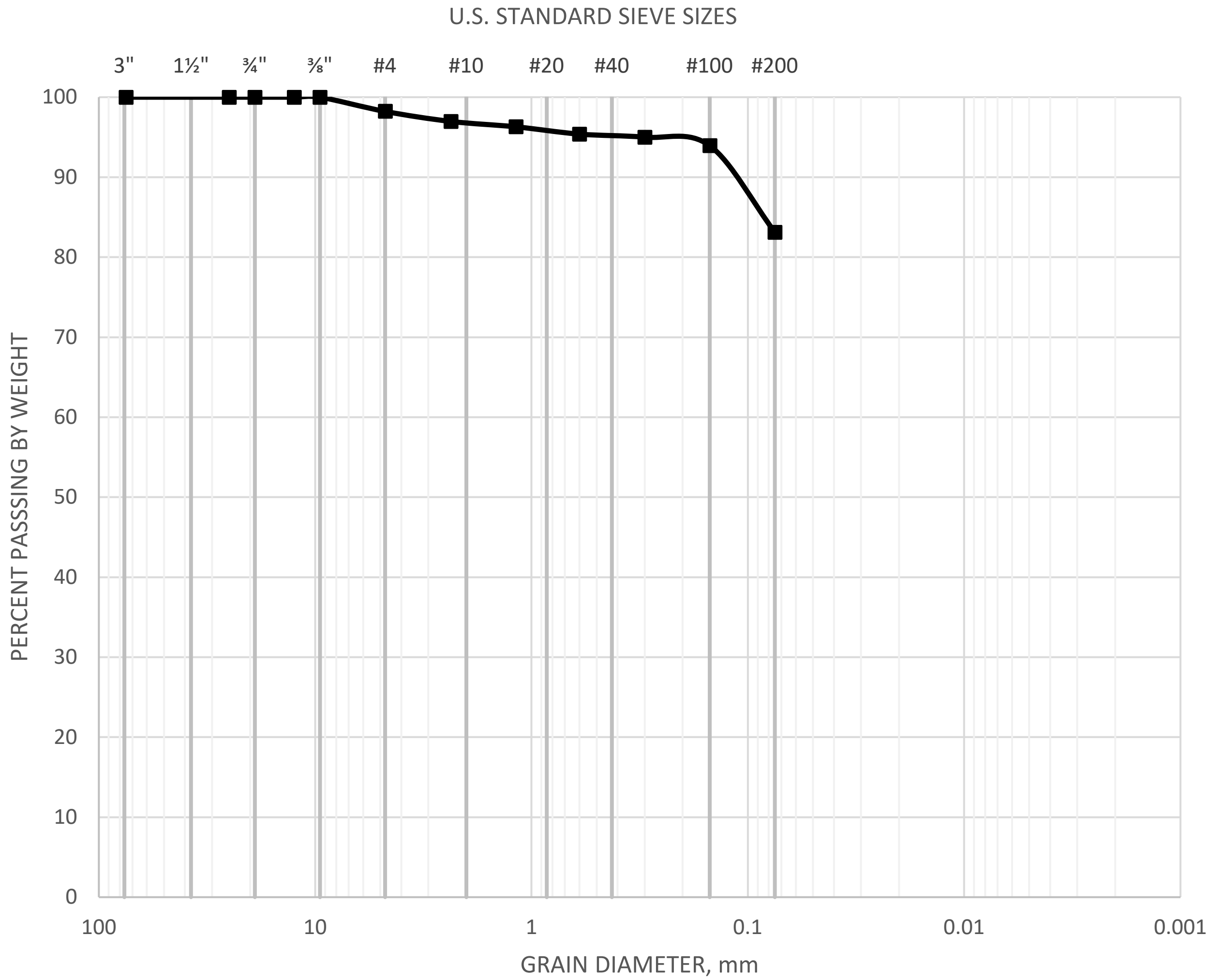
Figure B-20

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B4@10	Sandy SILT (ML), pale yellow			

GEOCON

GRAIN SIZE DISTRIBUTION

ASTM D-422

Checked by: ATS

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Thousand Palms Channel
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Indio, California

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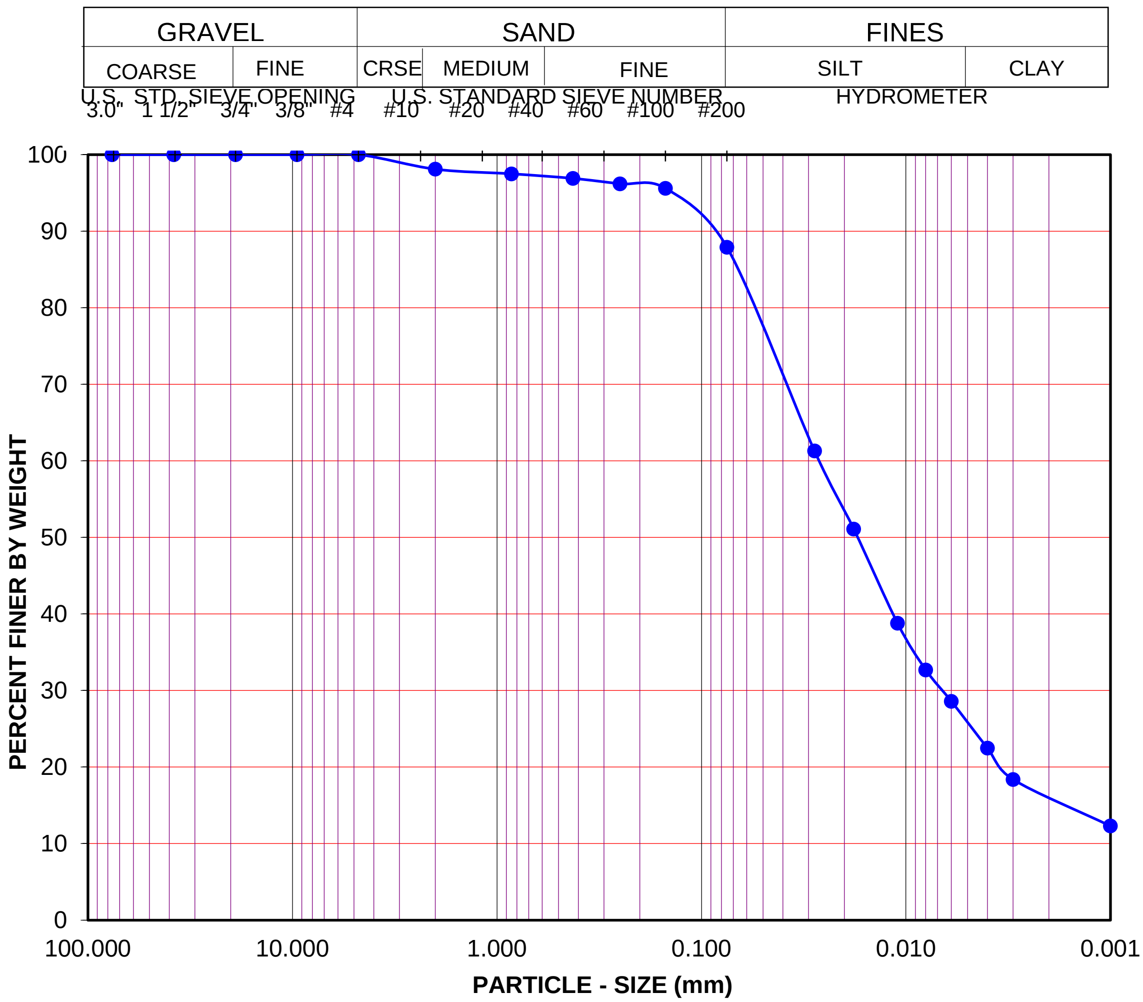
Figure B-21



Boring No.	Sample No.	Depth (ft.)	Soil Type		
B4	B4@10	10	ML		

Sample Description:
SILT with clay (ML)

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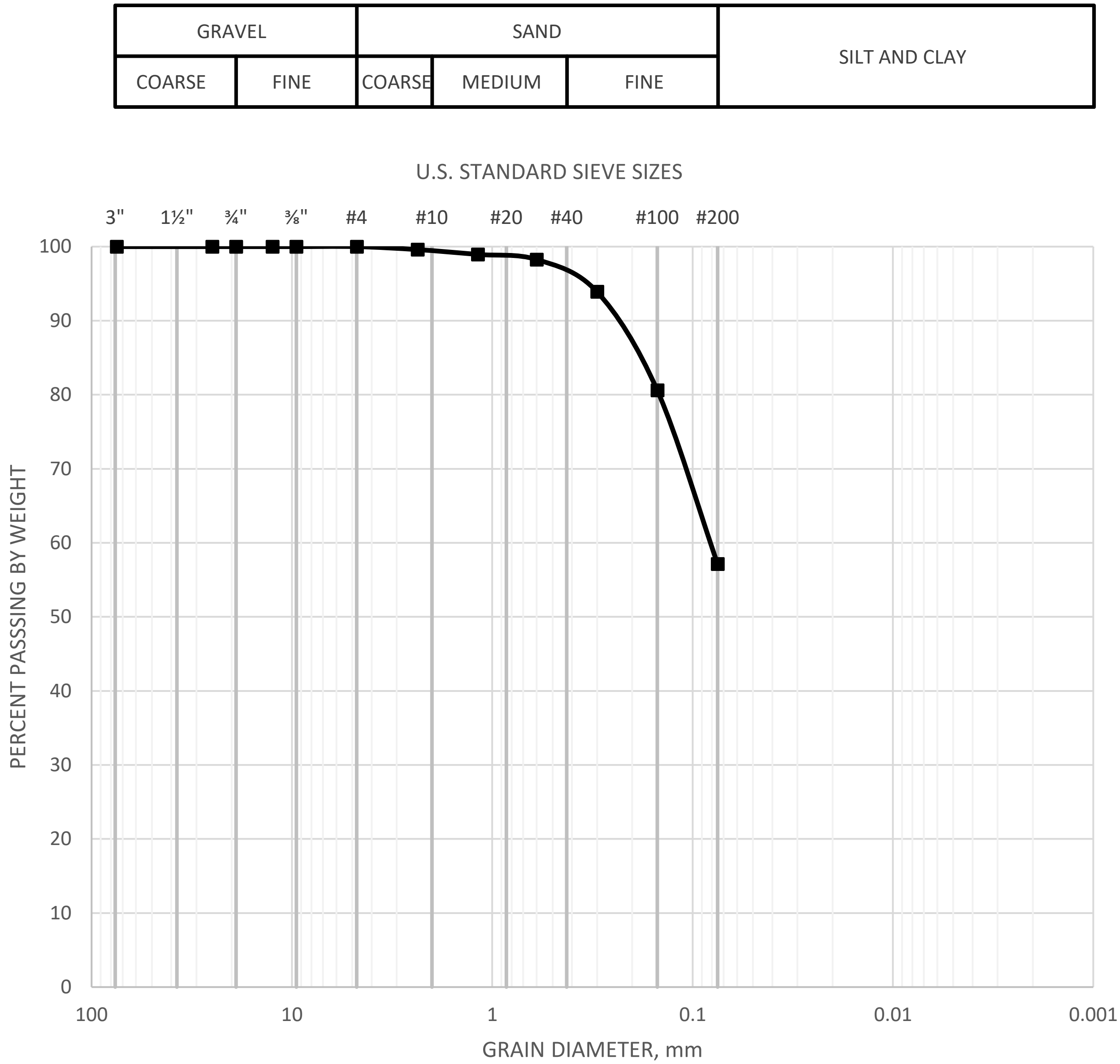
Indio, California

PARTICLE-SIZE CURVE (HYDROMETER)
ASTM D 4318, D 422

Figure B-22



SAMPLE	CLASSIFICATION	D60	D30	D10
B5@5'	SILT with Clay (CL-ML), gray	0.08	0.073	0.073

GEOCON

GRAIN SIZE DISTRIBUTION

ASTM D-422

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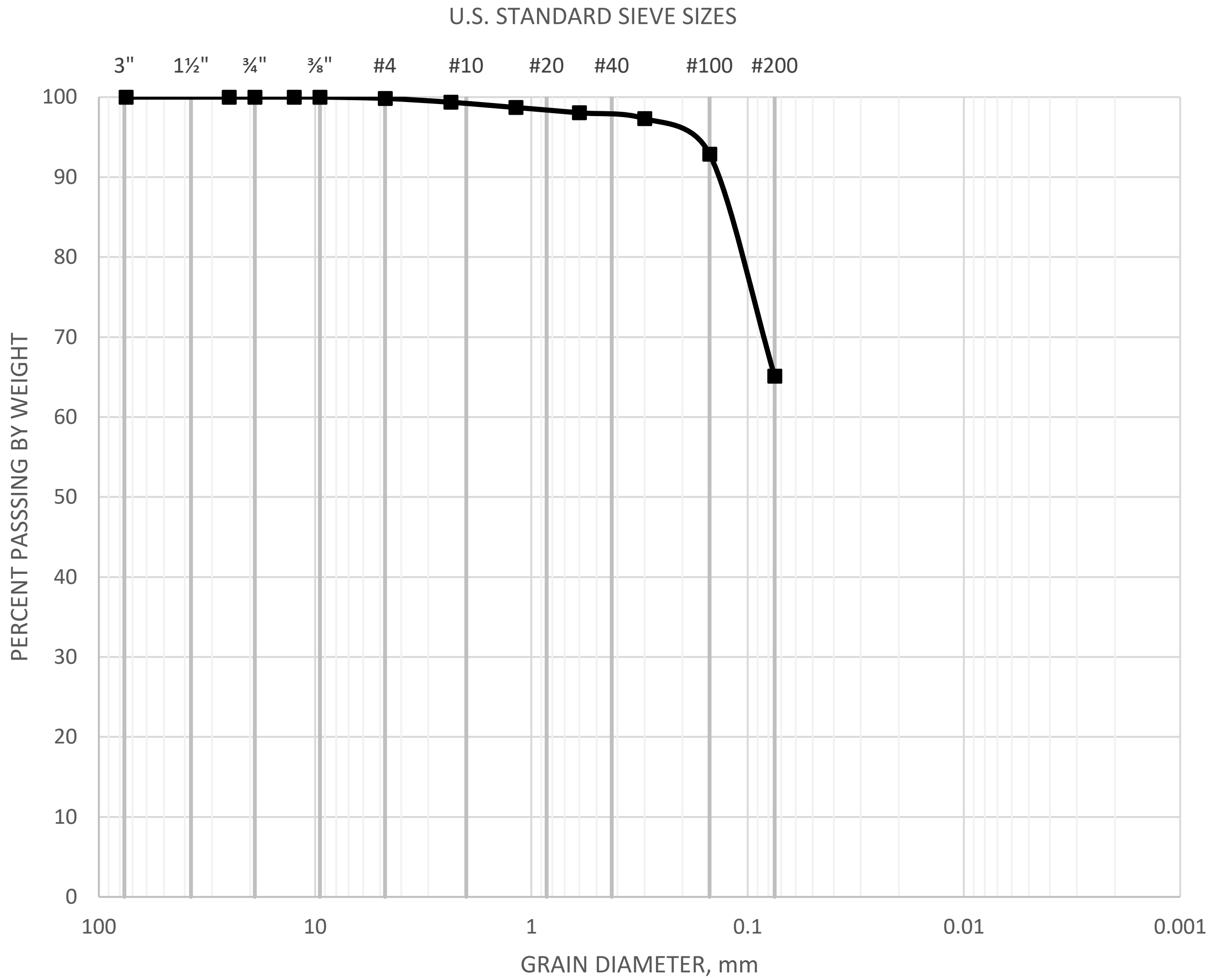
Project No.: T2581-22-05

Thousand Palms Channel
Coachella Valley Water District
Indio, California

JUNE 2022

Figure B-23

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B9@25'	SILT with Clay (CL-ML), gray	0.075	0.075	0.075

GEOCON

GRAIN SIZE DISTRIBUTION

ASTM D-422

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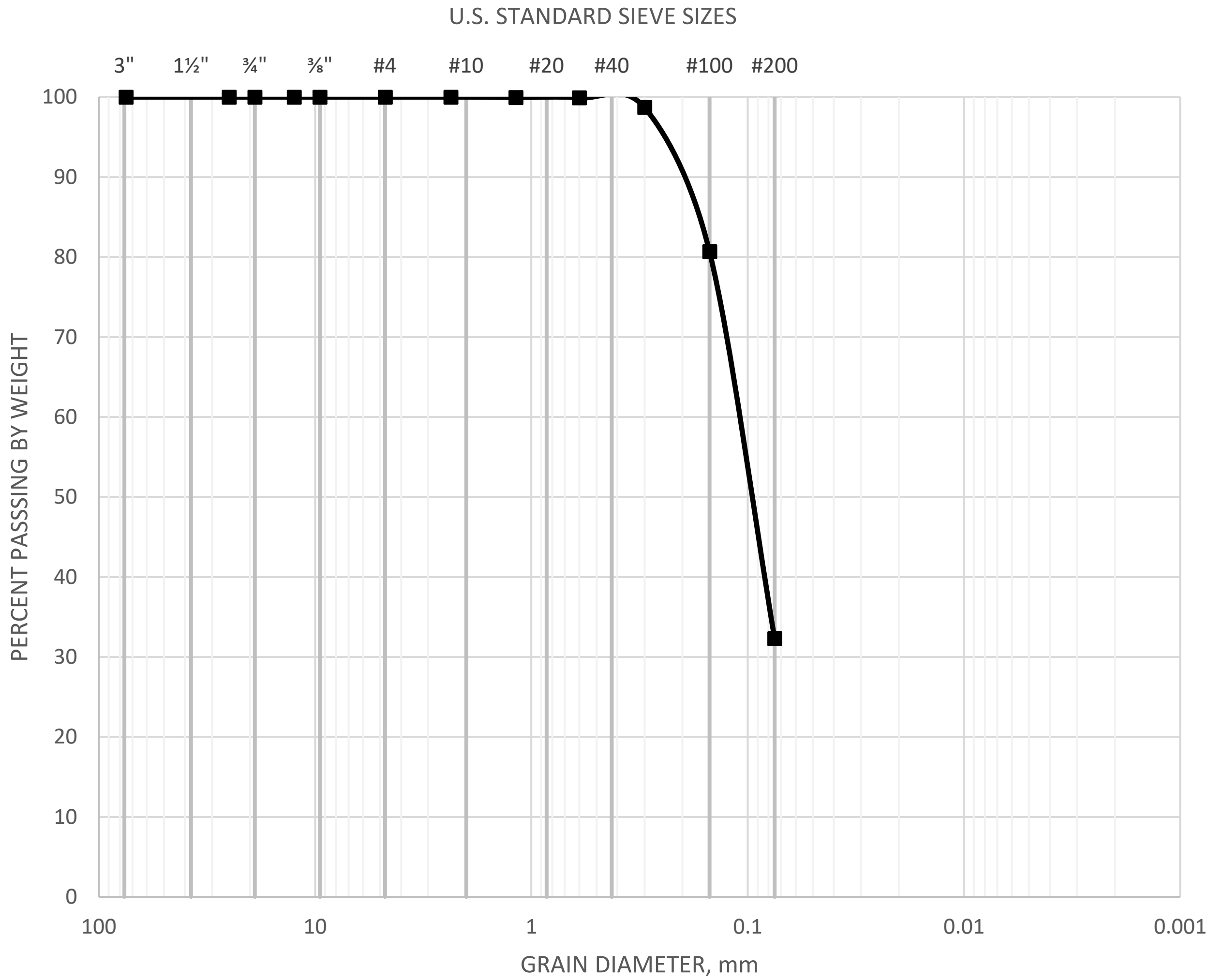
Indio, California

JUNE 2022

Figure B-24

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B9@35'	SILT with Clay (CL-ML), gray	0.11	0.075	0.075

GEOCON

GRAIN SIZE DISTRIBUTION

ASTM D-422

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Coachella Valley Water District
Indio, California

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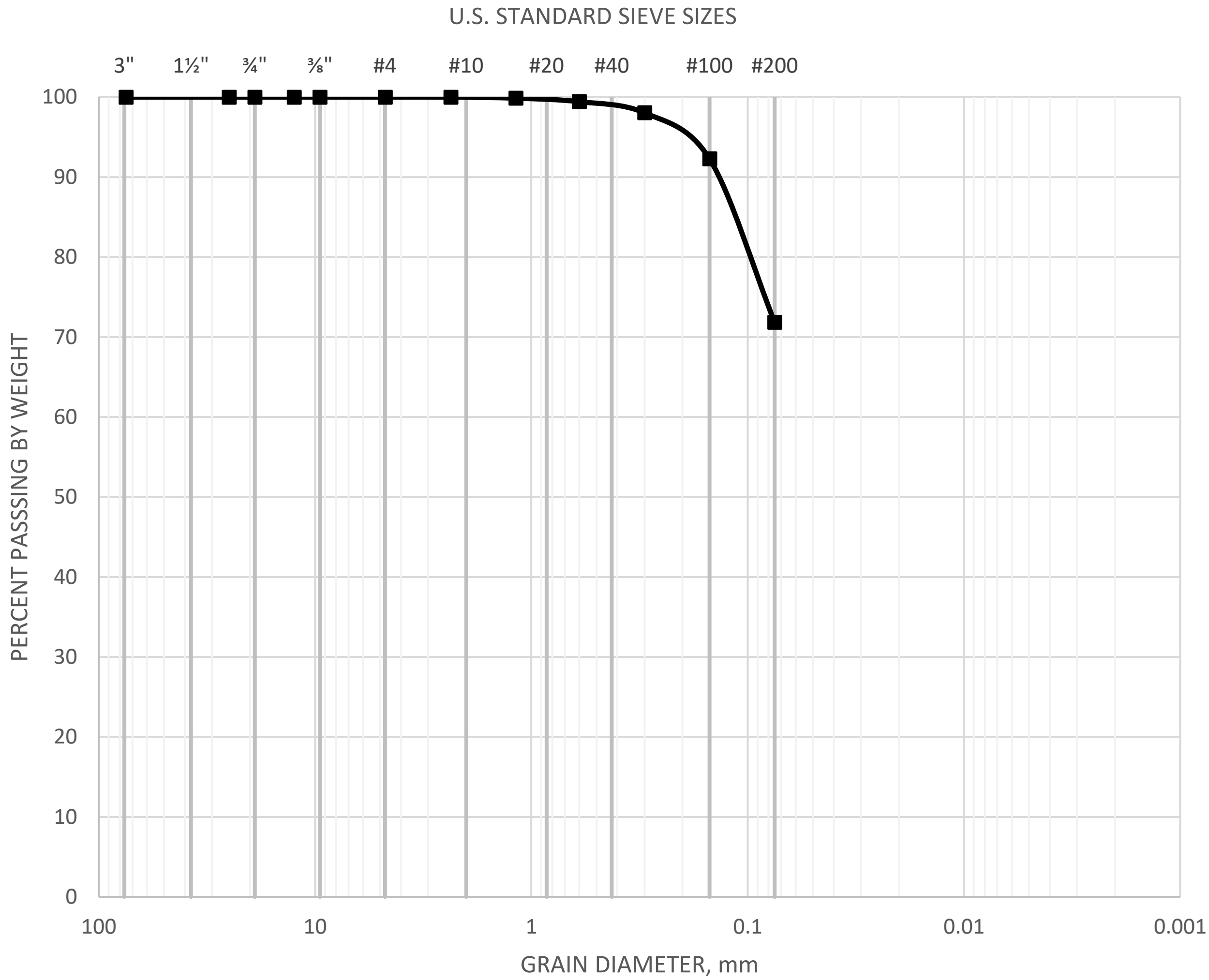
Figure B-25

GRAVEL		SAND			SILT AND CLAY
COARSE	FINE	COARSE	MEDIUM	FINE	



SAMPLE	CLASSIFICATION	D60	D30	D10
B13@40'	SILT with Clay (CL-ML), gray	0.075	0.075	0.075

GEOCON

GRAIN SIZE DISTRIBUTION

ASTM D-422

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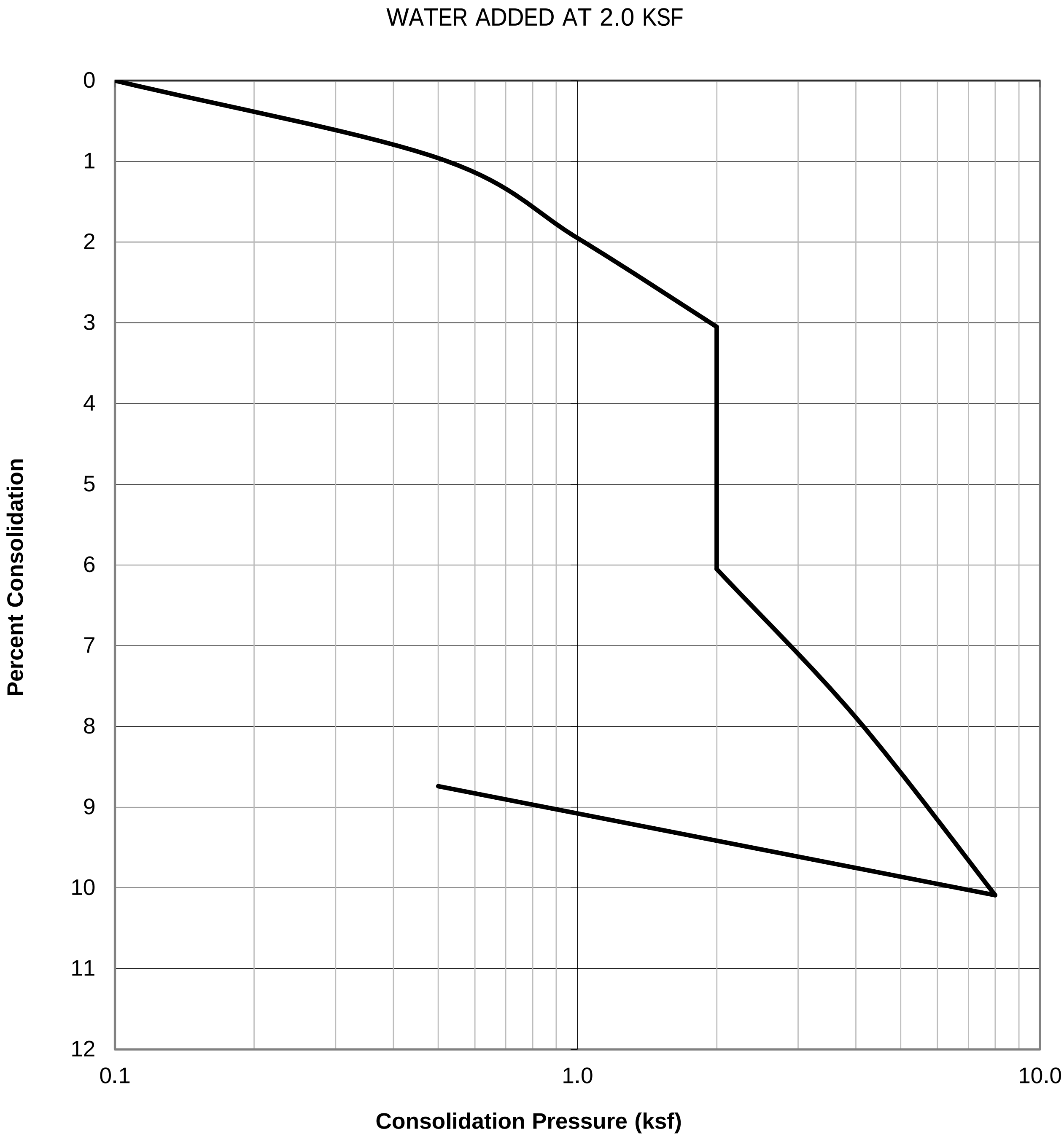
JUNE 2022

Figure B-26



SAMPLE ID.	SOIL TYPE	DRY DENSITY (PCF)	INITIAL MOISTURE (%)	FINAL MOISTURE (%)
B1@2.5	Silty SAND (SM), olive gray	97.5	3.2	23.3

GEOCON

CONSOLIDATION TEST RESULTS

ASTM D-2435

Checked by: ATS

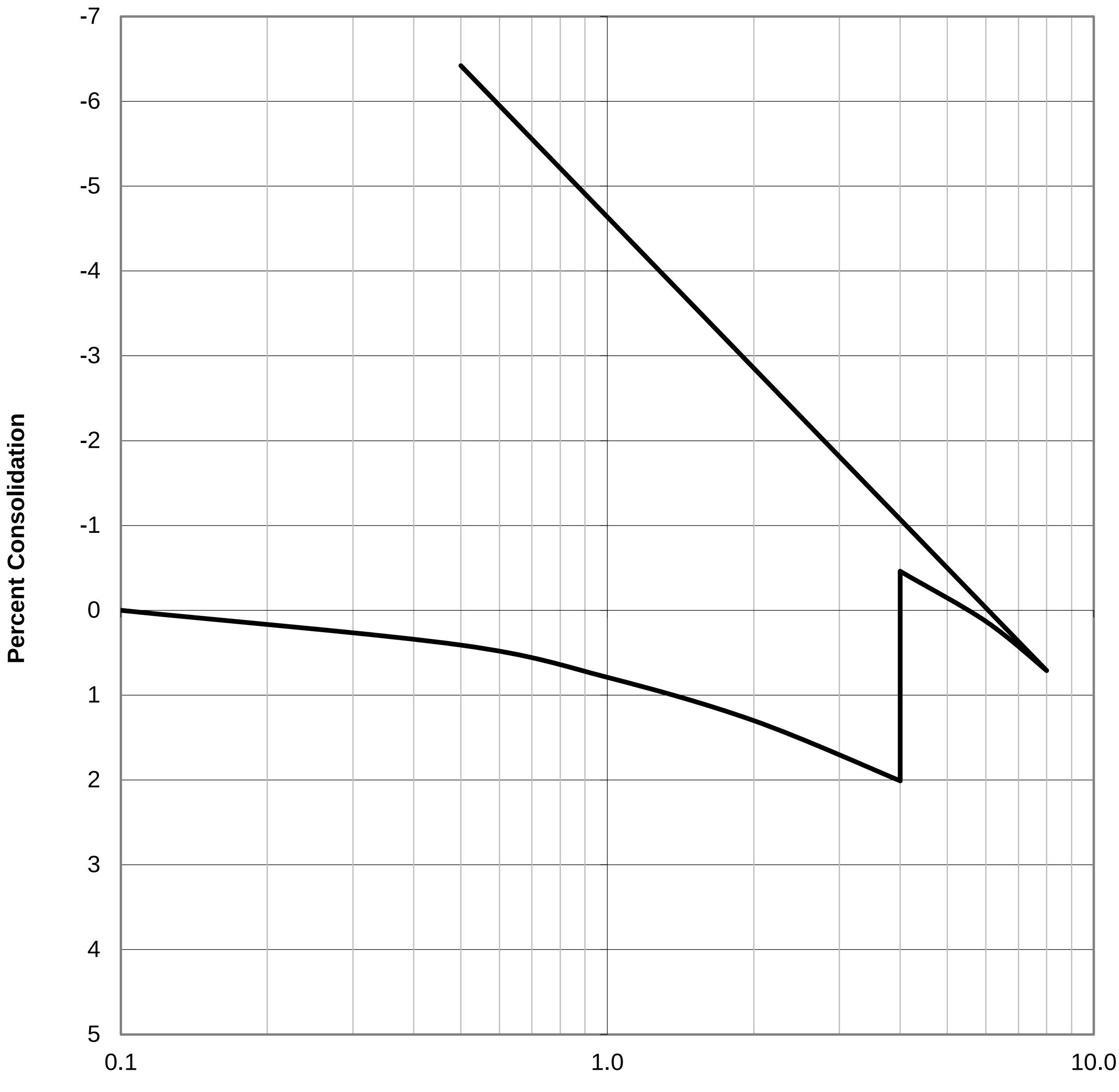
Project No.: T2581-22-04

Thousand Palms Channel
Coachella Valley Water District
Indio, California

November 2020

Figure B-27

WATER ADDED AT 2.0 KSF



SAMPLE ID.	SOIL TYPE	DRY DENSITY (PCF)	INITIAL MOISTURE (%)	FINAL MOISTURE (%)
B2@10	Sandy SILT (ML), grayish brown	103.4	17.1	30.1

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CONSOLIDATION TEST RESULTS

ASTM D-2435

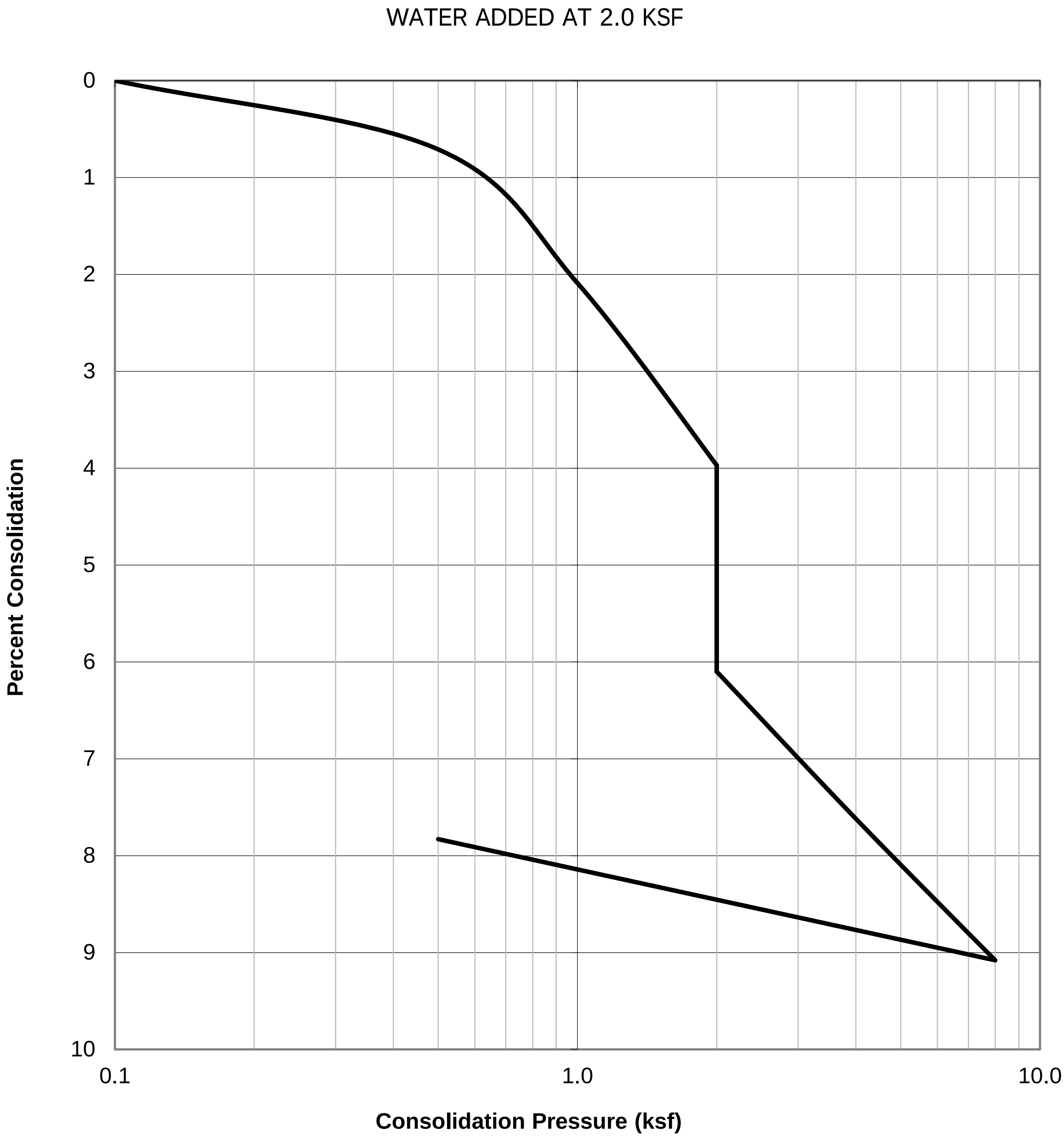
Checked by: ATS

Project No.: T2581-22-04

Thousand Palms Channel
Coachella Valley Water District
Indio, California

November 2020

Figure B-28



SAMPLE ID.	SOIL TYPE	DRY DENSITY (PCF)	INITIAL MOISTURE (%)	FINAL MOISTURE (%)
B3@5	Silty SAND (SP), gray	87.3	2.7	26.2

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CONSOLIDATION TEST RESULTS

ASTM D-2435

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Project No.: T2581-22-04

Thousand Palms Channel
Coachella Valley Water District
Indio, California

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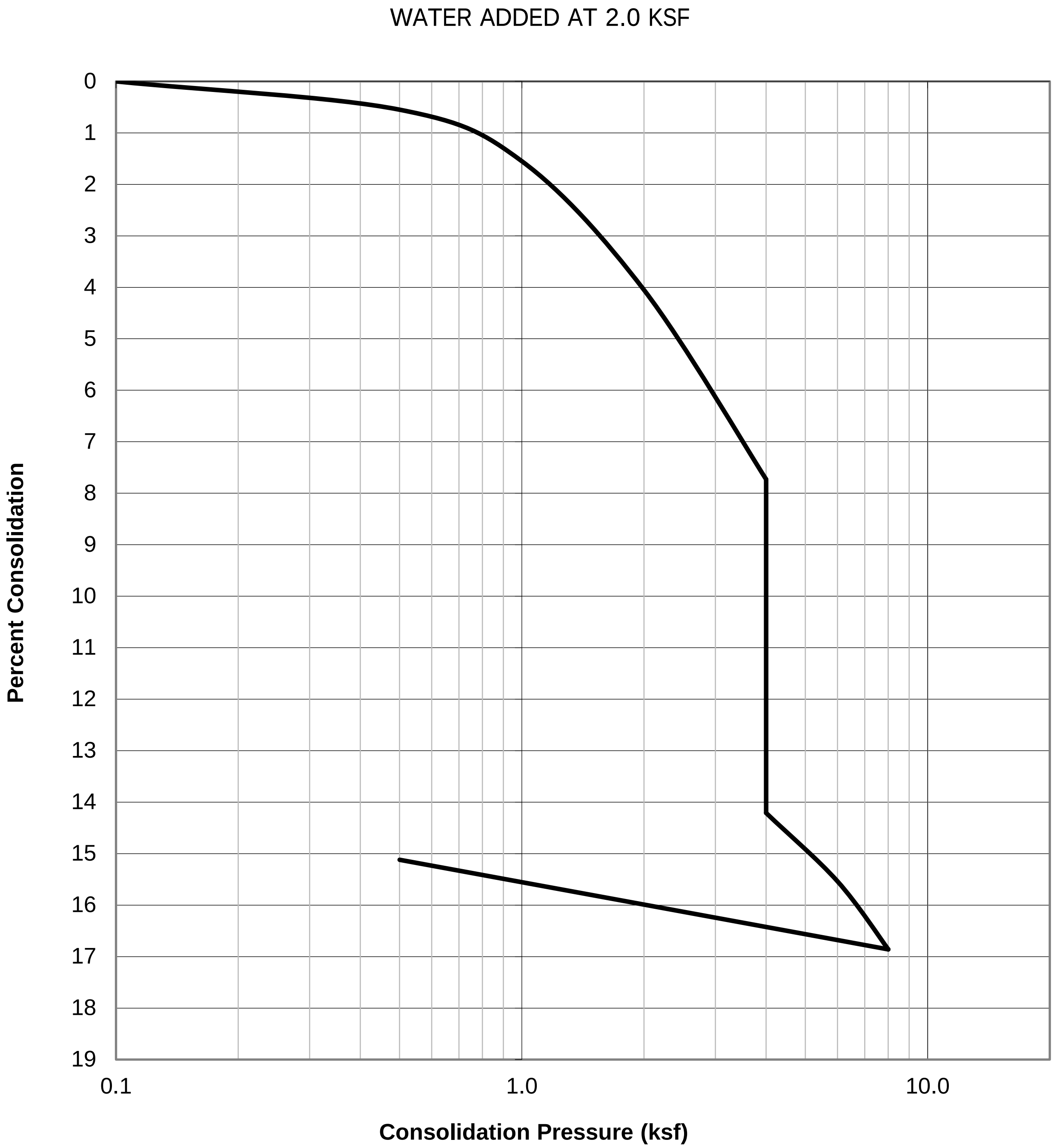
Figure B-29



SAMPLE ID.	SOIL TYPE	DRY DENSITY (PCF)	INITIAL MOISTURE (%)	FINAL MOISTURE (%)
B4@5	Sandy SILT (ML), grayish brown	88.2	6.1	25.8

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CONSOLIDATION TEST RESULTS

ASTM D-2435

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Project No.: T2581-22-04

Thousand Palms Channel
Coachella Valley Water District
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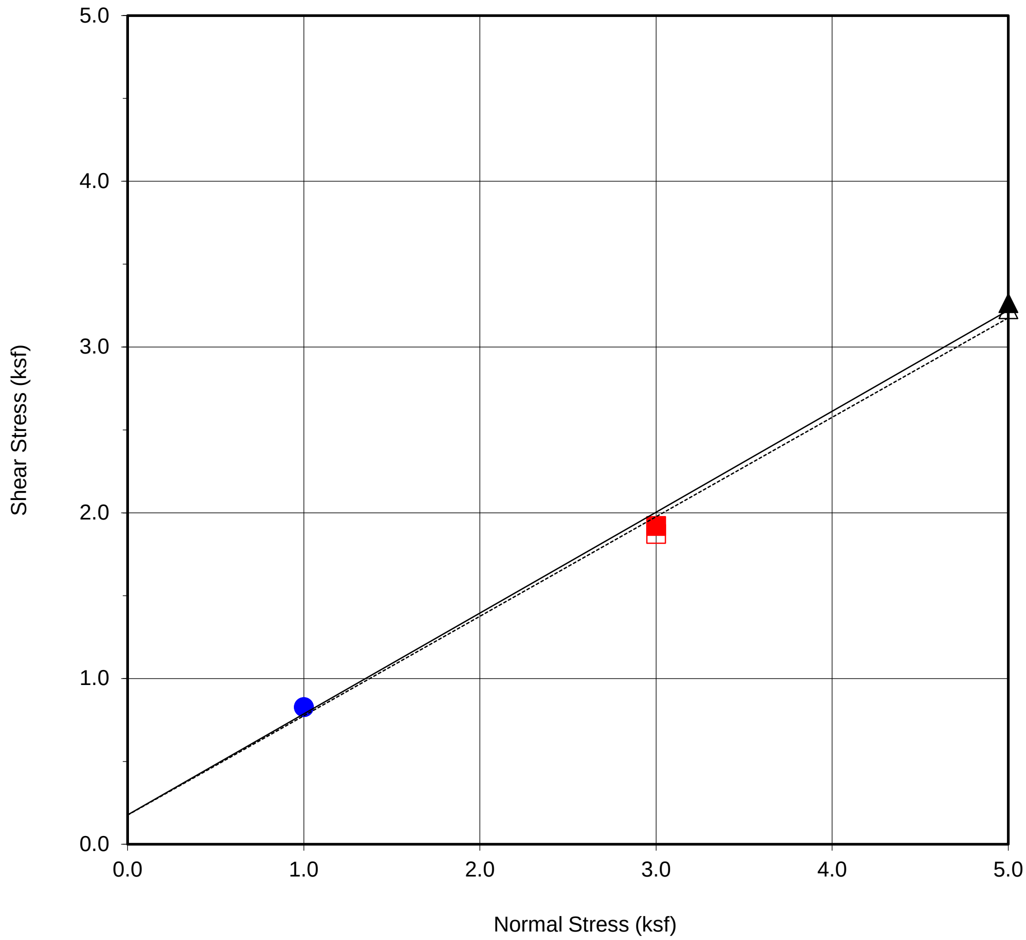
Figure B-30



Boring No.	**B1**
Sample No.	**B1@0-5'**
Depth (ft)	**0-5**
Sample Type:	Ring

Soil Identification:		
Silty SAND (SM), olive gray		
Strength Parameters		
	C (psf)	ϕ (°)
Peak	177	31.3
Ultimate	176	31.0

Normal Stress (kip/ft2)	1	3	5
Peak Shear Stress (kip/ft²)	● 0.83	■ 1.92	▲ 3.26
Shear Stress @ End of Test (ksf)	○ 0.83	□ 1.87	△ 3.23
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	13.1	13.1	13.1
Initial Dry Density (pcf)	108.0	108.1	108.0
Initial Degree of Saturation (%)	62.9	63.3	63.0
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	9.6	15.4	11.0

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DIRECT SHEAR TEST RESULTS

Consolidated Drained ASTM D-3080

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Project No.: T2581-22-04

Thousand Palms Channel
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Indio, California

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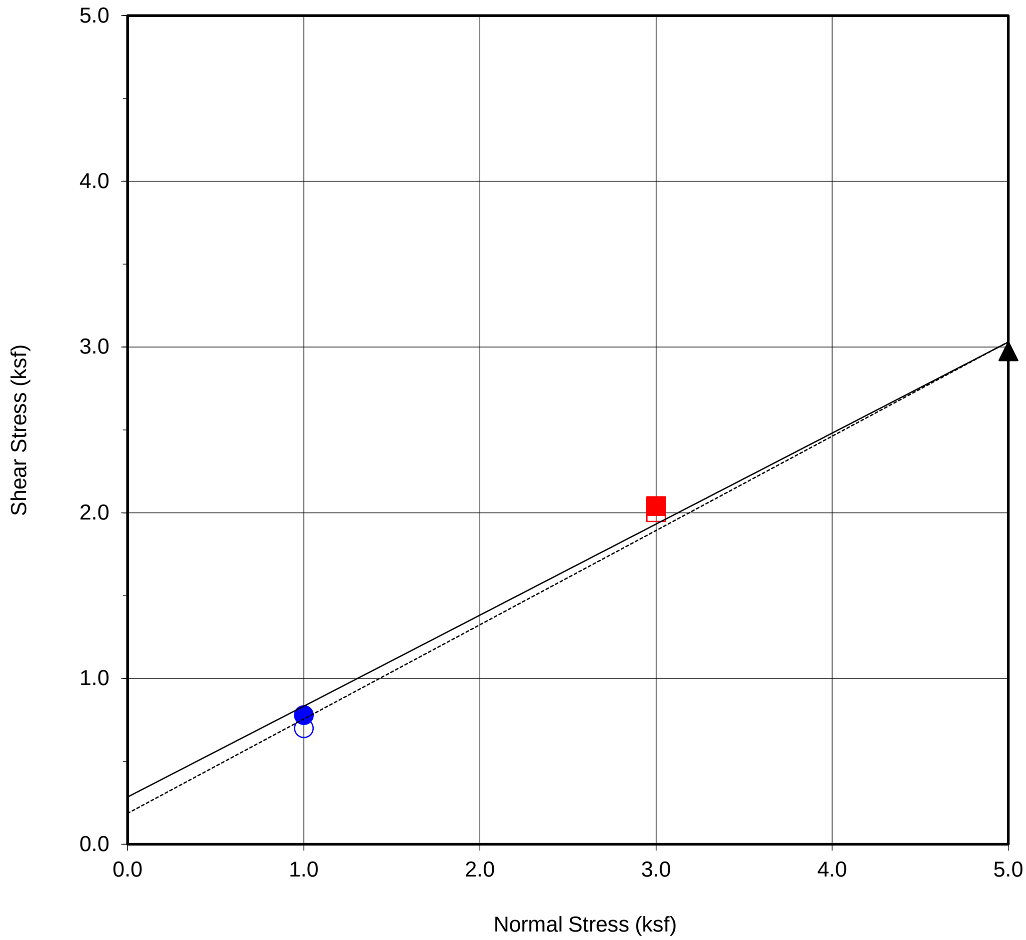
Figure B-31



Boring No.	**B3**
Sample No.	**B3@5-10'**
Depth (ft)	**5-10'**
Sample Type:	Ring

Normal Stress (kip/ft2)	1	3	5
Peak Shear Stress (kip/ft²)	● 0.78	■ 2.04	▲ 2.98
Shear Stress @ End of Test (ksf)	○ 0.70	□ 2.00	△ 2.98
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	12.9	13.0	13.0
Initial Dry Density (pcf)	106.0	105.9	106.0
Initial Degree of Saturation (%)	59.2	59.5	59.5
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	13.2	16.5	8.1

Soil Identification:

Silty SAND (SM), gray

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	285	28.8
Ultimate	186	29.6

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DIRECT SHEAR TEST RESULTS

Consolidated Drained ASTM D-3080

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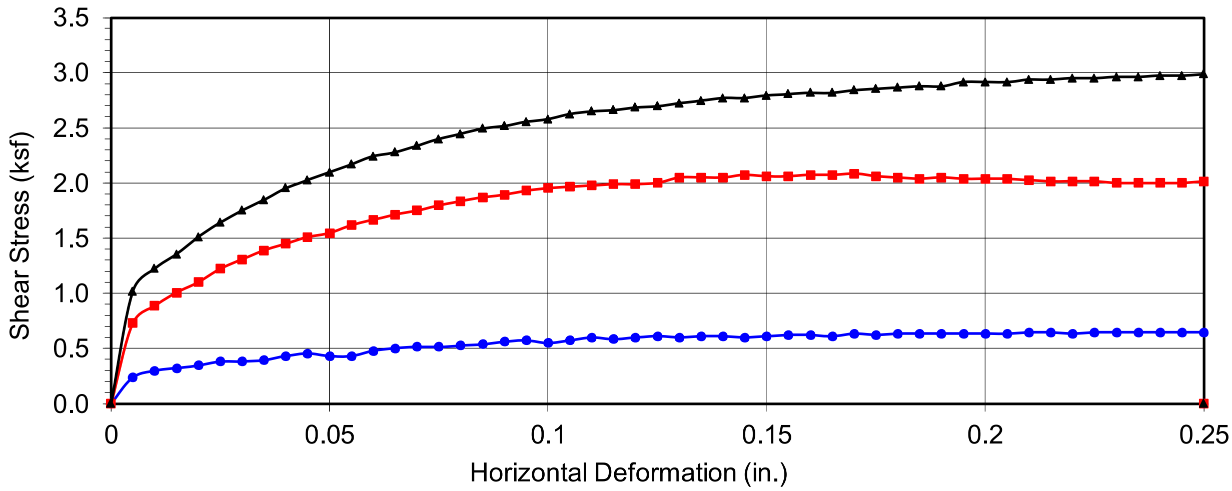
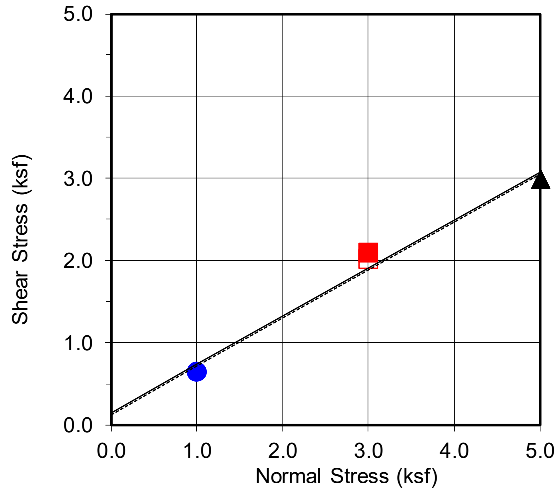
Thousand Palms Channel
Coachella Valley Water District
Indio, California

November 2020 Figure B-32





Boring No.	**B5**
Sample No.	**B5@10**
Depth (ft)	**10**
Sample Type:	Ring

Normal Stress (kip/ft2)	1	3	5
Peak Shear Stress (kip/ft²)	● 0.65	■ 2.09	▲ 2.99
Shear Stress @ End of Test (ksf)	○ 0.65	□ 2.02	△ 2.99
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	8.1	8.0	8.8
Initial Dry Density (pcf)	80.7	101.7	84.0
Initial Degree of Saturation (%)	20.0	33.0	23.6
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	32.5	23.6	20.4

Soil Identification:

SILT (ML), light gray

Strength Parameters

	C (psf)	ϕ (°)
Peak	153	30.3
Ultimate	129	30.3

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DIRECT SHEAR TEST RESULTS

Consolidated Drained ASTM D-3080

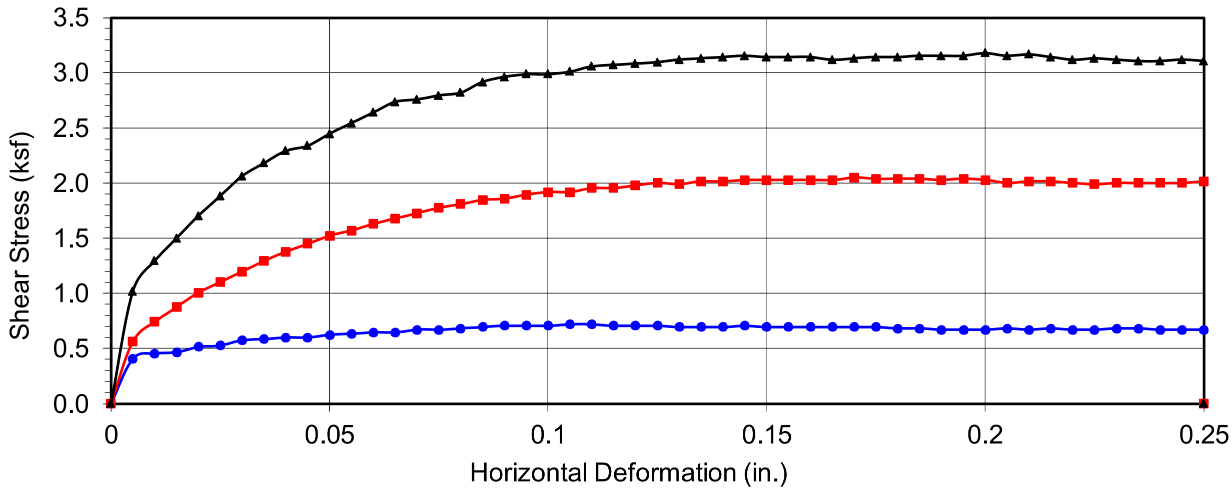
Checked by:

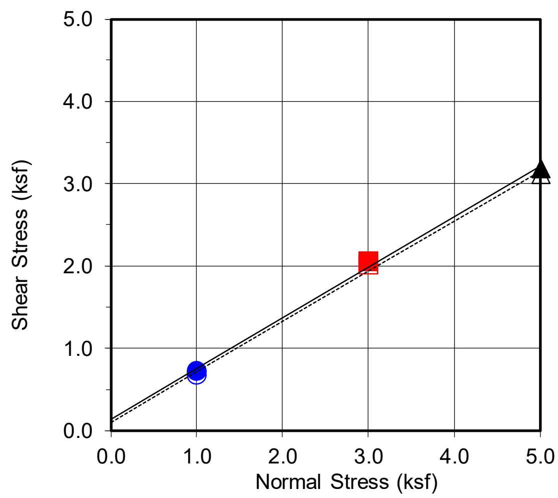
Project No.: T2581-22-05

THOUSAND PALMS CHANNEL
COACHELLA VALLEY WATER DISTRICT
INDIO, CALIFORNIA

JUNE 2022

Figure B33





Boring No.	**B8**
Sample No.	**B8@5-10**
Depth (ft)	**5-10**
Sample Type:	Bulk

Soil Identification:		
Poorly Graded SAND (SP), light yellowish brown		
Strength Parameters		
	C (psf)	ϕ (°)
Peak	139	31.6
Ultimate	105	31.3

Normal Stress (kip/ft2)	1	3	5
Peak Shear Stress (kip/ft²)	● 0.72	■ 2.05	▲ 3.18
Shear Stress @ End of Test (ksf)	○ 0.67	□ 2.02	△ 3.11
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	12.1	12.0	12.1
Initial Dry Density (pcf)	102.1	102.0	101.9
Initial Degree of Saturation (%)	50.1	49.8	50.0
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	18.9	16.5	18.8

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DIRECT SHEAR TEST RESULTS

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Project No.: T2581-22-05

THOUSAND PALMS CHANNEL
COACHELLA VALLEY WATER DISTRICT
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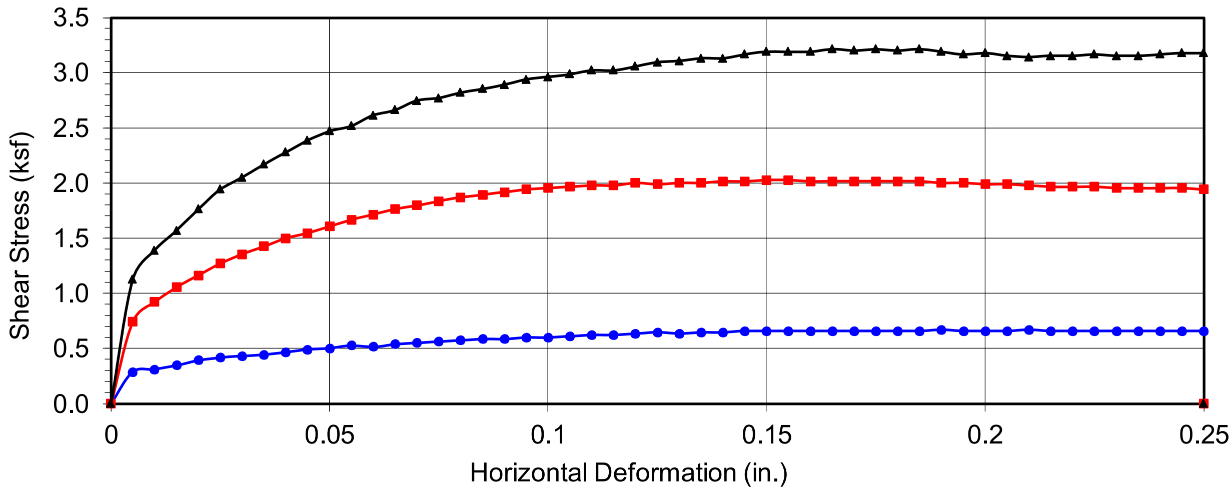
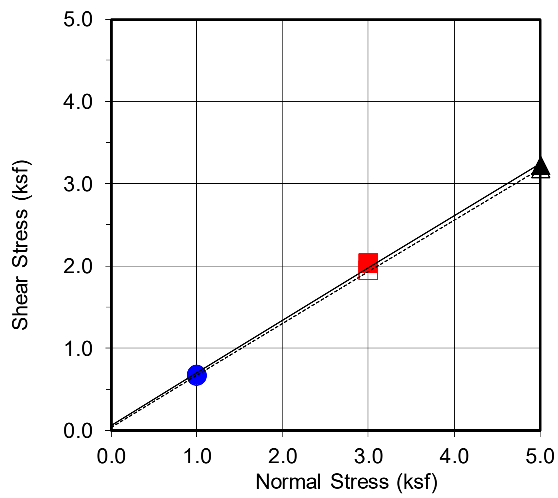
Figure B34





Boring No.	**B9**
Sample No.	**B9@15**
Depth (ft)	**15**
Sample Type:	Ring

Soil Identification:		
Silty SAND (SM), very light yellowish brown		
Strength Parameters		
	C (psf)	ϕ (°)
Peak	64	32.5
Ultimate	38	32.2

Normal Stress (kip/ft2)	1	3	5
Peak Shear Stress (kip/ft²)	● 0.67	■ 2.03	▲ 3.22
Shear Stress @ End of Test (ksf)	○ 0.66	□ 1.94	△ 3.18
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	14.0	13.4	13.9
Initial Dry Density (pcf)	78.0	89.6	84.4
Initial Degree of Saturation (%)	32.6	41.1	37.6
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	34.7	30.3	31.2

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DIRECT SHEAR TEST RESULTS

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Project No.: T2581-22-05

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COACHELLA VALLEY WATER DISTRICT
INDIO, CALIFORNIA

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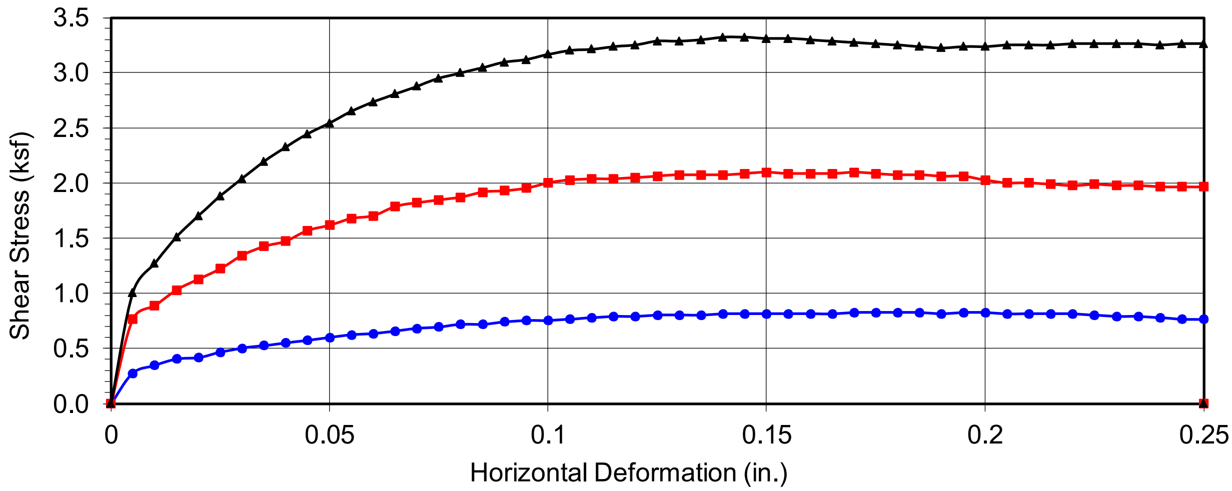
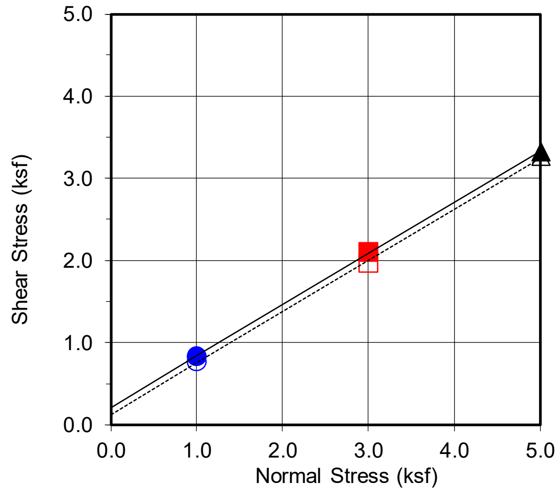
Figure B35





Boring No.	**B10**
Sample No.	**B10@10**
Depth (ft)	**10**
Sample Type:	Ring

Soil Identification:		
Poorly Graded SAND (SP), light yellowish brown		
Strength Parameters		
	C (psf)	ϕ (°)
Peak	212	32.0
Ultimate	128	32.0

Normal Stress (kip/ft2)	1	3	5
Peak Shear Stress (kip/ft²)	● 0.83	■ 2.10	▲ 3.32
Shear Stress @ End of Test (ksf)	○ 0.77	□ 1.97	△ 3.26
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	8.9	8.9	9.0
Initial Dry Density (pcf)	92.7	93.9	91.4
Initial Degree of Saturation (%)	29.3	30.2	28.9
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	28.5	27.0	25.2

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DIRECT SHEAR TEST RESULTS

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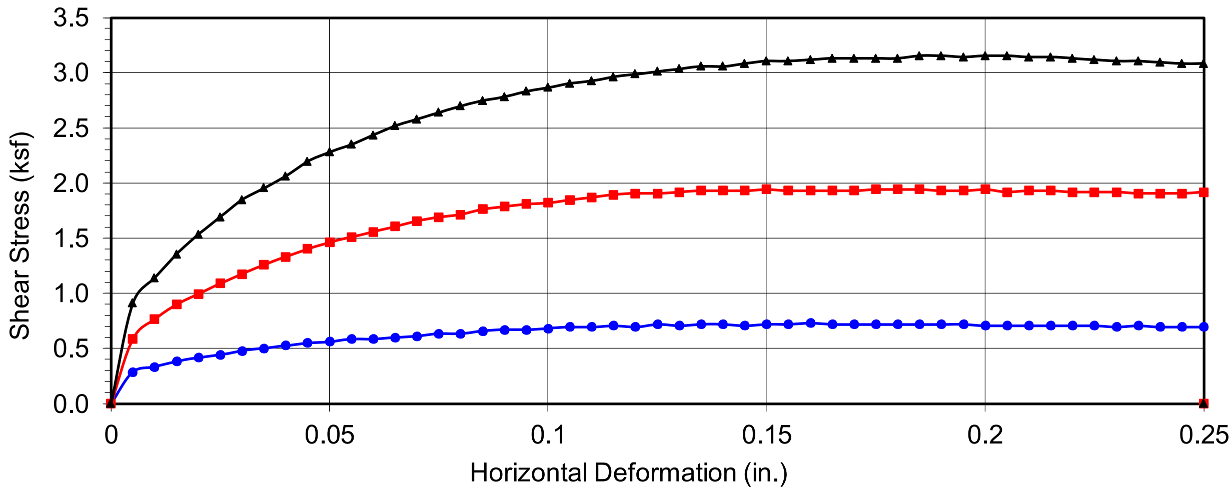
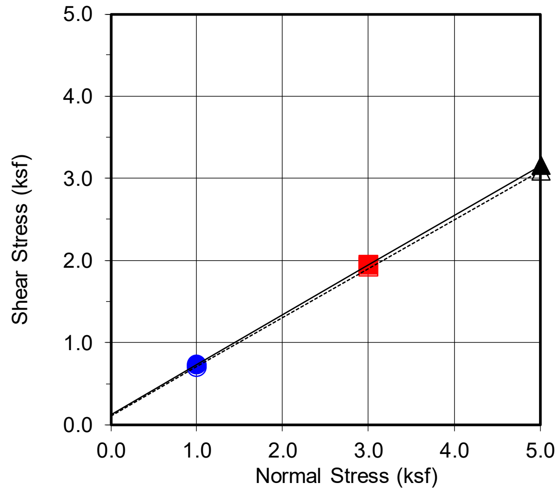
Project No.: T2581-22-05

THOUSAND PALMS CHANNEL
COACHELLA VALLEY WATER DISTRICT
INDIO, CALIFORNIA

JUNE 2022 Figure B36





Boring No.	**B12**
Sample No.	**B12@10**
Depth (ft)	**10**
Sample Type:	Ring

Soil Identification:		
Poorly Graded SAND (SP), light yellowish brown		
Strength Parameters		
	C (psf)	ϕ (°)
Peak	126	31.2
Ultimate	109	30.8

Normal Stress (kip/ft2)	1	3	5
Peak Shear Stress (kip/ft²)	● 0.73	■ 1.94	▲ 3.16
Shear Stress @ End of Test (ksf)	○ 0.70	□ 1.92	△ 3.08
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	8.6	11.6	12.7
Initial Dry Density (pcf)	82.4	85.3	88.1
Initial Degree of Saturation (%)	22.3	32.2	37.5
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	36.9	33.4	33.0

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DIRECT SHEAR TEST RESULTS

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Project No.: T2581-22-05

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INDIO, CALIFORNIA

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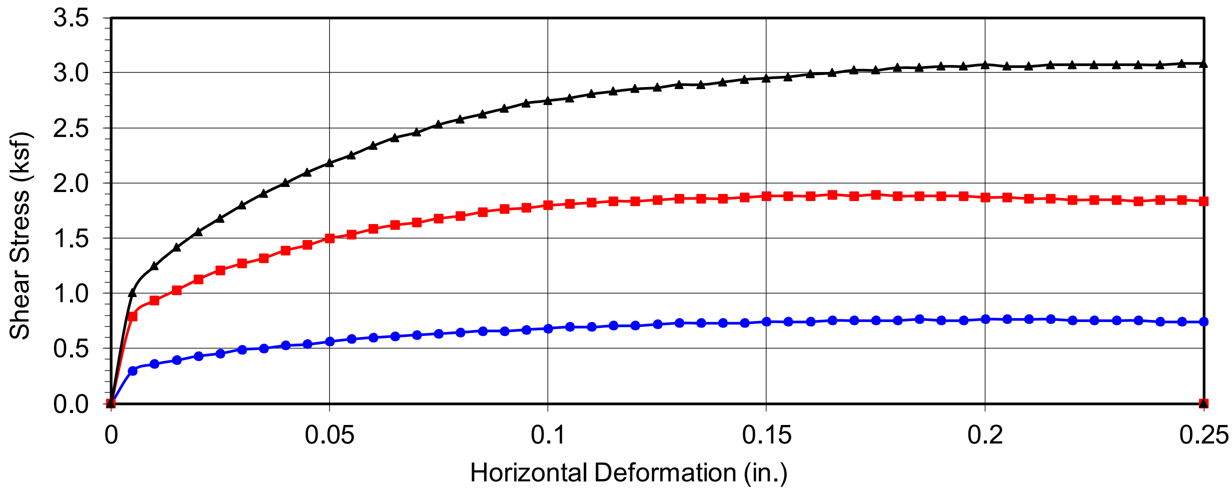
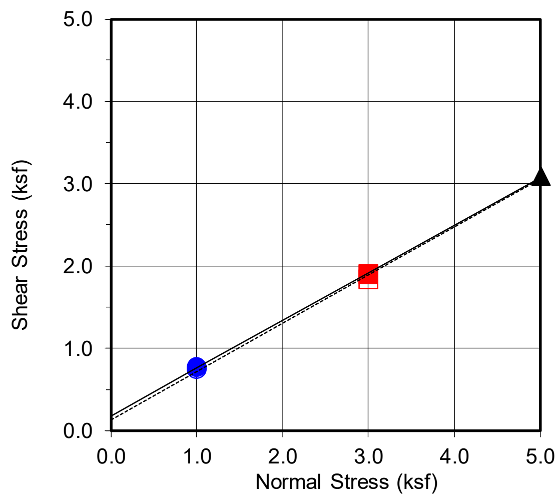
Figure B37





Boring No.	**B13**
Sample No.	**B13@5**
Depth (ft)	**5**
Sample Type:	Ring

Soil Identification:		
Silty SAND (SM), light olive brown		
Strength Parameters		
	C (psf)	ϕ (°)
Peak	179	30.1
Ultimate	133	30.3

Normal Stress (kip/ft2)	1	3	5
Peak Shear Stress (kip/ft²)	● 0.77	■ 1.90	▲ 3.08
Shear Stress @ End of Test (ksf)	○ 0.74	□ 1.84	△ 3.08
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	10.6	6.1	8.3
Initial Dry Density (pcf)	104.6	102.7	100.5
Initial Degree of Saturation (%)	46.7	25.8	33.0
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	18.9	27.1	16.1

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COACHELLA VALLEY WATER DISTRICT
INDIO, CALIFORNIA

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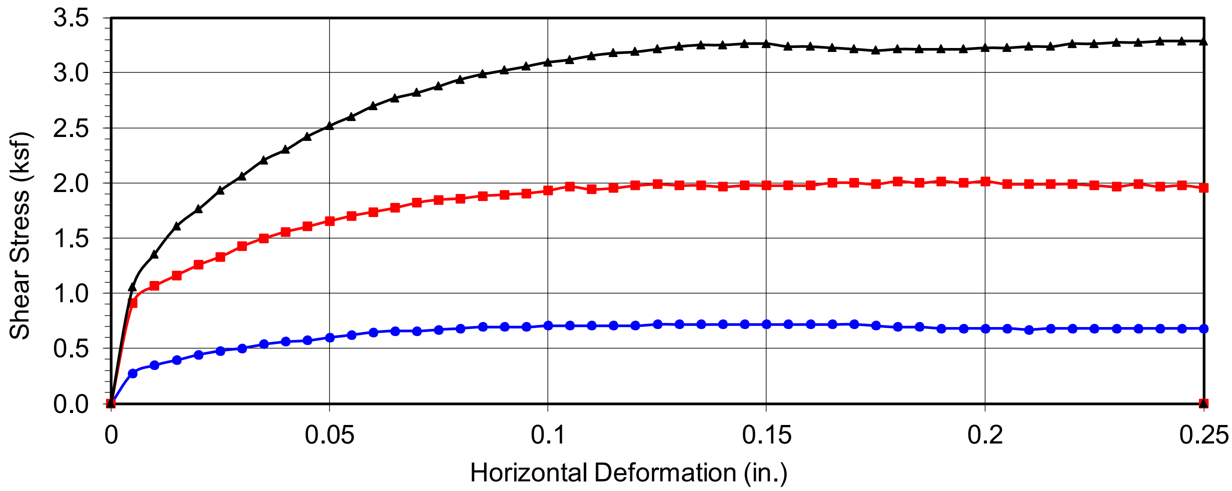
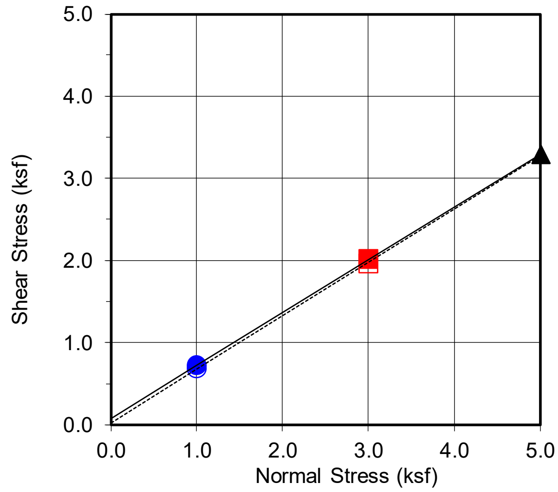
Figure B38





Boring No.	**B14**
Sample No.	**B14@5-10**
Depth (ft)	**5-10**
Sample Type:	Bulk

Normal Stress (kip/ft2)	1	3	5
Peak Shear Stress (kip/ft²)	● 0.72	■ 2.02	▲ 3.29
Shear Stress @ End of Test (ksf)	○ 0.68	□ 1.96	△ 3.29
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	12.5	12.4	12.5
Initial Dry Density (pcf)	103.1	102.9	103.1
Initial Degree of Saturation (%)	53.1	52.5	53.2
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	18.7	18.3	17.9

Soil Identification:

Poorly Graded SAND with Silt (SP-SM), light gray

Strength Parameters

	C (psf)	ϕ (°)
Peak	82	32.7
Ultimate	23	33.1

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DIRECT SHEAR TEST RESULTS

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INDIO, CALIFORNIA

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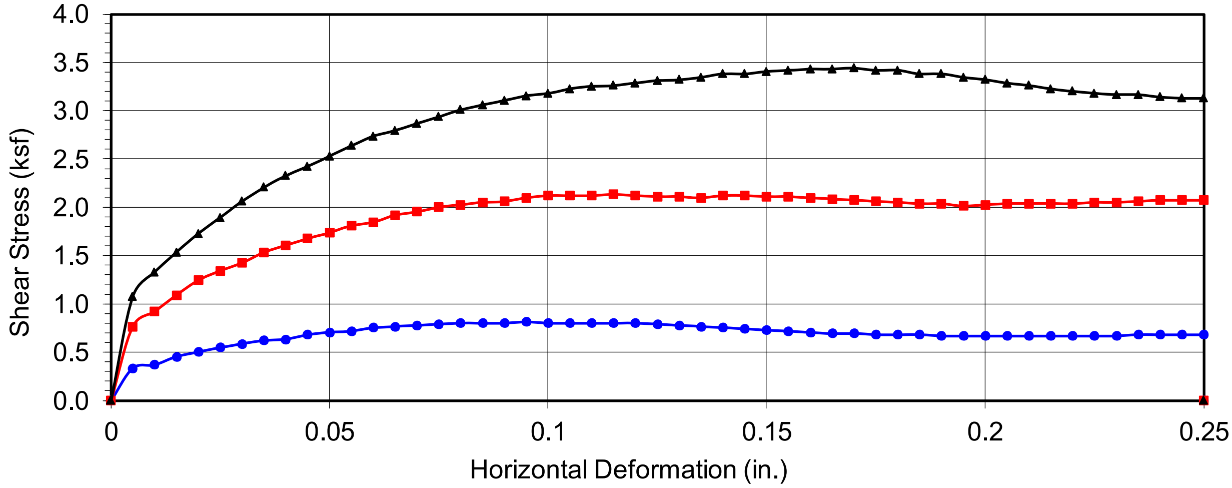
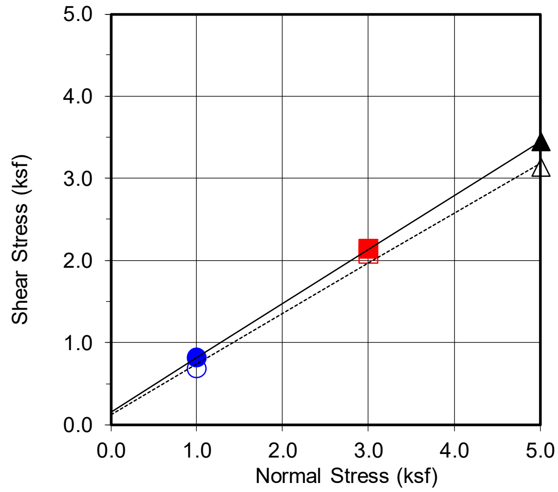
Figure B39





Boring No.	**B15**
Sample No.	**B15@10**
Depth (ft)	**10**
Sample Type:	Ring

Soil Identification:		
Poorly graded SAND (SP), light yellowish brown		
Strength Parameters		
	C (psf)	ϕ (°)
Peak	161	33.3
Ultimate	128	31.5

Normal Stress (kip/ft2)	1	3	5
Peak Shear Stress (kip/ft²)	● 0.82	■ 2.14	▲ 3.44
Shear Stress @ End of Test (ksf)	○ 0.68	□ 2.08	△ 3.13
Deformation Rate (in./min.)	0.05	0.05	0.05
Initial Sample Height (in.)	1.0	1.0	1.0
Ring Inside Diameter (in.)	2.375	2.375	2.375
Initial Moisture Content (%)	7.2	5.6	6.6
Initial Dry Density (pcf)	94.3	94.4	92.3
Initial Degree of Saturation (%)	24.6	19.4	21.6
Soil Height Before Shearing (in.)	1.2	1.2	1.2
Final Moisture Content (%)	26.4	26.3	25.8

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DIRECT SHEAR TEST RESULTS

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THOUSAND PALMS CHANNEL
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Figure B40

GEOCON
CONSULTANTS, INC.
3160 GOLD VALLEY DR – SUITE 800 – RANCHO CORDOVA, CA 95742
PHONE 916.852.9118 – FAX 916.852.9132

Hydraulic Conductivity
(ASTM D5084)

Project Name:	CVWD Thousand Palms Channel		
Project Number:	T2581-22-05	Cell Pressure (psi)	89
Beginning Test Date:	4/14/2022	In Pressure (psi)	80
Ending Test Date:	4/22/2022	Out Pressure (psi)	80
Sample ID:	B9-10	Burette area (cm^2)	0.872
Sample Description:	Brown Fat CLAY	Burette Correction (cm/ml)	1.147
Estimated Specific Gravity:	2.85		

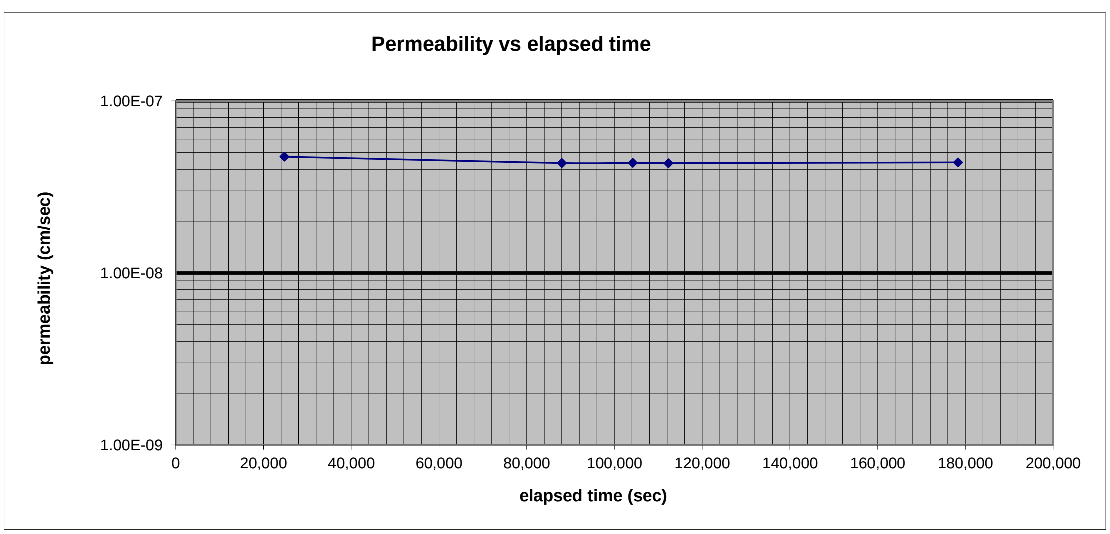
	1	2	3	AVG (inches)	AVG (cm)
Initial Height (in.)	1.949	1.947	1.948	1.95	4.95
Final Height (in.)	2.100	2.090	2.090	2.09	5.32
Initial Diameter (in.)	2.369	2.368	2.377	2.37	6.02
Final Diameter (in.)	2.487	2.450	2.437	2.46	6.24
Initial Area				4.42	28.49
Initial Volume (ft^3)	0.00498	Final Volume (ft^3)		0.00575	
Initial Volume (cm^3)	141.0	Final Volume (cm^3)		162.8	

	Weight (grams)	Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Void Ratio	Saturation (%)
Initial	267.38	**15.8**	118.4	**102.3**	0.739	60.8
Final	311.65	34.9	119.5	88.6	1.008	98.8
Dry	230.94					

Beginning Date & Time	End Date & Time	Elapsed Time (sec.)	Burette Out (ml)	Burette In (ml)	Pressure Head (cm)	Gradient	H1 (cm)	H2 (cm)	Outflow (ml)	Inflow (ml)	Outflow to Inflow Ratio	Permeability (cm/s)
4/20/22 8:24 AM			23.95	1.20	-	5.3	26.1					
	4/20/22 3:17 PM	24,780	23.80	1.40	-	5.2		25.7	0.15	0.20	0.75	4.74E-08
4/20/22 3:17 PM		24,780	23.80	1.40	-	5.2	25.7					
	4/21/22 8:51 AM	63,240	23.40	1.80	-	5.0		24.8	0.40	0.40	1.00	4.35E-08
4/21/22 8:51 AM		88,020	23.40	1.80	-	5.0	24.8					
	4/21/22 1:20 PM	16,140	23.30	1.90	-	5.0		24.5	0.10	0.10	1.00	4.36E-08
4/21/22 1:20 PM		104,160	23.30	1.90	-	5.0	24.5					
	4/21/22 3:36 PM	8,160	23.25	1.95	-	4.9		24.4	0.05	0.05	1.00	4.35E-08
4/21/22 3:36 PM		112,320	23.25	1.95	-	4.9	24.4					
	4/22/22 9:56 AM	66,000	22.90	2.40	-	4.8		23.5	0.35	0.45	0.78	4.39E-08
		178,320										

Average Permeability (cm/s):	**4.36E-08**
Average Permeability @ 20°C (in/hr):	**0.000**
Permeability @ 20°C (cm/s)	**4.14E-08**

Notes:	Insitu Soil Sample		
Average temperature during test °C =	22.2		
Tap water utlized as permeant			
Tested By:	M. Repking	Calculated By: MR	Reviewed By: JZ



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3160 GOLD VALLEY DR – SUITE 800 – RANCHO CORDOVA, CA 95742
PHONE 916.852.9118 – FAX 916.852.9132

Hydraulic Conductivity
(ASTM D5084)

Project Name:	CVWD Thousand Palms Channel		
Project Number:	T2581-22-05	Cell Pressure (psi)	88.1
Beginning Test Date:	4/14/2022	In Pressure (psi)	70
Ending Test Date:	4/21/2022	Out Pressure (psi)	70
Sample ID:	B9-20	Burette area (cm^2)	0.872
Sample Description:	Olive Brown Silty Clayey SAND	Burette Correction (cm/ml)	1.147
Estimated Specific Gravity:	2.85		

	1	2	3	AVG (inches)	AVG (cm)
Initial Height (in.)	2.000	2.000	2.000	2.00	5.08
Final Height (in.)	1.930	1.930	1.920	1.93	4.89
Initial Diameter (in.)	2.370	2.370	2.370	2.37	6.02
Final Diameter (in.)	2.350	2.350	2.350	2.35	5.97
Initial Area				4.41	28.46
Initial Volume (ft^3)	0.00511	Final Volume (ft^3)		0.00484	
Initial Volume (cm^3)	144.6	Final Volume (cm^3)		136.9	

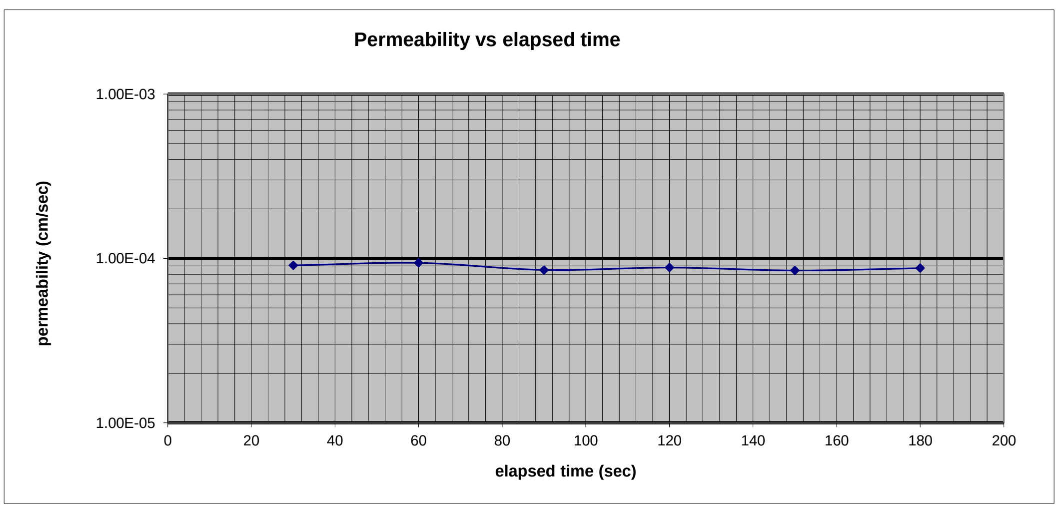
	Weight (grams)	Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Void Ratio	Saturation (%)
Initial	211.77	**3.9**	91.4	**88.0**	1.021	10.9
Final	267.63	31.3	122.0	92.9	0.914	97.6
Dry	203.84					

Beginning Date & Time	End Date & Time	Elapsed Time (sec.)	Burette Out (ml)	Burette In (ml)	Pressure Head (cm)	Gradient	H1 (cm)	H2 (cm)	Outflow (ml)	Inflow (ml)	Outflow to Inflow Ratio	Permeability (cm/s)
4/20/22 3:58 PM			24.40	1.10	-	5.3	26.7					
	4/20/22 3:58 PM	30	24.00	1.50	-	5.1		25.8	0.40	0.40	1.00	9.06E-05
4/20/22 3:58 PM		30	24.00	1.50	-	5.1	25.8					
	4/20/22 3:59 PM	30	23.60	1.90	-	4.9		24.9	0.40	0.40	1.00	9.39E-05
4/20/22 3:59 PM		60	23.60	1.90	-	4.9	24.9					
	4/20/22 3:59 PM	30	23.20	2.20	-	4.7		24.1	0.40	0.30	1.33	8.51E-05
4/20/22 3:59 PM		90	23.20	2.20	-	4.7	24.1					
	4/20/22 4:00 PM	30	22.90	2.60	-	4.6		23.3	0.30	0.40	0.75	8.79E-05
4/20/22 4:00 PM		120	22.90	2.60	-	4.6	23.3					
	4/20/22 4:00 PM	30	22.55	2.90	-	4.4		22.5	0.35	0.30	1.17	8.44E-05
4/20/22 4:00 PM		150	22.55	2.90	-	4.4	22.5					
	4/20/22 4:01 PM	30	22.20	3.20	-	4.3		21.8	0.35	0.30	1.17	8.73E-05
		180										

Average Permeability (cm/s):	**8.62E-05**
Average Permeability @ 20°C (in/hr):	**0.114**
Permeability @ 20°C (cm/s)	**8.02E-05**

Notes: Insitu Soil Sample
Average temperature during test °C = 23.0
Tap water utlized as permeant

Tested By: M. Repking | Calculated By: MR | Reviewed By: JZ



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PHONE 916.852.9118 – FAX 916.852.9132

Hydraulic Conductivity
(ASTM D5084)

Project Name:	CVWD Thousand Palms Channel		
Project Number:	T2581-22-05	Cell Pressure (psi)	87.1
Beginning Test Date:	4/14/2022	In Pressure (psi)	60
Ending Test Date:	4/21/2022	Out Pressure (psi)	60
Sample ID:	B9-30	Burette area (cm^2)	0.872
Sample Description	Olive Brown Silty Clayey SAND	Burette Correction (cm/ml)	1.147
Estimated Specific Gravity:	2.85		

	1	2	3	AVG (inches)	AVG (cm)
Initial Height (in.)	2.000	2.000	2.000	2.00	5.08
Final Height (in.)	1.910	1.910	1.910	1.91	4.85
Initial Diameter (in.)	2.370	2.370	2.370	2.37	6.02
Final Diameter (in.)	2.380	2.390	2.385	2.39	6.06
Initial Area				4.41	28.46

Initial Volume (ft^3)	0.00511	Final Volume (ft^3)	0.00494
Initial Volume (cm^3)	144.6	Final Volume (cm^3)	139.8

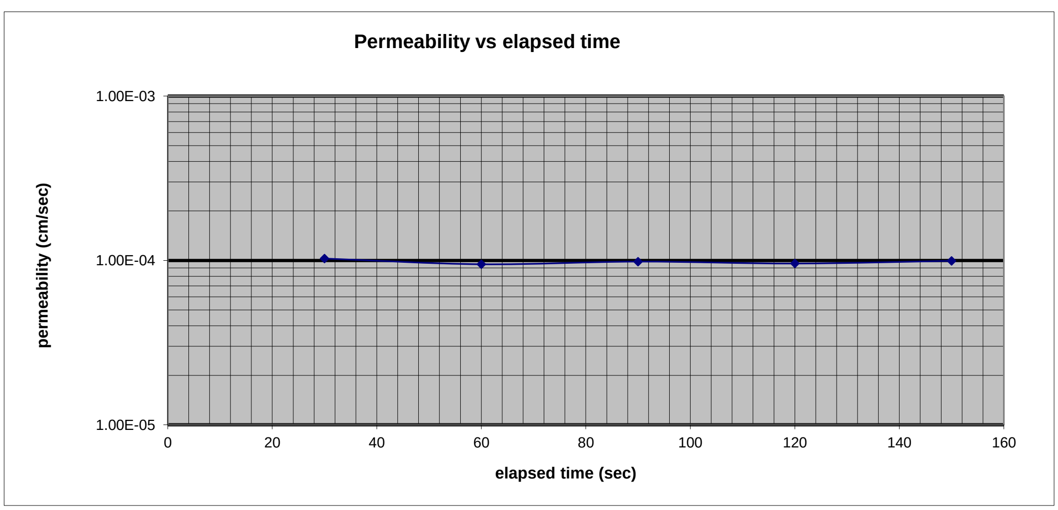
	Weight (grams)	Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Void Ratio	Saturation (%)
Initial	253.7	**15.6**	109.5	**94.8**	0.877	50.7
Final	281.23	28.1	125.6	98.0	0.815	98.4
Dry	219.47					

Beginning Date & Time	End Date & Time	Elapsed Time (sec.)	Burette Out (ml)	Burette In (ml)	Pressure Head (cm)	Gradient	H1 (cm)	H2 (cm)	Outflow (ml)	Inflow (ml)	Outflow to Inflow Ratio	Permeability (cm/s)
4/20/22 3:53 PM			24.20	1.00	-	5.2	26.6					
	4/20/22 3:53 PM	30	23.80	1.50	-	5.0		25.6	0.40	0.50	0.80	1.03E-04
4/20/22 3:53 PM		30	23.80	1.50	-	5.0	25.6					
	4/20/22 3:54 PM	30	23.40	1.90	-	4.9		24.7	0.40	0.40	1.00	9.48E-05
4/20/22 3:54 PM		60	23.40	1.90	-	4.9	24.7					
	4/20/22 3:54 PM	30	23.00	2.30	-	4.7		23.7	0.40	0.40	1.00	9.84E-05
4/20/22 3:54 PM		90	23.00	2.30	-	4.7	23.7					
	4/20/22 3:55 PM	30	22.60	2.65	-	4.5		22.9	0.40	0.35	1.14	9.57E-05
4/20/22 3:55 PM		120	22.60	2.65	-	4.5	22.9					
	4/20/22 3:55 PM	30	22.20	3.00	-	4.3		22.0	0.40	0.35	1.14	9.94E-05
		150										

Average Permeability (cm/s):	**9.76E-05**
Average Permeability @ 20°C (in/hr):	**0.129**
Permeability @ 20°C (cm/s)	**9.08E-05**

Notes: Insitu Soil Sample
Average temperature during test °C = 23.0
Tap water utlized as permeant

Tested By: M. Repking | Calculated By: MR | Reviewed By: JZ



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Hydraulic Conductivity
(ASTM D5084)

Project Name:	CVWD Thousand Palms Channel		
Project Number:	T2581-22-05	Cell Pressure (psi)	79
Beginning Test Date:	4/14/2022	In Pressure (psi)	70
Ending Test Date:	4/22/2022	Out Pressure (psi)	70
Sample ID:	B13-10	Burette area (cm^2)	0.872
Sample Description:	Olive Brown lean CLAY	Burette Correction (cm/ml)	1.147
Estimated Specific Gravity:	2.85		

	1	2	3	AVG (inches)	AVG (cm)
Initial Height (in.)	1.000	1.000	1.000	1.00	2.54
Final Height (in.)	0.950	0.975	0.970	0.97	2.45
Initial Diameter (in.)	2.370	2.370	2.370	2.37	6.02
Final Diameter (in.)	2.420	2.400	2.400	2.41	6.11
Initial Area				4.41	28.46
Initial Volume (ft^3)	0.00255	Final Volume (ft^3)		0.00254	
Initial Volume (cm^3)	72.3	Final Volume (cm^3)		71.9	

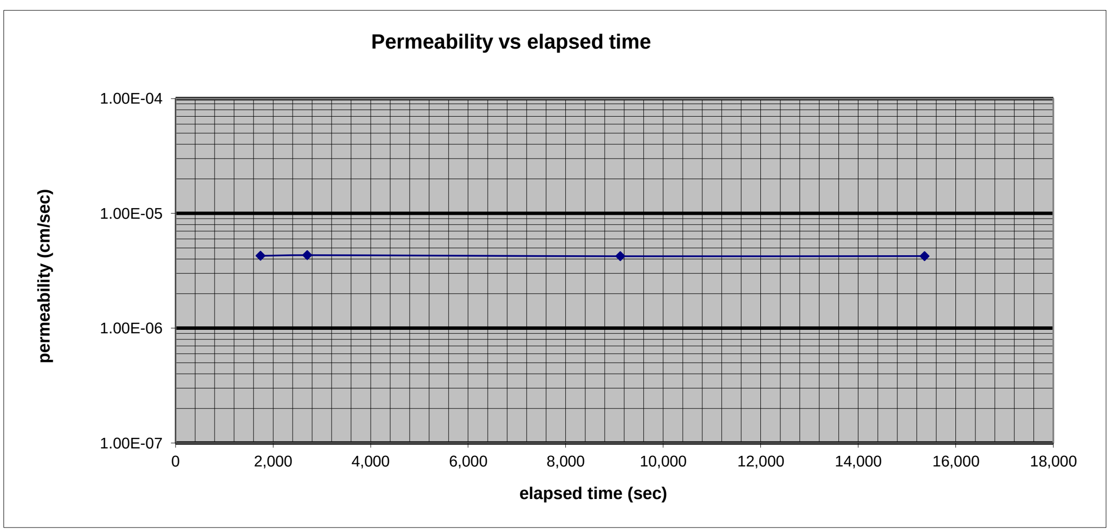
	Weight (grams)	Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Void Ratio	Saturation (%)
Initial	116.59	**8.6**	100.7	**92.7**	0.918	26.6
Final	141.6	31.9	122.9	93.2	0.908	100.0
Dry	107.39					

Beginning Date & Time	End Date & Time	Elapsed Time (sec.)	Burette Out (ml)	Burette In (ml)	Pressure Head (cm)	Gradient	H1 (cm)	H2 (cm)	Outflow (ml)	Inflow (ml)	Outflow to Inflow Ratio	Permeability (cm/s)
4/21/22 12:35 PM			24.00	0.70	-	10.5	26.7					
	4/21/22 1:04 PM	1,740	21.95	2.70	-	8.7		22.1	2.05	2.00	1.03	4.27E-06
4/21/22 1:04 PM		1,740	21.95	2.70	-	8.7	22.1					
	4/21/22 1:20 PM	960	20.95	3.65	-	7.8		19.8	1.00	0.95	1.05	4.33E-06
4/21/22 1:20 PM		2,700	20.95	3.65	-	7.8	19.8					
	4/21/22 3:07 PM	6,420	16.60	8.00	-	3.9		9.9	4.35	4.35	1.00	4.24E-06
4/21/22 3:07 PM		9,120	16.60	8.00	-	3.9	9.9					
	4/21/22 4:51 PM	6,240	14.45	10.10	-	2.0		5.0	2.15	2.10	1.02	4.25E-06
		15,360										

Average Permeability (cm/s): 4.27E-06
Average Permeability @ 20°C (in/hr): 0.006
Permeability @ 20°C (cm/s): 4.05E-06

Notes: Insitu Soil Sample
Average temperature during test °C = 22.2
Tap water utlized as permeant

Tested By: M. Repking | Calculated By: MR | Reviewed By: JZ



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Hydraulic Conductivity
(ASTM D5084)

Project Name:	CVWD Thousand Palms Channel		
Project Number:	T2581-22-05	Cell Pressure (psi)	79
Beginning Test Date:	4/15/2022	In Pressure (psi)	70
Ending Test Date:	4/22/2022	Out Pressure (psi)	70
Sample ID:	B13-20	Burette area (cm^2)	0.872
Sample Description:	Olive Silty CLAY	Burette Correction (cm/ml)	1.147
Estimated Specific Gravity:	2.75		

	1	2	3	AVG (inches)	AVG (cm)
Initial Height (in.)	2.000	2.000	2.000	2.00	5.08
Final Height (in.)	1.970	1.960	1.985	1.97	5.01
Initial Diameter (in.)	2.386	2.382	2.377	2.38	6.05
Final Diameter (in.)	2.385	2.415	2.382	2.39	6.08
Initial Area				4.46	28.74
Initial Volume (ft^3)	0.00516	Final Volume (ft^3)		0.00514	
Initial Volume (cm^3)	146.0	Final Volume (cm^3)		145.4	

	Weight (grams)	Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Void Ratio	Saturation (%)
Initial	256.91	**11.6**	109.8	**98.4**	0.744	42.9
Final	292.1	26.9	125.4	98.8	0.737	100.4
Dry	230.2					

Beginning Date & Time	End Date & Time	Elapsed Time (sec.)	Burette Out (ml)	Burette In (ml)	Pressure Head (cm)	Gradient	H1 (cm)	H2 (cm)	Outflow (ml)	Inflow (ml)	Outflow to Inflow Ratio	Permeability (cm/s)
4/21/22 8:56 AM			24.50	1.40	-	5.2	26.5					
	4/21/22 10:00 AM	3,840	23.20	2.60	-	4.7		23.6	1.30	1.20	1.08	2.30E-06
4/21/22 10:00 AM		3,840	23.20	2.60	-	4.7	23.6					
	4/21/22 12:32 PM	9,120	20.70	5.10	-	3.5		17.9	2.50	2.50	1.00	2.35E-06
4/21/22 12:32 PM		12,960	20.70	5.10	-	3.5	17.9					
	4/21/22 1:05 PM	1,980	20.25	5.55	-	3.3		16.9	0.45	0.45	1.00	2.31E-06
4/21/22 1:05 PM		14,940	20.25	5.55	-	3.3	16.9					
	4/21/22 1:21 PM	960	20.05	5.75	-	3.2		16.4	0.20	0.20	1.00	2.21E-06
4/21/22 1:21 PM		15,900	20.05	5.75	-	3.2	16.4					
	4/21/22 3:08 PM	6,420	18.90	7.00	-	2.7		13.6	1.15	1.25	0.92	2.21E-06
		22,320										

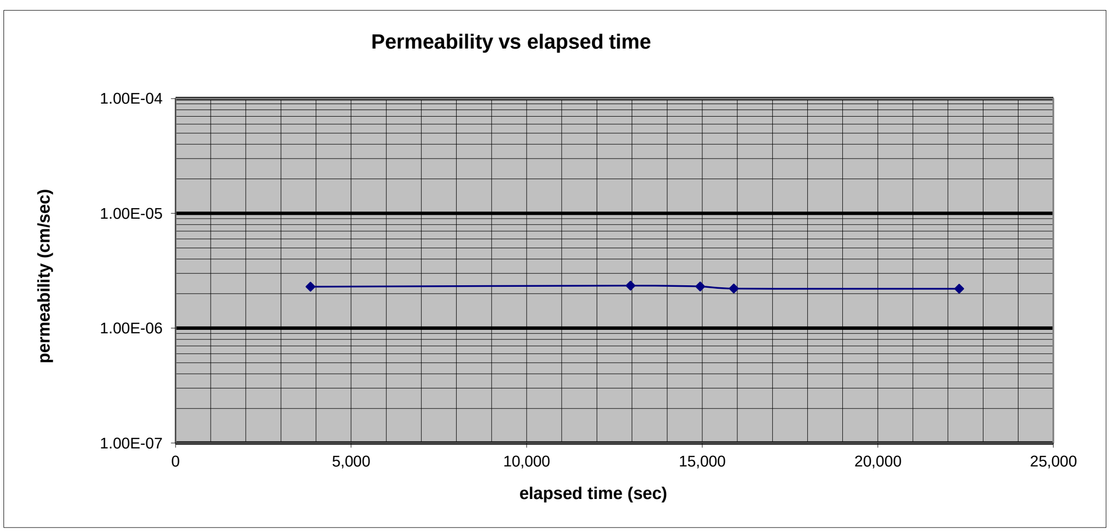
Average Permeability (cm/s):	2.27E-06
Average Permeability @ 20^{o}C (in/hr):	**0.003**
Permeability @ 20^{o}C (cm/s)	**2.10E-06**

Notes: Insitu Soil Sample

Average temperature during test ^{0}C = 23.3

Tap water utlized as permeant

Tested By: M. Repking | Calculated By: MR | Reviewed By: MR



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Hydraulic Conductivity
(ASTM D5084)

Project Name:	CVWD Thousand Palms Channel		
Project Number:	T2581-22-05	Cell Pressure (psi)	87.1
Beginning Test Date:	4/15/2022	In Pressure (psi)	60
Ending Test Date:	4/21/2022	Out Pressure (psi)	60
Sample ID:	B13-30	Burette area (cm^2)	0.872
Sample Description:	Olive Silty SAND	Burette Correction (cm/ml)	1.147
Estimated Specific Gravity:	2.75		

	1	2	3	AVG (inches)	AVG (cm)
Initial Height (in.)	2.000	2.000	2.000	2.00	5.08
Final Height (in.)	1.950	1.950	1.950	1.95	4.95
Initial Diameter (in.)	2.370	2.370	2.370	2.37	6.02
Final Diameter (in.)	2.365	2.365	2.365	2.37	6.01
Initial Area				4.41	28.46
Initial Volume (ft^3)	0.00511	Final Volume (ft^3)		0.00496	
Initial Volume (cm^3)	144.6	Final Volume (cm^3)		140.4	

	Weight (grams)	Moisture Content (%)	Wet Density (pcf)	Dry Density (pcf)	Void Ratio	Saturation (%)
Initial	237.42	**2.8**	102.5	**99.7**	0.722	10.8
Final	285.97	23.9	127.2	102.7	0.671	97.8
Dry	230.86					

Beginning Date & Time	End Date & Time	Elapsed Time (sec.)	Burette Out (ml)	Burette In (ml)	Pressure Head (cm)	Gradient	H1 (cm)	H2 (cm)	Outflow (ml)	Inflow (ml)	Outflow to Inflow Ratio	Permeability (cm/s)
4/20/22 3:46 PM			24.00	0.45	-	5.3	27.0					
	4/20/22 3:46 PM	30	22.90	1.50	-	4.8		24.5	1.10	1.05	1.05	2.48E-04
4/20/22 3:46 PM		30	22.90	1.50	-	4.8	24.5					
	4/20/22 3:47 PM	30	22.00	2.40	-	4.4		22.5	0.90	0.90	1.00	2.28E-04
4/20/22 3:47 PM		60	22.00	2.40	-	4.4	22.5					
	4/20/22 3:47 PM	30	21.20	3.20	-	4.1		20.6	0.80	0.80	1.00	2.21E-04
4/20/22 3:47 PM		90	21.20	3.20	-	4.1	20.6					
	4/20/22 3:48 PM	30	20.50	3.90	-	3.7		19.0	0.70	0.70	1.00	2.10E-04
4/20/22 3:48 PM		120	20.50	3.90	-	3.7	19.0					
	4/20/22 3:48 PM	30	19.90	4.50	-	3.5		17.7	0.60	0.60	1.00	1.95E-04
4/20/22 3:48 PM		150	19.90	4.50	-	3.5	17.7					
	4/20/22 3:49 PM	30	19.25	5.10	-	3.2		16.2	0.65	0.60	1.08	2.20E-04
4/20/22 3:49 PM		180	19.25	5.10	-	3.2	16.2					
	4/20/22 3:49 PM	30	18.70	5.60	-	3.0		15.0	0.55	0.50	1.10	2.00E-04
		210										

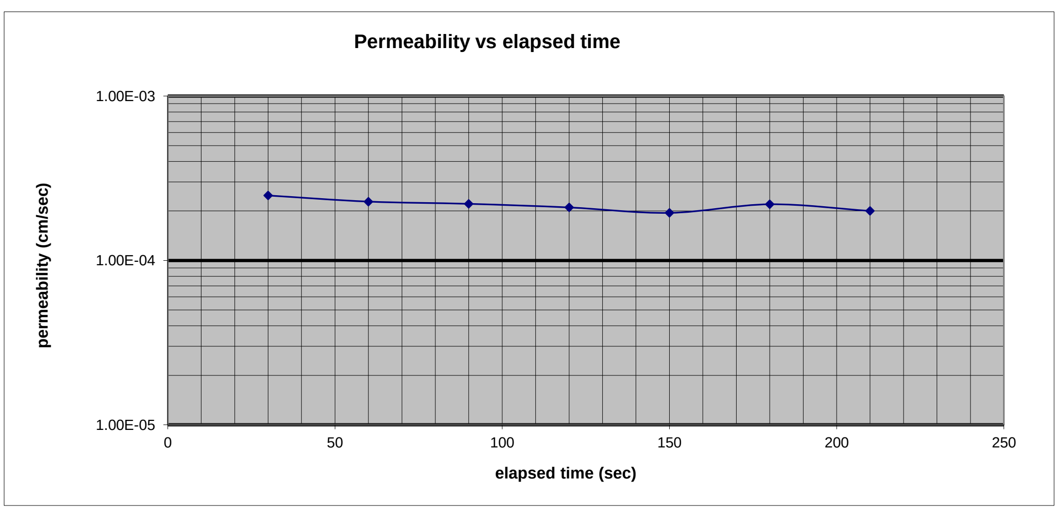
Average Permeability (cm/s):	**2.06E-04**
Average Permeability @ 20°C (in/hr):	**0.277**
Permeability @ 20°C (cm/s)	**1.96E-04**

Notes: Insitu Soil Sample

Average temperature during test °C = 22.2

Tap water utlized as permeant

Tested By: M. Repking   Calculated By: MR   Reviewed By: JZ



APPENDIX C

APPENDIX C

RECOMMENDED GRADING SPECIFICATIONS

FOR

THOUSAND PALMS CHANNEL
COACHELLA VALLEY WATER DISTRICT
INDIO, CALIFORNIA

PROJECT NO. T2581-22-05

RECOMMENDED GRADING SPECIFICATIONS

1. GENERAL

1.1 These Recommended Grading Specifications shall be used in conjunction with the Geotechnical Report for the project prepared by Geocon. The recommendations contained in the text of the Geotechnical Report are a part of the earthwork and grading specifications and shall supersede the provisions contained hereinafter in the case of conflict.

1.2 Prior to the commencement of grading, a geotechnical consultant (Consultant) shall be employed for the purpose of observing earthwork procedures and testing the fills for substantial conformance with the recommendations of the Geotechnical Report and these specifications. The Consultant should provide adequate testing and observation services so that they may assess whether, in their opinion, the work was performed in substantial conformance with these specifications. It shall be the responsibility of the Contractor to assist the Consultant and keep them apprised of work schedules and changes so that personnel may be scheduled accordingly.

1.3 It shall be the sole responsibility of the Contractor to provide adequate equipment and methods to accomplish the work in accordance with applicable grading codes or agency ordinances, these specifications and the approved grading plans. If, in the opinion of the Consultant, unsatisfactory conditions such as questionable soil materials, poor moisture condition, inadequate compaction, and/or adverse weather result in a quality of work not in conformance with these specifications, the Consultant will be empowered to reject the work and recommend to the Owner that grading be stopped until the unacceptable conditions are corrected.

2. DEFINITIONS

2.1 **Owner** shall refer to the owner of the property or the entity on whose behalf the grading work is being performed and who has contracted with the Contractor to have grading performed.

2.2 **Contractor** shall refer to the Contractor performing the site grading work.

2.3 **Civil Engineer** or **Engineer of Work** shall refer to the California licensed Civil Engineer or consulting firm responsible for preparation of the grading plans, surveying and verifying as-graded topography.

2.4 **Consultant** shall refer to the soil engineering and engineering geology consulting firm retained to provide geotechnical services for the project.

2.5 **Soil Engineer** shall refer to a California licensed Civil Engineer retained by the Owner, who is experienced in the practice of geotechnical engineering. The Soil Engineer shall be responsible for having qualified representatives on-site to observe and test the Contractor's work for conformance with these specifications.

2.6 **Engineering Geologist** shall refer to a California licensed Engineering Geologist retained by the Owner to provide geologic observations and recommendations during the site grading.

2.7 **Geotechnical Report** shall refer to a soil report (including all addenda) which may include a geologic reconnaissance or geologic investigation that was prepared specifically for the development of the project for which these Recommended Grading Specifications are intended to apply.

3. MATERIALS

3.1 Materials for compacted fill shall consist of any soil excavated from the cut areas or imported to the site that, in the opinion of the Consultant, is suitable for use in construction of fills. In general, fill materials can be classified as *soil* fills, *soil-rock* fills or *rock* fills, as defined below.

3.1.1 **Soil fills** are defined as fills containing no rocks or hard lumps greater than 12 inches in maximum dimension and containing at least 40 percent by weight of material smaller than ¾ inch in size.

3.1.2 **Soil-rock fills** are defined as fills containing no rocks or hard lumps larger than 4 feet in maximum dimension and containing a sufficient matrix of soil fill to allow for proper compaction of soil fill around the rock fragments or hard lumps as specified in Paragraph 6.2. **Oversize rock** is defined as material greater than 12 inches.

3.1.3 **Rock fills** are defined as fills containing no rocks or hard lumps larger than 3 feet in maximum dimension and containing little or no fines. Fines are defined as material smaller than ¾ inch in maximum dimension. The quantity of fines shall be less than approximately 20 percent of the rock fill quantity.

3.2 Material of a perishable, spongy, or otherwise unsuitable nature as determined by the Consultant shall not be used in fills.

3.3 Materials used for fill, either imported or on-site, shall not contain hazardous materials as defined by the California Code of Regulations, Title 22, Division 4, Chapter 30, Articles 9 and 10; 40CFR; and any other applicable local, state or federal laws. The Consultant shall not be responsible for the identification or analysis of the potential presence of hazardous materials. However, if observations, odors or soil discoloration cause Consultant to suspect the presence of hazardous materials, the Consultant may request from the Owner the termination of grading operations within the affected area. Prior to resuming grading operations, the Owner shall provide a written report to the Consultant indicating that the suspected materials are not hazardous as defined by applicable laws and regulations.

3.4 The outer 15 feet of *soil-rock* fill slopes, measured horizontally, should be composed of properly compacted *soil* fill materials approved by the Consultant. *Rock* fill may extend to the slope face, provided that the slope is not steeper than 2:1 (horizontal:vertical) and a soil layer no thicker than 12 inches is track-walked onto the face for landscaping purposes. This procedure may be utilized provided it is acceptable to the governing agency, Owner and Consultant.

3.5 Samples of soil materials to be used for fill should be tested in the laboratory by the Consultant to determine the maximum density, optimum moisture content, and, where appropriate, shear strength, expansion, and gradation characteristics of the soil.

3.6 During grading, soil or groundwater conditions other than those identified in the Geotechnical Report may be encountered by the Contractor. The Consultant shall be notified immediately to evaluate the significance of the unanticipated condition

4. CLEARING AND PREPARING AREAS TO BE FILLED

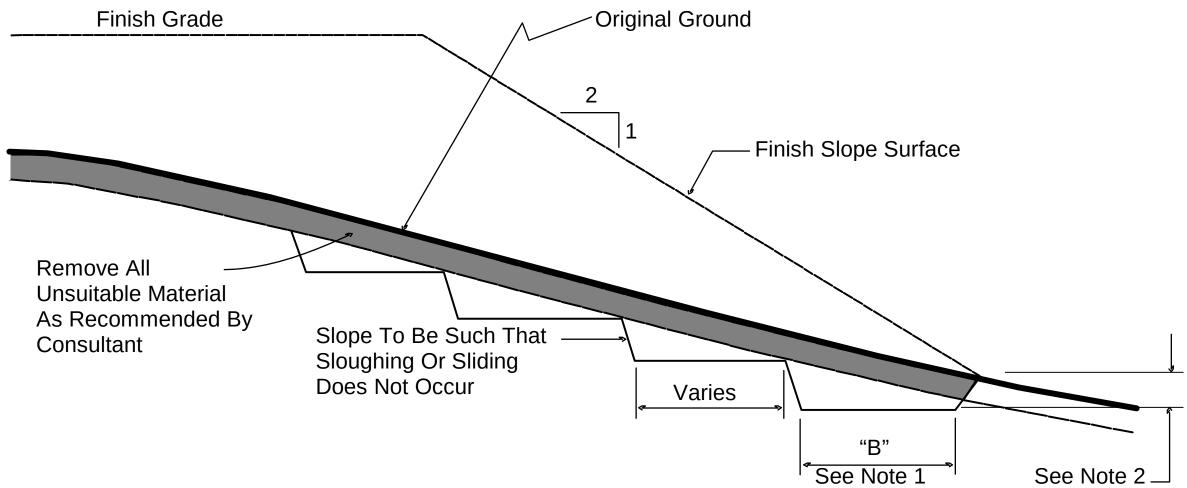
4.1 Areas to be excavated and filled shall be cleared and grubbed. Clearing shall consist of complete removal above the ground surface of trees, stumps, brush, vegetation, man-made structures, and similar debris. Grubbing shall consist of removal of stumps, roots, buried logs and other unsuitable material and shall be performed in areas to be graded. Roots and other projections exceeding 1½ inches in diameter shall be removed to a depth of 3 feet below the surface of the ground. Borrow areas shall be grubbed to the extent necessary to provide suitable fill materials.

4.2 Asphalt pavement material removed during clearing operations should be properly disposed at an approved off-site facility or in an acceptable area of the project evaluated by Geocon and the property owner. Concrete fragments that are free of reinforcing steel may be placed in fills, provided they are placed in accordance with Section 6.2 or 6.3 of this document.

4.3 After clearing and grubbing of organic matter and other unsuitable material, loose or porous soils shall be removed to the depth recommended in the Geotechnical Report. The depth of removal and compaction should be observed and approved by a representative of the Consultant. The exposed surface shall then be plowed or scarified to a minimum depth of 6 inches and until the surface is free from uneven features that would tend to prevent uniform compaction by the equipment to be used.

4.4 Where the slope ratio of the original ground is steeper than 5:1 (horizontal:vertical), or where recommended by the Consultant, the original ground should be benched in accordance with the following illustration.

TYPICAL BENCHING DETAIL



No Scale

DETAIL NOTES: (1) Key width "B" should be a minimum of 10 feet, or sufficiently wide to permit complete coverage with the compaction equipment used. The base of the key should be graded horizontal, or inclined slightly into the natural slope.

(2) The outside of the key should be below the topsoil or unsuitable surficial material and at least 2 feet into dense formational material. Where hard rock is exposed in the bottom of the key, the depth and configuration of the key may be modified as approved by the Consultant.

4.5 After areas to receive fill have been cleared and scarified, the surface should be moisture conditioned to achieve the proper moisture content, and compacted as recommended in Section 6 of these specifications.

5. COMPACTION EQUIPMENT

5.1 Compaction of *soil* or *soil-rock* fill shall be accomplished by sheepsfoot or segmented-steel wheeled rollers, vibratory rollers, multiple-wheel pneumatic-tired rollers, or other types of acceptable compaction equipment. Equipment shall be of such a design that it will be capable of compacting the *soil* or *soil-rock* fill to the specified relative compaction at the specified moisture content.

5.2 Compaction of *rock* fills shall be performed in accordance with Section 6.3.

6. PLACING, SPREADING AND COMPACTION OF FILL MATERIAL

6.1 *Soil* fill, as defined in Paragraph 3.1.1, shall be placed by the Contractor in accordance with the following recommendations:

6.1.1 *Soil* fill shall be placed by the Contractor in layers that, when compacted, should generally not exceed 8 inches. Each layer shall be spread evenly and shall be thoroughly mixed during spreading to obtain uniformity of material and moisture in each layer. The entire fill shall be constructed as a unit in nearly level lifts. Rock materials greater than 12 inches in maximum dimension shall be placed in accordance with Section 6.2 or 6.3 of these specifications.

6.1.2 In general, the *soil* fill shall be compacted at a moisture content at or above the optimum moisture content as determined by ASTM D 1557.

6.1.3 When the moisture content of *soil* fill is below that specified by the Consultant, water shall be added by the Contractor until the moisture content is in the range specified.

6.1.4 When the moisture content of the *soil* fill is above the range specified by the Consultant or too wet to achieve proper compaction, the *soil* fill shall be aerated by the Contractor by blading/mixing, or other satisfactory methods until the moisture content is within the range specified.

6.1.5 After each layer has been placed, mixed, and spread evenly, it shall be thoroughly compacted by the Contractor to a relative compaction of at least 90 percent. Relative compaction is defined as the ratio (expressed in percent) of the in-place dry density of the compacted fill to the maximum laboratory dry density as determined in accordance with ASTM D 1557. Compaction shall be continuous over the entire area, and compaction equipment shall make sufficient passes so that the specified minimum relative compaction has been achieved throughout the entire fill.

6.1.6 Where practical, soils having an Expansion Index greater than 50 should be placed at least 3 feet below finish pad grade and should be compacted at a moisture content generally 2 to 4 percent greater than the optimum moisture content for the material.

6.1.7 Properly compacted *soil* fill shall extend to the design surface of fill slopes. To achieve proper compaction, it is recommended that fill slopes be over-built by at least 3 feet and then cut to the design grade. This procedure is considered preferable to track-walking of slopes, as described in the following paragraph.

6.1.8 As an alternative to over-building of slopes, slope faces may be back-rolled with a heavy-duty loaded sheepsfoot or vibratory roller at maximum 4-foot fill height intervals. Upon completion, slopes should then be track-walked with a D-8 dozer or similar equipment, such that a dozer track covers all slope surfaces at least twice.

6.2 *Soil-rock* fill, as defined in Paragraph 3.1.2, shall be placed by the Contractor in accordance with the following recommendations:

6.2.1 Rocks larger than 12 inches but less than 4 feet in maximum dimension may be incorporated into the compacted *soil* fill, but shall be limited to the area measured 15 feet minimum horizontally from the slope face and 5 feet below finish grade or 3 feet below the deepest utility, whichever is deeper.

6.2.2 Rocks or rock fragments up to 4 feet in maximum dimension may either be individually placed or placed in windrows. Under certain conditions, rocks or rock fragments up to 10 feet in maximum dimension may be placed using similar methods. The acceptability of placing rock materials greater than 4 feet in maximum dimension shall be evaluated during grading as specific cases arise and shall be approved by the Consultant prior to placement.

6.2.3 For individual placement, sufficient space shall be provided between rocks to allow for passage of compaction equipment.

6.2.4 For windrow placement, the rocks should be placed in trenches excavated in properly compacted *soil* fill. Trenches should be approximately 5 feet wide and 4 feet deep in maximum dimension. The voids around and beneath rocks should be filled with approved granular soil having a Sand Equivalent of 30 or greater and should be compacted by flooding. Windrows may also be placed utilizing an "open-face" method in lieu of the trench procedure, however, this method should first be approved by the Consultant.

6.2.5 Windrows should generally be parallel to each other and may be placed either parallel to or perpendicular to the face of the slope depending on the site geometry. The minimum horizontal spacing for windrows shall be 12 feet center-to-center with a 5-foot stagger or offset from lower courses to next overlying course. The minimum vertical spacing between windrow courses shall be 2 feet from the top of a lower windrow to the bottom of the next higher windrow.

6.2.6 Rock placement, fill placement and flooding of approved granular soil in the windrows should be continuously observed by the Consultant.

6.3 *Rock* fills, as defined in Section 3.1.3, shall be placed by the Contractor in accordance with the following recommendations:

6.3.1 The base of the *rock* fill shall be placed on a sloping surface (minimum slope of 2 percent). The surface shall slope toward suitable subdrainage outlet facilities. The *rock* fills shall be provided with subdrains during construction so that a hydrostatic pressure buildup does not develop. The subdrains shall be permanently connected to controlled drainage facilities to control post-construction infiltration of water.

6.3.2 *Rock* fills shall be placed in lifts not exceeding 3 feet. Placement shall be by rock trucks traversing previously placed lifts and dumping at the edge of the currently placed lift. Spreading of the *rock* fill shall be by dozer to facilitate *seating* of the rock. The *rock* fill shall be watered heavily during placement. Watering shall consist of water trucks traversing in front of the current rock lift face and spraying water continuously during rock placement. Compaction equipment with compactive energy comparable to or greater than that of a 20-ton steel vibratory roller or other compaction equipment providing suitable energy to achieve the required compaction or deflection as recommended in Paragraph 6.3.3 shall be utilized. The number of passes to be made should be determined as described in Paragraph 6.3.3. Once a *rock* fill lift has been covered with *soil* fill, no additional *rock* fill lifts will be permitted over the *soil* fill.

6.3.3 Plate bearing tests, in accordance with ASTM D 1196, may be performed in both the compacted *soil* fill and in the *rock* fill to aid in determining the required minimum number of passes of the compaction equipment. If performed, a minimum of three plate bearing tests should be performed in the properly compacted *soil* fill (minimum relative compaction of 90 percent). Plate bearing tests shall then be performed on areas of *rock* fill having two passes, four passes and six passes of the compaction equipment, respectively. The number of passes required for the *rock* fill shall be determined by comparing the results of the plate bearing tests for the *soil* fill and the *rock* fill and by evaluating the deflection variation with number of passes. The required number of passes of the compaction equipment will be performed as necessary until the plate bearing deflections are equal to or less than that determined for the properly compacted *soil* fill. In no case will the required number of passes be less than two.

6.3.4 A representative of the Consultant should be present during *rock* fill operations to observe that the minimum number of "passes" have been obtained, that water is being properly applied and that specified procedures are being followed. The actual number of plate bearing tests will be determined by the Consultant during grading.

6.3.5 Test pits shall be excavated by the Contractor so that the Consultant can state that, in their opinion, sufficient water is present and that voids between large rocks are properly filled with smaller rock material. In-place density testing will not be required in the *rock* fills.

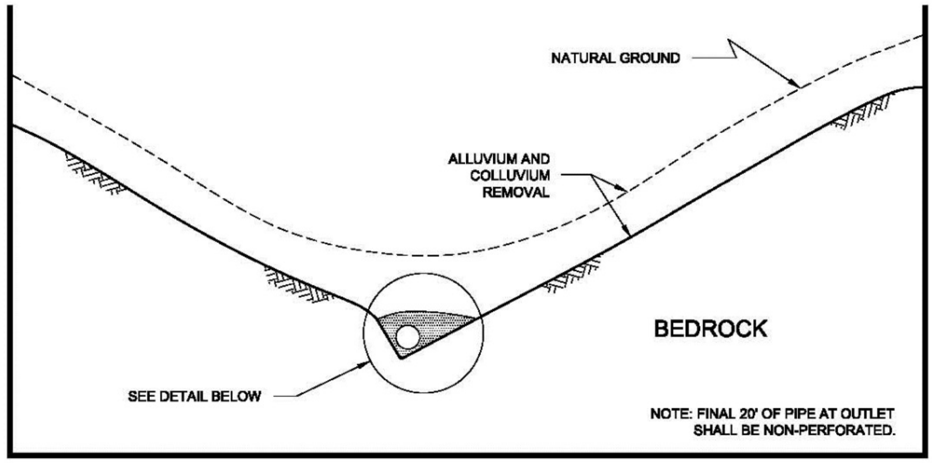
6.3.6 To reduce the potential for "piping" of fines into the *rock* fill from overlying *soil* fill material, a 2-foot layer of graded filter material shall be placed above the uppermost lift of *rock* fill. The need to place graded filter material below the *rock* should be determined by the Consultant prior to commencing grading. The gradation of the graded filter material will be determined at the time the *rock* fill is being excavated. Materials typical of the *rock* fill should be submitted to the Consultant in a timely manner, to allow design of the graded filter prior to the commencement of *rock* fill placement.

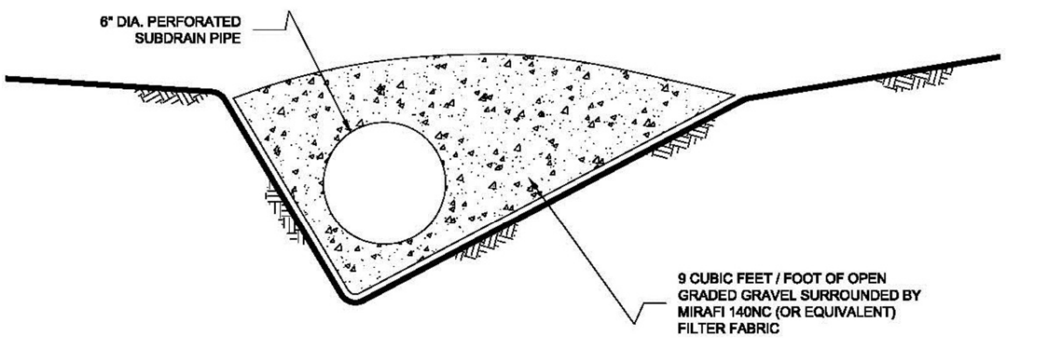
6.3.7 *Rock* fill placement should be continuously observed during placement by the Consultant.

7. SUBDRAINS

7.1 The geologic units on the site may have permeability characteristics and/or fracture systems that could be susceptible under certain conditions to seepage. The use of canyon subdrains may be necessary to mitigate the potential for adverse impacts associated with seepage conditions. Canyon subdrains with lengths in excess of 500 feet or extensions of existing offsite subdrains should use 8-inch-diameter pipes. Canyon subdrains less than 500 feet in length should use 6-inch-diameter pipes.

TYPICAL CANYON DRAIN DETAIL





NOTES:

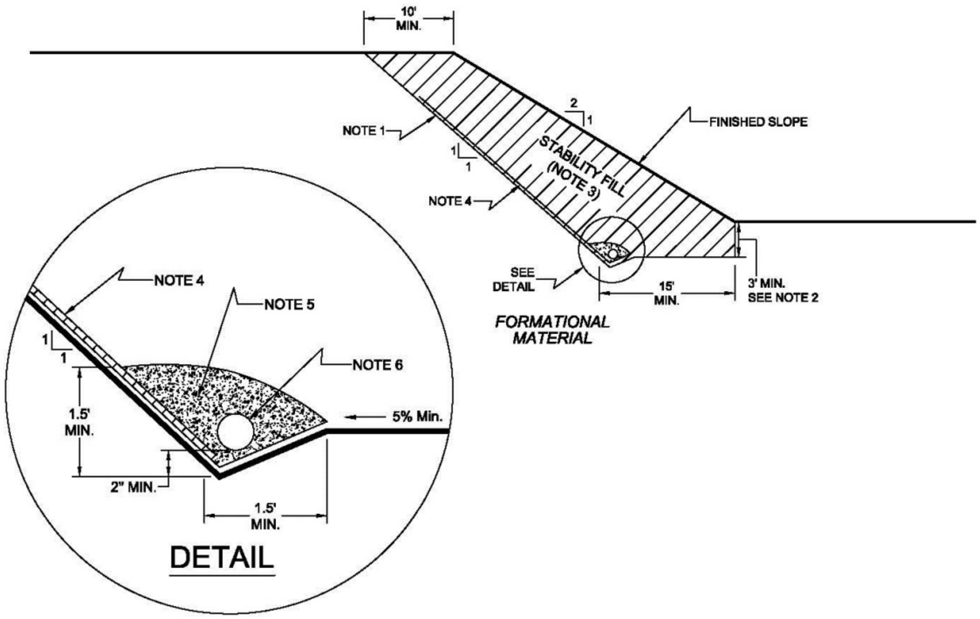
1......6-INCH DIAMETER, SCHEDULE 80 PVC PERFORATED PIPE FOR FILLS IN EXCESS OF 100-FEET IN DEPTH OR A PIPE LENGTH OF LONGER THAN 500 FEET.

2......6-INCH DIAMETER, SCHEDULE 40 PVC PERFORATED PIPE FOR FILLS LESS THAN 100-FEET IN DEPTH OR A PIPE LENGTH SHORTER THAN 500 FEET.

NO SCALE

7.2 Slope drains within stability fill keyways should use 4-inch-diameter (or lager) pipes.

TYPICAL STABILITY FILL DETAIL



NOTES:

1.....EXCAVATE BACKCUT AT 1:1 INCLINATION (UNLESS OTHERWISE NOTED).

2.....BASE OF STABILITY FILL TO BE 3 FEET INTO FORMATIONAL MATERIAL, SLOPING A MINIMUM 5% INTO SLOPE.

3.....STABILITY FILL TO BE COMPOSED OF PROPERLY COMPACTED GRANULAR SOIL.

4.....CHIMNEY DRAINS TO BE APPROVED PREFABRICATED CHIMNEY DRAIN PANELS (MIRADRAIN G200N OR EQUIVALENT) SPACED APPROXIMATELY 20 FEET CENTER TO CENTER AND 4 FEET WIDE. CLOSER SPACING MAY BE REQUIRED IF SEEPAGE IS ENCOUNTERED.

5.....FILTER MATERIAL TO BE 3/4-INCH, OPEN-GRADED CRUSHED ROCK ENCLOSED IN APPROVED FILTER FABRIC (MIRAFI 140NC).

6.....COLLECTOR PIPE TO BE 4-INCH MINIMUM DIAMETER, PERFORATED, THICK-WALLED PVC SCHEDULE 40 OR EQUIVALENT, AND SLOPED TO DRAIN AT 1 PERCENT MINIMUM TO APPROVED OUTLET.

NO SCALE

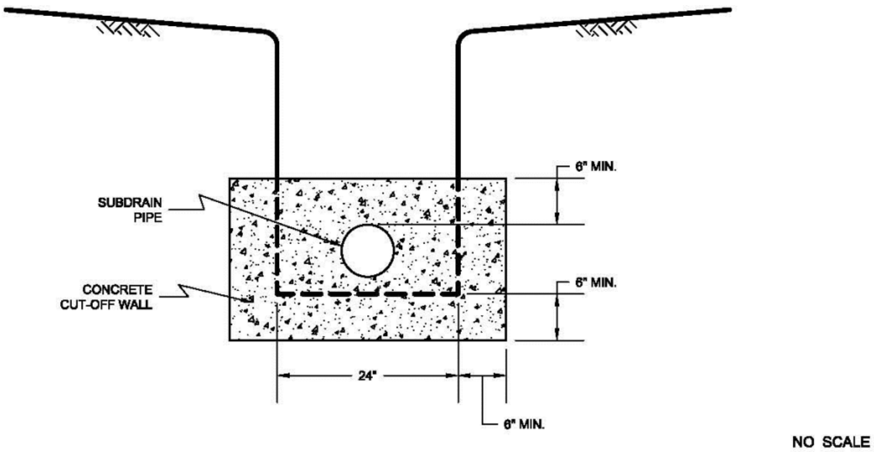
7.3 The actual subdrain locations will be evaluated in the field during the remedial grading operations. Additional drains may be necessary depending on the conditions observed and the requirements of the local regulatory agencies. Appropriate subdrain outlets should be evaluated prior to finalizing 40-scale grading plans.

7.4 *Rock* fill or *soil-rock* fill areas may require subdrains along their down-slope perimeters to mitigate the potential for buildup of water from construction or landscape irrigation. The subdrains should be at least 6-inch-diameter pipes encapsulated in gravel and filter fabric. *Rock* fill drains should be constructed using the same requirements as canyon subdrains.

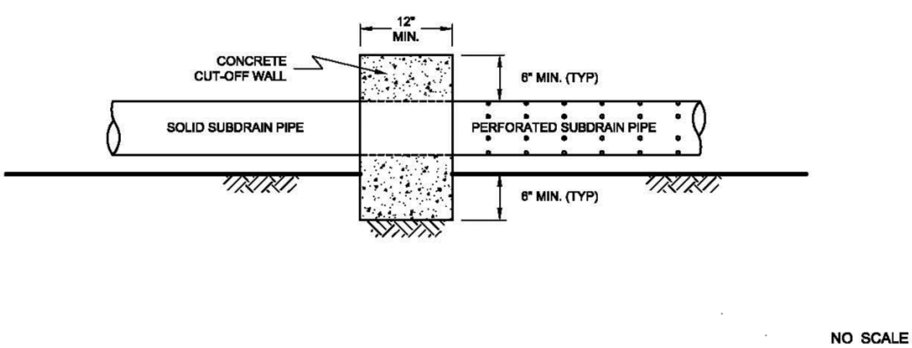
7.5 Prior to outletting, the final 20-foot segment of a subdrain that will not be extended during future development should consist of non-perforated drainpipe. At the non-perforated/ perforated interface, a seepage cutoff wall should be constructed on the downslope side of the pipe.

TYPICAL CUT OFF WALL DETAIL

FRONT VIEW

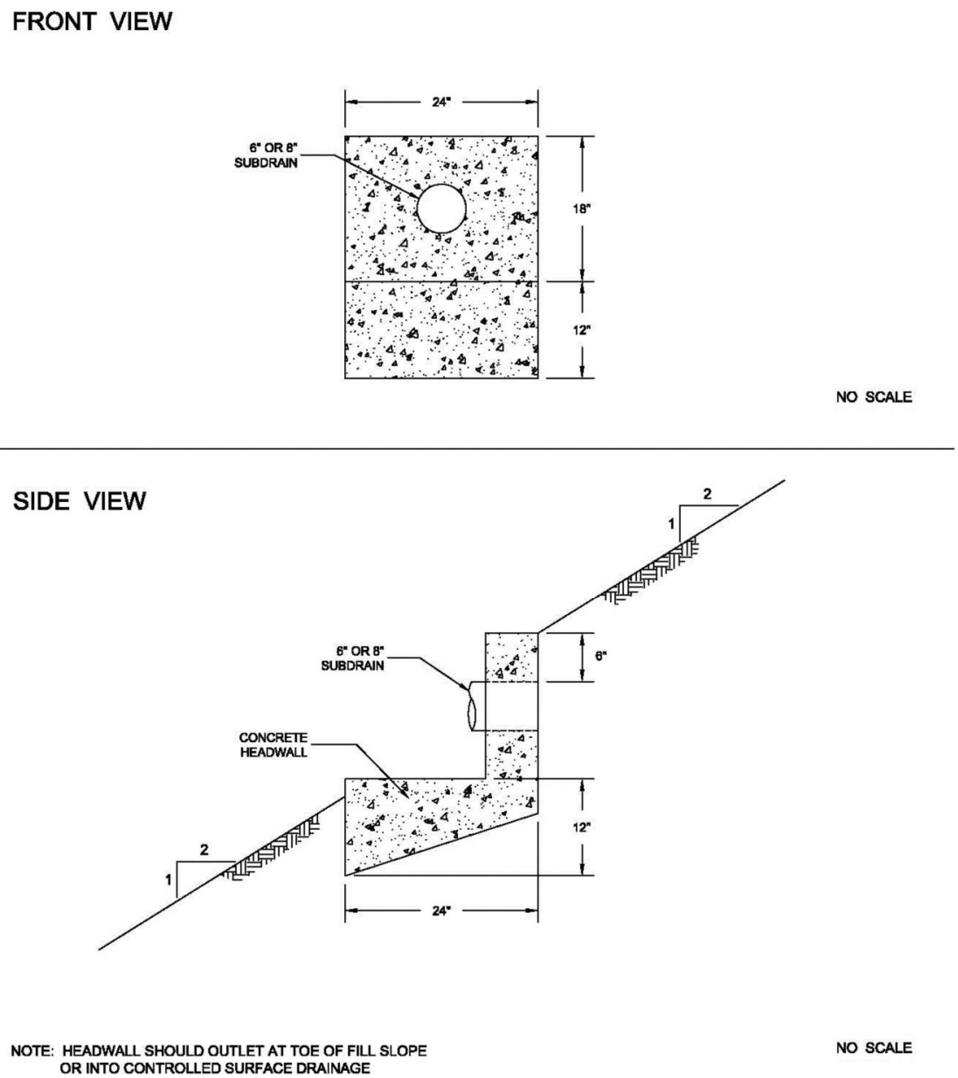


SIDE VIEW



7.6 Subdrains that discharge into a natural drainage course or open space area should be provided with a permanent headwall structure.

TYPICAL HEADWALL DETAIL



7.7 The final grading plans should show the location of the proposed subdrains. After completion of remedial excavations and subdrain installation, the project civil engineer should survey the drain locations and prepare an "as-built" map showing the drain locations. The final outlet and connection locations should be determined during grading operations. Subdrains that will be extended on adjacent projects after grading can be placed on formational material and a vertical riser should be placed at the end of the subdrain. The grading contractor should consider videoing the subdrains shortly after burial to check proper installation and functionality. The contractor is responsible for the performance of the drains.

8. OBSERVATION AND TESTING

8.1 The Consultant shall be the Owner's representative to observe and perform tests during clearing, grubbing, filling, and compaction operations. In general, no more than 2 feet in vertical elevation of *soil* or *soil-rock* fill should be placed without at least one field density test being performed within that interval. In addition, a minimum of one field density test should be performed for every 2,000 cubic yards of *soil* or *soil-rock* fill placed and compacted.

8.2 The Consultant should perform a sufficient distribution of field density tests of the compacted *soil* or *soil-rock* fill to provide a basis for expressing an opinion whether the fill material is compacted as specified. Density tests shall be performed in the compacted materials below any disturbed surface. When these tests indicate that the density of any layer of fill or portion thereof is below that specified, the particular layer or areas represented by the test shall be reworked until the specified density has been achieved.

8.3 During placement of *rock* fill, the Consultant should observe that the minimum number of passes have been obtained per the criteria discussed in Section 6.3.3. The Consultant should request the excavation of observation pits and may perform plate bearing tests on the placed *rock* fills. The observation pits will be excavated to provide a basis for expressing an opinion as to whether the *rock* fill is properly seated and sufficient moisture has been applied to the material. When observations indicate that a layer of *rock* fill or any portion thereof is below that specified, the affected layer or area shall be reworked until the *rock* fill has been adequately seated and sufficient moisture applied.

8.4 A settlement monitoring program designed by the Consultant may be conducted in areas of *rock* fill placement. The specific design of the monitoring program shall be as recommended in the Conclusions and Recommendations section of the project Geotechnical Report or in the final report of testing and observation services performed during grading.

8.5 We should observe the placement of subdrains, to check that the drainage devices have been placed and constructed in substantial conformance with project specifications.

8.6 Testing procedures shall conform to the following Standards as appropriate:

8.6.1 Soil and Soil-Rock Fills:

8.6.1.1 Field Density Test, ASTM D 1556, *Density of Soil In-Place By the Sand-Cone Method.*

8.6.1.2 Field Density Test, Nuclear Method, ASTM D 6938, *Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth)*.

8.6.1.3 Laboratory Compaction Test, ASTM D 1557, *Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-Pound Hammer and 18-Inch Drop*.

8.6.1.4. Expansion Index Test, ASTM D 4829, *Expansion Index Test*.

9. PROTECTION OF WORK

9.1 During construction, the Contractor shall properly grade all excavated surfaces to provide positive drainage and prevent ponding of water. Drainage of surface water shall be controlled to avoid damage to adjoining properties or to finished work on the site. The Contractor shall take remedial measures to prevent erosion of freshly graded areas until such time as permanent drainage and erosion control features have been installed. Areas subjected to erosion or sedimentation shall be properly prepared in accordance with the Specifications prior to placing additional fill or structures.

9.2 After completion of grading as observed and tested by the Consultant, no further excavation or filling shall be conducted except in conjunction with the services of the Consultant.

10. CERTIFICATIONS AND FINAL REPORTS

10.1 Upon completion of the work, Contractor shall furnish Owner a certification by the Civil Engineer stating that the lots and/or building pads are graded to within 0.1 foot vertically of elevations shown on the grading plan and that all tops and toes of slopes are within 0.5 foot horizontally of the positions shown on the grading plans. After installation of a section of subdrain, the project Civil Engineer should survey its location and prepare an *as-built* plan of the subdrain location. The project Civil Engineer should verify the proper outlet for the subdrains and the Contractor should ensure that the drain system is free of obstructions.

10.2 The Owner is responsible for furnishing a final as-graded soil and geologic report satisfactory to the appropriate governing or accepting agencies. The as-graded report should be prepared and signed by a California licensed Civil Engineer experienced in geotechnical engineering and by a California Certified Engineering Geologist, indicating that the geotechnical aspects of the grading were performed in substantial conformance with the Specifications or approved changes to the Specifications.