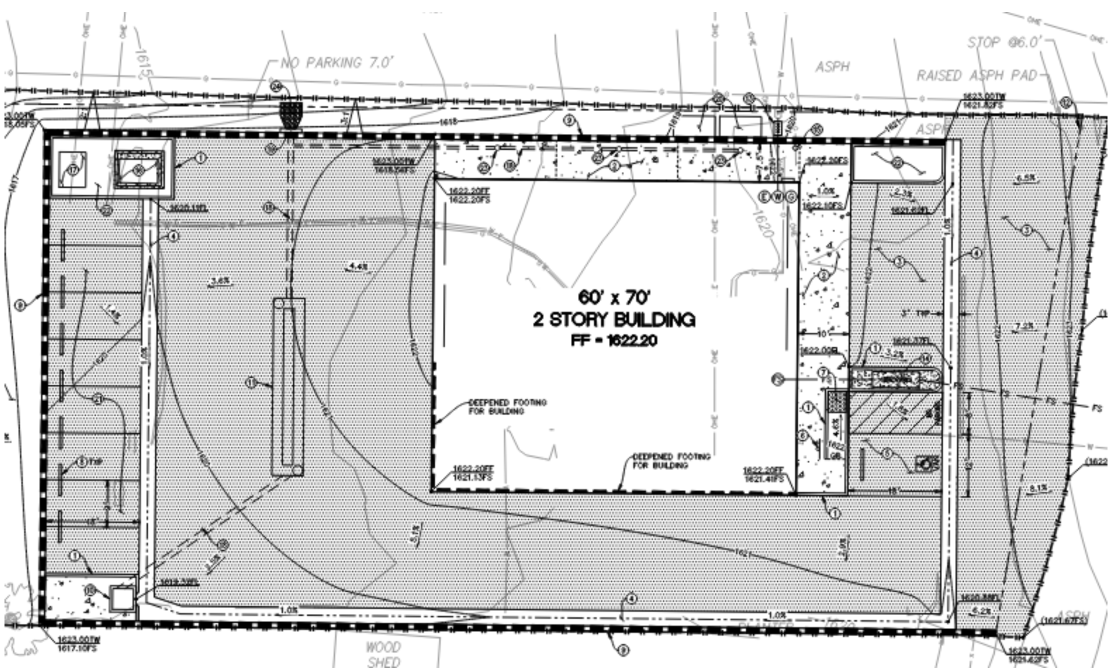
GEOCON

GEOTECHNICAL INVESTIGATION

SAN MIGUEL FIRE STATION NO.18
1811 SUNCREST BOULEVARD
EL CAJON, CALIFORNIA

MARCH 12, 2024
PROJECT NO. G3263-52-01



PREPARED FOR:

SAN MIGUEL
FIRE & RESCUE

GEOCON
INCORPORATED
GEOTECHNICAL ■ ENVIRONMENTAL ■ MATERIALS

Project No. G3263-52-01
March 12, 2024

San Miguel Fire & Rescue
2850 Via Orange Way
Spring Valley, California 91978

Attention: Mr. Ron Quinlan

Subject: GEOTECHNICAL INVESTIGATION
SAN MIGUEL FIRE STATION #18
1811 SUNCREST BOULEVARD
EL CAJON, CALIFORNIA

Dear Mr. Quinlan:

In accordance with your request and authorization of our Proposal No. SD-24-0089-P-GT dated January 12, 2024, we herein submit the results of our geotechnical investigation for the subject project. We performed our investigation to evaluate the underlying soil and geologic conditions and potential geologic hazards, and to assist in the design of the proposed building and associated improvements.

The accompanying report presents the results of our study and conclusions and recommendations pertaining to geotechnical aspects of the proposed project. The site is suitable for the proposed buildings and improvements provided the recommendations of this report are incorporated into the design and construction of the planned project.

Should you have questions regarding this report, or if we may be of further service, please contact the undersigned at your convenience.

Very truly yours,

GEOCON INCORPORATED

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GEOTECHNICAL INVESTIGATION

1. PURPOSE AND SCOPE

This report presents the results of our geotechnical investigation for the new San Miguel Fire & Rescue Station No.18 in the Crest neighborhood in the City of El Cajon, California (see Vicinity Map).

Vicinity Map

The purpose of the geotechnical investigation is to evaluate the surface and subsurface soil conditions and general site geology, and to identify geotechnical constraints that may affect development of the property including faulting, liquefaction and seismic shaking based on the 2022 CBC seismic design criteria. In addition, we provided recommendations for remedial grading, shallow foundations, concrete slab-on-grade, concrete flatwork, pavement and retaining walls. We also reviewed the plans titled *Grading and Improvement Plans for San Miguel Fire Station #18, San Miguel Fire District* prepared by Nasland Engineering received January 11, 2024 (California Coordinate index 230-1809, Project No. 121-138.1) in preparation of this report.

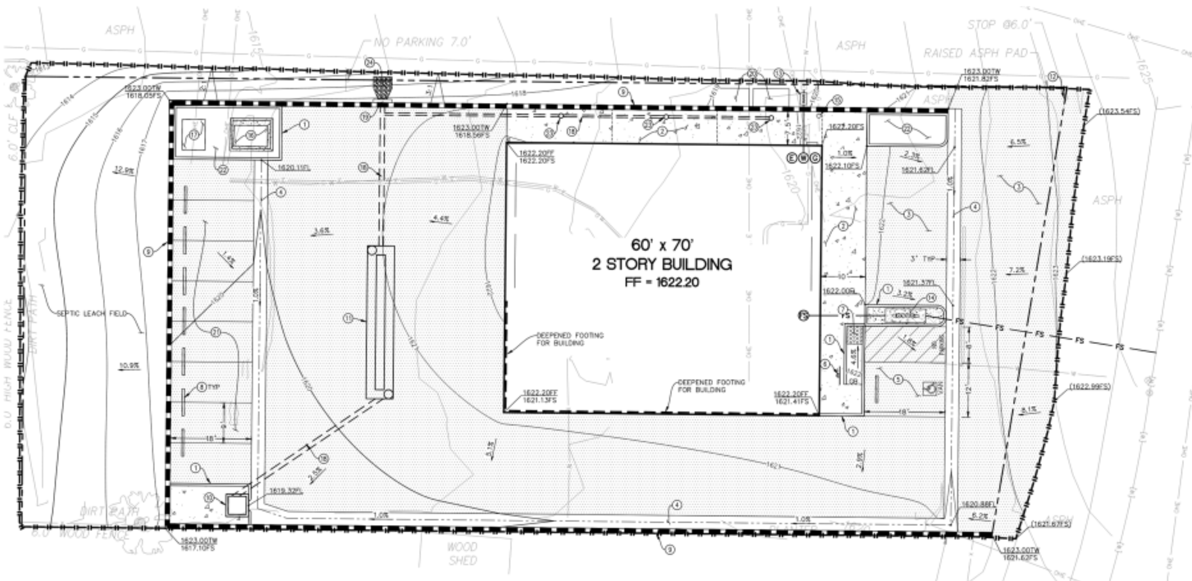
The scope of this investigation included reviewing readily available published and unpublished geologic literature (see List of References), performing engineering analyses and preparing this report. We advanced 6 exploratory borings to a maximum depth of about 11 feet, performed infiltration testing, sampled soil and performed laboratory testing. Appendix A presents the exploratory boring logs and details of the field investigation. The details of the laboratory tests and a summary of the test results are shown in Appendix B and on the boring logs in Appendix A.

2. SITE AND PROJECT DESCRIPTION

The subject property is located west of Suncrest Boulevard and south of North Lane in the Crest neighborhood in the City of El Cajon, California. The subject site is developed with the existing San Miguel Fire Station No. 18 that consists of a single-story office and maintenance building on the east and a single-story, masonry garage building on the west with accommodating parking, utilities and landscaping. Based on historic aerial imaging, the building on the east was constructed prior to 1953 and the building on the west was constructed between 1981 and 1982. Overall, the site is relatively flat at elevations of approximately 1,615 to 1,625 feet mean sea level (MSL). The Existing Site Plan shows the current site conditions.

Existing Site Plan

Based on the referenced grading plans, we understand that the existing buildings and improvements will be demolished and the property will be redeveloped with a new fire station. The new building will consist of a two-story, light framed metal building with two drive-through bays. The site will be raised approximately 3 to 6 feet and a new storm water detention system will be constructed under the proposed drive lanes. We understand concrete pavement will be used in lieu of asphalt for the drive lanes and parking areas. A septic leach field will be installed on the westernmost portion of the property. In addition, new fuel tanks, salvage generators, storage bins will be constructed with accommodating landscaping and utilities. The Proposed Site Plan shows the planned development.



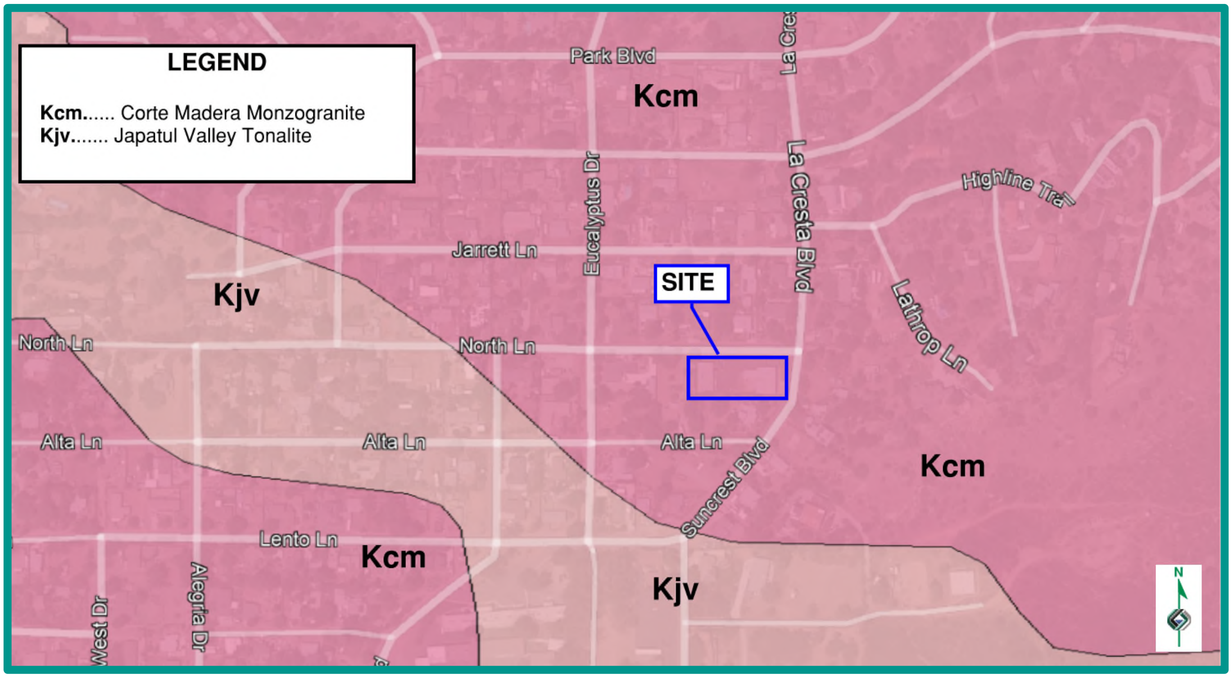
Proposed Site Plan

The locations, site descriptions, and proposed development are based on our site reconnaissance, review of published geologic literature, field investigations, and discussions with project personnel. If development plans differ from those described herein, Geocon Incorporated should be contacted for review of the plans and possible revisions to this report.

3. GEOLOGIC SETTING

The site is in the eastern portion of the coastal plain within the southern portion of the Peninsular Ranges Geomorphic Province of southern California. The Peninsular Ranges is a geologic and geomorphic province that extends from the Imperial Valley to the Pacific Ocean and from the Transverse Ranges to the north and into Baja California to the south. The coastal plain of San Diego County is underlain by a thick sequence of relatively undisturbed and non-conformable sedimentary rocks that thicken to the west and range in age from Upper Cretaceous through the Pleistocene with intermittent deposition. The sedimentary units are deposited on bedrock Cretaceous to Jurassic age igneous and metavolcanic rocks.

Geomorphically, the coastal plain is characterized by a series of 21, stair-stepped marine terraces (younger to the west) that have been dissected by west flowing rivers. The coastal plain is a relatively stable block that is dissected by relatively few faults consisting of the potentially active La Nacion Fault Zone and the active Rose Canyon Fault Zone. The Peninsular Ranges Province is also dissected by the Elsinore Fault Zone that is associated with and sub-parallel to the San Andreas Fault Zone, which is the plate boundary between the Pacific and North American Plates. The Regional Geologic Map shows the geologic units in the area of the site.



Regional Geologic Map

4. SOIL AND GEOLOGIC CONDITIONS

We encountered one surficial soil unit (consisting of undocumented fill) and one formational unit (consisting of Granitic Rock). The occurrence, distribution, and description of each unit encountered is shown on the Geologic Map and Cross-Sections, Figure 1, and on the boring logs in Appendix A. The cross-sections show the approximate subsurface relationship between the geologic units. We prepared the geologic cross-sections using interpolation between exploratory excavations and observations; therefore, actual geotechnical conditions may vary from those illustrated and should be considered approximate. The surficial soil and geologic units are described herein in order of increasing age.

4.1 Undocumented Fill (Qudf)

We encountered undocumented fill in our borings to depths ranging from about 2 to 5 feet. In general, the fill consists of loose to medium dense, moist to wet, clayey to silty sand and possesses a “very low” expansion index (expansion index of 20 or less). The undocumented fill is not considered suitable in its current condition for the support of foundations or structural fill and remedial grading will required. The undocumented fill can be reused for new compacted fill during grading operations provided it is generally free of roots and debris.

4.2 Granitic Rock (Kgr)

Cretaceous-age granitic rock of the Corte Madera Monzogranite geologic unit underlies the undocumented fill. The granitic rock encountered generally varies from weak to strong and completely weathered to fresh rock. The upper 1 to 2 feet of granitic rock generally consists of highly weathered rock and excavates to silty sand. We encountered practical refusal in Boring B-1 at approximately 11 feet below existing grade. We expect the proposed grading of the building pads and proposed improvements will be possible without blasting or rock breaking. However, localized corestones and strong rock should be expected during the construction operations. The granitic rock is generally suitable for support of proposed fill and structural loads. In addition, the granitic rock is considered stable for construction of the proposed cut slopes if free of loose rock after excavation.

5. GROUNDWATER

We encountered perched groundwater and/or seepage during our site investigation. We measured groundwater at approximately 5 feet below the ground surface (1612 Feet MSL) in the existing piezometer near Boring B-6. We observed seepage in Borings B-2 through B-5 after leaving the boring excavation open for a minimum of 20 minutes. Seepage is dependent on seasonal precipitation, irrigation, land use, among other factors, and varies as a result. Proper surface drainage will be important to future performance of the project. We expect that perched groundwater and/or seepage could be encountered during site grading and during construction of site utilities and other buried elements. The following table presents the boring locations and depths/elevations of the groundwater encountered on the subject site.

RECORDED GROUNDWATER/SEEPAGE ELEVATIONS

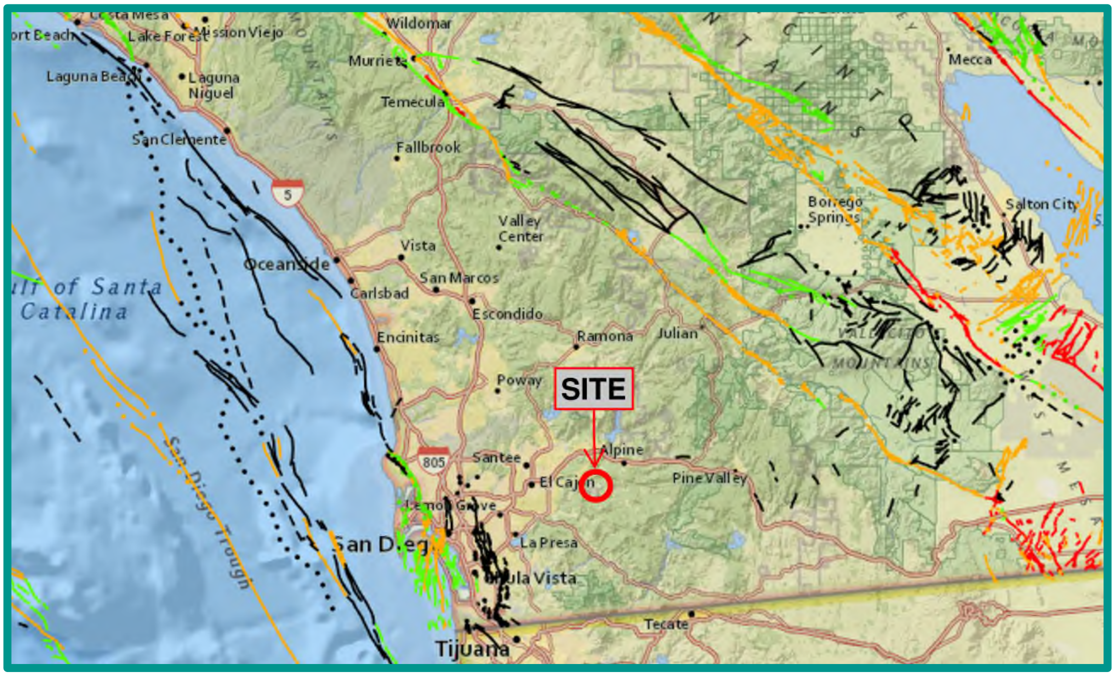
Boring No.	Date Recorded	Approximate Depth of Groundwater/Seepage Below Existing Grade (Feet)	Approximate Elevation of Groundwater (Feet, NVGD29)
B-2	2/13/2024	5	1613
B-3	2/13/2024	6	1612
B-4	2/13/2024	10	1610
B-5	2/13/2024	10.5	1608.5
P-1	2/13/2024	5	1612

6. GEOLOGIC HAZARDS

6.1 Regional Faulting and Seismicity

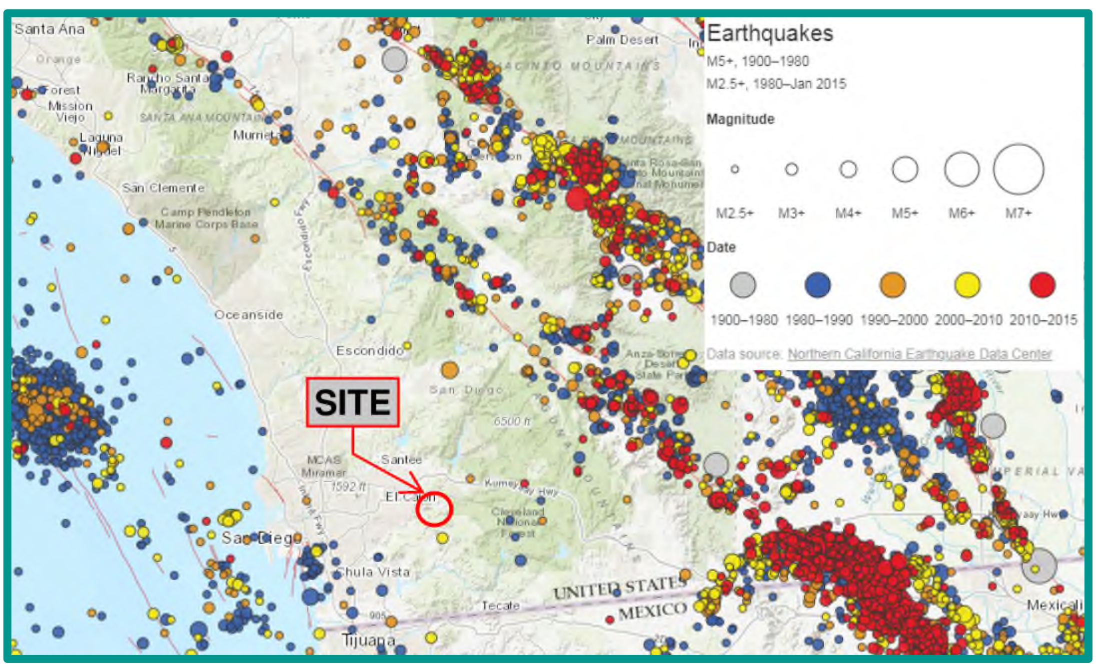
A review of the referenced geologic materials and our knowledge of the general area indicate that the site is not underlain by active, potentially active, or inactive faults. An active fault is defined by the California Geological Survey (CGS) as a fault showing evidence for activity within the last 11,700 years. The site is not located within a State of California Earthquake Fault Zone.

The USGS has developed a program to evaluate the approximate location of faulting in the area of properties. The following figure shows the location of the existing faulting in the San Diego County and Southern California region. The fault traces are shown as solid, dashed and dotted that represent well-constrained, moderately constrained and inferred, respectively. The fault line colors represent faults with ages less than 150 years (red), 15,000 years (orange), 130,000 years (green), 750,000 years (blue) and 1.6 million years (black).



Faults in Southern California

The San Diego County and Southern California region is seismically active. The following figure presents the occurrence of earthquakes with a magnitude greater than 2.5 from the period of 1900 through 2015 according to the Bay Area Earthquake Alliance website.



Earthquakes in Southern California

Considerations important in seismic design include the frequency and duration of motion and the soil conditions underlying the site. Seismic design of structures should be evaluated in accordance with the California Building Code (CBC) guidelines currently adopted by the local agency.

6.2 Ground Rupture

Ground surface rupture occurs when movement along a fault is sufficient to cause a gap or rupture where the upper edge of the fault zone intersects the ground surface. The potential for ground rupture is considered to be very low due to the absence of active faults at the subject site.

6.3 Liquefaction

Liquefaction typically occurs when a site is in a zone with seismic activity, onsite soils are cohesionless or silt/clay with low plasticity, groundwater is encountered within 50 feet of the surface and soil relative densities are less than about 70 percent. If the four previous criteria are met, a seismic event could result in a rapid pore water pressure increase from the earthquake-generated ground accelerations. Due to the very dense nature of the underlying Granitic Rock, liquefaction potential for the site is considered very low.

6.4 Storm Surge, Tsunamis, and Seiches

Storm surges are large ocean waves that sweep across coastal areas when storms make landfall. Storm surges can cause inundation, severe erosion and backwater flooding along the water front. The site is located over 25 miles from the Pacific Ocean and is at an elevation of about 1,615 feet or greater above Mean Sea Level (MSL). Therefore, the potential of storm surges affecting the site is considered low.

A tsunami is a series of long period waves generated in the ocean by a sudden displacement of large volumes of water. Causes of tsunamis include underwater earthquakes, volcanic eruptions, or offshore slope failures. The potential for the site to be affected by a tsunami is negligible due to the distance from the Pacific Ocean and the site elevation.

A seiche is a run-up of water within a lake or embayment triggered by fault- or landslide-induced ground displacement. The site is not located in the vicinity of or downstream from such bodies of water. Therefore, the risk of seiches affecting the site is negligible.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 General

7.1.1 We did not encounter soil or geologic conditions during our exploration that would preclude the proposed development, provided the recommendations presented herein are followed and implemented during design and construction. We will provide supplemental recommendations if we observe variable or undesirable conditions during construction, or if the proposed construction will differ from that anticipated herein. The following table summarizes our conclusions and recommendations for the proposed project.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Attribute	Conclusion/Recommendations
Existing Geologic Hazards	Strong Seismic Shaking
Existing Geologic Units	Undocumented Fill (Requiring Recompaction)
	Granitic Rock (Suitable for Support)
Groundwater	Perched Groundwater at 5 to 10 Feet (1609 to 1613 Feet MSL)
Excavations	Surficial Soil – Moderate to Difficult
	Rock – Difficult to Non-Rippable
Expansion Index	20 or Less
Water-Soluble Sulfate Content	“S0”
Drainage	Maintain Drainage As Discussed Herein

7.1.2 Except for possible moderate to strong seismic shaking, we did not observe or know of significant geologic hazards to exist on the site that would adversely affect the proposed project.

7.1.3 We performed a storm water management investigation under a separate report to help evaluate the potential for infiltration on the property. The project civil engineer should use that report to help design the storm water management devices.

7.1.4 Based on our review of the project plans, we opine the planned development can be constructed in accordance with our recommendations provided herein. We do not expect the planned development will destabilize or result in settlement of adjacent properties if properly constructed.

7.1.5 Surface settlement monuments and canyon subdrains will not be required on this project.

7.2 Excavation and Soil Characteristics

7.2.1 Excavation of the in-situ soil should be possible with moderate to heavy effort using conventional heavy-duty equipment. Excavation of the formational materials will require very heavy effort and may generate oversized material using conventional heavy-duty equipment during the grading operations. Oversized rock (rocks greater than 12 inches in dimension) may be generated with the granitic rock materials that can be incorporated into landscape use or deep compacted fill areas, if available. The grading and improvement contractors should review this report and evaluate the proper equipment to use for the planned excavations.

7.2.2 The soil encountered in the field investigation is “non-expansive” (expansion index [EI] of 20 or less) as defined by 2022 California Building Code (CBC) Section 1803.5.3. We expect most of the soil encountered possess a “very low” expansion potential (EI of 20 or less) in accordance with ASTM D 4829. The following presents soil classifications based on the expansion index.

EXPANSION CLASSIFICATION BASED ON EXPANSION INDEX

Expansion Index (EI)	ASTM D 4829 Expansion Classification	2022 CBC Expansion Classification
0 – 20	Very Low	Non-Expansive
21 – 50	Low	Expansive
51 – 90	Medium	
91 – 130	High	
Greater Than 130	Very High	

7.2.3 We performed laboratory tests on samples of the site materials to evaluate the percentage of water-soluble sulfate content. Appendix B presents results of the laboratory water-soluble sulfate content tests. The test results indicate the on-site materials at the locations tested possess “S0” sulfate exposure to concrete structures as defined by 2022 CBC Section

1904 and ACI 318-19 Chapter 19. The presence of water-soluble sulfates is not a visually discernible characteristic; therefore, other soil samples from the site could yield different concentrations. Additionally, over time landscaping activities (i.e., addition of fertilizers and other soil nutrients) may affect the concentration.

7.2.4 Geocon Incorporated does not practice in the field of corrosion engineering. Therefore, further evaluation by a corrosion engineer may be performed if improvements susceptible to corrosion are planned.

7.3 Grading

7.3.1 Grading should be performed in accordance with the recommendations provided in this report, the Recommended Grading Specifications contained in Appendix C and the local grading ordinance. Geocon Incorporated should observe the grading operations on a full-time basis and provide testing during the fill placement.

7.3.2 Prior to commencing grading, a preconstruction conference should be held at the site with the agency inspector, developer, grading and underground contractors, civil engineer, and geotechnical engineer in attendance. Special soil handling and/or the grading plans can be discussed at that time.

7.3.3 Site preparation should begin with the removal of deleterious material, debris, and vegetation. The depth of vegetation removal should be such that material exposed in cut areas or soil to be used as fill is relatively free of organic matter. Material generated during stripping and/or site demolition should be exported from the site. Asphalt and concrete should not be mixed with the fill soil unless approved by the Geotechnical Engineer.

7.3.4 Abandoned foundations and buried utilities (if encountered) should be removed and the resultant depressions and/or trenches should be backfilled with properly compacted material as part of the remedial grading.

7.3.5 We expect the building will be supported on shallow foundations embedded into properly compacted fill. Additionally, we understand up to 6 feet of fill will be placed across the site to raise site grades and create a relatively level pad (including non-building areas). Therefore, the undocumented fill should be excavated to expose the underlying formational material and properly compacted fill should be placed across the improvement areas (not including the proposed leach field). In addition, the proposed buildings should be graded such that there is a minimum of 5 feet of compacted fill below the proposed building pad or at least 2 feet of fill exists below the proposed footings (whichever results in a deeper excavation). The excavations should extend at least 10 feet laterally outside of the proposed building foundation zones and 2 feet outside improvements, where possible. Deeper excavations may be required in areas where loose or saturated materials are encountered. The following table summarizes the remedial grading recommendations.

SUMMARY OF REMEDIAL GRADING RECOMMENDATIONS

Area	Remedial Grading Excavation Requirements
Site Development (including Building Pad, Fill and Site Improvement Areas)	Excavate the Undocumented Fill Exposing Formational Material
	Excavate Upper 5 Feet Below Pad Grade or 2 Feet Below Foundations Bottoms and Place Compacted Fill
Lateral Grading Limits	10 Feet Outside of Buildings
	2 Feet Outside of Improvement Areas
Exposed Bottoms of Excavations	Scarify Upper 12 Inches

7.3.6 The bottom of the excavations should be sloped 1 percent to the adjacent street or deepest fill. Prior to fill soil being placed, the existing ground surface should be scarified, moisture conditioned as necessary, and compacted to a depth of at least 12 inches. Deeper excavations may be required if saturated or loose fill soil is encountered. A representative of Geocon should be on-site during excavations to evaluate the limits of the remedial grading.

7.3.7 Some areas of overly wet and saturated soil could be encountered due to the existing landscape and pavement areas. The saturated soil would require additional effort prior to placement of compacted fill or additional improvements. Stabilization of the soil would include scarifying and air-drying, removing and replacement with drier soil, use of stabilization fabric (e.g. Tensar TX7 or other approved fabric), or chemical treating (i.e. cement or lime treatment).

7.3.8 The site should then be brought to final subgrade elevations with fill compacted in layers as recommended in the following table. In general, the existing soil is suitable for use from a geotechnical engineering standpoint as fill if relatively free from vegetation, debris and other deleterious material. Layers of fill should be about 6 to 8 inches in loose thickness and no thicker than will allow for adequate bonding and compaction. Fill materials placed below optimum moisture content may require additional moisture conditioning prior to placing additional fill.

SUMMARY OF COMPACTED FILL RECOMMENDATIONS

Fill Location	Relative Compaction*	Relative Moisture Content*
Grading	90% of Laboratory Maximum Dry Density	Near to Slightly Above Optimum
Utility/Retaining Wall Backfill		
Sidewalk and Curb/Gutter Subgrade		
Pavement and Cross-Gutter Subgrade	95% of Laboratory Maximum Dry Density	Near to Slightly Above Optimum
Base Materials		

*In accordance with ASTM D 1557.

7.3.9 Import fill (if necessary) should consist of the characteristics presented in the following table. Geocon Incorporated should be notified of the import soil source and should perform laboratory testing of import soil prior to its arrival at the site to determine its suitability as fill material.

SUMMARY OF IMPORT FILL RECOMMENDATIONS

Soil Characteristic	Values
Expansion Potential	"Very Low" to "Low" (Expansion Index of 50 or less)
Particle Size	Maximum Dimension Less Than 3 Inches
	Generally Free of Debris

7.4 Temporary Excavations

7.4.1 The recommendations included herein are provided for stable excavations. It is the responsibility of the contractor and their competent person to ensure all excavations, temporary slopes and trenches are properly constructed and maintained in accordance with applicable OSHA guidelines in order to maintain safety and the stability of the excavations and adjacent improvements. These excavations should not be allowed to become saturated or to dry out. Surcharge loads should not be permitted to a distance equal to the height of the excavation from the top of the excavation. The top of the excavation should be a minimum of 15 feet from the edge of existing improvements. Excavations steeper than those recommended or closer than 15 feet from an existing surface improvement should be shored in accordance with applicable OSHA codes and regulations.

7.4.2 The stability of the excavations is dependent on the design and construction of the shoring system and site conditions. Therefore, Geocon Incorporated cannot be responsible for site safety and the stability of the proposed excavations.

7.5 Groundwater and Dewatering

7.5.1 We observed perched groundwater during our site exploration at a depth of approximately 5 to 10 feet below the ground surface (approximate elevations of 1609 to 1613 feet MSL). The contractor should be prepared to accommodate seepage and/or groundwater in project excavations with one or more of the following conventional measures. We do not expect groundwater would be encountered during grading; however, deeper utilities may encounter groundwater during the installation operations.

7.5.2 Where minor seepage is encountered during excavation, sloping excavation bottoms to a sump and pumping from the sump can be utilized. In this case, an approximately 1-foot-thick layer of freely draining gravel or crushed rock placed on the excavation bottom would help groundwater to flow toward the sump and provide a working pad. If migration of contaminates along a utility alignment is a concern, a 12-inch wide bentonite slurry barrier can be installed every 20 feet of trench as part of the excavation bottom. A sump would need to be installed within that 20-foot length in order to remove water during construction.

7.5.3 If more than heavy seepage is encountered during excavation work, the water may be collected and controlled within the excavation through the use of gravel filled trenches (French drains). The number and locations of the French drains can be adjusted during excavation activities as necessary to collect and control encountered seepage. The French drains could then direct the collected seepage to a sump where it will be pumped out of the excavation. It is likely that due to the soft soils expected at the excavation bottom, a gravel blanket may be required for this project for stabilization. This gravel blanket may also be utilized for dewatering purposes as necessary.

7.5.4 The dewatering system should be designed by an experienced, qualified contractor and the plans should be reviewed by the contractor's geotechnical engineer. Appropriate permits should be obtained and possible treatment may be required to discharge water generated by dewatering.

7.6 Seismic Design Criteria – 2022 California Building Code

7.6.1 The following table summarizes site-specific design criteria obtained from the 2022 California Building Code (CBC; Based on the 2021 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 2022 CBC and Table 20.3-1 of ASCE 7-16. The values presented herein are for the risk-targeted maximum considered earthquake (MCE_R).

2022 CBC SEISMIC DESIGN PARAMETERS

Parameter	Value	2022 CBC Reference
Site Class	C	Section 1613.2.2
MCE_R Ground Motion Spectral Response Acceleration – Class B (short), S_S	0.757g	Figure 1613.2.1(1)
MCE_R Ground Motion Spectral Response Acceleration – Class B (1 sec), S_1	0.278g	Figure 1613.2.1(3)
Site Coefficient, F_A	1.200	Table 1613.2.3(1)
Site Coefficient, F_V	1.500	Table 1613.2.3(2)
Site Class Modified MCE_R Spectral Response Acceleration (short), S_{MS}	0.908g	Section 1613.2.3 (Eqn 16-20)
Site Class Modified MCE_R Spectral Response Acceleration – (1 sec), S_{M1}	0.417g	Section 1613.2.3 (Eqn 16-21)
5% Damped Design Spectral Response Acceleration (short), S_{DS}	0.605g	Section 1613.2.4 (Eqn 16-22)
5% Damped Design Spectral Response Acceleration (1 sec), S_{D1}	0.278g	Section 1613.2.4 (Eqn 16-23)

7.6.2 The following table 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.

ASCE 7-16 PEAK GROUND ACCELERATION

Parameter	Value	ASCE 7-16 Reference
Mapped MCE_G Peak Ground Acceleration, PGA	0.325g	Figure 22-9
Site Coefficient, F_{PGA}	1.200	Table 11.8-1
Site Class Modified MCE_G Peak Ground Acceleration, PGA_M	0.390g	Section 11.8.3 (Eqn 11.8-1)

7.6.3 Conformance to the criteria in this section 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.

7.6.4 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. The following table summarizes of the risk categories in accordance with ASCE 7-16.

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

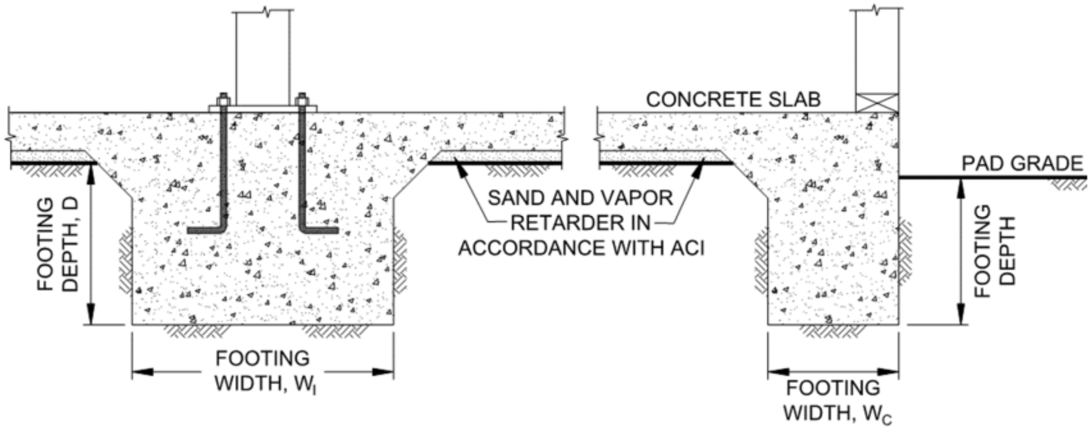
7.7 Shallow Foundations

7.7.1 The proposed structure can be supported on a shallow foundation system founded in the compacted fill. Foundations for the structure should consist of continuous strip footings and/or isolated spread footings and should be designed using the parameters in the following table.

SUMMARY OF FOUNDATION RECOMMENDATIONS

Parameter	Value
Minimum Continuous Foundation Width, W_C	12 Inches
Minimum Isolated Foundation Width, W_I	24 Inches
Minimum Foundation Depth, D	24 Inches Below Lowest Adjacent Grade
Minimum Steel Reinforcement	4 No. 5 Bars, 2 Top and 2 Bottom
Allowable Bearing Capacity (Compacted Fill)	2,500 psf
Bearing Capacity Increase	500 psf per Foot of Depth
	300 psf per Foot of Width
Maximum Allowable Bearing Capacity	4,000 psf
Estimated Total Settlement	1 Inch
Estimated Differential Settlement	½ Inch in 40 Feet
Footing Size Used for Settlement	10-Foot Square
Design Expansion Index	20 or Less

7.7.2 The foundations should be embedded in accordance with the recommendations herein and the Wall/Column Footing Dimension Detail. The embedment depths should be measured from the lowest adjacent pad grade for both interior and exterior footings. Footings should be deepened such that the bottom outside edge of the footing is at least 7 feet horizontally from the face of the slope (unless designed with a post-tensioned foundation system as discussed herein).



Wall/Column Footing Dimension Detail

7.7.3 The bearing capacity values presented herein are for dead plus live loads and may be increased by one-third when considering transient loads due to wind or seismic forces.

7.7.4 We should observe the foundation excavations prior to the placement of reinforcing steel and concrete to check that the exposed soil conditions are similar to those expected and that they have been extended to the appropriate bearing strata. Foundation modifications may be required if unexpected soil conditions are encountered.

7.7.5 Geocon Incorporated should be consulted to provide additional design parameters as required by the structural engineer.

7.8 Concrete Slabs-On-Grade

7.8.1 Concrete slabs-on-grade for the structures should be constructed using the parameters presented in the following table.

MINIMUM CONCRETE SLAB-ON-GRADE RECOMMENDATIONS

Parameter	Value
Minimum Concrete Slab Thickness	5 Inches
Minimum Steel Reinforcement	No. 3 Bars 18 Inches on Center, Both Directions
Typical Slab Underlayment	3 to 4 Inches of Sand/Gravel/Base
Design Expansion Index	50 or Less

7.8.2 Slabs that may receive moisture-sensitive floor coverings or may be used to store moisture-sensitive materials should be underlain by a vapor retarder. The vapor retarder design should be consistent with the guidelines presented in the American Concrete Institute's (ACI) *Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials* (ACI 302.2R-06). In addition, the membrane should be installed in accordance with manufacturer's recommendations and ASTM requirements and installed in a manner that prevents puncture. The vapor retarder used should be specified by the project architect or developer based on the type of floor covering that will be installed and if the structure will possess a humidity controlled environment.

7.8.3 The bedding sand thickness should be determined by the project foundation engineer, architect, and/or developer. It is common to have 3 to 4 inches of sand in the southern California region. However, we should be contacted to provide recommendations if the bedding sand is thicker than 6 inches. The foundation design engineer should provide appropriate concrete mix design criteria and curing measures to assure proper curing of the slab by reducing the potential for rapid moisture loss and subsequent cracking and/or slab curl. We suggest that the foundation design engineer present the concrete mix design and proper curing methods on the foundation plans. It is critical that the foundation contractor understands and follows the recommendations presented on the foundation plans.

7.8.4 Concrete slabs should be provided with adequate crack-control joints, construction joints and/or expansion joints to reduce unsightly shrinkage cracking. The design of joints should consider criteria of the American Concrete Institute (ACI) when establishing crack-control spacing. Crack-control joints should be spaced at intervals no greater than 12 feet. Additional steel reinforcing, concrete admixtures and/or closer crack control joint spacing should be considered where concrete-exposed finished floors are planned.

7.8.5 Special subgrade presaturation is not deemed necessary prior to placing concrete; however, the exposed foundation and slab subgrade soil should be moisturized to maintain a moist condition as would be expected in any such concrete placement.

7.8.6 The concrete slab-on-grade recommendations are based on soil support characteristics only. The project structural engineer should evaluate the structural requirements of the concrete slabs for supporting expected loads.

7.8.7 The recommendations of this report are intended to reduce the potential for cracking of slabs due to expansive soil (if present), differential settlement of existing soil or soil with varying thicknesses. However, even with the incorporation of the recommendations presented herein, foundations, stucco walls, and slabs-on-grade placed on such conditions may still exhibit some cracking due to soil movement and/or shrinkage. The occurrence of concrete shrinkage cracks is independent of the supporting soil characteristics. Their occurrence may be reduced and/or controlled by limiting the slump of the concrete, proper concrete placement and curing, and by the placement of crack control joints at periodic intervals, in particular, where re-entrant slab corners occur.

7.9 Exterior Concrete Flatwork

7.9.1 Exterior concrete flatwork not subject to vehicular traffic should be constructed in accordance with the recommendations presented in the following table. The recommended steel reinforcement would help reduce the potential for cracking.

MINIMUM CONCRETE FLATWORK RECOMMENDATIONS

Expansion Index, EI	Minimum Steel 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.

7.9.2 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.

7.9.3 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 steel reinforcement 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.

7.9.4 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.

7.9.5 Where exterior flatwork abuts the structure at entrant or exit points, the exterior slab should be dowelled into the structure's foundation stemwall. This recommendation is intended to reduce the potential for differential elevations that could result from differential settlement or minor heave of the flatwork. Dowelling details should be designed by the project structural engineer.

7.9.6 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-on-grade 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.

7.10 Retaining Walls

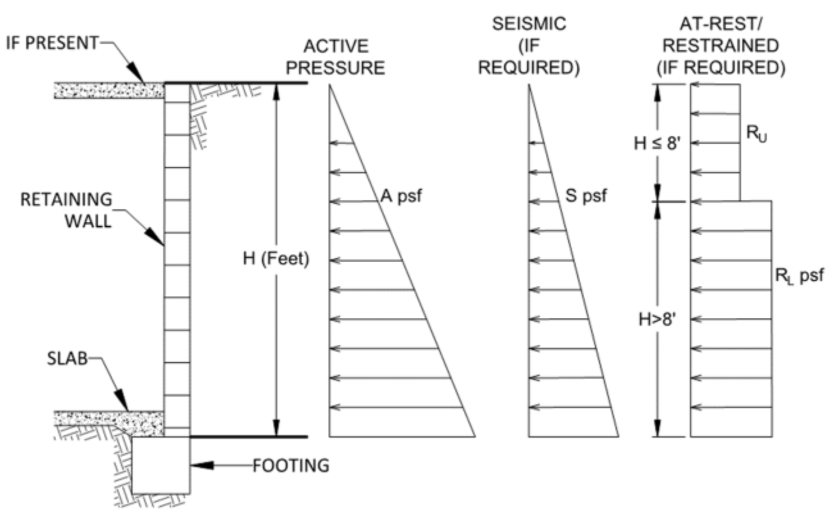
7.10.1 Retaining walls should be designed using the values presented in the following table. Soil with an expansion index (EI) of greater than 50 should not be used as backfill material behind retaining walls.

RETAINING WALL DESIGN RECOMMENDATIONS

Parameter	Value
Active Soil Pressure, A (Fluid Density, Level Backfill)	35 pcf
Active Soil Pressure, A (Fluid Density, 2:1 Sloping Backfill)	50 pcf
Seismic Pressure, S	10H psf
At-Rest/Restrained Walls Additional Uniform Pressure, R_U (0 to 8 Feet High)	7H psf
At-Rest/Restrained Walls Additional Uniform Pressure, R_L (8+ Feet High)	13H psf
Expected Expansion Index for the Subject Property	EI$\leq$50

H equals the height of the retaining portion of the wall

7.10.2 The project retaining walls should be designed as shown in the Retaining Wall Loading Diagram.



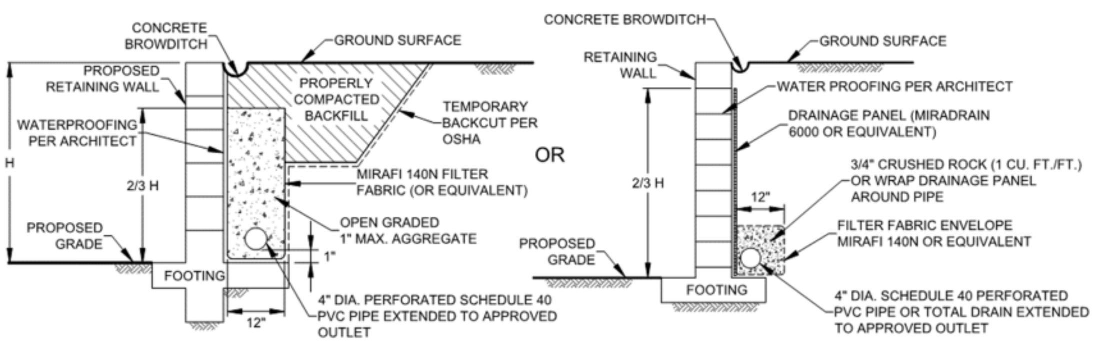
Retaining Wall Loading Diagram

7.10.3 Unrestrained walls are those that are allowed to rotate more than 0.001H (where H equals the height of the retaining portion of the wall) at the top of the wall. Where walls are restrained from movement at the top (at-rest condition), an additional uniform pressure should be applied to the wall. For retaining walls subject to vehicular loads within a horizontal distance equal to two-thirds the wall height, a surcharge equivalent to 2 feet of fill soil should be added to the upper 10 feet of the retaining wall.

7.10.4 The structural engineer should determine the Seismic Design Category for the project in accordance with Section 1613 of the 2022 CBC or Section 11.6 of ASCE 7-16. For structures assigned to 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 2022 CBC. 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.

7.10.5 Retaining walls should be designed to ensure stability against overturning sliding, and excessive foundation pressure. Where a keyway is extended below the wall base with the intent to engage passive pressure and enhance sliding stability, it is not necessary to consider active pressure on the keyway.

7.10.6 Drainage openings through the base of the wall (weep holes) should not be used where the seepage could be a nuisance or otherwise adversely affect the property adjacent to the base of the wall. The recommendations herein assume a properly compacted granular (EI of 90 or less) free-draining backfill material with no hydrostatic forces or imposed surcharge load. The retaining wall should be properly drained as shown in the Typical Retaining Wall Drainage Detail. If conditions different than those described are expected, or if specific drainage details are desired, Geocon Incorporated should be contacted for additional recommendations.



Typical Retaining Wall Drainage Detail

7.10.7 The retaining walls may be designed using either the active and restrained (at-rest) loading condition or the active and seismic loading condition as suggested by the structural engineer. Typically, it appears the design of the restrained condition for retaining wall loading may be adequate for the seismic design of the retaining walls. However, the active earth pressure combined with the seismic design load should be reviewed and also considered in the design of the retaining walls.

7.10.8 In general, wall foundations should be designed using the parameters presented in the following table. The proximity of the foundation to the top of a slope steeper than 3:1 could impact the allowable soil bearing pressure. Therefore, retaining wall foundations should be deepened such that the bottom outside edge of the footing is at least 7 feet horizontally from the face of the slope.

SUMMARY OF RETAINING WALL FOUNDATION RECOMMENDATIONS

Parameter	Value
Minimum Retaining Wall Foundation Width	12 Inches
Minimum Retaining Wall Foundation Depth	12 Inches
Minimum Steel Reinforcement	Per Structural Engineer
Allowable Bearing Capacity	2,500 psf
Estimated Total Settlement	1 Inch
Estimated Differential Settlement	½ Inch in 40 Feet

7.10.9 The recommendations presented herein are generally applicable to the design of rigid concrete or masonry retaining walls. In the event that other types of walls (such as mechanically stabilized earth [MSE] walls, soil nail walls, or soldier pile walls) are planned, Geocon Incorporated should be consulted for additional recommendations.

7.10.10 Unrestrained walls will move laterally when backfilled and loading is applied. The amount of lateral deflection is dependent on the wall height, the type of soil used for backfill, and loads acting on the wall. The retaining walls and improvements above the retaining walls should be designed to incorporate an appropriate amount of lateral deflection as determined by the structural engineer.

7.10.11 Soil contemplated for use as retaining wall backfill, including import materials, should be identified in the field prior to backfill. At that time, Geocon Incorporated should obtain samples for laboratory testing to evaluate its suitability. Modified lateral earth pressures may be necessary if the backfill soil does not meet the required expansion index or shear strength. City or regional standard wall designs, if used, are based on a specific active lateral earth pressure and/or soil friction angle. In this regard, on-site soil to be used as backfill may or may not meet the values for standard wall designs. Geocon Incorporated should be consulted to assess the suitability of the on-site soil for use as wall backfill if standard wall designs will be used.

7.11 Mechanically Stabilized Earth (MSE) Retaining Walls

7.11.1 Mechanized stabilized earth (MSE) retaining walls can be used on the property. MSE retaining walls are alternative walls that consist of modular block facing units with geogrid reinforced earth behind the block. The reinforcement grid attaches to the block units and is typically placed at specified vertical intervals and embedment lengths. The grid length and spacing will be determined by the wall designer. The designer should also check that sufficient horizontal distance exists to install the grids without having to excavate into the slope as the slope face consists of very strong rock material or rock fill.

7.11.2 The geotechnical parameters listed in the following table can be used for preliminary design of the MSE walls. We understand that import soil will be used as backfill material behind the walls. Once the import source has been determined, laboratory testing should be performed to check that the shear strength parameters used in the design of the MSE walls meet the required strength within the reinforced zone.

GEOTECHNICAL PARAMETERS FOR MSE WALLS*

Parameter	Reinforced Zone	Retained Zone	Foundation Zone
Angle of Internal Friction	32 degrees	32 degrees	32 degrees
Cohesion	300 psf	300 psf	300 psf
Wet Unit Density	130 pcf	130 pcf	130 pcf

*Assumed for on-site soil.

7.11.3 The soil parameters presented in the previous table are based on our experience and direct shear-strength tests performed during the geotechnical investigation and represent some of the on-site materials. The wet unit density values can be used for design but actual in-place densities may range from approximately 90 to 135 pounds per cubic foot. Geocon has no way of knowing which materials will actually be used as backfill behind the wall during construction. It is up to the wall designers to use their judgment in selection of the design parameters. As such, once backfill materials have been selected and/or stockpiled, sufficient shear tests should be conducted on samples of the proposed backfill materials to check that they conform to actual design values. Results should be provided to the designer to re-evaluate stability of the walls. Dependent upon test results, the designer may require modifications to the original wall design (e.g., longer reinforcement embedment lengths and/or steel reinforcement).

7.11.4 The foundation zone is the area where the footing is embedded, the reinforced zone is the area of the backfill that possesses the reinforcing fabric, and the retained zone is the area behind the reinforced zone.

7.11.5 The MSE wall foundations should be designed using the values in the following table. The walls should be deepened such that the bottom outside edge of the footing is at least 7 feet horizontally from the face of the slope.

SUMMARY OF MSE RETAINING WALL FOUNDATION RECOMMENDATIONS

Parameter	Value
Minimum Retaining Wall Foundation Width	12 Inches
Minimum Retaining Wall Foundation Depth	12 Inches
Maximum Bearing Capacity	2,500 psf
Estimated Total Settlement	1 Inch
Estimated Differential Settlement	½ Inch in 40 Feet

7.11.6 Backfill materials within the reinforced zone 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. This is applicable to the entire embedment width of the reinforcement. Typically, wall designers specify no heavy compaction equipment within 3 feet of the face of the wall. However, smaller equipment (e.g., walk-behind, self-driven compactors or hand whackers) can be used to compact the materials without causing deformation of the wall. If the designer specifies no compactive effort for this zone, the materials are essentially not properly compacted and the reinforcement grid within the uncompacted zone should not be relied upon for reinforcement, and overall embedment lengths will have to be increased to account for the difference.

7.11.7 Select backfill materials may be required to be in accordance with the MSE retaining wall system. Materials as outlined in the specifications of the retaining wall plans may be generated and stockpiled during grading, if encountered, or may require import. Geocon should perform laboratory tests during the backfill materials to check that soil properties are in accordance with the retaining wall plans and specifications.

7.11.8 The wall should be provided with a drainage system sufficient to prevent excessive seepage through the wall and the base of the wall, thus preventing hydrostatic pressures behind the wall.

7.11.9 Geosynthetic reinforcement must elongate to develop full tensile resistance. This elongation generally results in movement at the top of the wall. The amount of movement is dependent on the height of the wall (e.g., higher walls rotate more) and the type of reinforcing grid used. In addition, over time the reinforcement grid has been known to exhibit creep (sometimes as much as 5 percent) and can undergo additional movement. Given this condition, the owner should be aware that structures and pavement placed within the reinforced and retained zones of the wall may undergo movement.

7.11.10 The MSE wall contractor should provide the estimated deformation of wall and adjacent ground in associated with wall construction. The calculated horizontal and vertical deformations should be determined by the wall designer. The estimated movements should be provided to the project structural engineer to determine if the planned improvements can tolerate the expected movements.

7.11.11 The MSE wall designer/contractor should review this report, including the slope stability requirements, and incorporate our recommendations as presented herein. We should be provided the plans for the MSE walls to check if they are in conformance with our recommendations prior to issuance of a permit and construction.

7.12 Lateral Loading

7.12.1 The values in the following table 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.

SUMMARY OF LATERAL LOAD DESIGN RECOMMENDATIONS

Parameter	Value
Passive Pressure Fluid Density	400 pcf
Coefficient of Friction (Concrete and Soil)	0.40
Coefficient of Friction (Along Vapor Barrier)	0.2 to 0.25*

*Per manufacturer's recommendations.

7.12.2 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.

7.13 Preliminary Pavement Recommendations

7.13.1 We calculated the flexible pavement sections in general conformance with the *Caltrans Method of Flexible Pavement Design* (Highway Design Manual, Section 608.4) using an estimated Traffic Index (TI) of 5.0, 5.5, 6.0, and 7.0 for parking stalls, driveways, medium truck traffic areas, and heavy truck traffic areas, respectively. The project civil engineer and owner should review the pavement designations to determine appropriate locations for pavement thickness. The final pavement sections for the parking lot should be based on the R-Value of the subgrade soil encountered at final subgrade elevation. We have assumed an R-Value of 20 for import soils to the site, 54 for the existing subgrade soil and 78 for base materials, respectively, for the purposes of this preliminary analysis. The following table presents the preliminary flexible pavement sections.

PRELIMINARY FLEXIBLE PAVEMENT SECTION

Location	Assumed Traffic Index	Assumed Subgrade R-Value	Asphalt Concrete (Inches)	Class 2 Aggregate Base (Inches)
Parking Stalls for Automobiles and Light-Duty Vehicles	5.0	20	3	7
		54	3	4
Driveways for Automobiles and Light-Duty Vehicles	5.5	20	3	9
		54	9	4
Medium Truck Traffic Areas	6.0	20	3.5	10
		54	3.5	4
Driveways for Heavy Truck Traffic	7.0	20	4	12
		54	4	4

7.13.2 Prior to placing base materials, the upper 12 inches of the subgrade soil should be scarified, moisture conditioned as necessary, and recompacted to a dry density of at least 95 percent of the laboratory maximum dry density near to slightly above optimum moisture content as determined by ASTM D 1557. Similarly, the base material should be compacted to a dry density of at least 95 percent of the laboratory maximum dry density near to slightly above optimum moisture content. Asphalt concrete should be compacted to a density of at least 95 percent of the laboratory Hveem density in accordance with ASTM D 2726.

7.13.3 Base materials should conform to Section 26-1.02B of the *Standard Specifications for The State of California Department of Transportation (Caltrans)* with a ¾-inch maximum size aggregate. Asphalt concrete should conform to Section 203-6 of the *Standard Specifications for Public Works Construction (Greenbook)*.

7.13.4 The base thickness can be reduced if a reinforcement geogrid is used during the installation of the pavement. Geocon should be contact for additional recommendations if alternate design parameters are requested.

7.13.5 A rigid Portland cement concrete (PCC) pavement section should be placed in roadway aprons and cross gutters. We calculated the rigid pavement section in general conformance with the procedure recommended by the American Concrete Institute report ACI 330-21 *Commercial Concrete Parking Lots and Site Paving Design and Construction – Guide.* We used the following traffic categories and design parameters used for the calculations for 20-year design life.

TRAFFIC CATEGORIES

Traffic Category	Description	Reliability (%)	Slabs Cracked at End of Design Life (%)
A	Car Parking Areas and Access Lanes	60	15
E	Garbage or Fire Truck Lane	75	15

7.13.6 We used the parameters presented in the following table to calculate the pavement design sections. We should evaluate the pavement subgrade materials after site grading is complete to determine if updated design sections are necessary.

RIGID PAVEMENT DESIGN PARAMETERS

Design Parameter	Design Value
Modulus of Subgrade Reaction, k	100 pci
Modulus of Rupture for Concrete, M_R	500 psi
Concrete Compressive Strength	3,000 psi
Concrete Modulus of Elasticity, E	3,150,000 psi

7.13.7 Based on the criteria presented herein, the PCC pavement sections should have the following minimum thicknesses for the applicable traffic category.

RIGID VEHICULAR PAVEMENT RECOMMENDATIONS

Traffic Category	Trucks Per Day	Portland Cement Concrete, T (Inches)
A = Car Parking Areas and Access Lanes	10	5½
E = Garbage or Fire Truck Lanes	10	7
	50	7½

7.13.8 The PCC vehicular pavement should be placed over subgrade soil that is compacted to a dry density of at least 95 percent of the laboratory maximum dry density near to slightly above optimum moisture content. The garbage truck pad should be large enough such that all wheels are on the concrete pad during the loading operations.

7.13.9 Adequate joint spacing should be incorporated into the design and construction of the rigid pavement in accordance with the following table.

MAXIMUM JOINT SPACING

Pavement Thickness, T (Inches)	Maximum Joint Spacing (Feet)
$4<T<5$	10
$5\leq T<6$	12.5
$6\leq T$	15

7.13.10 The rigid pavement should also be designed and constructed incorporating the following parameters.

ADDITIONAL RIGID PAVEMENT RECOMMENDATIONS

Subject	Value
Thickened Edge	1.2 Times Slab Thickness Adjacent to Structures
	1.5 Times Slab Thickness Adjacent to Soil
	Minimum Increase of 2 Inches
	4 Feet Wide
Crack Control Joint Depth	Early Entry Sawn = T/6 to T/5, 1.25 Inch Minimum
	Conventional (Tooled or Conventional Sawing) = T/4 to T/3
Crack Control Joint Width	¼-Inch for Sealed Joints and Per Sealer Manufacturer's Recommendations
	$^1/_{16}$- to $^1/_4$-Inch is Common for Unsealed Joints

7.13.11 Reinforcing steel will not be necessary within the concrete for geotechnical purposes with the possible exception of dowels at construction joints as discussed herein.

7.13.12 To control the location and spread of concrete shrinkage cracks, crack-control joints (weakened plane joints) should be included in the design of the concrete pavement slab. Crack-control joints should be sealed with an appropriate sealant to prevent the migration of water through the control joint to the subgrade materials. The depth of the crack-control joints should be in accordance with the referenced ACI guide.

7.13.13 To provide load transfer between adjacent pavement slab sections, a butt-type construction joint should be constructed. The butt-type joint should be thickened by at least 20 percent at the edge and taper back at least 4 feet from the face of the slab.

7.13.14 Concrete curb/gutter should be placed on soil subgrade compacted to a dry density of at least 90 percent of the laboratory maximum dry density near to slightly above optimum moisture content. Cross-gutters that receive vehicular traffic should be placed on subgrade soil compacted to a dry density of at least 95 percent of the laboratory maximum dry density near to slightly above optimum moisture content. Base materials should not be placed below the curb/gutter, or cross-gutters so water is not able to migrate from the adjacent parkways to the pavement sections. Where flatwork is located directly adjacent to the curb/gutter, the concrete flatwork should be structurally connected to the curbs to help reduce the potential for offsets between the curbs and the flatwork.

7.14 Site Drainage and Moisture Protection

7.14.1 Adequate site drainage is critical to reduce the potential for differential soil movement, erosion and subsurface seepage. Under no circumstances should water be allowed to pond adjacent to footings. The site should be graded and maintained such that surface drainage is directed away from structures in accordance with 2022 CBC 1804.4 or other applicable standards. In addition, surface drainage should be directed away from the top of slopes into swales or other controlled drainage devices. Roof and pavement drainage should be directed into conduits that carry runoff away from the proposed structure.

7.14.2 In the case of basement walls or building walls retaining landscaping areas, a water-proofing system should be used on the wall and joints, and a Miradrain drainage panel (or similar) should be placed over the waterproofing. The project architect or civil engineer should provide detailed specifications on the plans for all waterproofing and drainage.

7.14.3 Underground utilities should be leak free. Utility and irrigation lines should be checked periodically for leaks and detected leaks should be repaired promptly. Detrimental soil movement could occur if water is allowed to infiltrate the soil for prolonged periods of time.

7.14.4 Landscaping planters adjacent to paved areas are not recommended due to the potential for surface or irrigation water to infiltrate the pavement's subgrade and base course. Area drains to collect excess irrigation water and transmit it to drainage structures or impervious above-grade planter boxes can be used. In addition, where landscaping is planned adjacent to the pavement, construction of a cutoff wall along the edge of the pavement that extends at least 6 inches below the bottom of the base material should be considered.

7.14.5 We should prepare a storm water infiltration feasibility report of storm water management devices are planned.

7.15 Grading and Foundation Plan Review

7.15.1 Geocon Incorporated should review the grading and building foundation plans for the project prior to final design submittal to evaluate if additional analyses and/or recommendations are required.

7.16 Testing and Observation Services During Construction

7.16.1 Geocon Incorporated should provide geotechnical testing and observation services during the grading operations, foundation construction, utility installation, retaining wall backfill and pavement installation. The following table presents the typical geotechnical observations we would expect for the proposed improvements.

EXPECTED GEOTECHNICAL TESTING AND OBSERVATION SERVICES

Construction Phase	Observations	Expected Time Frame
Grading	Base of Removal	Part Time During Removals
	Geologic Logging	Part Time to Full Time
	Fill Placement and Soil Compaction	Full Time
Foundations	Foundation Excavation Observations	Full Time
Utility Backfill	Fill Placement and Soil Compaction	Part Time to Full Time
Retaining Wall Backfill	Fill Placement and Soil Compaction	Part Time to Full Time
Subgrade for Sidewalks, Curb/Gutter and Pavement	Soil Compaction	Part Time
Pavement Construction	Base Placement and Compaction	Part Time
	Asphalt Concrete Placement and Compaction	Full Time

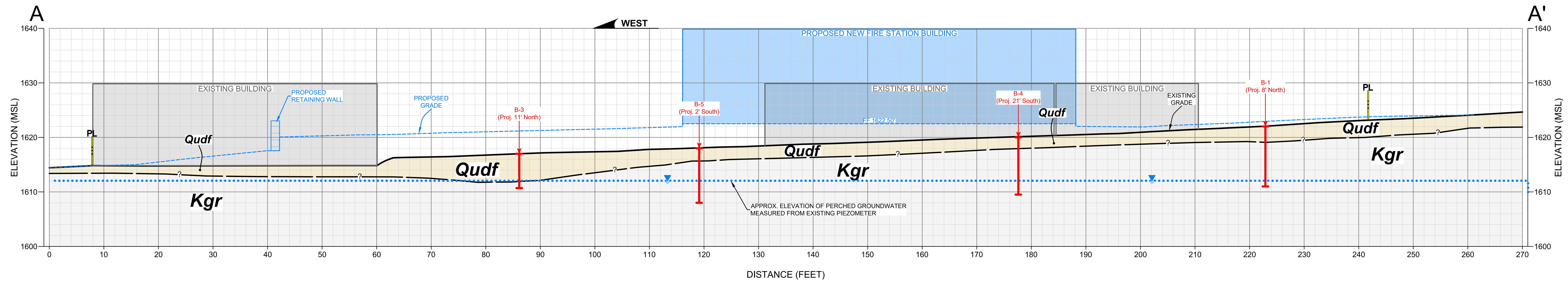
LIMITATIONS AND UNIFORMITY OF CONDITIONS

1. 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.

2. 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 Incorporated should be notified so that supplemental recommendations can be given. The evaluation or identification of the potential presence of hazardous or corrosive materials was not part of the scope of services provided by Geocon Incorporated.

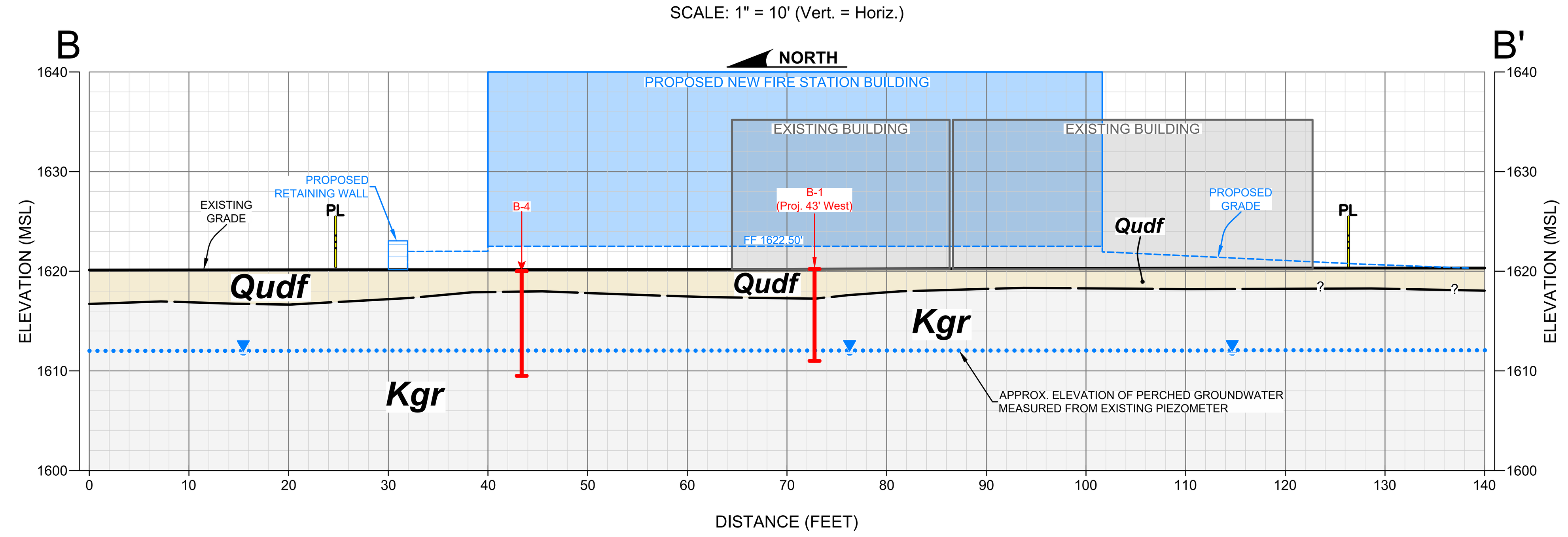
3. This report is issued with the understanding that it is the responsibility of the owner or his representative to ensure that the information and recommendations contained herein are brought to the attention of the architect and engineer for the project and incorporated into the plans, and the necessary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

4. The findings of this report are valid as of the present date. However, changes in the conditions of a property can occur with the passage of time, whether they be 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.



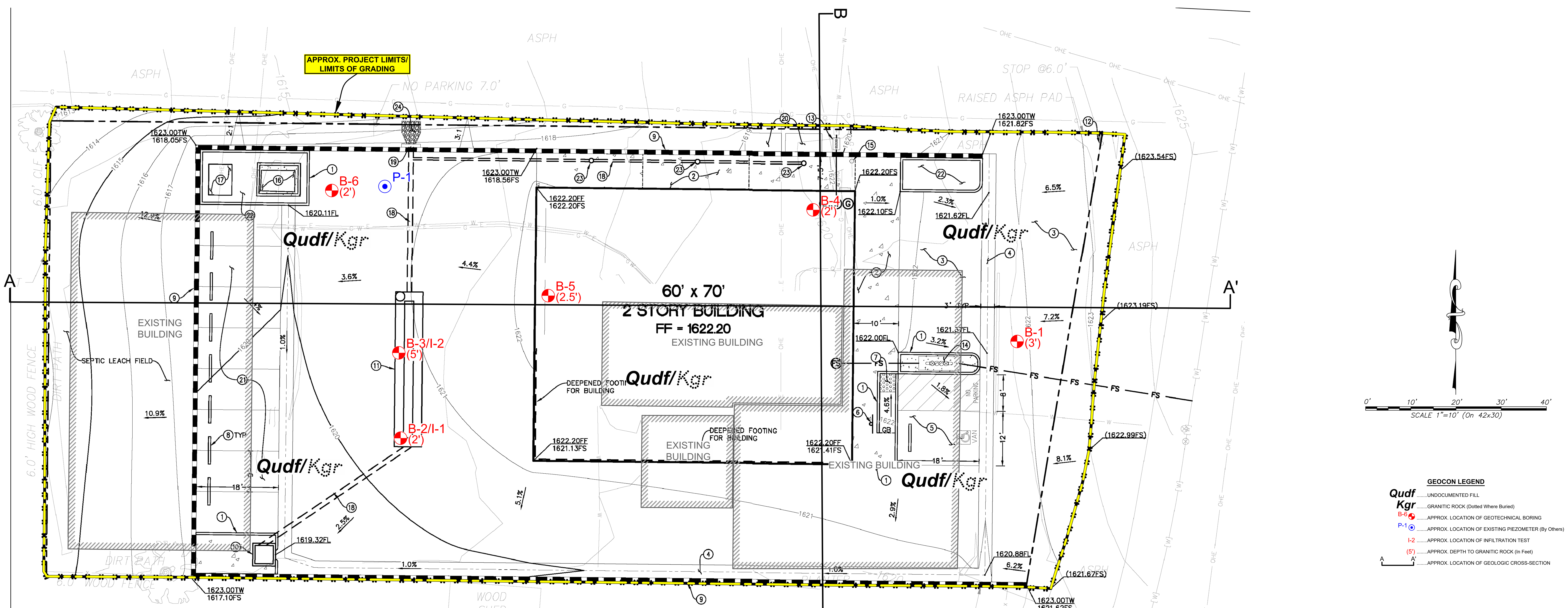
GEOLOGIC CROSS-SECTION A-A'

SCALE: 1" = 10' (Vert. = Horiz.)



GEOLOGIC CROSS-SECTION B-B'

SCALE: 1" = 10' (Vert. = Horiz.)



GEOLOGIC MAP AND CROSS-SECTIONS

SAN MIGUEL FIRE STATION #18
SAN DIEGO COUNTY, CALIFORNIA

GEOCON INCORPORATED
GEOTECHNICAL ■ ENVIRONMENTAL ■ MATERIALS
6960 FLANDERS DRIVE - SAN DIEGO, CALIFORNIA 92121-2974
PHONE 858 558-6900 - FAX 858 558-6159

SCALE	1" = 10'
DATE	03 - 12 - 2024
PROJECT NO.	G3263 - 52 - 01
SHEET	1 OF 1
FIGURE	1

APPENDIX A

APPENDIX A
FIELD INVESTIGATION

We performed the field exploratory operations on February 13, 2024 using a Ingersoll Rand A-300 truck-mounted, hollow stem drill rig with North County Drilling. Our borings extended to maximum depth of approximately 11 feet. We extended the infiltration test borings to depths of approximately 5 to 6 feet. The Geologic Map, Figure 1, shows the approximate locations of the current exploratory excavations for this study. We located the borings in the field using a measuring tape and existing reference points; therefore, actual boring locations may deviate slightly. The exploratory logs are presented herein.

We obtained samples during our subsurface exploration in the borings using a California sampler. The sampler is composed of steel and is driven to obtain ring samples. The California sampler has an inside diameter of 2.5 inches and an outside diameter of 3 inches. Up to 18 rings are placed inside the sampler that is 2.4 inches in diameter and 1 inch in height. We obtained ring samples at appropriate intervals, placed them in moisture-tight containers, and transported them to the laboratory for testing. The type of sample is noted on the exploratory boring logs.

The sampler was driven 12 inches. The sampler is connected to A rods and driven into the bottom of the excavation using a 140-pound hammer with a 30-inch drop. Blow counts are recorded for every 6 inches the sampler is driven. The penetration resistances shown on the boring logs are shown in terms of blows per foot. The values indicated on the boring logs are the sum of the blow counts for 12 inches. If the sampler was not driven for 12 inches, an approximate value is calculated in term of blows per foot or the final 6-inch interval is reported. These values are not to be taken as N-values as adjustments have not been applied. We estimated elevations shown on the boring logs either from a topographic map or by using a benchmark. Each excavation was backfilled as noted on the boring logs.

We visually examined, classified, and logged the soil encountered in the borings in general accordance with American Society for Testing and Materials (ASTM) practice for Description and Identification of Soils (Visual-Manual Procedure D 2488). The logs depict the soil and geologic conditions observed and the depth at which samples were obtained.

GEOCON

Key to Symbols

CLIENT	San Miguel Fire Station No. 18	**PROJECT NAME**	San Miguel Fire Station No. 18
PROJECT NUMBER	G3263-52-01	**PROJECT LOCATION**	1811 Suncrest Blvd, El Cajon, CA

LITHOLOGIC SYMBOLS

(Unified Soil Classification System)

ASPHALT:Asphalt

SC:USCS Clayey Sand

SC-SM:USCS Clayey Sand

SM:USCS Silty Sand

USGS 721:Igneous Rock 1

SAMPLER SYMBOLS

B:Bulk Sample

MC:Modified California Sampler

WELL CONSTRUCTION SYMBOLS

ABBREVIATIONS

LL	-LIQUID LIMIT (%)
PL	-PLASTIC LIMIT (%)
NP	-NON PLASTIC
TV	-TORVANE (TSF)
PP	-POCKET PENETROMETER (TSF)
MC	-MOISTURE CONTENT (%)
DD	-DRY DENSITY (%)
FC	-PERCENT PASSING NO. 200 SIEVE
PID	-PHOTOIONIZATION DETECTOR
FID	-FLAME IONIZATION DETECTOR
▽	Water Level at Time of Drilling, or as shown
▼	Water Level at End of Drilling, or as shown
▼	Water Level After Drilling, or as shown

GEOCON

BOREHOLE NUMBER B-1

Sheet 1 of 1

PROJECT NAME	San Miguel Fire Station No. 18		
PROJECT NUMBER	G3263-52-01	**LATITUDE** 32.807086	**LONGITUDE** -116.863746
DATE STARTED	02-13-2024 **COMPLETED** 02-13-2024	**DRILL DEPTH**	11.0 ft
DRILLING CONTRACTOR	North County	**TOP OF BORING ELEVATION**	1622.0 ft
DRILLING RIG TYPE	Ingersoll Rand A-300 **METHOD** HSA	**GROUNDWATER DEPTHS**	
HAMMER TYPE	Cathead	▽ **FIRST ENCOUNTERED**	NA
BORING DIAMETER	8.0 in.	▼ **AT END OF DRILLING**	NA
LOGGED BY	D. Thomas	▼ **AFTER DRILLING**	NA **TIME AFTER DRILLING** NA

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE NUMBER	USCS	Depth / Elev.	MATERIAL DESCRIPTION	BLOW COUNTS (Blows per 6")	DRY UNIT WT (pcf)	MOISTURE CONTENT (%)
				0.33 / 1621.7	**ASPHALT CONCRETE**; 4"			
		B B1-1	SC-SM	3.00 / 1619.0	**UNDOCUMENTED FILL (Qudf)**; Medium dense, wet, dark reddish brown, Clayey to Silty, fine to medium SAND			
					GRANITIC ROCK (Kgr); Highly weathered, moderately strong, light gray, GRANITIC ROCK; excavates to Silty SAND			
5	1617	MC B1-2			- From 5 feet; becomes moderately weathered	33-50/5"	125.7	8.2
					- Driller reports chatter and very hard drilling			
10	1612	MC B1-3		11.00 / 1611.0	- Becomes fresh rock	50/3"	112.2	5.1
					Practical refusal at 11 feet.			
15	1607							

NOTES

Template: GeoCon - Master Template - Default / Strip Set: Geotech BH Columns (1) / Produced on : March 12 2024 by OpenGround

GEOCON

BOREHOLE NUMBER B-2/I-1

PROJECT NAME	San Miguel Fire Station No. 18		
PROJECT NUMBER	G3263-52-01	**LATITUDE** 32.807025	**LONGITUDE** -116.864190
DATE STARTED	02-13-2024 **COMPLETED** 02-13-2024	**DRILL DEPTH**	5.5 ft
DRILLING CONTRACTOR	North County	**TOP OF BORING ELEVATION**	1618.0 ft
DRILLING RIG TYPE	Ingersoll Rand A-300 **METHOD** HSA	**GROUNDWATER DEPTHS**	
HAMMER TYPE	Cathead	▽ **FIRST ENCOUNTERED**	NA
BORING DIAMETER	4.0 in.	▼ **AT END OF DRILLING**	NA
LOGGED BY	D. Thomas	▽ **AFTER DRILLING**	5.0 ft **TIME AFTER DRILLING** 2.00 hrs

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE NUMBER	LITHOLOGY	USCS		MATERIAL DESCRIPTION	BLOW COUNTS (Blows per 6")	DRY UNIT WT (pcf)	MOISTURE CONTENT (%)
					0.38 1617.6	**ASPHALT CONCRETE**; 4.5"			
				SM	2.00 1616.0	**UNDOCUMENTED FILL (Qudf)**; Medium dense, moist to wet, dark brown, Silty, fine to medium SAND (SM)			
		MC B2-1				**GRANITIC ROCK (Kgr)**; Slightly weathered, moderately fractured, strong, light gray, GRANITIC ROCK; excavates to Silty SAND	50/5"	107.0	8.1
5	1613				5.00 1613.0 ▽				
					5.50 1612.5				
						Boring terminated at 5.5 feet.			
10	1608								
15	1603								

NOTES

Template: GeoCon - Master Template - Default / Strip Set: Geotech BH Columns (1) / Produced on : March 12 2024 by OpenGround

GEOCON

BOREHOLE NUMBER B-3/I-2

PROJECT NAME	San Miguel Fire Station No. 18		
PROJECT NUMBER	G3263-52-01	**LATITUDE** 32.807077	**LONGITUDE** -116.864192
DATE STARTED	02-13-2024 **COMPLETED** 02-13-2024	**DRILL DEPTH**	6.3 ft
DRILLING CONTRACTOR	North County	**TOP OF BORING ELEVATION**	1618.0 ft
DRILLING RIG TYPE	Ingersoll Rand A-300 **METHOD** HSA	**GROUNDWATER DEPTHS**	
HAMMER TYPE	Cathead	▽ **FIRST ENCOUNTERED**	NA
BORING DIAMETER	4.0 in.	▼ **AT END OF DRILLING**	NA
LOGGED BY	D. Thomas	▽ **AFTER DRILLING**	6.2 ft **TIME AFTER DRILLING** 1.00 hrs

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE NUMBER	LITHOLOGY	USCS		MATERIAL DESCRIPTION	BLOW COUNTS (Blows per 6")	DRY UNIT WT (pcf)	MOISTURE CONTENT (%)
					0.33 1617.7	**ASPHALT CONCRETE**; 4"			
				SC		**UNDOCUMENTED FILL (Qudf)**; Medium dense, moist to wet, dark brown, Clayey, fine to coarse SAND			
		MC B3-1					6-12	118.5	14.4
5	1613				5.00 1613.0				
		MC B3-2				**GRANITIC ROCK (Kgr)**; Completely weathered, weak, light reddish brown, GRANITIC ROCK; excavates to Silty SAND	8-15	119.8	13.5
					6.20 1611.8 ▽				
					6.30 1611.7	Boring terminated at 6.3 feet.			
10	1608								
15	1603								

NOTES

GEOCON

BOREHOLE NUMBER B-4

PROJECT NAME	San Miguel Fire Station No. 18		
PROJECT NUMBER	G3263-52-01	**LATITUDE**	32.807165
		LONGITUDE	-116.863894
DATE STARTED	02-13-2024	**COMPLETED**	02-13-2024
DRILL DEPTH	10.5 ft		
DRILLING CONTRACTOR	North County	**TOP OF BORING ELEVATION**	1620.0 ft
DRILLING RIG TYPE	Ingersoll Rand A-300	**METHOD**	HSA
HAMMER TYPE	Cathead		
BORING DIAMETER	8.0 in.		
LOGGED BY	D, Thomas+D. Thomas		

GROUNDWATER DEPTHS

FIRST ENCOUNTERED	NA	
AT END OF DRILLING	NA	
AFTER DRILLING	10.3 ft	**TIME AFTER DRILLING** 0.16 hrs

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE NUMBER	USCS	Depth / Elev.	MATERIAL DESCRIPTION	BLOW COUNTS (Blows per 6")	DRY UNIT WT (pcf)	MOISTURE CONTENT (%)
				0.48 1619.5	**ASPHALT CONCRETE**; 5.5"			
			SC-SM	2.00 1618.0	**UNDOCUMENTED FILL (Qudf)**; Medium dense, moist to wet, light reddish brown, Silty to Clayey, fine to medium SAND			
		B B4-1			**GRANITIC ROCK (Kgr)**; Slightly to moderately weathered, strong, light gray, GRANITIC ROCK; excavates to Silty SAND			
5	1615	MC B4-2				50/6"	124.2	7.2
					- Slow drilling			
10	1610	MC B4-3		10.30 1609.7 / 10.50 1609.5		50/4"	122.1	5.6
					Boring terminated at 10.5 feet.			
15	1605							

NOTES

GEOCON

BOREHOLE NUMBER B-5

PROJECT NAME	San Miguel Fire Station No. 18				
PROJECT NUMBER	G3263-52-01	**LATITUDE**	32.807112	**LONGITUDE**	-116.864084
DATE STARTED	02-13-2024 **COMPLETED** 02-13-2024	**DRILL DEPTH**	11.0 ft		
DRILLING CONTRACTOR	North County	**TOP OF BORING ELEVATION**	1619.0 ft		
DRILLING RIG TYPE	Ingersoll Rand A-300 **METHOD** HSA	**GROUNDWATER DEPTHS**			
HAMMER TYPE	Cathead	**FIRST ENCOUNTERED**	NA		
BORING DIAMETER	8.0 in.	**AT END OF DRILLING**	NA		
LOGGED BY	D. Thomas	**AFTER DRILLING**	10.6 ft	**TIME AFTER DRILLING**	0.33 hrs

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE NUMBER	LITHOLOGY	USCS	Depth / Elev.	MATERIAL DESCRIPTION	BLOW COUNTS (Blows per 6")	DRY UNIT WT (pcf)	MOISTURE CONTENT (%)
0–2.5				SC-SM	2.50 1616.5	**UNDOCUMENTED FILL**; Loose, wet, dark brown, Clayey to Silty, fine to coarse SAND			
2.5–11						**GRANITIC ROCK**; Moderately weathered, strong, gray to dark, GRANITIC ROCK; excavates to Silty SAND			
5	1614	MC B5-1					15-30	122.7	12.5
						- Cutting becomes all black, strong odor			
						- Slightly weathered, very strong			
10	1609	MC B5-2			10.60 1608.4 ▼		35-50/3"		
					11.00 1608.0				
15	1604					Boring terminated at 11 feet.			

NOTES

GEOCON

BOREHOLE NUMBER B-6

PROJECT NAME	San Miguel Fire Station No. 18		
PROJECT NUMBER	G3263-52-01	**LATITUDE** 32.807175	**LONGITUDE** -116.864240
DATE STARTED	02-13-2024 **COMPLETED** 02-13-2024	**DRILL DEPTH**	10.5 ft
DRILLING CONTRACTOR	North County	**TOP OF BORING ELEVATION**	1617.0 ft
DRILLING RIG TYPE	Ingersoll Rand A-300 **METHOD** HSA	**GROUNDWATER DEPTHS**	
HAMMER TYPE	Cathead	▽ **FIRST ENCOUNTERED**	NA
BORING DIAMETER	8.0 in.	▼ **AT END OF DRILLING**	5ft (in piezometer next to boring)
LOGGED BY	D. Thomas	▼ **AFTER DRILLING**	NA **TIME AFTER DRILLING** NA

DEPTH (ft)	ELEVATION (ft)	SAMPLE TYPE NUMBER	LITHOLOGY	USCS			MATERIAL DESCRIPTION	BLOW COUNTS (Blows per 6")	DRY UNIT WT (pcf)	MOISTURE CONTENT (%)
					0.45	1616.6	5" of ASPHALT CONCRETE			
				SM	2.00	1615.0	**UNDOCUMENTED FILL (Qudf)**; Medium dense, wet, reddish brown, Silty, fine to coarse SAND			
		MC B6-1					**GRANITIC ROCK (Kgr)**; Moderately weathered, strong, light gray-reddish brown, GRANITIC ROCK; excavates to Silty SAND			
5	1612	MC B6-2						18-50/3"	122.7	11.5
							- Becomes slightly weathered and very strong			
10	1607	MC B6-3			10.50	1606.5		50/6"	113.6	8.1
							Boring terminated at 10.5 feet.			
15	1602									

NOTES

APPENDIX B

APPENDIX B
LABORATORY TESTING

We performed laboratory tests in accordance with generally accepted test methods of the American Society for Testing and Materials (ASTM) or other suggested procedures. We tested selected soil samples for in-place dry density/moisture content, maximum density/optimum moisture content, expansion index, water-soluble sulfate, R-Value, unconfined compressive strength, consolidation, and direct shear strength. The results of our current laboratory tests are presented herein. The in-place dry density and moisture content of the samples tested are presented on the boring logs in Appendix A.

SUMMARY OF LABORATORY MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE CONTENT TEST RESULTS ASTM D 1557

Sample No.	Description	Maximum Dry Density (pcf)	Optimum Moisture Content (% dry wt.)
B1-1	Dark reddish brown, Clayey to Silty , fine to medium SAND	134.5	7.2

SUMMARY OF LABORATORY EXPANSION INDEX TEST RESULTS ASTM D 4829

Sample No.	Moisture Content (%)		Dry Density (pcf)	Expansion Index	2022 CBC Expansion Classification	ASTM Soil Expansion Classification
	Before Test	After Test				
B1-1	7.8	14.3	118.5	1	Non Expansive	Very Low

SUMMARY OF LABORATORY WATER-SOLUBLE SULFATE TEST RESULTS CALIFORNIA TEST NO. 417

Sample No.	Depth (feet)	Geologic Unit	Water-Soluble Sulfate (%)	ACI 318 Sulfate Exposure
B1-1	1-5	Qudf	0.023	S0

SUMMARY OF LABORATORY RESISTANCE VALUE (R-VALUE) TEST RESULTS
ASTM D 2844

Sample No.	Depth (Feet)	Description (Geologic Unit)	R-Value
B1-1	1-5	Dark reddish brown, Clayey to Silty , fine to medium SAND (Qudf)	54

SUMMARY OF LABORATORY UNCONFINED COMPRESSIVE STRENGTH TEST RESULTS
ASTM D 1558

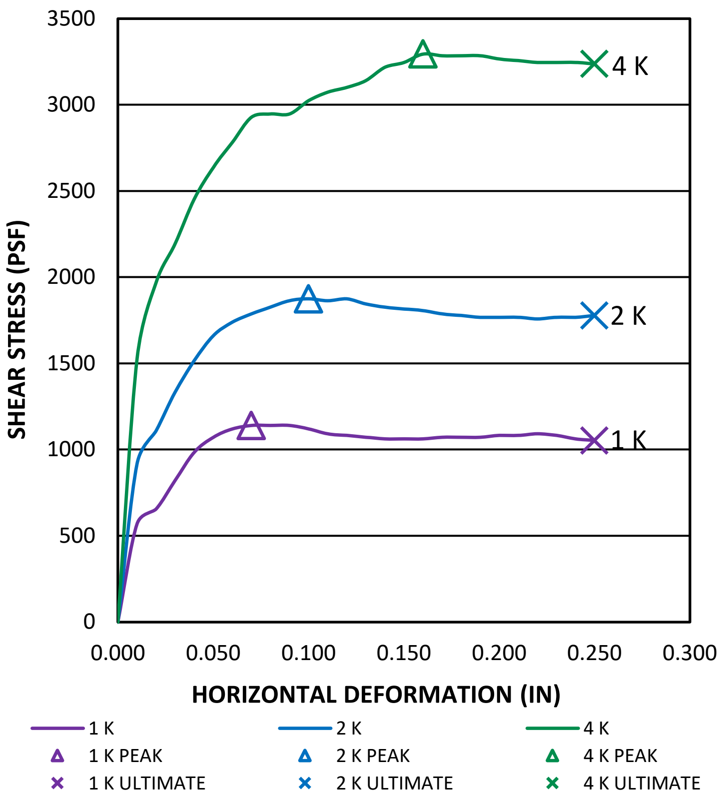
Sample No.	Depth (Feet)	Geologic Unit	Hand Penetrometer Reading/Unconfined Compression Strength (tsf) and Undrained Shear Strength (ksf)
B1-2	5	Kgr	4.5+
B1-3	10	Kgr	4.5+
B2-1	4	Kgr	4.5+
B3-1	2.5	Qudf	4.5+
B3-2	5	Kgr	4.5+
B4-2	5	Kgr	4.5+
B4-3	10	Kgr	4.5+
B5-1	5	Kgr	4.5+
B5-2	10	Kgr	4.5+
B6-2	5	Kgr	4.5+
B6-3	10	Kgr	4.5+

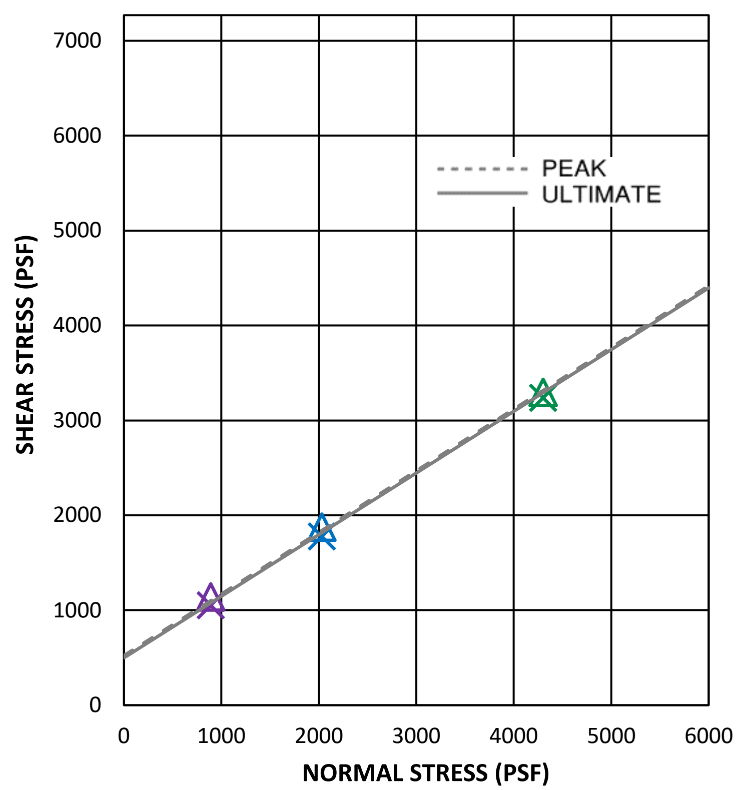
SAMPLE NO.:	B1-1	GEOLOGIC UNIT:	Qudf-Kgr
SAMPLE DEPTH (FT):	1'-5'	NATURAL/REMOLDED:	R

INITIAL CONDITIONS				
NORMAL STRESS TEST LOAD	1 K	2 K	4 K	AVERAGE
ACTUAL NORMAL STRESS (PSF):	890	2030	4300	--
WATER CONTENT (%):	7.2	7.5	6.7	7.2
DRY DENSITY (PCF):	121.0	120.7	121.4	121.0

AFTER TEST CONDITIONS				
NORMAL STRESS TEST LOAD	1 K	2 K	4 K	AVERAGE
WATER CONTENT (%):	11.4	11.0	11.0	11.2
PEAK SHEAR STRESS (PSF):	1140	1874	3295	--
ULT.-E.O.T. SHEAR STRESS (PSF):	1053	1778	3237	--

RESULTS		
PEAK	COHESION, C (PSF)	525
	FRICTION ANGLE (DEGREES)	33
ULTIMATE	COHESION, C (PSF)	500
	FRICTION ANGLE (DEGREES)	33





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PHONE 858 558-6900 - FAX 858 558-6159

DIRECT SHEAR - AASHTO T-236

SAN MIGUEL FIRE STATION NO. 18

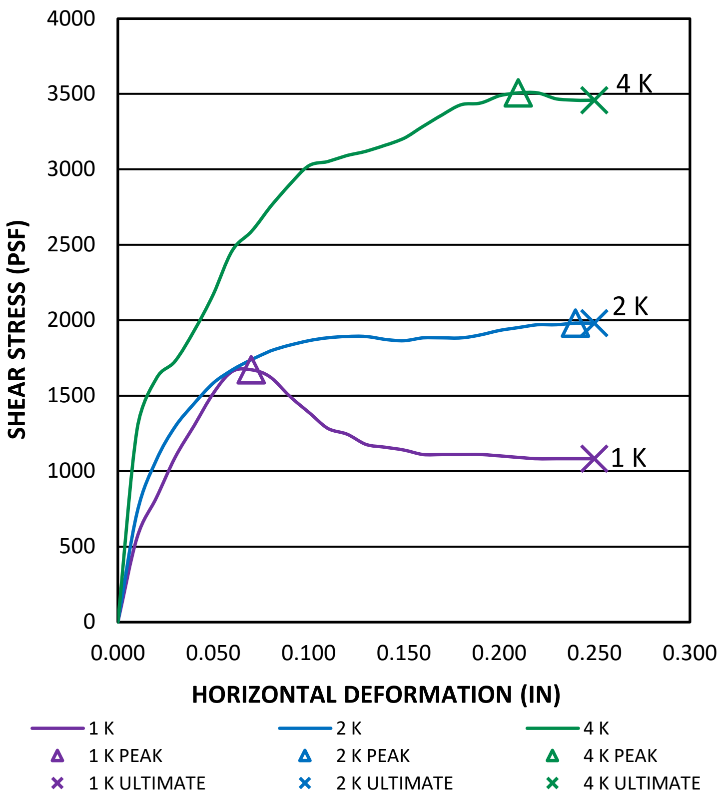
PROJECT NO.: G3263-52-01

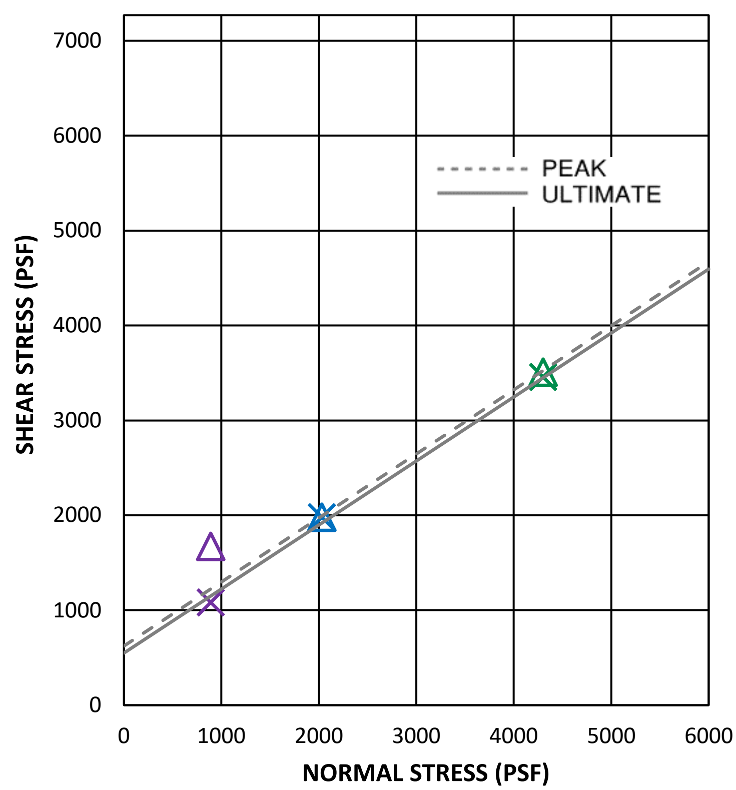
SAMPLE NO.:	B5-1	GEOLOGIC UNIT:	Kgr
SAMPLE DEPTH (FT):	5'	NATURAL/REMOLDED:	N

INITIAL CONDITIONS				
NORMAL STRESS TEST LOAD	1 K	2 K	4 K	AVERAGE
ACTUAL NORMAL STRESS (PSF):	890	2030	4300	--
WATER CONTENT (%):	12.1	12.8	12.6	12.5
DRY DENSITY (PCF):	124.4	121.0	122.7	122.7

AFTER TEST CONDITIONS				
NORMAL STRESS TEST LOAD	1 K	2 K	4 K	AVERAGE
WATER CONTENT (%):	13.0	15.1	13.6	13.9
PEAK SHEAR STRESS (PSF):	1671	1981	3507	--
ULT.-E.O.T. SHEAR STRESS (PSF):	1082	1981	3459	--

RESULTS		
PEAK	COHESION, C (PSF)	625
	FRICTION ANGLE (DEGREES)	34
ULTIMATE	COHESION, C (PSF)	550
	FRICTION ANGLE (DEGREES)	34





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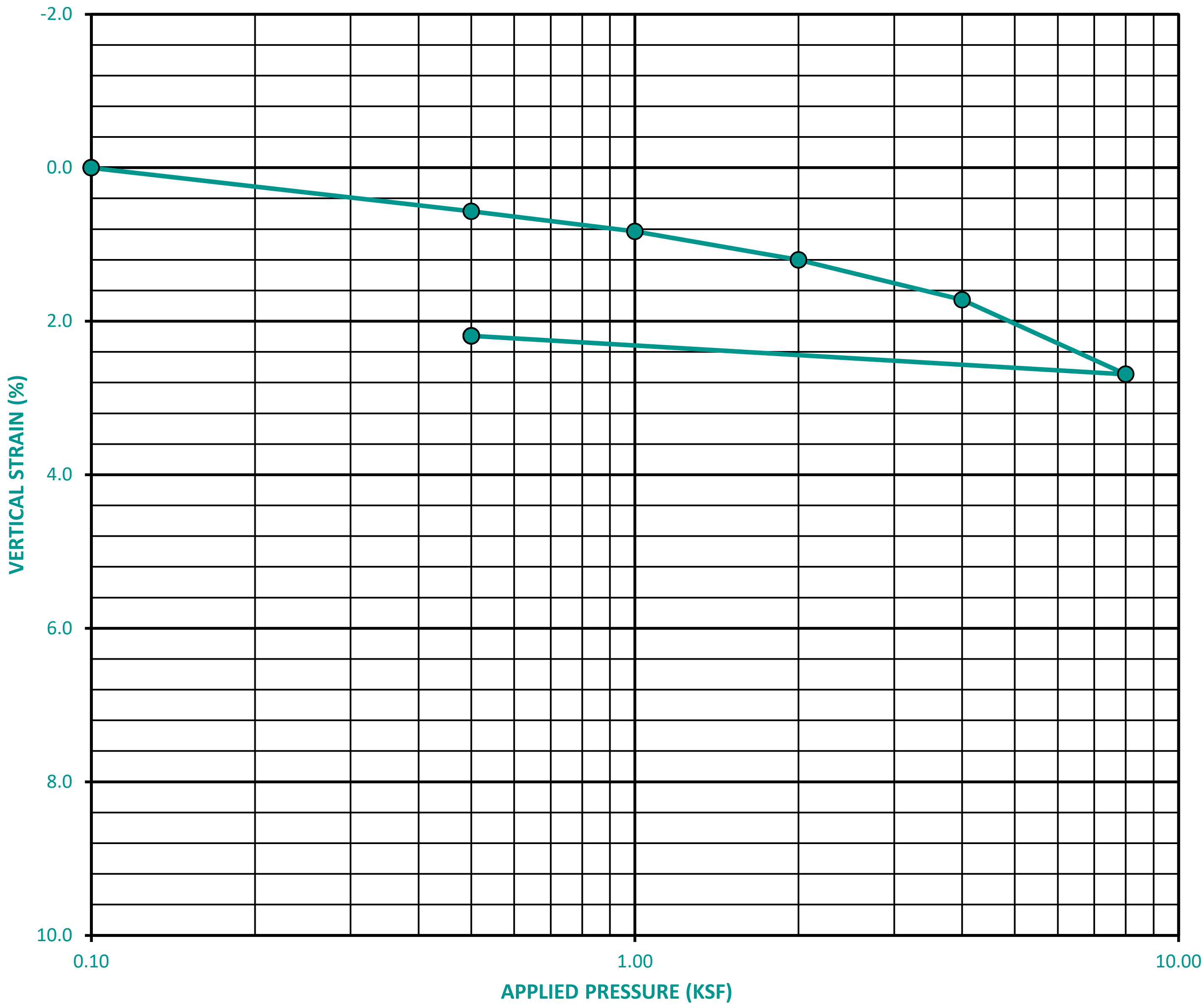
DIRECT SHEAR - AASHTO T-236

SAN MIGUEL FIRE STATION NO. 18

PROJECT NO.: G3263-52-01

SAMPLE NO.:	B3-2	**GEOLOGIC UNIT:**	Kgr
SAMPLE DEPTH (FT):	5'		

TEST INFORMATION	
INITIAL DRY DENSITY (PCF):	119.8
INITIAL WATER CONTENT (%):	13.5%
SAMPLE SATURATED AT (KSF):	2.0
INITIAL SATURATION (%):	93.0%



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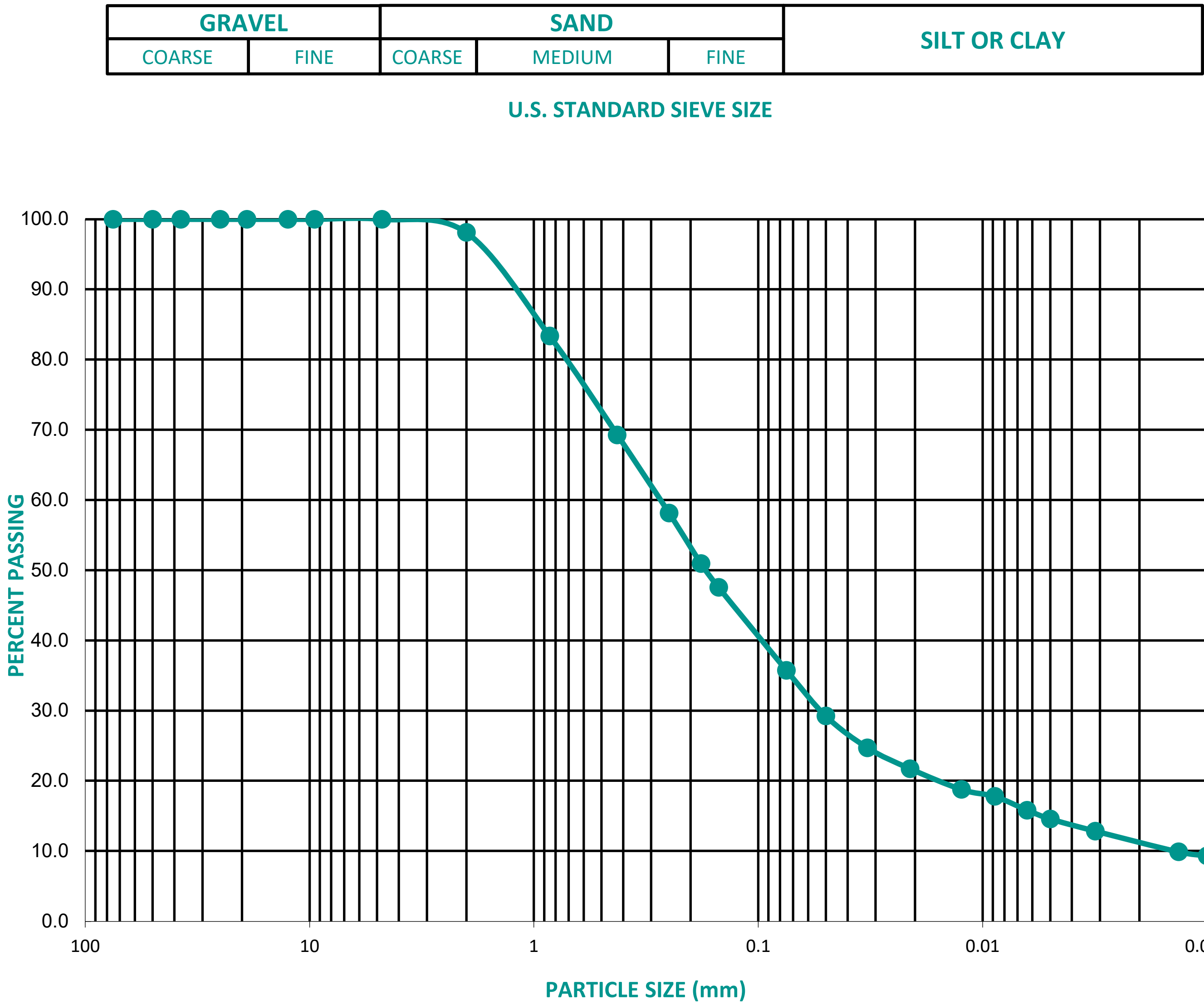
CONSOLIDATION CURVE - ASTM D 2435

SAN MIGUEL FIRE STATION NO. 18

PROJECT NO.: G3263-52-01

SAMPLE NO.: **B1-1** GEOLOGIC UNIT: **Qudf-Kgr**

SAMPLE DEPTH (FT.): **1'-5'**



TEST DATA					
D_{10} (mm)	D_{30} (mm)	D_{60} (mm)	C_c	C_u	SOIL DESCRIPTION
0.00141	0.05294	0.27896	7.1	197.9	Silty SAND

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SIEVE ANALYSES - ASTM D 135 & D 422

SAN MIGUEL FIRE STATION NO. 18

PROJECT NO.: G3263-52-01

APPENDIX C

APPENDIX C

RECOMMENDED GRADING SPECIFICATIONS

FOR

SAN MIGUEL FIRE STATION NO. 18
1811 SUNCREST BOULEVARD
EL CAJON, CALIFORNIA

PROJECT NO. G3263-52-01

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

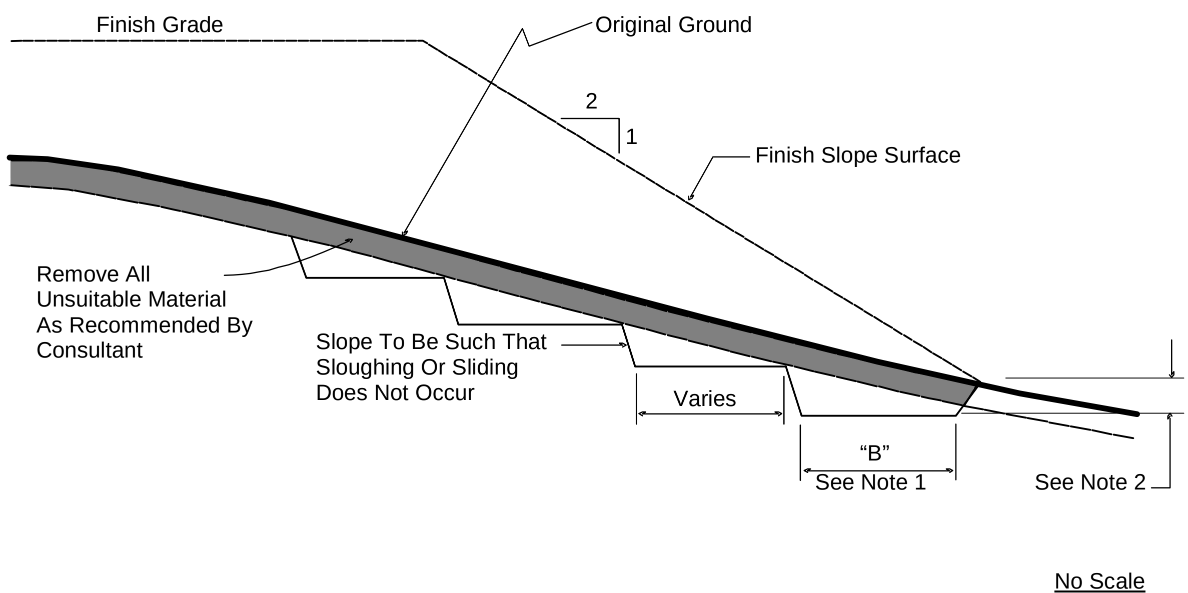
4.1 Areas to be excavated and filled shall be cleared and grubbed. Clearing shall consist of complete removal above the ground surface of trees, stumps, brush, vegetation, man-made structures, and similar debris. Grubbing shall consist of removal of stumps, roots, buried logs and other unsuitable material 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



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.

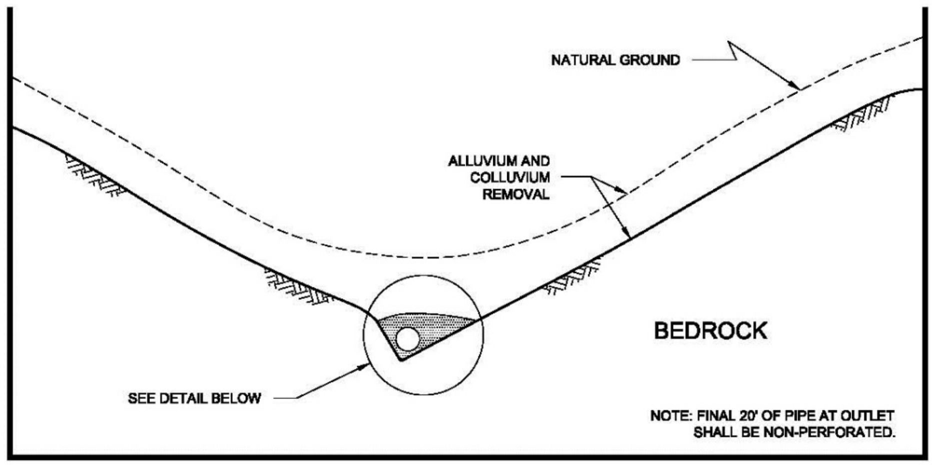
6.3.6 To reduce the potential for “piping” of fines into the *rock* fill from overlying *soil* fill material, a 2-foot layer of graded filter material shall be placed above the uppermost lift of *rock* fill. The need to place graded filter material below the *rock* should be determined by the Consultant 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.

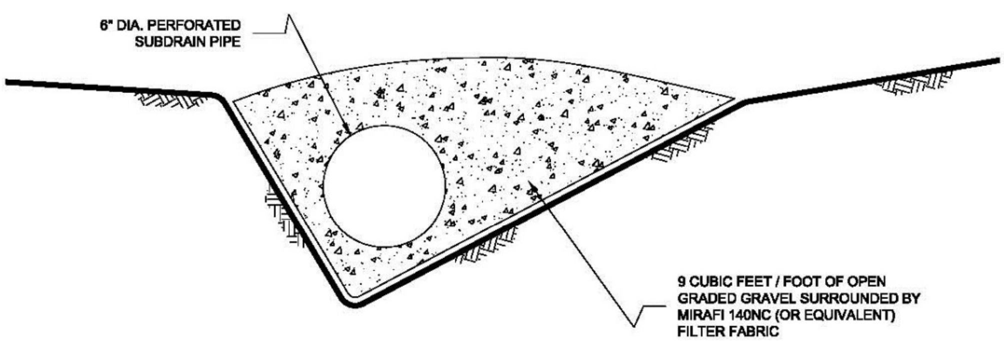
6.3.7 *Rock* fill placement should be continuously observed during placement by the Consultant.

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:

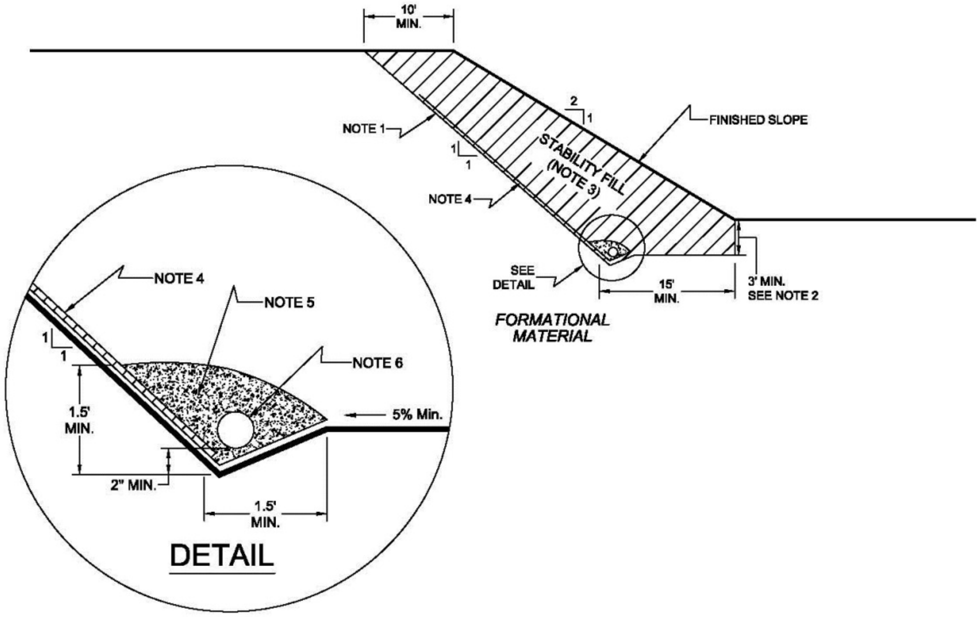
1......6-INCH DIAMETER, SCHEDULE 80 PVC PERFORATED PIPE FOR FILLS IN EXCESS OF 100-FEET IN DEPTH OR A PIPE LENGTH OF LONGER THAN 500 FEET.

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.

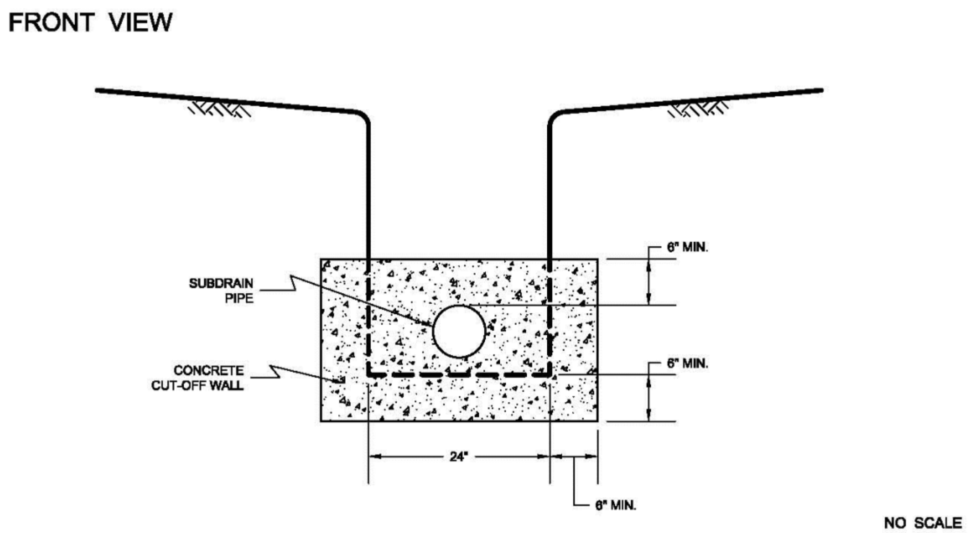
NO SCALE

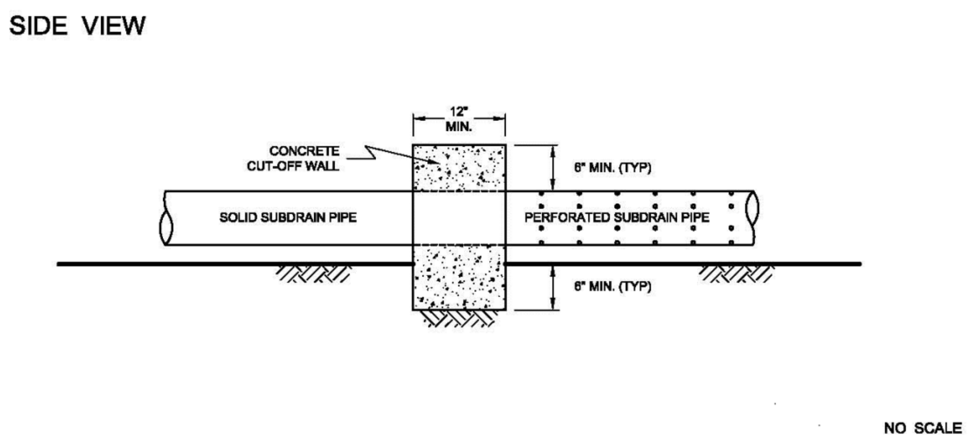
7.3 The actual subdrain locations will be evaluated in the field during the remedial grading operations. Additional drains may be necessary depending on the conditions observed and the requirements of the local regulatory agencies. Appropriate subdrain outlets should be evaluated prior to finalizing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

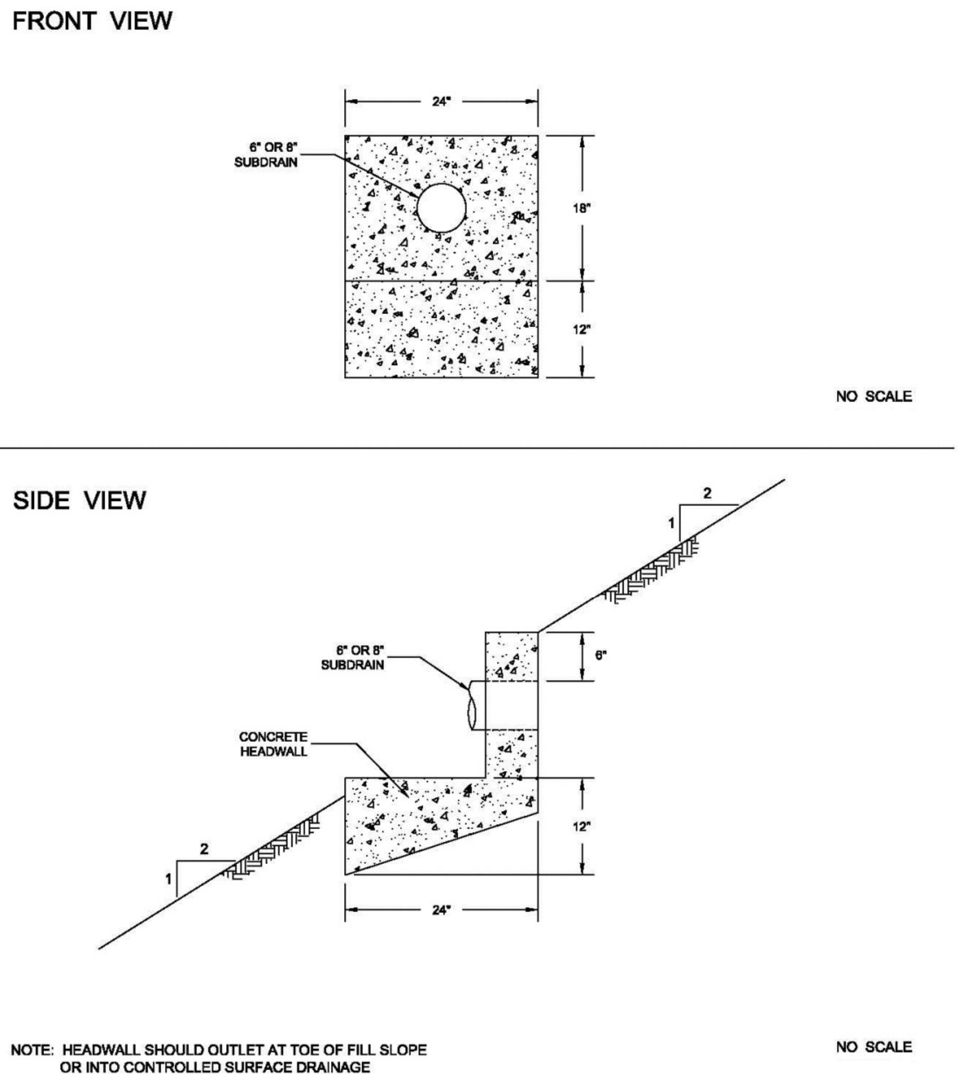
TYPICAL CUT OFF WALL DETAIL





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.

LIST OF REFERENCES

1. *2022 California Building Code, California Code of Regulations, Title 24, Part 2, based on the 2021 International Building Code*, prepared by California Building Standards Commission, dated July 2022.

2. *ACI 318-19, Commentary on Building Code Requirements for Structural Concrete,* prepared by the American Concrete Institute, dated May 2019.

3. *ACI 330-21, Commercial Concrete Parking Lots and Site Paving Design and Construction,* prepared by the American Concrete Institute, dated May 2021.

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

2. County of San Diego, *San Diego County Multi Jurisdiction Hazard Mitigation Plan, San Diego, California – Final Draft,* dated 2017*.*

3. Historical Aerial Photos. *http://www.historicaerials.com*

4. Jennings, C. W., 1994, California Division of Mines and Geology, *Fault Activity Map of California and Adjacent Areas,* California Geologic Data Map Series Map No. 6.

5. Kennedy, M. P., and S. S. Tan, 2008, *Geologic Map of the El Cajon 30'x60' Quadrangle, California*, USGS Regional Map Series Map No. 3, Scale 1:100,000.

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

7. Risk Engineering, *EZ-FRISK*, 2016.

8. Special Publication 117A, *Guidelines For Evaluating and Mitigating Seismic Hazards in California 2008*, California Geological Survey, Revised and Re-adopted September 11, 2008.

9. Unpublished reports, aerial photographs, and maps on file with Geocon Incorporated.

10. USGS computer program, Seismic Hazard Curves and Uniform Hazard Response Spectra, *http://geohazards.usgs.gov/designmaps/us/application.php.*