APPENDIX C

Geotechnical Studies

SDVOSB . DVBE

SCST, Inc.
Corporate Headquarters
6280 Riverdale Street
San Diego, CA 92120
T 877.215.4321
P 619.280.4321
F 619.280.4717
W www.scst.com

GEOTECHNICAL INVESTIGATION
MULTI-STORY RESIDENTIAL DEVELOPMENT
DUARTE ROAD
MONROVIA, CALIFORNIA

PREPARED FOR:
COLIN HOFMANN
DEVELOPMENT ANALYSIST
RICHMAN GROUP
7817 HERSCHEL AVENUE, SUITE 102
SAN DIEGO, CALIFORNIA 92037

PREPARED BY:

SCST, INC.
6280 RIVERDALE STREET
SAN DIEGO, CALIFORNIA 92120

Providing Professional Engineering Services Since 1959

SDVOSB . DVBE

SCST, Inc.
Corporate Headquarters
6280 Riverdale Street
San Diego, CA 92120
T 877.215.4321
P 619.280.4321
F 619.280.4717
W www.scst.com

February 24, 2017

SCST No. 170107N
Report No. 1

Colin Hofmann
Development Analysist
Richman Group
7817 Herschel Avenue, Suite 102
San Diego, California 92037

Subject: GEOTECHNICAL INVESTIGATION
DUARTE ROAD APARTMENTS
PROPOSED MULTI-STORY RESIDENTIAL DEVELOPMENT
DUARTE ROAD
MONROVIA, CALIFORNIA

Dear Mr. Hofmann:

SCST, Inc. (SCST) is pleased to present our report describing the geotechnical investigation performed for the subject project. We conducted the geotechnical investigation in general conformance with the scope of work presented in our proposal dated January 10, 2017. Based on the results of our investigation, we consider the planned construction feasible from a geotechnical standpoint provided the recommendations of this report are followed. If you have any questions, please call our office at (619) 280-4321.

Respectfully submitted,
SCST, INC.

EMIL RUDOLPH
No. 2767
Exp. 6/30/17

DOUGLAS A. SKINNER
No. 2472

Emil Rudolph, PE, GE 2767
Principal Geotechnical Engineer

Douglas A. Skinner, CEG 2472
Senior Geologist

Vincent A. Uhde, EIT
Project Manager

VAU:ER:DS:rt

(1) Addressee via email: HofmannC@RichmanCapital.com

TABLE OF CONTENTS (CONTINUED)

TABLE OF CONTENTS (CONTINUED)

SECTION **PAGE**

ATTACHMENTS

FIGURES

APPENDICES

EXECUTIVE SUMMARY

This report presents the results of the geotechnical investigation SCST, Inc. (SCST) performed for the subject project located in Monrovia, California. We understand the project will consist of the design and construction of a multi-story residential development consisting of 296 units, a 6-level parking structure with a subterranean level, and associated improvements. Additionally, the project will implement stormwater quality control measure Best Management Practice (BMP) infiltration facilities. The purpose of our work is to provide conclusions and recommendations regarding the geotechnical aspects of the project.

We explored the subsurface conditions by advancing a total of seven exploratory geotechnical borings to depths of between approximately 10 and 51 feet deep at the site using a truck-mounted drill rig equipped with an 8-inch hollow-stem auger. An SCST engineer logged the borings and obtained samples of the materials encountered for laboratory testing. SCST tested selected samples from the borings to evaluate pertinent soil classification and engineering properties to assist in developing geotechnical conclusions and recommendations.

The materials encountered in the borings consist of surficial sediments encountered as alluvium and older alluvium. The alluvium consists of loose to medium dense, poorly graded sand with varying amounts of silt, gravel, and cobbles to silty sand with gravel. Lenses of silt and sandy silt were encountered within the alluvium. Older alluvium consisting of dense silty sand and poorly graded sand was encountered below the alluvium and extended beyond the maximum depth explored. Groundwater was not encountered in the borings.

We performed two in situ constant head boring percolation tests at depths of 10 and 30 feet below the existing surface. The adjusted percolation and infiltration rates were 2.8 and 1.5 inches per hour, respectively. Based on the results of our testing, Low Impact Development stormwater infiltration is considered feasible at the site.

The main geotechnical consideration affecting the planned construction is the presence of potentially compressible alluvium. Based on our dynamic settlement calculations, we recommend deep earthwork or ground improvements. The alluvium within 10 feet of the deepest planned footing bottom level should be excavated and replaced with compacted fill to mitigate the potential for adverse differential settlement. The onsite material tested possess a very low expansion potential. The planned buildings can be supported on shallow spread footings with bottoms levels on compacted fill.

The grading and foundation recommendations presented herein may need to be updated once final plans are developed.

1. INTRODUCTION

This report presents the results of the geotechnical investigation SCST, Inc. (SCST) performed for the subject project located in the City of Monrovia, California. Additionally, an Infiltration Feasibility Study was performed as part of our investigation.

1.1 SITE AND PROJECT DESCRIPTION

The project site spans 6 commercial / industrial parcels with a footprint of approximately 3.4 acres. The site is bound to the north by the Metro Gold Line Extension light rail and Monrovia Station, to the west by S. Magnolia Avenue, to the south by W. Duarte Road and the east by commercial/industrial property. Peck Road divides the parcels, extending from W. Duarte Road north to the Metro rail where it terminates.

Existing improvements consist of four commercial/industrial structures, hardscape and landscape areas, and associated parking pavements. The site is slopes gently to the south with an elevation difference of about 1 foot over a distance of about 40 feet. Site elevations range from about 436 feet at the northern portion of the site to about 426 feet at the southern portion of the site. The general site location is shown on the Site Vicinity Map (Figure 1).

We understand the project will consist of the design and construction of a multi-story residential development consisting of 296 units, a 6-level parking structure with a subterranean level, and associated improvements. Additionally, the project will implement storm water Best Management Practice (BMP) facilities.

1.2 PURPOSE AND SCOPE OF WORK

The purpose of our work is to provide conclusions and recommendations regarding the geotechnical aspects of the project. The scope of work performed by SCST consisted of the following:

- Reviewing readily available geologic maps and geotechnical reports of work previously performed in the project vicinity
- Performing a subsurface investigation at the site that included advancing seven exploratory geotechnical borings advanced to depths between approximately 10 and 51½ feet below the existing ground surface.
- Logging the borings and collecting representative bulk and relatively undisturbed soil samples for observation and testing.
- Converting two geotechnical borings into percolation test borings and performed in situ percolation testing.
- Preforming laboratory testing of selected soil samples to determine pertinent classification and engineering properties of the subgrade material
- Performing a geotechnical evaluation and analysis of collected data.

- Preparation of this report summarizing our findings, conclusions, and recommendations.

2. FIELD INVESTIGATION

Prior to drilling, an SCST representative visited the site to observe existing conditions and mark out the proposed boring locations. SCST notified Underground Service Alert (USA), as required by law, prior to commencement of field activities.

Our field investigation was performed on February 8 and 9, 2017 and consisted of advancing a total of seven exploratory geotechnical borings at the existing site using a truck-mounted drill rig equipped with an 8-inch hollow-stem auger. One boring was advanced to approximately 51½ feet below the existing ground surface within the footprint of the proposed parking structure and six borings were advanced to depths of between approximately 10 and 31½ feet below the existing surface across the project site. An SCST engineer logged and the borings and collected samples of the materials encountered for laboratory testing. Bulk and drive samples were obtained from the borings in general conformance with current applicable ASTM standards. The samples were then transported to our in-house geotechnical laboratory for testing. Borings were backfilled with soil cuttings and paved areas were patched with high strength, rapid set concrete.

Upon completion of logging and sampling, two of the geotechnical borings were converted to percolation test borings for in situ testing. The approximate locations of the geotechnical and percolation test borings are shown on the Subsurface Exploration Map (Figure 2). Logs of the borings are presented in Appendix I. Soils are classified in accordance with the Unified Soil Classification System (USCS) illustrated on Figure I-1.

3. LABORATORY TESTING

Selected samples obtained from the borings were tested to evaluate pertinent classification and engineering properties and enable development of geotechnical conclusions. Laboratory testing of representative soil samples included:

- moisture content and density determination
- Grain Distribution (ASTM D422)
- Expansion Index (ASTM D4289)
- Direct Shear (ASTM D3080)
- Resistance Value (R-Value) (Cal 301, ASTM D2844)
- Corrosivity

The results of the laboratory tests, and brief descriptions of the laboratory test procedures, are presented in Appendix II. Although not encountered in our borings, undocumented fill material may be present at the site.

4. ANALYSIS AND REPORT

The results of the field and laboratory programs were evaluated to develop conclusions and recommendations regarding:

- Subsurface conditions beneath the site, including groundwater levels if encountered
- Potential geologic hazards
- Criteria for seismic design in accordance with 2013 California Building Code (CBC)
- Site preparation and grading
- Excavation characteristics
- Appropriate alternatives for foundation support, along with geotechnical engineering criteria for design of the foundations
- Resistance to lateral loads
- Estimated foundation settlements
- Support for concrete slabs-on-grade
- Lateral pressure for retaining wall design
- Pavement structural sections
- Soil corrosivity
- Infiltration rates and storm water infiltration feasibility

5. GEOTECHNICAL FINDINGS

5.1 GEOLOGIC SETTING

The site is located in the Los Angeles Basin, which is a large structural depression within the northern portion of the Peninsular Ranges Geomorphic Province. To the north of the Los Angeles Basin are the San Gabriel Mountains, which are a part of the Transverse Ranges Geomorphic Province. The San Gabriel Mountains are a lenticular-shaped range of essentially plutonic and metamorphic rocks bounded by fault zones on all sides. The Sierra Madre Fault Zone is located north of the site along the southern portion of the San Gabriel Mountains. The regional geology in the vicinity of the site is shown on the Regional Geology Map (Figure 3).

5.2 SUBSURFACE CONDITIONS

The site is underlain by surficial sediments encountered as alluvium and older alluvium. Although not encountered in our borings, undocumented fill material may be present at the site. Descriptions of the materials are presented below.

Alluvium: Alluvium, consisting of loose to medium dense, poorly graded sand with varying amounts of silt, gravel and cobbles to silty sand with gravel, was encountered in the borings. Lenses of silt and sandy silt were encountered within the alluvium.

Older Alluvium: Older alluvium, consisting of dense silty sand and poorly graded sand was encountered below the alluvium in borings B-5 and B-6. The older alluvium extended beyond the maximum depth explored in these borings of 31½ feet below the existing ground surface.

Groundwater: Groundwater was not encountered in the borings. The groundwater table is expected to be below a depth that will influence planned construction. Based on groundwater monitoring well data maintained by the County of Los Angeles Department of Public Works Water Resources Division, the historic high groundwater level as the site is approximately 200 feet below the ground surface.

However, groundwater levels may fluctuate in the future due to rainfall, irrigation, broken pipes, or changes in site drainage. Because groundwater rise or seepage is difficult to predict, such conditions are typically mitigated if and when they occur.

5.3 INFILTRATION FEASIBILITY

Our infiltration feasibility study consisted of converting two geotechnical borings to boring percolation tests. The in-situ infiltration testing was performed at depths of 10 and 30 feet below the existing ground elevation on February 10, 2017. The boring percolation testing procedures were executed in general accordance with the County of Los Angeles Guidelines for Design Investigation, and Reporting Low Impact Development Stormwater Infiltration (County of Los Angeles, 2017) using an 8-inch diameter hollow stem auger and 4-inch perforated PVC pipe. An SCST engineer logged and sampled the borings for laboratory testing consisting of sieve analysis (ASTM D422). The percolation borings were presoaked a approximately 24 hours by maintaining approximately 12 inches of constant water head.

The in-situ boring percolation test results were adjusted using a correction factor and reduction factor to assess the corrected percolation and infiltration rates, respectfully. The appropriate design percolation / infiltration rate should be adopted based on the specific BMP facility selected by the civil engineer, i.e. percolation rate for dry well design or infiltration rate for infiltration basin design. The soil type classification and percolation and infiltration rates are presented in Table 1. Test data from the boring percolation testing are presented in Appendix III.

TABLE 1
Soil Type Classification and Adjusted Percolation & Infiltration Rates

Percolation Test	**Depth of Test (feet)**	**Soil Classification**		**Percolation Rate (inches/hour)**	**Infiltration Rate (inches/hour)**
		USCS[1]	**HSG[2]**		
P-1	30	Silty Sand	Group A	2.8	1.5
P-2	10	Silty Sand	Group A	3.0	1.5

1 Unified Soil Classification System defined by ASTM D2487.
2 Hydrologic Soil Group as defined by United States Department of Agriculture Natural Resources Conservation Service

No septic / sewage disposal systems, groundwater contamination or potable production wells are known to exist in the near vicinity of the site. The probability of sewage and contaminant migration from the site is considered low.

6. GEOLOGIC HAZARDS

6.1 FAULTING AND SURFACE RUPTURE

The closest known major, active and potentially active earthquake faults include the Raymond, Sierra Madre, Clamshell-Sawpit Section, Whittier and Newport-Inglewood Faults. The closest active fault, the Raymond Fault, is located about 2.7 kilometers northwest of the site. The site is not located in an Alquist-Priolo Earthquake Fault Zone. No active faults are known to underlie or project toward the site. Therefore, the probability of fault rupture at the site is low. The regional faults in the vicinity of the site is shown on the Regional Fault Map (Figure 4).

6.2 CBC SEISMIC DESIGN PARAMETERS

A geologic hazard likely to affect the project is ground shaking as a result of movement along an active fault zone in the vicinity of the subject site. The site coefficients and adjusted maximum considered earthquake spectral response accelerations in accordance with the 2013 California Building Code (CBC) are presented in Table 2.

TABLE 2
2013 California Building Code Seismic Design Criteria

Site Coordinates	
Latitude	**Longitude**
34.1328°	-118.00355°

Site Coefficients and Spectral Response Acceleration Parameters	**Values**
Site Class	E
Site Coefficients, F_a	0.900
Site Coefficients, F_v	2.400
Mapped Spectral Response Acceleration at Short Period, S_s	2.100g
Mapped Spectral Response Acceleration at 1-Second Period, S_1	0.833g
Design Spectral Acceleration at Short Period, S_{DS}	1.260g
Design Spectral Acceleration at 1-Second Period, S_{D1}	1.333g
Site Peak Ground Acceleration, PGA_M	0.718g

6.3 LIQUEFACTION AND DYNAMIC SETTLEMENT

Liquefaction is the loss of soil strength or stiffness due to a buildup of pore-water pressure during server ground shaking. Liquefaction is associated primarily with loose, saturated, fine to medium grained, cohesionless soils. Effects of severe liquefaction can included sand boils, excessive settlement, bearing capacity failures and lateral spreading.

The site is not mapped in the potential liquefaction zone on the State of California Seismic Hazards Zones Map (CDMG 1999). The liquefaction potential in the vicinity of the site is shown on the Seismic Hazards Map (Figure 5). Given the depth to groundwater (greater than 200 feet), the potential for liquefaction and dynamic settlement to occur is considered low.

6.4 DRY SAND DYNAMIC SETTLEMENT

Relatively dry soils (e.g., soils above the groundwater table) with low density tend to undergo a degree of compaction during a seismic event. The likely settlement induced by dynamic compaction of relatively dry soil layers above the historic high groundwater level was calculated using the method proposed by Tokimatsu and Seed (1987). Under the current conditions, the relatively dry, near-surface soils are estimated to undergo a total post-earthquake settlement of approximately 6.5 inches and differential settlement on the order of ½ the total over a horizontal distance of approximately 40 feet.

6.5 LANDSLIDES AND SLOPE STABILITY

The site is not mapped in an area of potential earthquake induced landslide movement on the State of California Seismic Hazards Zones Map (CDMG 1999). The earth-induced landslide zones in the vicinity of the site is shown on the Seismic Hazards Map (Figure 5). Evidence of landslides or slope instabilities was not observed. The potential for landslides or slope instabilities to occur at the site is considered low.

6.6 SUBSIDENCE

The site is not located in an area of known subsidence associated with fluid withdrawal (groundwater or petroleum); therefore, the potential for subsidence due to the extraction of fluids is negligible.

6.7 HYDRO-CONSOLIDATION

Hydro-consolidation can occur in recently deposited (less than 10,000 years old) sediments that were deposited in a semi-arid environment. Examples of such sediments are aolian sands, alluvial fan deposits, and mudflow sediments deposited during flash floods. The pore space between particle grains can re-adjust when inundated by groundwater causing the material to consolidate. Based on blowcounts and laboratory testing, the relatively loose, alluvial materials underlying the site are considered moderately susceptible to hydro-consolidation.

7. CONCLUSIONS

Based on the results of our investigation, we consider the planned construction feasible from a geotechnical standpoint provided the recommendations of this report are followed. The main geotechnical consideration affecting the planned development is the presence of potentially compressible alluvial deposits. Based on the loose nature of the materials underlying the site and calculated the dynamic settlement remedial grading will need to be performed to reduce the potential for distress to the planned structures and improvements. The planned structures can be supported on shallow spread footings with bottoms levels on compacted fill, as discussed below. Alternatively, ground improvement techniques may be used to mitigate the loose materials and provide foundation support. The site is considered suitable for storm water Best Management Practice (BMP) facilities with inverts located at depths 10 feet beneath footings within 30 feet of buildings.

8. RECOMMENDATIONS

8.1 SITE PREPARATION AND GRADING

8.1.1 Site Preparation

Site preparation should begin with the removal of existing improvements, foundations, topsoil, vegetation and debris. The debris and unsuitable material generated during clearing and grubbing should be removed from areas to be graded and disposed of in accordance with applicable regulations. Underground utilities located within the proposed limits of the construction should be removed or abandoned, capped off or relocated so as not to interfere with earthwork operations. If appropriate, abandoned pipelines can be filled with grout or slurry as recommended by and observed by the geotechnical engineer.

8.1.2 Remedial Grading

In the areas of the proposed structures and improvements, existing fill, if encountered, should be removed. Additionally, alluvium within 10 feet of the deepest planned footing bottom level should be excavated and replaced with compacted fill to mitigate the potential for adverse differential settlement. Horizontally, the excavations should extend at least 10 feet outside the planned perimeter foundations, at least 2 feet outside the planned hardscape and pavements, or up to existing improvements, whichever is less. An SCST representative should observe conditions exposed in the bottom of the excavation to evaluate if additional excavation is recommended.

8.1.3 Ground Improvements

Ground improvement techniques are considered a viable alternative to deep earthwork and additional shoring at the parking garage site to improve the bearing capacity and reduce the settlement potential of the underlying granular materials. Vibro-compaction, vibro-replacement (stone columns), and aggregate piers may be considered for the site conditions to support the proposed parking garage. The selected method and specific design should be performed by a specialty contractor having significant experience using various ground improvement techniques. For planning purposes, we estimate that a conventional layout of columns beneath and outside column and wall footings to a depth of approximately 25 feet can provide allowable bearing pressures on the order of 7 to 10 kips per square foot.

8.1.4 Compacted Fill

Excavated material, except for roots, debris and rocks greater than 6 inches, can generally be used as compacted fill. Material with an expansion index of 50 or less determined in accordance with ASTM D4829 should be placed and compacted from 3 feet below the deepest planned footing bottom level to finished pad grade elevation. Concrete slabs should be underlain by at least 3 feet of material with an expansion index of 20 or less. We expect that the onsite materials will meet the expansion index criteria.

Fill should be moisture conditioned to near optimum moisture content and compacted to at least 90% relative compaction. Fill should be placed in horizontal lifts at a thickness appropriate for the equipment spreading, mixing, and compacting the material, but generally should not exceed 8 inches in loose thickness. The maximum dry density and optimum moisture content for evaluating relative compaction should be determined in accordance with ASTM D 1557. Utility trench backfill beneath structures, pavements and hardscape should be compacted to at least 90% relative compaction. The top 12 inches of subgrade beneath pavements should be compacted to at least 95%.

8.1.5 Excavation Characteristics

It is anticipated that excavations can be achieved with conventional earthwork equipment in good working order. However, due to the presence of gravel and cobbles, difficult drilling and excavating conditions are anticipated. The contractor should be prepared mobilize heavy equipment capable of drilling, excavating and compacting gravel and cobble materials.

8.1.6 Temporary Excavations

Temporary excavations 3 feet deep or less can be made vertically. Deeper temporary excavations should be laid back no steeper than 1½:1 (horizontal:vertical). The faces of temporary slopes should be inspected daily by the contractor’s Competent Person before personnel are allowed to enter the excavation. Any zones of potential instability, sloughing or raveling should be brought to the attention of the Engineer and corrective action implemented before personnel begin working in the excavation. Excavated soils should not be stockpiled behind temporary excavations within a distance equal to the depth of the excavation. SCST should be notified if other surcharge loads are anticipated so that lateral load criteria can be developed for the specific situation. If temporary slopes are to be maintained during the rainy season, berms are recommended along the tops of slopes to prevent runoff water from entering the excavation and eroding the slope faces. Slopes steeper than those described above will require shoring. Additionally, temporary excavations that extend below a plane inclined at 1½:1 (horizontal:vertical) downward from the outside bottom edge of existing structures or improvements will need to be shored.

8.1.7 Temporary Shoring

A shoring system consisting of soldier piles and lagging can be used. For design of cantilevered shoring, an active soil pressure equal to a fluid weighing 40 pcf can be used for level retained ground or 60 pcf for 2:1 (horizontal:vertical) sloping ground or for braced conditions. The surcharge loads on shoring from traffic and construction equipment adjacent to the excavation can be modeled by assuming an additional 2 feet of soil behind the shoring. For design of soldier piles, an allowable passive pressure of 300 psf per foot of embedment over twice the pile diameter up to a maximum of 3,500 psf can be used. Soldier piles should be spaced at least three pile diameters, center to center. Continuous lagging will be required throughout. The soldier piles should be designed for the full anticipated lateral pressure; however, the pressure on the lagging will be less due to arching in the soils. For design of lagging, the earth pressure but can be limited to a maximum value of 400 psf.

8.1.8 Oversized Material

Excavations may generate oversized material. Oversized material is defined as rocks or cemented clasts greater than 6 inches in largest dimension. Oversized material should be broken down to no greater than 6 inches in largest dimension for use in fill, used as landscape material, or disposed offsite.

8.1.9 Expansive Soil

The onsite material tested possess a very low expansion potential. The grading and foundation recommendations presented in this report reflect a very low expansion potential.

8.1.10 Imported Soil

Imported soil should consist of predominately granular soil free of organic matter and rocks greater than 6 inches. Imported soil should have an expansion index of 20 or less and should be inspected and, if appropriate, tested by SCST prior to transport to the site.

8.1.11 Slopes

All permanent slopes should be constructed no steeper than 2:1 (horizontal:vertical). Faces of fill slopes should be compacted either by rolling with a sheep-foot roller or other suitable equipment, or by overfilling and cutting back to design grade. Fills should be benched into sloping ground inclined steeper than 5:1 (horizontal:vertical). An engineering geologist should observe all cut slopes during grading to ascertain that no unforeseen adverse geologic conditions are encountered that require revised recommendations. All slopes are susceptible to surficial slope failure and erosion. Water should not be allowed to flow over the top of slope. Additionally, slopes should be planted with vegetation that will reduce the potential for erosion.

8.1.12 Surface Drainage

Final surface grades around structures should be designed to collect and direct surface water away from the structure and toward appropriate drainage facilities. The ground around the structure should be graded so that surface water flows rapidly away from the structure without ponding. In general, we recommend that the ground adjacent to the structure slope away at a gradient of at least 2%. Densely vegetated areas where runoff can be impaired should have a minimum gradient of at least 5% within the first 5 feet from the structure. Roof gutters with downspouts that discharge directly into a closed drainage system are recommended on structures. Drainage patterns established at the time of fine grading should be maintained throughout the life of the proposed structures. Site irrigation should be limited to the minimum necessary to sustain landscape growth. Should excessive irrigation, impaired drainage, or unusually high rainfall occur, saturated zones of perched groundwater can develop.

8.1.13 Grading Plan Review

SCST should review the grading plans and earthwork specifications to ascertain whether the intent of the recommendations contained in this report have been implemented, and that no revised recommendations are needed due to changes in the development scheme.

8.2 FOUNDATIONS

8.2.1 Shallow Spread Footings

The planned buildings can be supported on shallow spread footings with bottoms levels on at least 8 feet of compacted fill. Footings should extend at least 24 inches below lowest adjacent finished grade. Continuous footings should be at least 24 inches wide. Isolated footings should be at least 24 inches wide. An allowable bearing capacity of 2,500 psf can be used. The bearing capacity can be increased by 500 psf for each foot of depth below the minimum and 250 psf for each foot of width beyond the minimum up to a maximum of 4,500 psf. The bearing value can be increased by ⅓ when considering the total of all loads, including wind or seismic forces.

Lateral loads will be resisted by friction between the bottoms of footings and passive pressure on the faces of footings and other structural elements below grade. An allowable coefficient of friction of 0.35 can be used. Passive pressure can be computed using an allowable lateral pressure of 300 psf per foot of depth below the ground surface up to a maximum of 3,000 psf, for level ground. Reductions for sloping ground should be made. The passive pressure can be increased by ⅓ when considering the total of all loads, including wind or seismic forces. The upper 1 foot of soil should not be relied on for passive support unless the ground is covered with pavements or slabs.

8.2.2 Settlement Characteristics

Total foundation settlements are estimated to be less than 1 inch. Differential settlements between adjacent columns and across continuous footings are estimated to be less than 1 inch over a distance of 40 feet. Settlements should be completed shortly after structural loads are applied.

8.2.3 Foundation Plan Review

SCST should review the foundation plans to ascertain that the intent of the recommendations in this report has been implemented and that revised recommendations are not necessary as a result of changes after this report was completed.

8.2.4 Foundation Excavation Observations

A representative from SCST should observe the foundation excavations prior to forming or placing reinforcing steel.

8.3 SLABS-ON-GRADE

8.3.1 Interior Slabs-on-Grade

The project structural engineer should design the interior concrete slabs-on-grade floor. However, we recommend that building slabs be at least 5 inches thick and reinforced with at least No. 4 bars at 18 inches on center each way.

Moisture protection should be installed beneath slabs where moisture sensitive floor coverings will be used. The project architect should review the tolerable moisture transmission rate of the proposed floor covering and specify an appropriate moisture protection system. Typically, a plastic vapor barrier is used. A minimum 15-mil plastic is recommended. The plastic should comply with ASTM E1745. The vapor barrier installation should comply with ASTM E1643. Construction practice often includes placement of a 2-inch thick sand cushion between the bottom of the concrete slab and the moisture vapor retarder/barrier. This cushion can provide some protection to the vapor retarder/barrier during construction, and may assist in reducing the potential for edge curling in the slab during curing. However, the sand layer also provides a source of moisture to the underside of the slab that can increase the time required to reduce vapor emissions to limits acceptable for the type of floor covering placed on top of the slab. Alternatively, the slab can be placed directly on the vapor retarder/barrier.

8.3.2 Exterior Slabs-on-Grade

Exterior slabs should be at least 4 inches thick and reinforced with at least No. 3 bars at 18 inches on center each way. Slabs should be provided with weakened plane joints. Joints should be placed in accordance with the American Concrete Institute (ACI) guidelines. The project architect should select the final joint patterns. A 1-inch maximum size aggregate mix is recommended for concrete for exterior slabs. Coarse and fine aggregate in concrete should conform to the “Greenbook” Standard Specifications for Public Works Construction.

8.4 CONVENTIONAL RETAINING WALLS

8.4.1 Foundations

The recommendations provided in the foundation section of this report are also applicable to conventional retaining walls.

8.4.2 Lateral Earth Pressures

The active earth pressure for the design of unrestrained retaining walls with level backfill can be taken as equivalent to the pressure of a fluid weighing 40 pcf. The at-rest earth pressure for the design of restrained retaining walls with level backfills can be taken as equivalent to the pressure of a fluid weighing 60 pcf. These values assume a granular and drained backfill condition. An additional 20 pcf should be added to these values for walls with a 2:1 (horizontal:vertical) sloping backfill. An increase in earth pressure equivalent to an additional 2 feet of retained soil can be used to account for surcharge loads from light traffic. The above values do not include a factor of safety. Appropriate factors of safety should be incorporated into the design. If any other surcharge loads are anticipated, SCST should be contacted for the necessary increase in soil pressure.

Retaining walls should be designed to resist hydrostatic pressures or be provided with a backdrain to reduce the accumulation of hydrostatic pressures. Backdrains may consist of a 2-foot wide zone of ¾-inch crushed rock. The backdrain should be separated from the adjacent soils using a non-woven filter fabric, such as Mirafi 140N or equivalent. Weep holes should be provided or a perforated pipe should be installed at the base of the backdrain and sloped to discharge to a suitable storm drain facility. As an alternative, a geocomposite drainage system such as Miradrain 6000 or equivalent placed behind the wall and connected to a suitable storm drain facility can be used. The project architect should provide waterproofing specifications and details. Figure 6 presents typical conventional retaining wall backdrain details.

8.4.3 Seismic Earth Pressure

If required, the seismic earth pressure can be taken as equivalent to the pressure of a fluid weighing 17 pcf. This value is for level backfill and does not include a factor of safety. Appropriate factors of safety should be incorporated into the design. This pressure is in addition to the un-factored, static active earth pressure. The passive pressure and bearing capacity can be increased by ⅓ in determining the seismic stability of the wall.

8.4.4 Backfill

Wall backfill should consist of granular, free-draining material. Expansive or clayey soil should not be used. Additionally, backfill within 3 feet from the back of the wall should not contain rocks greater than 3 inches in dimension. We anticipate that the onsite soils will be suitable for wall backfill. Backfill should be compacted to at least 90% relative compaction. Backfill should not be placed until walls have achieved adequate structural strength. Compaction of wall backfill will be necessary to minimize settlement of the backfill and overlying settlement sensitive improvements. However, some settlement should still be anticipated. Provisions should be made for some settlement of concrete slabs and pavements supported on backfill. Additionally, any utilities supported on backfill should be designed to tolerate differential settlement.

8.5 PIPELINES

8.5.1 Thrust Blocks

For level ground conditions, a passive earth pressure of 300 psf per foot of depth below the lowest adjacent final grade can be used to compute allowable thrust block resistance. Thrust blocks should be backfilled with granular backfill material and compacted to at least 90% relative compaction.

8.5.2 Modulus of Soil Reaction

A modulus of soil reaction (E') of 2,000 psi can be used to evaluate the deflection of buried flexible pipelines. This value assumes that granular bedding material is placed adjacent to the pipe and is compacted to at least 90% relative compaction.

8.5.3 Pipe Bedding

Pipe bedding as specified in the “Greenbook” Standard Specifications for Public Works Construction can be used. Bedding material should consist of clean sand having a sand equivalent not less than 30 and should extend to at least 12 inches above the top of pipe. Alternative materials meeting the intent of the bedding specifications are also acceptable. Samples of materials proposed for use as bedding should be provided to the engineer for inspection and testing before the material is imported for use on the project. The onsite materials are not expected to meet “Greenbook” bedding specifications. The pipe bedding material should be placed over the full width of the trench. After placement of the pipe, the bedding should be brought up uniformly on both sides of the pipe to reduce the potential for unbalanced loads. No voids or uncompacted areas should be left beneath the pipe haunches. Ponding or jetting the pipe bedding should not be allowed.

8.5.4 Backfill

Excavated material free of organic debris and rocks greater than 6 inches in dimension are generally expected to be suitable for use as backfill unless beneath buildings or hardscape. Imported material should not contain rocks greater than 4 inches in dimension or organic debris. Backfill should be placed in lifts 8 inches or less in loose thickness, moisture conditioned to optimum moisture content or slightly above, and compacted to at least 90% relative compaction. The top 12 inches of soil beneath pavement subgrade should be compacted to at least 95% relative compaction.

8.6 PAVEMENT SECTION RECOMMENDATIONS

The pavement support characteristics of the soils encountered during our investigation are considered very good. Based on the tested R-values and assumed Traffic Indices, preliminary flexible and rigid pavement sections for 20-year life cycles are presented in Tables

3 and 4, respectively. The actual R-value of the subgrade soils may be checked after removals and final pavement sections can be provided.

TABLE 3
Flexible Asphalt Concrete Pavement Sections

Traffic Type	Traffic Index	Asphalt Concrete (inches)	Aggregate Base (inches)
Parking Stalls / Drive Lanes	5.0	2.5	4
Heavy Traffic Areas	6.0	3	4

TABLE 4
Portland Cement Concrete (PCC) Pavement Sections

Traffic Type	Traffic Index	PCC* (inches)
Parking Stalls / Drive Lanes	5.0	6
Heavy Traffic Areas	6.0	7

***Parking garage pavement recommended to include No. 4 reinforcing bars 24-inches on center each way**

The top 12 inches of subgrade should be scarified, moisture conditioned to near optimum moisture content and compacted to at least 95% relative compaction. All soft or yielding areas should be removed and replaced with compacted fill or aggregate base. Aggregate base and asphalt concrete should conform to the Caltrans Standard Specifications or the "Greenbook" and should be compacted to at least 95% relative compaction. Aggregate base should have an R-value of not less than 78. All materials and methods of construction should conform to good engineering practices and the minimum standards of City of Monrovia.

8.7 SOIL CORROSIVITY

A representative sample of the onsite soils was tested to evaluate corrosion potential. The test results are presented in Appendix II. The project design engineer can use the sulfate results in conjunction with ACI 318 to specify the water/cement ratio, compressive strength and cementitious material types for concrete exposed to soil. A corrosion engineer should be contacted to provide specific corrosion control recommendations if corrosion sensitive improvements are planned.

9. GEOTECHNICAL ENGINEERING DURING CONSTRUCTION

The geotechnical engineer should review project plans and specifications prior to bidding and construction to check that the intent of the recommendations in this report has been incorporated. Observations and tests should be performed during construction. If the conditions encountered during construction differ from those anticipated based on the subsurface exploration program, the presence of the geotechnical engineer during construction will enable an evaluation of the exposed conditions and modifications of the recommendations in this report or development of additional recommendations in a timely manner.

10. CLOSURE

SCST should be advised of any changes in the project scope so that the recommendations contained in this report can be evaluated with respect to the revised plans. Changes in recommendations will be verified in writing. The findings in this report are valid as of the date of this report. Changes in the condition of the site can, however, occur with the passage of time, whether they are due to natural processes or work on this or adjacent areas. In addition, changes in the standards of practice and government regulations can occur. Thus, the findings in this report may be invalidated wholly or in part by changes beyond our control. This report should not be relied upon after a period of two years without a review by us verifying the suitability of the conclusions and recommendations to site conditions at that time.

In the performance of our professional services, we comply with that level of care and skill ordinarily exercised by members of our profession currently practicing under similar conditions and in the same locality. The client recognizes that subsurface conditions may vary from those encountered at the boring locations, and that our data, interpretations, and recommendations are based solely on the information obtained by us. We will be responsible for those data, interpretations, and recommendations, but shall not be responsible for interpretations by others of the information developed. Our services consist of professional consultation and observation only, and no warranty of any kind whatsoever, express or implied, is made or intended in connection with the work performed or to be performed by us, or by our proposal for consulting or other services, or by our furnishing of oral or written reports or findings.

11. REFERENCES

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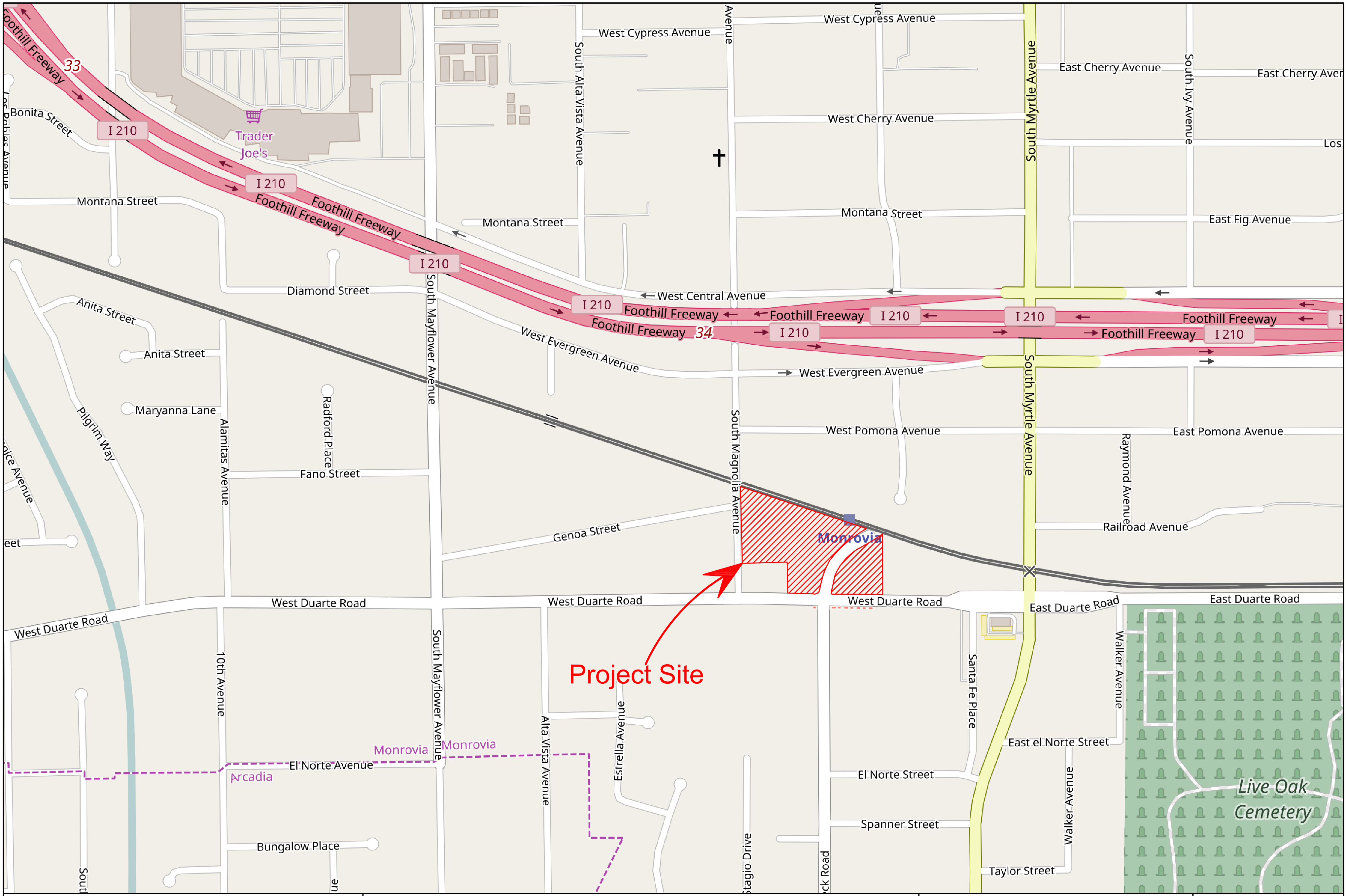


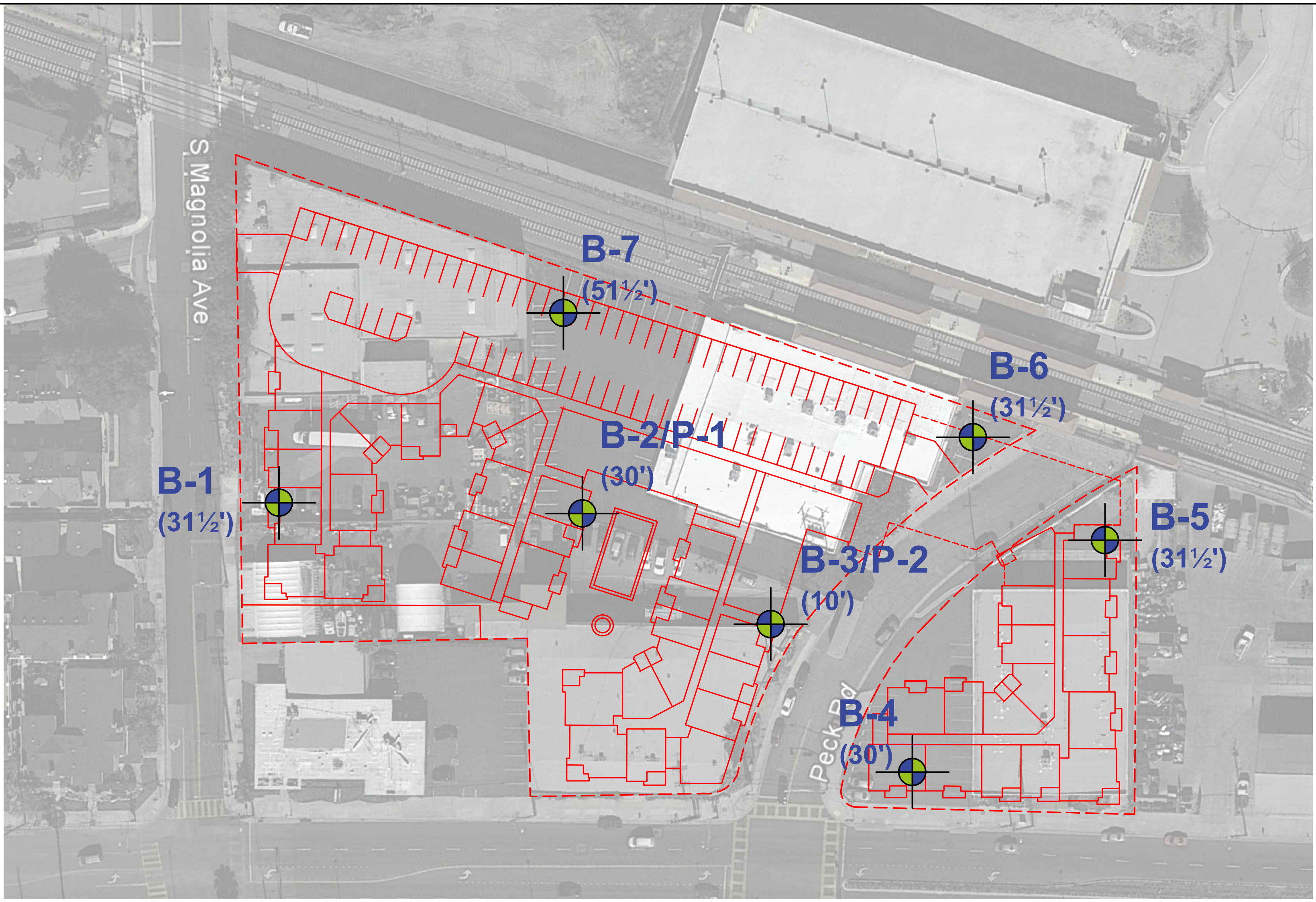
SCST, Inc.

SITE VICINITY MAP

Duarte Road Apartments
Monrovia, California

Date: February, 2017
By: MAW
Job No.: 170107N

Figure:
1



SCST LEGEND:

B-7 (51½') Approximate Location of Boring (with Depth in Feet)

P-2 Approximate Location of Boring Percolation Test

Approximate Site Boundary

0 100′ 200′

Scale

N

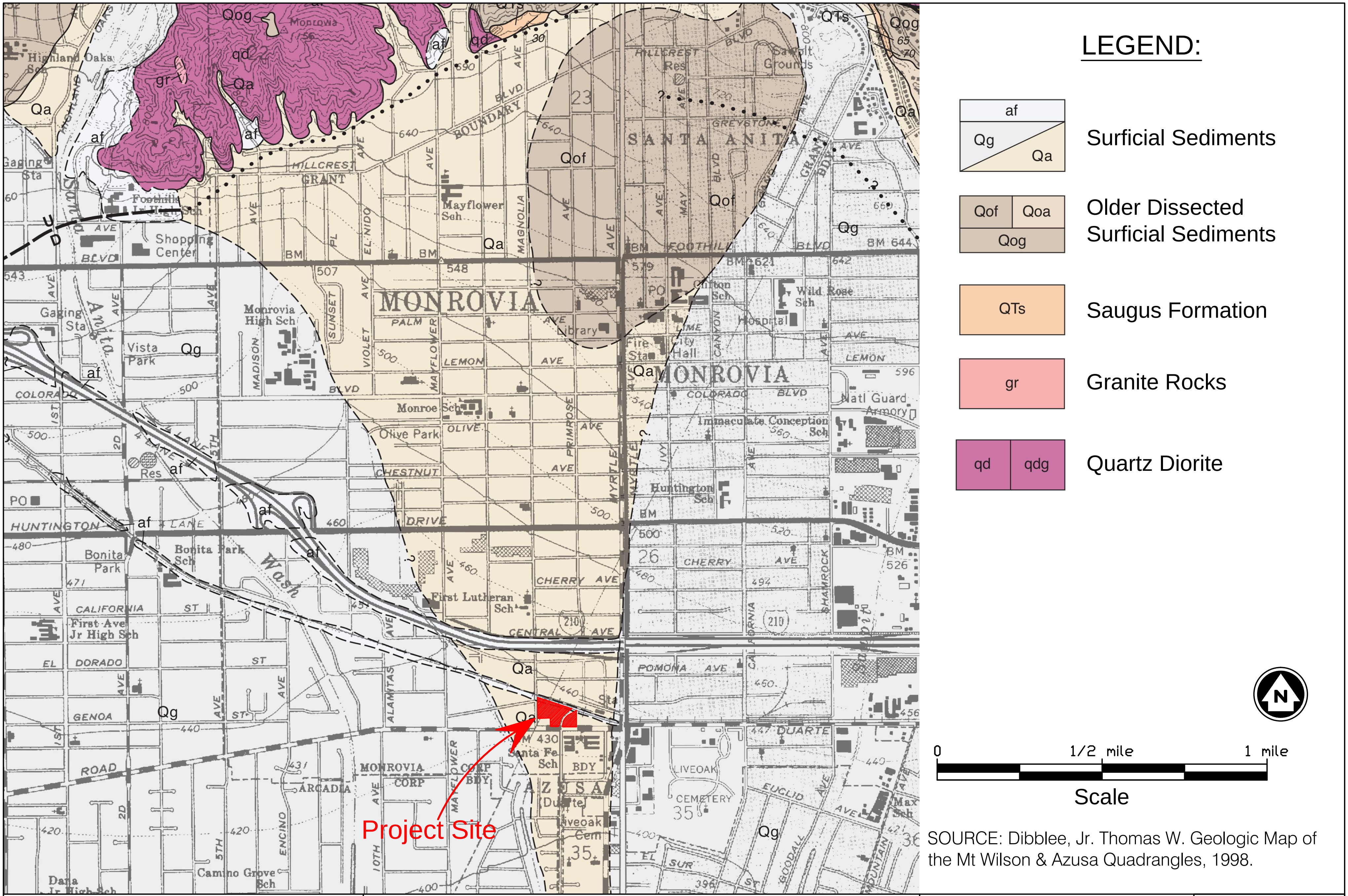
SCST, Inc.

SUBSURFACE EXPLORATION MAP

Duarte Road Apartments
Monrovia, California

Date: February, 2017
By: MAW
Job No.: 170107N

Figure:
2



SOURCE: Dibblee, Jr. Thomas W. Geologic Map of the Mt Wilson & Azusa Quadrangles, 1998.

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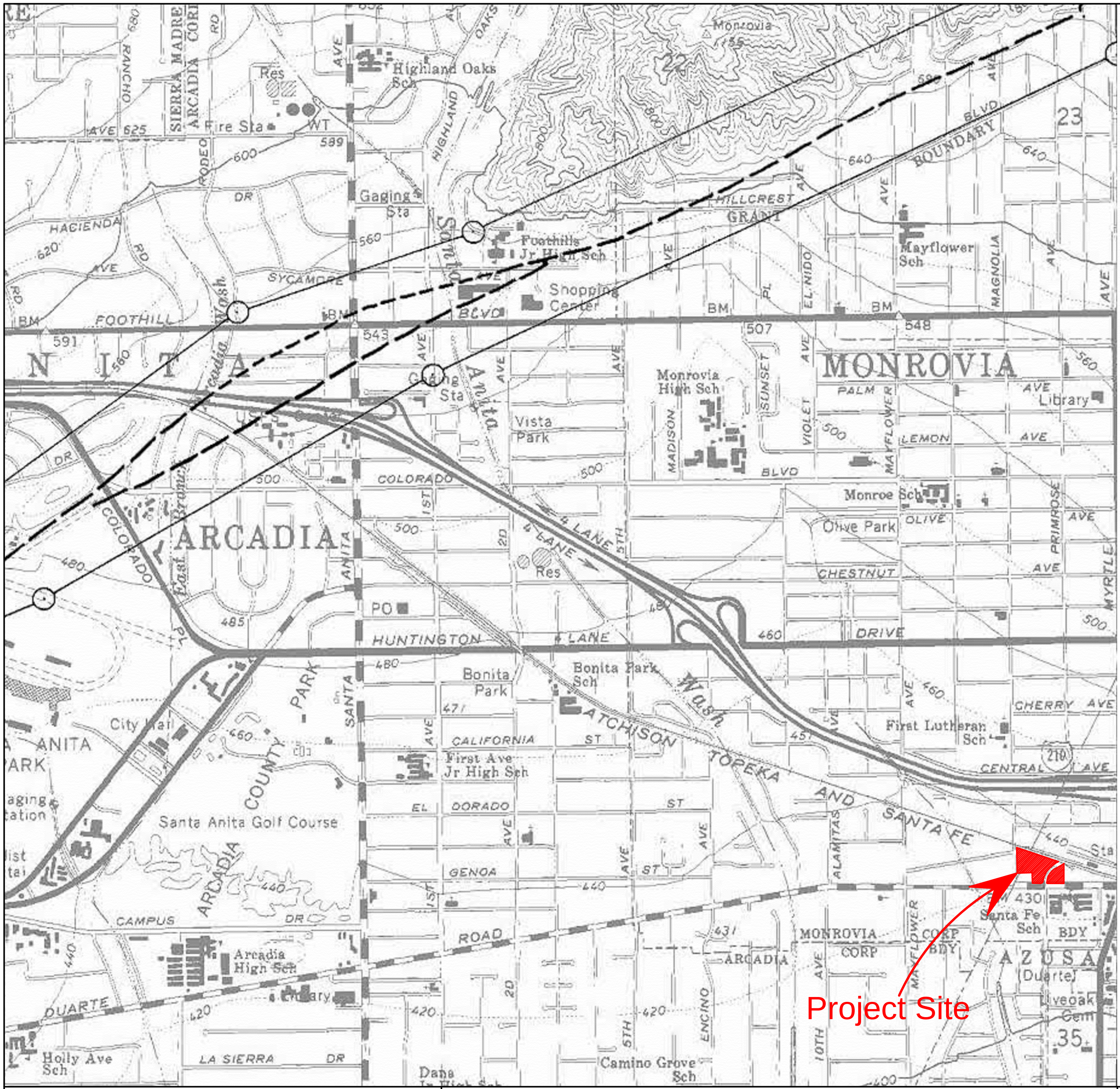
ENGINEERING

REGIONAL GEOLOGY MAP

Duarte Road Apartments
Monrovia, California

Date:	February, 2017
By:	MAW
Job No.:	170107N

Figure:
3



LEGEND:

Potentially Active Faults

1906 C

Faults considered to have been active during Quaternary time; solid line where accurately located, long dash where approximately located, short dash where inferred, dotted where concealed; query (?) indicates additional uncertainty.

Aerial photo lineaments (not field checked); based on youthful geomorphic and other features believed to be the results of Quaternary faulting.

Special Studies Zone Boundaries

Special studies zone segments.

Seaward projection of zone boundary.

N

0 1/2 mile 1 mile

Scale

SOURCE: State of California, Special Studies Zones, Mt. Wilson Quadrangle.

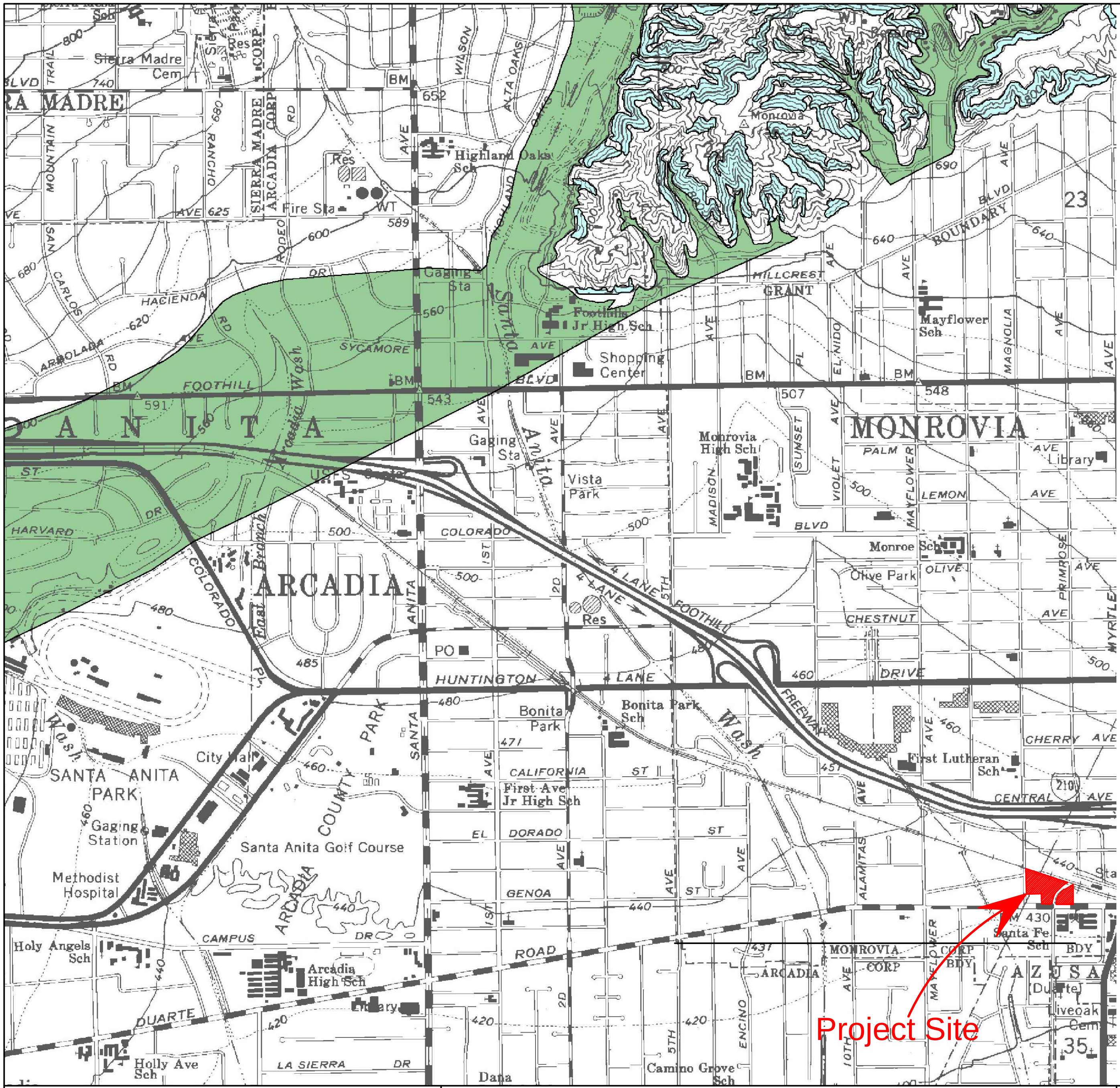
SCST, Inc.

REGIONAL FAULT MAP

Duarte Road Apartments
Monrovia, California

Date:	February, 2017
By:	MAW
Job No.:	170107N

Figure:
4



LEGEND:

🟩 **Liquefaction**

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

🟦 **Earthquake-Induced Landslides**

Area where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

N

0 1/2 mile 1 mile

Scale

SOURCE: Seismic Hazard Zones, Mt. Wilson Quadrangle. California Department of Conservation, Division of Mines and Geology. 1999

SCST ENGINEERING

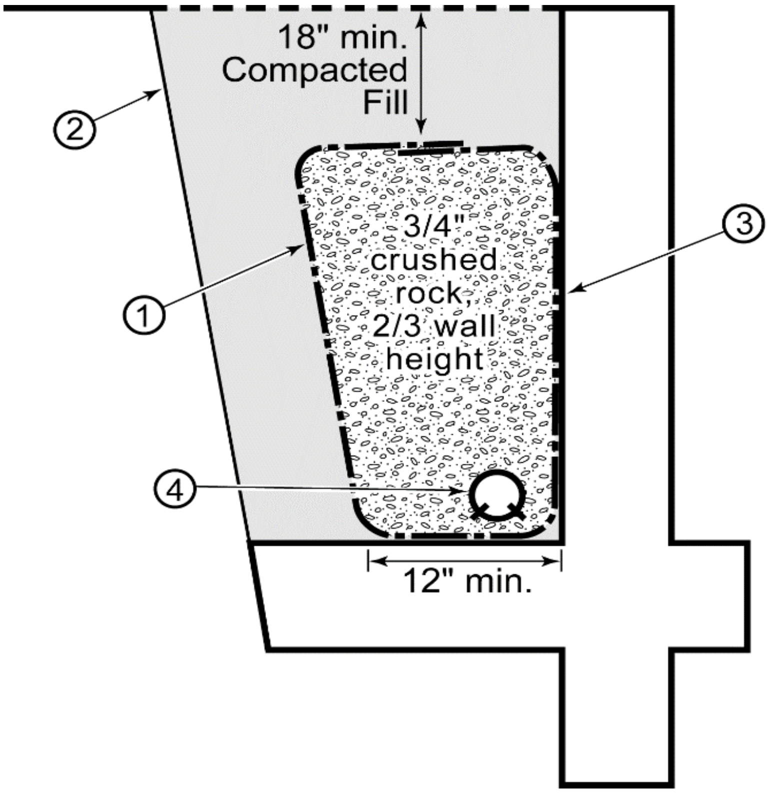
SCST, Inc.

SEISMIC HAZARDS MAP

Duarte Road Apartments
Monrovia, California

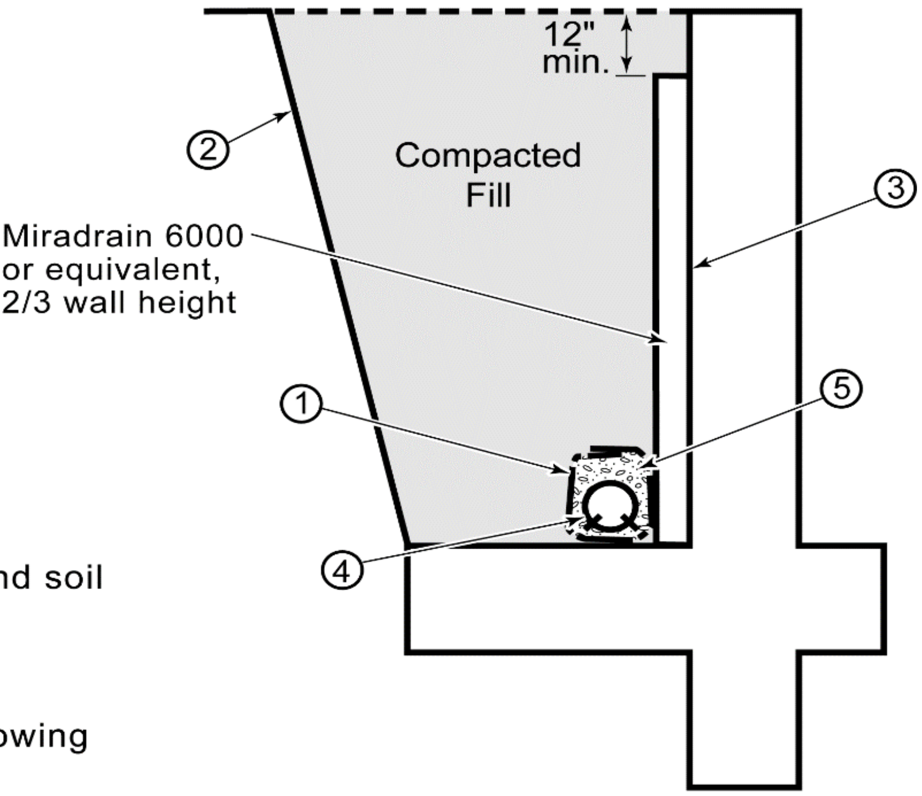
Date:	February, 2017
By:	MAW
Job No.:	170107N

Figure:
5



Typical Retaining Wall Backdrain Detail

Not to Scale



① Filter fabric between rock and soil

② Backcut

③ Waterproof back of wall following architect's specifications

④ 4" minimum perforated pipe, SDR35 or equivalent, holes down, 1% fall to outlet, encased in 3/4" crushed rock. Provide 3 cubic feet per linear foot crushed rock minimum. Crushed rock to be surrounded by filter fabric (Mirafi 140N or equivalent), with 6" minimum overlap. Provide solid outlet pipe at suitable location.

⑤ 3/4" crushed rock

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	VAU	Date:	February 2017
Job No:	170107N	Figure:	6

APPENDIX I

APPENDIX I
FIELD INVESTIGATION

Our field investigation consisted of drilling two borings and four percolation test holes on September 7 and 22, 2016 to depths between about 1½ and 15½ feet below the existing ground surface using a limited access drill rig equipped with a solid-stem auger and a truck-mounted drill rig equipped with a hollow-stem auger. Auger refusal was encountered in one of the two borings and in three of the four percolation test holes. Figure 2 presents the approximate locations of the borings and percolation test holes. The field investigation was performed under the observation of an SCST engineer who also logged the borings and test holes and obtained samples of the materials encountered.

Relatively undisturbed samples were obtained using a modified California (CAL) sampler, which is ring-lined split tube sampler with a 3-inch outer diameter and 2½-inch inner diameter. Standard Penetration Tests (SPT) were performed using a 2-inch outer diameter and 1⅜-inch inner diameter split tube sampler. The CAL and SPT samplers were driven with a 140-pound weight dropping 30 inches. The number of blows needed to drive the samplers the final 12 inches of an 18-inch drive is noted on the borings logs as “Driving Resistance (blows/foot of drive).” SPT and CAL sampler refusal was encountered when 50 blows were applied during any one of the three 6-inch intervals, a total of 100 blows was applied, or there was no discernible sampler advancement during the application of 10 successive blows. The SPT penetration resistance was normalized to a safety hammer (cathead and rope) with a 60% energy transfer ratio in accordance with ASTM D6066. The normalized SPT penetration resistance is noted on the boring logs as “N_{60}.” Disturbed bulk samples were obtained from the SPT sampler and drill cuttings.

The soils are classified in accordance with the Unified Soil Classification System as illustrated on Figure I-1. Logs of the borings and test holes are presented on Figures I-2 through I-7.

SUBSURFACE EXPLORATION LEGEND

UNIFIED SOIL CLASSIFICATION CHART

SOIL DESCRIPTION		GROUP SYMBOL	TYPICAL NAMES
I. COARSE GRAINED, more than 50% of material is larger than No. 200 sieve size.			
GRAVELS More than half of coarse fraction is larger than No. 4 sieve size but smaller than 3".	CLEAN GRAVELS	GW	Well graded gravels, gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels, gravel sand mixtures, little or no fines.
	GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, poorly graded gravel-sand-silt mixtures.
		GC	Clayey gravels, poorly graded gravel-sand, clay mixtures.
SANDS More than half of coarse fraction is smaller than No. 4 sieve size.	CLEAN SANDS	SW	Well graded sand, gravelly sands, little or no fines.
		SP	Poorly graded sands, gravelly sands, little or no fines.
		SM	Silty sands, poorly graded sand and silty mixtures.
		SC	Clayey sands, poorly graded sand and clay mixtures.
II. FINE GRAINED, more than 50% of material is smaller than No. 200 sieve size.			
	SILTS AND CLAYS (Liquid Limit less than 50)	ML	Inorganic silts and very fine sands, rock flour, sandy silt or clayey-silt-sand mixtures with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
		OL	Organic silts and organic silty clays or low plasticity.
	SILTS AND CLAYS (Liquid Limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity.
III. HIGHLY ORGANIC SOILS		PT	Peat and other highly organic soils.

SAMPLE SYMBOLS

☒	- Bulk Sample
CAL	- Modified California sampler
CK	- Undisturbed Chunk sample
MS	- Maximum Size of Particle
ST	- Shelby Tube
SPT	- Standard Penetration Test sampler

GROUNDWATER SYMBOLS

▽	- Water level at time of excavation or as indicated
≀≀	- Water seepage at time of excavation or as indicated

LABORATORY TEST SYMBOLS

AL	- Atterberg Limits
CBR	- California Bearing Ratio
COR	- Corrosivity Tests (Resistivity, pH, Chloride, Sulfate)
DS	- Direct Shear
EI	- Expansion Index
MAX	- Maximum Density
RV	- R-Value
SA	- Sieve Analysis
UC	- Unconfined Compression

SCST, Inc.

Duarte Road Apartments Monrovia, California			
By:	RS	Date:	February, 2017
Job Number:	170107N	Figure:	I-1

LOG OF BORING B-1

Date Drilled: 2/9/2017

Equipment: CME 75 equipped with 8-inch hollow stem auger

Elevation (ft): Approximately 428

Logged by: RS

Checked by : DAS

Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES		DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
			DRIVEN	BULK					
		1 inch of Asphalt Concrete							
1	SM	**ALLUVIUM (Qa):** SILTY SAND, dark brown, fine to medium grained, trace gravel, moist, loose.		☒					
2				☒					
3		Difficult drilling.	SPT	☒	8	11			RV COR
4				☒					
5	ML	SANDY SILT, moderate brown, fine grained, trace gravel, moist, loose.							
6			CAL		14		5.0	107.4	
7									
8									
9									
10	SM	SILTY SAND, light brown, fine grained, trace gravel, moist, medium dense.							
11			SPT		14	19			
12									
13									
14									
15									
16			SPT		13	18			
17									
18									
19									
20									

BORING CONTINUED ON I-3.

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N	Figure:	I-2

LOG OF BORING B-1 (continued)

Date Drilled: 2/9/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 428

Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES		DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
			DRIVEN	BULK					
21			SPT		13	18			
22									
23									
24									
25	SP-SM	POORLY GRADED SAND with SILT, light to moderate brown, fine to medium grained, trace gravel, dry, medium dense.							
26			SPT		10	14			
27									
28									
29									
30	SP	SILTY SAND, white to light brown, fine to coarse grained, trace gravel, dry, dense.							
31			SPT		43	58			
32		**BORING TERMINATED AT 31½ FEET.**							
33									
34									
35									
36									
37									
38									
39									
40									

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N	Figure:	I-3

LOG OF BORING B-2/P-1

Date Drilled: 2/8/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 430

Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES DRIVEN	SAMPLES BULK	DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
		1 inch of Asphalt Concrete							
1	SP-SM	**<u>ALLUVIUM (Qa)</u>:** POORLY GRADED SAND with SILT, dark brown, fine to coarse grained, trace gravel, moist, medium dense.		☒					
2									
3			CAL		19				EI
4									
5	SM	SILTY SAND, dark brown, fine to medium grained, trace gravel, moist, loose.							
6			SPT		4	5			
7									
8									
9									
10		Medium dense.							
11			CAL		24		14.2	119.3	
12									
13									
14									
15		No recovery.							
16			SPT		10	14			
17									
18									
19									
20									

BORING CONTINUED ON I-3.

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N	Figure:	I-4

LOG OF BORING B-2/P-1 (continued)

Date Drilled: 2/9/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 430

Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES		DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
			DRIVEN	BULK					
21		No recovery.	SPT		14	19			
22									
23									
24									
25									
26			SPT		11	15			
27									
28									
29			CAL		32				SA
30		**BORING TERMINATED AT 30 FEET.**							
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N	Figure:	I-5

LOG OF BORING B-3/P-2

Date Drilled: 2/8/2017
Logged by: RS
Equipment: CME 75 equipped with 8-inch hollow stem auger
Checked by : DAS
Elevation (ft): Approximately 429
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES DRIVEN	SAMPLES BULK	DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
		1 inch of Asphalt Concrete							
1	SM	**ALLUVIUM (Qa)**: SILTY SAND, moderate brown, fine to medium grained, trace gravel, trace cobble, moist, loose.							
2									
3									
4									
5	SM	SILTY SAND, moderate brown, fine to medium grained, trace gravel, moist, loose.							
6			SPT		6	8			
7									
8	SC-SM	SILTY, CLAYEY SAND, moderate brown, fine to medium grained, trace gravel, moist, loose.							
9			SPT		7	9			SA
10		**BORING TERMINATED AT 10 FEET.**							
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By: RS
Date: February, 2017
Job Number: 170107N
Figure: I-6

LOG OF BORING B-4

Date Drilled: 2/8/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 427

Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES DRIVEN	SAMPLES BULK	DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
		4 inches of Asphalt Concrete							
1	SM	**<u>ALLUVIUM (Qa)</u>:** SILTY SAND, dark brown, fine to medium grained, trace gravel, moist, loose to medium dense.		☒					
2	SP	POORLY GRADED SAND with GRAVEL, moderate brown, medium to coarse grained, moist, loose to medium dense.		☒					
3			CAL	☒	13		4.8	106.6	
4									
5	SM	SILTY SAND, dark brown, fine to medium grained, trace gravel, moist, loose to medium dense.							
6			CAL		13		6.2	107.2	DS
7									
8									
9									
10		…becomes orangish brown.							
11			SPT		8	11			
12									
13									
14									
15		Loose to medium dense.							
16			SPT		7	9			
17									
18									
19									
20									

BORING CONTINUED ON I-8.

LOG OF BORING B-4 (continued)

Date Drilled:	2/8/2017	Logged by:	RS
Equipment:	CME 75 equipped with 8-inch hollow stem auger	Checked by :	DAS
Elevation (ft):	Approximately 427	Depth to Groundwater (ft):	not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES DRIVEN	 BULK	DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
21		…trace cobbles.	SPT		10	14			
22									
23									
24									
25									
26			SPT		14	19			
27									
28									
29			SPT		10	14			
30		**BORING TERMINATED AT 30 FEET.**							
31									
32									
33									
34									
35									
36									
37									
38									
39									
40									

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N	Figure:	I-8

LOG OF BORING B-5

Date Drilled: 2/9/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 432
Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES		DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
			DRIVEN	BULK					
		1 inch of Asphalt Concrete							
1	SM	**ALLUVIUM (Qa):** SILTY SAND with GRAVEL, dark brown, fine to medium grained, moist, loose.		☒					
2									
3			SPT		5	7			
4									
5	SP	POORLY GRADED SAND with GRAVEL, light to moderate brown, fine to coarse grained, moist, loose.							
6			CAL		13		4.5	109.7	
7									
8									
9									
10	SM	SILTY SAND, yellowish brown, fine to medium grained, trace gravel, dry, medium dense.							
11			SPT		20	27			
12									
13									
14									
15									
16			SPT		18	24			
17									
18									
19									
20									

BORING CONTINUED ON I-10.

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N	Figure:	I-9

LOG OF BORING B-5 (continued)

Date Drilled: 2/9/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 432

Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES		DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
			DRIVEN	BULK					
21			SPT		22	30			
22									
23									
24									
25	SP-SM	**OLDER ALLUVIUM (Qoa):** POORLY GRADED SAND with SILT, white to light yellowish brown, fine to medium grained, trace gravel, dry, dense.							
26			SPT		26	35			
27									
28									
29									
30									
31			SPT		27	36			
32		**BORING TERMINATED AT 31½ FEET.**							
33									
34									
35									
36									
37									
38									
39									
40									

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N.1	Figure:	I-10

LOG OF BORING B-6

Date Drilled: 2/8/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 433
Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES DRIVEN	SAMPLES BULK	DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
		3 inches of Asphalt Concrete							
1	SM	**<u>ALLUVIUM (Qa)</u>:** SILTY SAND with GRAVEL, dark brown, medium to coarse grained, moist, medium dense.							
2									
3			CAL		22		6.7	116.3	
4									
5									
6			SPT		11	15			
7									
8									
9									
10									
11			CAL		17				CON
12									
13									
14									
15	ML	SILT, orangish brown, trace gravel, moist, medium dense.							
16			SPT		11	15			
17									
18									
19									
20									

BORING CONTINUED ON I-12.

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N	Figure:	I-11

LOG OF BORING B-6 (continued)

Date Drilled: 2/8/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 433

Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES DRIVEN	SAMPLES BULK	DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
	SM	SITLY SAND, orangish brown, fine to medium grained, trace gravel, moist, medium dense.							
21			SPT		17	23			
22									
23									
24									
25									
26			SPT		34	46			
	SP-SM	**OLDER ALLUVIUM (Qoa)**: POORLY GRADED SAND with SILT, light brown and white, fine to medium grained, trace gravel, moist, dense.							
27									
28									
29									
30									
31		Very dense.	SPT		39	53			
		BORING TERMINATED AT 31½ FEET.							
32									
33									
34									
35									
36									
37									
38									
39									
40									

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N	Figure:	I-12

LOG OF BORING B-7

Date Drilled: 2/8/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 433
Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES DRIVEN	SAMPLES BULK	DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
		2½ inches of Asphalt Concrete							
1	SM	**ALLUVIUM (Qa):** SILTY SAND with GRAVEL, dark brown, fine to medium grained, moist, loose.							
2									
3			SPT		6	8			
4									
5									
6		cobbles 4" maximum dimension (tonalite rock).	SPT		31	42			
7									
8									
9									
10									
11	SC	CLAYEY SAND with GRAVEL, moderate brown, fine to medium grained, moist, medium dense.	CAL		19		16.0	114.7	DS
12									
13									
14									
15									
16	SM	SILTY SAND, light to orangish brown, fine to medium grained, trace gravel, moist, medium dense	SPT		9	12			
17									
18									
19									
20									

BORING CONTINUED ON I-14.

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N	Figure:	I-13

LOG OF BORING B-7 (continued)

Date Drilled: 2/8/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 433
Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES DRIVEN	SAMPLES BULK	DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
21		…becomes medium dense.	SPT		10	14			
22									
23									
24									
25	SP-SM	POORLY GRADED SAND with SILT, moderate brown, medium to coarse grained, trace gravel, moist, medium dense.	SPT		12	16			
26									
27									
28									
29	SP	POORLY GRADED SAND, white and light brown, fine to medium grained, moist, medium dense.							
30	SP-SM	POORLY GRADE SAND with SAND,light brown, fine to medium grained, trace gravel, moist, medium dense.	SPT		12	16			
31									
32									
33									
34									
35	SP	POORLY GRADED SAND, white and light brown, fine to medium grained, trace gravel, moist, dense.	SPT		25	34			
36	SM	SILTY SAND, orangish brown, fine grained, trace gravel, moist, dense.							
37									
38									
39									
40									

BORING CONTINUED ON I-15

LOG OF BORING B-7 (continued)

Date Drilled: 2/8/2017
Equipment: CME 75 equipped with 8-inch hollow stem auger
Elevation (ft): Approximately 433

Logged by: RS
Checked by : DAS
Depth to Groundwater (ft): not encountered

DEPTH (ft)	USCS	SUMMARY OF SUBSURFACE CONDITIONS	SAMPLES DRIVEN	SAMPLES BULK	DRIVING RESISTANCE (blows/ft of drive)	N_{60}	MOISTURE CONTENT (%)	DRY UNIT WEIGHT (pcf)	LABORATORY TESTS
41		…increase in gravel content, medium dense.	SPT		16	22			
42									
43									
44									
45									
46			SPT		22	30			
47									
48									
49									
50	ML	SANDY SILT, orangish brown, fine grained, trace gravel, moist, medium dense.							
51			SPT		15	20			
52		**BORING TERMINATED AT 51½ FEET.**							
53									
54									
55									
56									
57									
58									
59									
60									

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	RS	Date:	February, 2017
Job Number:	170107N.1	Figure:	I-15

APPENDIX II
LABORATORY TESTING

A brief description of each type of test is presented below. Results are given on the following pages and on the boring logs in Appendix I.

- **CLASSIFICATION:** Field classifications were verified in the laboratory by visual examination. The final soil classifications are in accordance with the Unified Soil Classification System.

- **MOISTURE AND DENSITY DETERMINATIONS:** Moisture content and dry density tests were performed on selected drive samples obtained from our borings. The tests were performed in general accordance with ASTM D2216, moisture content, and with ASTM D2937, dry unity weight. The results of the tests are presented on the boring logs in Appendix I.

- **GRAIN SIZE DISTRIBUTION:** The grain size distribution was determined on selected samples in accordance with ASTM D 422. The results are presented in this Appendix.

- **ATTERBERG LIMITS:** The Atterberg limits were determined on selected soil samples to aid in soil classification and evaluate the plasticity characteristics. The tests were performed in accordance with ASTM D4318. The results are presented in this Appendix.

- **EXPANSION INDEX:** The expansion index was determined on selected samples in accordance with ASTM D4829. The results are presented in this Appendix.

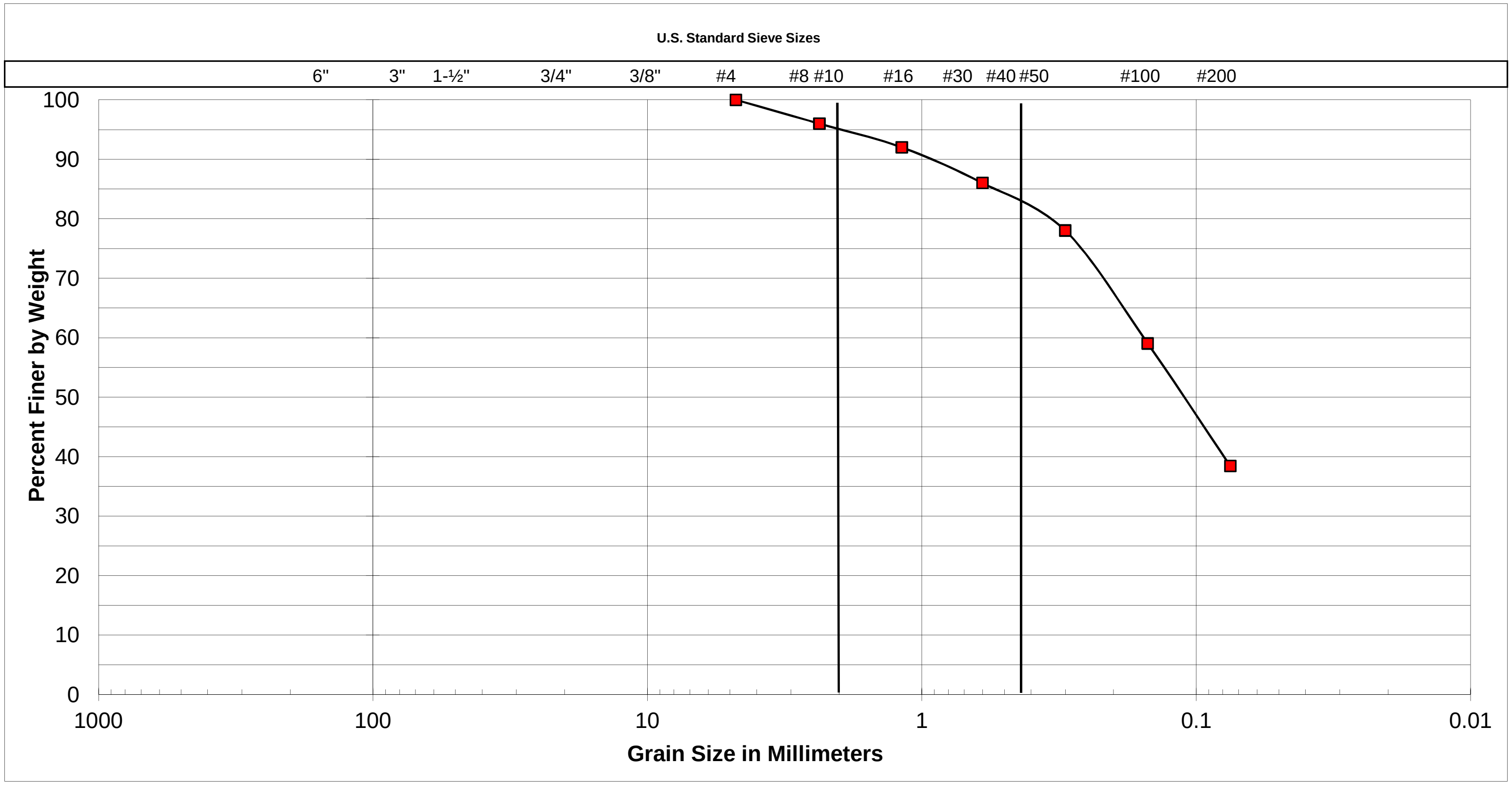
- **DIRECT SHEAR:** Direct shear tests were performed on selected samples in accordance with ASTM D3080. The shear stress was applied at a constant rate of strain of 0.003 inch per minute. The results are presented in this Appendix.

- **CONSOLIDATION:** A one-dimensional consolidation test was performed on selected, relatively undisturbed samples in general accordance with ASTM D 2435. The results are presented in this Appendix.

- **CORROSIVITY**: Corrosivity tests were performed on selected samples. The pH and minimum resistivity were determined in general accordance with California Test 643. The soluble sulfate content was determined in accordance with California Test 417. The total chloride ion content was determined in accordance with California Test 422. The results are presented in this Appendix.

- **R-VALUE:** An R-value test was performed on one sample in accordance with California Test Method 301. The results are presented in this Appendix.

Soil samples not tested are now stored in our laboratory for future reference and analysis, if needed. Unless notified to the contrary, all samples will be disposed of 30 days from the date of this report.



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

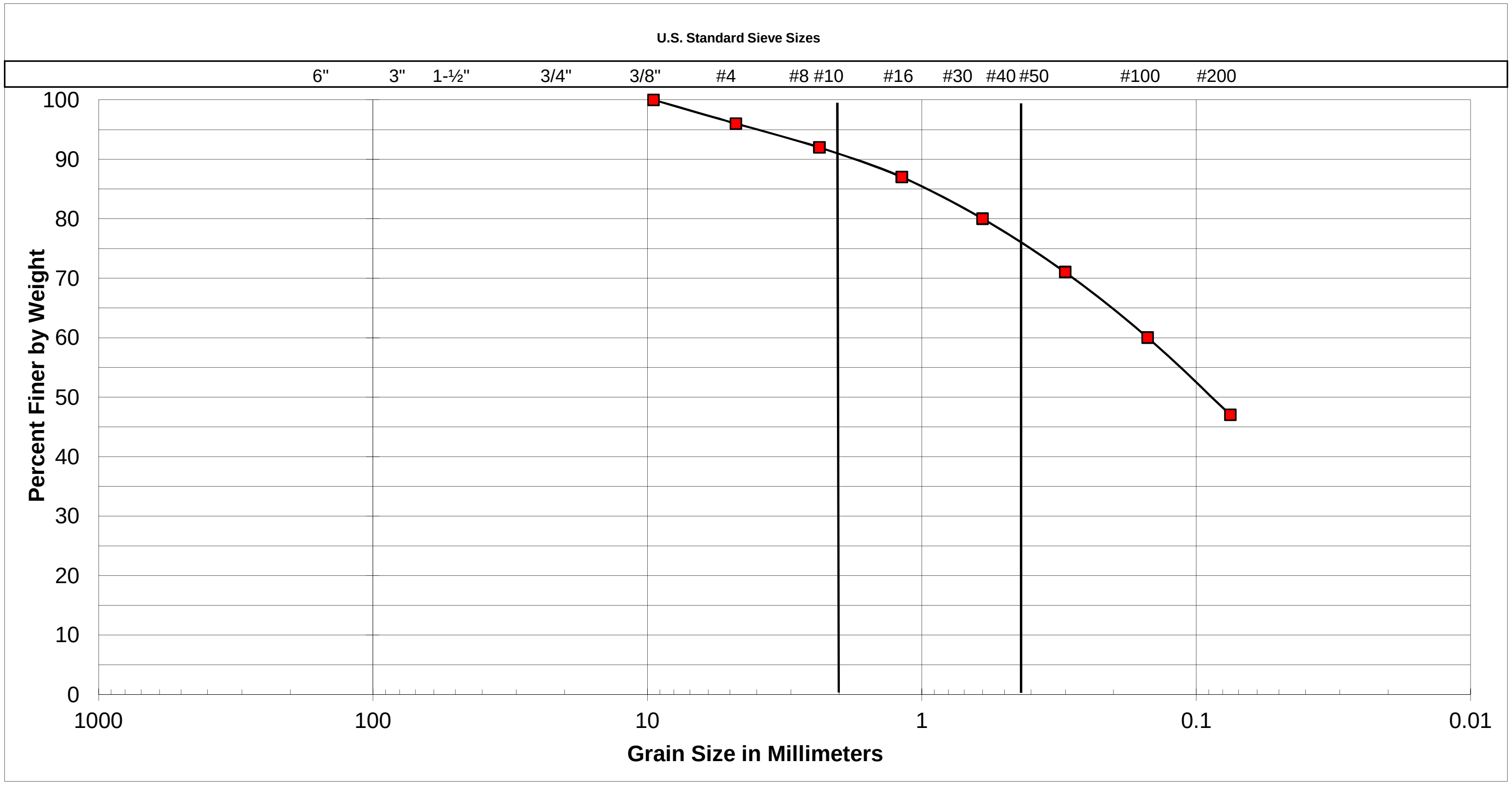
SAMPLE LOCATION
B-2 at 29½ to 30 feet

UNIFIED SOIL CLASSIFICATION:	SM
DESCRIPTION	SILTY SAND

ATTERBERG LIMITS	
LIQUID LIMIT	-
PLASTIC LIMIT	-
PLASTICITY INDEX	-

SCST, Inc.

Duarte Road Apartments Monrovia, California			
By:	CM/VAU	Date:	February, 2017
Job Number:	170107N	Figure:	II-1



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

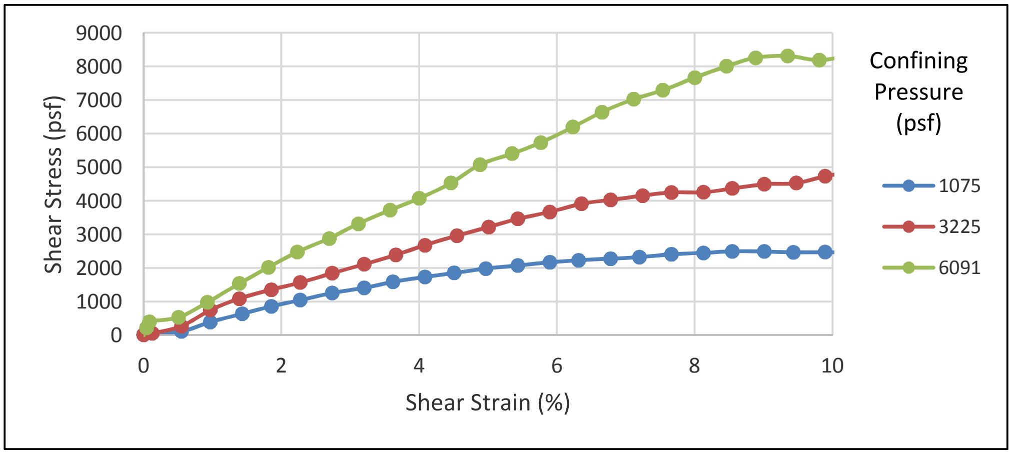
SAMPLE LOCATION
B-3 at 8½ to 9½ feet

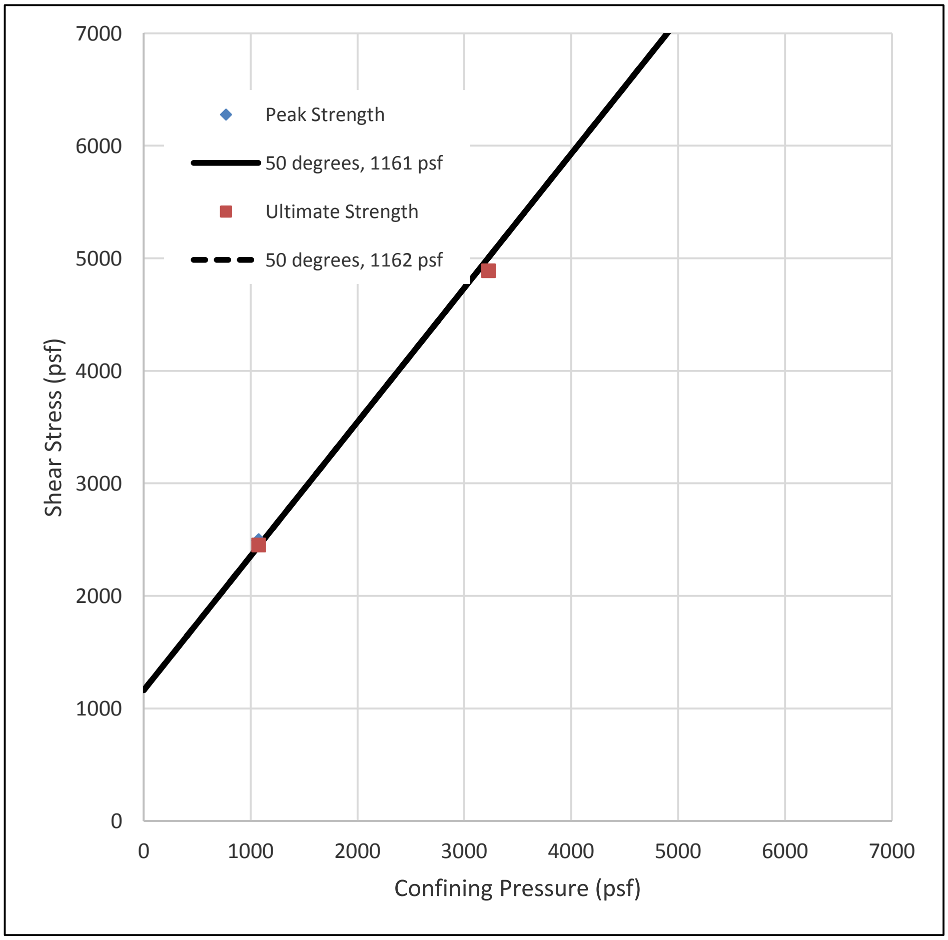
UNIFIED SOIL CLASSIFICATION:	SM
DESCRIPTION	SILTY SAND

ATTERBERG LIMITS	
LIQUID LIMIT	-
PLASTIC LIMIT	-
PLASTICITY INDEX	-

SCST, Inc.

Duarte Road Apartments Monrovia, California			
By:	CM/VAU	Date:	February, 2017
Job Number:	170107N	Figure:	II-2





SAMPLE ID: B-4 at 5½ to 6 feet

SILTY SAND

NOTES: Insitu

Strain Rate: 0.003 in/min

Sample was consolidated and drained

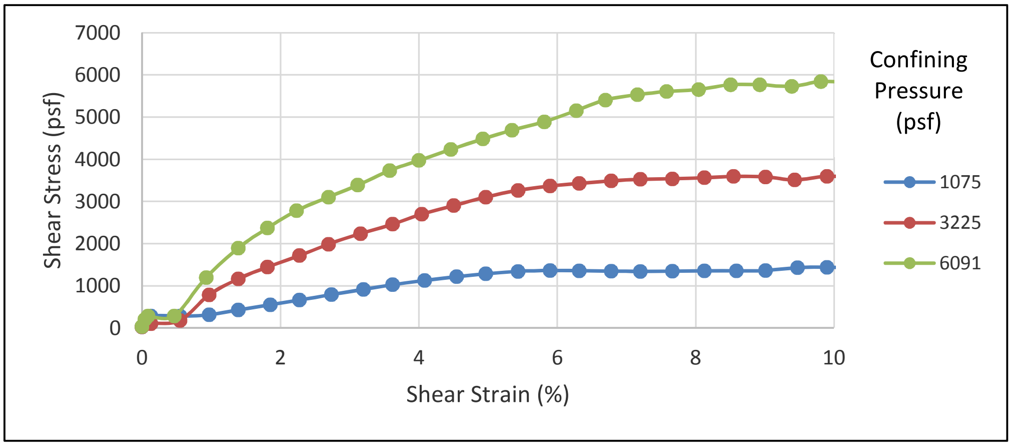
	Peak	Ultimate
Φ	50 °	50 °
c	1161 psf	1162 psf

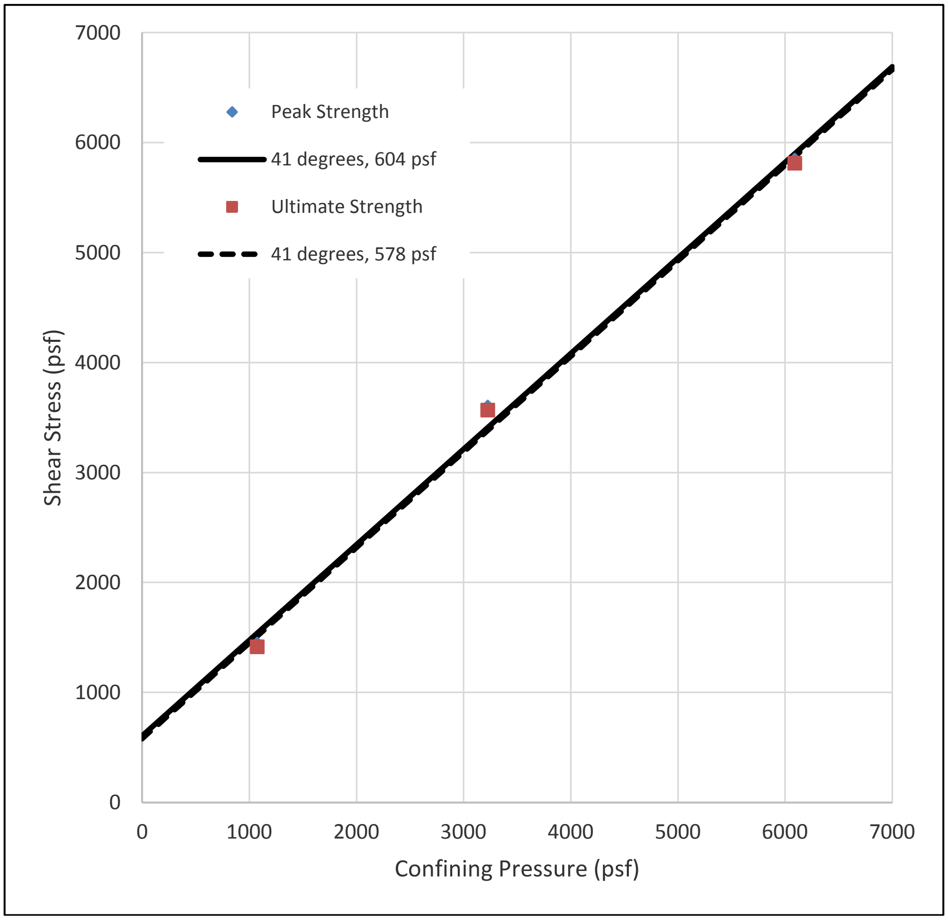
	Initial	Final
γ_d	107.2 pcf	107.2 pcf
w_c	6.2 %	16.8 %
Saturation	30 %	80 %

SCST Inc.

Duarte Road Apartments
Monrovia, California

By:	VAU	Date:	February, 2017
Job Number:	170107N	Figure:	II-3





			Peak	Ultimate
SAMPLE ID:	B-7 at 11 to 11½ feet	Φ	41 °	41 °
		c	604 psf	578 psf

SILTY SAND

		Initial	Final
NOTES: Insitu	γ_d	114.7 pcf	114.7 pcf
Strain Rate: 0.003 in/min	w_c	16.0 %	16.1 %
Sample was consolidated and drained	Saturation	93 %	94 %

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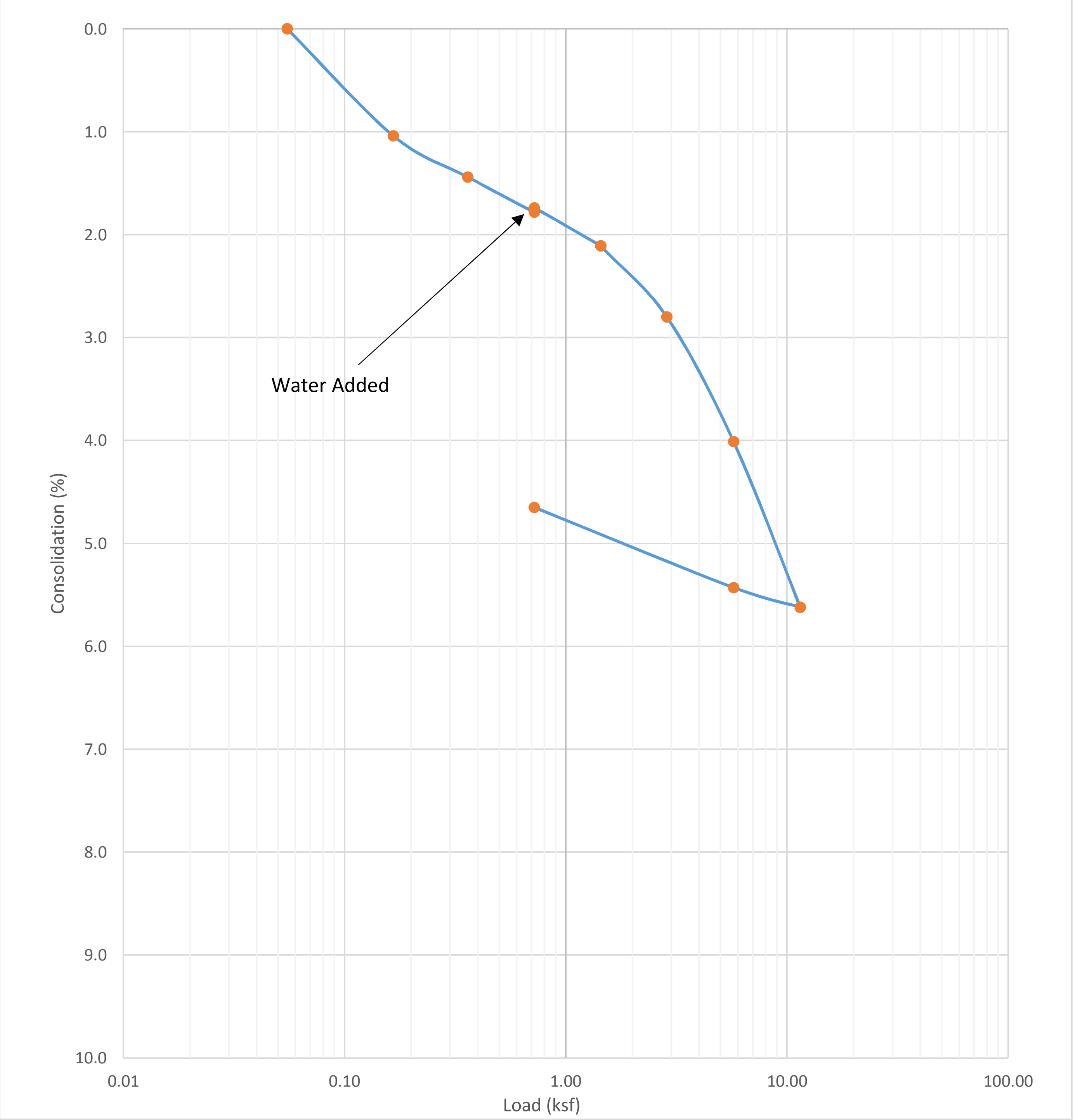
Duarte Road Apartments
Monrovia, California

By:	VAU	Date:	February, 2017
Job Number:	170107N	Figure:	II-4

Consolidation Test Results

ASTM D2435



Sample ID: B-6 at 11 - 11½

Sample Description: SILTY SAND

Sample Source: CAL sample

γ_d 114.0 pcf

Pre-consolidation w_c 15.8 %

Post-consolidation w_c 14.0 %

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Duarte Road Apartments Monrovia, California			
By:	CA/VU	Date:	February, 2017
Job No:	170107N-1	Figure:	II-5

R-VALUE

CALIFORNIA TEST 301

SAMPLE	DESCRIPTION	R-VALUE
B-1 at 1 to 4 feet	SILTY SAND	78

EXPANSION INDEX

ASTM D2489

SAMPLE	DESCRIPTION	EXPANSION INDEX
B-2 at 1 to 4 feet	POORLY GRADED SAND with SILT	0

CLASSIFICATION OF EXPANSIVE SOIL [1]

EXPANSION INDEX	POTENTIAL EXPANSION
0 - 20	Very Low
21 - 50	Low
51 - 90	Medium
91 - 130	High
Above 130	Very High

1. ASTM D4829

RESISTIVITY, pH, SOLUBLE CHLORIDE and SOLUBLE SULFATE

SAMPLE	RESISTIVITY (Ω-cm)	pH	CHLORIDE (%)	SULFATE (%)
B-1 at 1 to 4 Feet	7,890	5.9	0.001	0.001

SULFATE EXPOSURE CLASSES [2]

Class	Severity	Water-Soluble Sulfate (SO_4) in Soil, Percent by Mass
S0	Not applicable	$SO_4 < 0.10$
S1	Moderate	$0.10 \leq SO_4 < 0.20$
S2	Severe	$0.20 \leq SO_4 \leq 2.00$
S3	Very Severe	$SO_4 > 2.00$

2. ACI 318, Table 4.2.1

SCST, Inc.

Duarte Road Apartments
Monrovia, California

By:	VAU	Date:	February, 2017
Job Number:	170107N	Figure:	II-6

APPENDIX III
BORING PERCOLATION TESTING

In-situ constant head boring percolation testing was performed at two location (P-1 and P-2) in general conformance with County of Los Angeles Guidelines for Design Investigation, and Reporting Low Impact Development Stormwater Infiltration using an 8-inch diameter hollow stem auger and 4-inch perforated PVC pipe. An SCST engineer logged and sampled the borings for laboratory testing consisting of sieve analysis (ASTM D422). The percolation borings were presoaked a minimum of 24 hours by maintaining approximately 12 inches of constant head. The in-situ boring percolation test results were adjusted using a reduction factor to determine the infiltration rates. Figures III-1 and III-2 present the results of the testing.

Report of Constant Head Boring Percolation Testing

Storm Water Infiltration

Project Name:	DUARTE ROAD APARTMENTS	Test Location Number:	P-1
Job Number:	170107N	Tested By:	RS
Depth (ft):	30	Date Tested:	2/9/2017
Presoak Time (hrs):	24		

Reading	Time	Interval (min)	Initial Level (in)	Final Level (in)	Change in Level (in)	Percolation Rate (in/min)	Percolation Rate (min/in)
1	11:45 12:15	0:30	21.6	17.2	4.4	0.148	7
2	12:15 12:45	0:30	21.6	17.4	4.2	0.140	7
3	12:45 13:15	0:30	22.8	18.2	4.6	0.155	6
4	13:15 13:45	0:30	22.4	18.1	4.3	0.144	7
5	13:45 14:15	0:30	21.7	17.6	4.1	0.136	7
6	14:15 14:45	0:30	21.6	17.3	4.3	0.144	7
7							
8							
Preadjusted Percolation Rate:					7 min/in 8.5 in/hr		

$$\text{Reduction Factor (Rf)} = \frac{2{*}d_1 - \Delta d}{\text{DIA}} + 1$$

d_1 = Initial Water Depth (in.)

Δd = Water Level Drop of Final Period or Stabilized Rate (in.)

DIA = Diameter of Boring (in.)

$$Rf = \frac{2{*}21.6-4.3}{8} + 1$$

Rf = 5.86

Corrected Percolation Rate:	**2.8 in/hr**
Corected Infiltration Rate:	**1.5 in/hr**

*Correction Factor of 3 adopted to assess corrected percolation rate

SCST Inc.

Duarte Road Apartments Monrovia, California			
By:	RS	Date:	Febuary, 2017
Job No:	170107N	Figure:	III-1

Report of Constant Head Boring Percolation Testing

Storm Water Infiltration

Project Name:	DUARTE ROAD APARTMENTS	Test Location Number:	P-2
Job Number:	170107N	Tested By:	RS
Depth (ft):	10	Date Tested:	2/9/2017
Presoak Time (hrs):	24		

Reading	Time	Interval (min)	Initial Level (in)	Final Level (in)	Change in Level (in)	Percolation Rate (in/min)	Percolation Rate (min/in)
1	11:55 12:25	0:30	21.6	17.3	4.3	0.144	7
2	12:25 12:55	0:30	21.6	17.4	4.2	0.140	7
3	12:55 13:25	0:30	22.2	17.6	4.6	0.152	7
4	13:25 13:55	0:30	22.9	18.5	4.4	0.148	7
5	13:55 14:25	0:30	21.8	17.3	4.6	0.152	7
6							
7							
8							
Preadjusted Percolation Rate:					7 min/in 9.0 in/hr		

$$\text{Reduction Factor (Rf)} = \frac{2*d_1 - \Delta d}{\text{DIA}} + 1$$

d_1 = Initial Water Depth (in.)

Δd = Water Level Drop of Final Period or Stabilized Rate (in.)

DIA = Diameter of Boring (in.)

$$\text{Rf} = \frac{2*21.8-4.6}{8} + 1$$

Rf = 5.89

Corrected Percolation Rate:	**3.0 in/hr**
Corrected Infiltration Rate:	**1.5 in/hr**

*Correction Factor of 3 adopted to assess corrected percolation rate

SCST Inc.

Duarte Road Apartments

Monrovia, California

By:	RS	Date:	Febuary, 2017
Job No:	170107N	Figure:	III-2