SCST

— AN ATLAS COMPANY —

GEOTECHNICAL INVESTIGATION

JUNIPERO SERRA MUSEUM ADA IMPROVEMENTS

San Diego, California

Prepared By:
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GEOTECHNICAL INVESTIGATION

March 27, 2019

SCST No. 180320P4.1
Report No. 1

Larry Thornburgh, PE, PLS
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San Diego, CA 92111

Subject: GEOTECHNICAL INVESTIGATION
JUNIPERO SERRA MUSEUM ADA IMPROVEMENTS
2727 PRESIDIO DRIVE
SAN DIEGO, CALIFORNIA

Dear Larry:

SCST, LLC (SCST) is pleased to present our report describing the geotechnical investigation performed for the subject project. We conducted the investigation in general conformance with the scope of work presented in our proposal dated November 30, 2017. Based on the results of our investigation, we consider the planned development feasible from a geotechnical standpoint, provided the recommendations of this report are followed. If you have any questions, please call us at (619) 280-4321.

Respectfully submitted,
SCST, LLC

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TABLE OF CONTENTS

SECTION **PAGE**

TABLE OF CONTENTS (Continued)

ATTACHMENTS

FIGURES

APPENDICES

1. INTRODUCTION

This report presents the results of the geotechnical investigation SCST, LLC (SCST) performed for the subject project. We understand the project will consist of the design and construction of a new concrete ADA accessible path, driveway, parking area, landscaping, and biofiltration basins located south of the main terrace of Junipero Serra Museum. The purpose of our work is to provide conclusions and recommendations regarding the geotechnical aspects of the project. Figure 1 presents the site vicinity map.

2. SCOPE OF WORK

2.1 FIELD INVESTIGATION

We explored the subsurface conditions by drilling four borings and 3 percolation test borings to depths between about 3 and 5 feet below the existing ground surface using a hand auger. Auger refusal was encountered in each boring except B-4. Figure 2 presents the approximate locations of the borings. An SCST geologist logged the borings and collected samples of the materials encountered for laboratory testing. Logs of the borings are presented in Appendix I. Soils are classified according to the Unified Soil Classification System illustrated on Figure I-1.

2.2 LABORATORY TESTING

We tested selected samples to evaluate soil classification and engineering properties and develop geotechnical conclusions and recommendations. The laboratory tests consisted of in situ moisture and density, particle-size distribution, Atterberg limits, R-value, expansion index, and corrosivity. The results of the laboratory tests and brief explanations of the test procedures are presented in Appendix II.

2.3 BOREHOLE PERCOLATION TESTING

We performed borehole percolation testing in general conformance with the City of San Diego BMP Design Manual at three locations (P-1, P-2, and P-3) to assess stormwater infiltration feasibility. The results of the testing are presented in Appendix III.

2.4 ANALYSIS AND REPORT

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

- Subsurface conditions beneath the site
- Potential geologic hazards
- Criteria for seismic design in accordance with the 2016 California Building Code (CBC)
- Site preparation and grading

- Excavation characteristics
- Concrete slabs-on-grade
- Pavement sections
- Foundation support, potential foundation settlement, resistance to lateral loads, and lateral earth pressures for retaining wall design
- Pipelines
- Soil corrosivity
- Infiltration test results and feasibility

3. SITE DESCRIPTION

The site is within a eucalyptus tree grove located in Presidio Park at 2727 Presidio Drive in the City of San Diego, California. The existing park consists of historic buildings, pavements, hardscape, and landscape areas. The site is located on a mesa south of Mission Valley. Existing site elevations range from about 175 feet near the top of the mesa with gradual slopes down to about 145 feet to the north and northwest, and gradual slopes down to about 165 feet to the southwest of the mesa.

4. PROPOSED DEVELOPMENT

We understand the project will consist of the design and construction of a new concrete ADA accessible path, driveway, parking area, landscaping, and biofiltration basins located south of the main terrace of Junipero Serra Museum. Current grading plans indicate that cuts up to about 9 feet and fills up to about 4 feet will be required to achieve finish site grades.

5. GEOLOGY AND SUBSURFACE CONDITIONS

The materials encountered in our borings consist of fill and very old paralic deposits. Descriptions of the materials encountered are presented below. Figure 3 presents the regional geology in the vicinity of the site.

Fill: Fill was encountered in each boring except for P-1. The fill encountered in the borings extends to depths varying from about 1 foot below the existing ground surface to the maximum-explored depth of 5 feet and consists of loose to medium dense silty to clayey sand and soft to stiff sandy clay with varying amounts of gravel and cobbles.

Very Old Paralic Deposits: Very old paralic deposits underlie the entire site. These deposits consist of weathered, moderately to strongly cemented silty sandstone.

Groundwater: Groundwater was not encountered in the borings. The groundwater table is expected to be below a depth that will influence the planned construction. 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.

6. GEOLOGIC HAZARDS

6.1 CITY OF SAN DIEGO SEISMIC SAFETY STUDY

Figure 4 shows the approximate site location on the City of San Diego Seismic Safety Study map. The site is located in Geologic Hazard Category 53, defined as level or sloping terrain and unfavorable geologic structure with moderate to low risk. In our opinion, the geologic risk is low.

6.2 FAULTING AND SURFACE RUPTURE

No active faults are known to underlie or project toward the site. However, the potentially active Rose Canyon fault zone is located about 800 feet southwest of the site. The site is not located in an Alquist-Priolo Earthquake Fault Zone. Therefore, the probability of fault rupture is low.

6.3 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 maximum considered earthquake (MCE_R) spectral response acceleration parameters in accordance with the 2016 CBC are presented below:

Site Coordinates: Latitude 32.758357°
Longitude -117.193069°

Site Class: C

Site Coefficients, F_a = 1.000
F_v = 1.307

Mapped Spectral Response Acceleration at Short Period, S_s = 1.273g

Mapped Spectral Response Acceleration at 1-Second Period, S_1 = 0.493g

Design Spectral Acceleration at Short Period, S_{DS} = 0.849g

Design Spectral Acceleration at 1-Second Period, S_{D1} = 0.429g

Site Peak Ground Acceleration, PGA_M = 0.578g

6.4 LIQUEFACTION AND DYNAMIC SETTLEMENT

Liquefaction occurs when loose, saturated sands and silts are subjected to strong ground shaking. The soils lose shear strength and become liquid, resulting in large total and differential ground surface settlements and possible lateral spreading during an earthquake. Given the dense nature of the materials beneath the site, and due to the lack of a shallow groundwater table, the potential for liquefaction and dynamic settlement to occur is low.

6.5 LANDSLIDES AND SLOPE STABILITY

Evidence of landslides or slope instabilities was not observed during our investigation. However, Kennedy and Tan (2008) have noted that the Presidio Park area is underlain by an ancient landslide. Mike Hart (2014) conducted a detailed fault and landslide study of the Presidio Park area and noted that although probable ancient landslides do exist in the Presidio Park area, the mapped landslides are much smaller in size than what Kennedy and Tan mapped in 2008. Hart's mapped areas of landslides are presented in Figure 5 and are outside of the project limits. The potential for landslides or slope instabilities to occur at the site is considered low.

6.6 TSUNAMIS, SEICHES, AND FLOODING

The site is not located within a mapped area on the State of California Tsunami Inundation Maps (Cal EMA, 2009); therefore, damage due to tsunamis is considered low. Seiches are periodic oscillations in large bodies of water such as lakes, harbors, bays, or reservoirs. The site is not located adjacent to lakes or confined bodies of water; therefore, the potential for a seiche to affect the site is considered negligible. The site is not located within a flood zone or dam inundation area (County of San Diego, 2012).

6.7 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 considered low.

6.8 HYDRO-CONSOLIDATION

Hydro-consolidation can occur in recently deposited sediments (less than 10,000 years old) that were deposited in a semi-arid environment. Examples of such sediments are aeolian sands, alluvial fan deposits, and mudflow sediments deposited during flash floods. The pore spaces between the particle grains can re-adjust when inundated by groundwater causing the material to consolidate. The relatively dense materials underlying the site are not considered susceptible to hydro-consolidation.

7. CONCLUSIONS

Based on the results of our investigation, we consider the proposed construction feasible from a geotechnical standpoint provided the recommendations of this report are followed. The main geotechnical considerations affecting the proposed ADA access path, driveway, parking area, and other improvements are the presence of potentially compressible fill and potentially expansive soils. Remedial grading is recommended to reduce the potential for distress to the planned improvements. Remedial grading recommendations are provided herein. The recommendations presented herein may need to be updated once final plans are developed.

8. RECOMMENDATIONS

8.1 SITE PREPARATION AND GRADING

8.1.1 Site Preparation

Site preparation should begin with the removal of existing improvements, vegetation, and debris. Subsurface improvements that are to be abandoned should be removed, and the resulting excavations should be backfilled and compacted in accordance with the recommendations of this report. Pipeline abandonment can consist of capping or rerouting at the project perimeter and removal within the project perimeter. If appropriate, abandoned pipelines can be filled with grout or slurry as recommended by and observed by the geotechnical consultant.

8.1.2 Remedial Grading

To improve subgrade support, the existing soils should be excavated to a depth of at least 1 foot below finish subgrade elevation for hardscape and pavements and at least 2 feet below the footing bottom elevation for retaining walls. Horizontally, the excavations should extend a distance equal to the depth of excavation, up to existing improvements or the limits of disturbance, whichever is less. An SCST representative should observe conditions exposed in the bottom of the excavation to determine if additional excavation is required.

8.1.3 Expansive Soil

The on-site soils tested have expansion indexes of 6 and 59. To reduce the potential for expansive heave, the top 2 feet of material beneath hardscape, pavements, and retaining wall footings should have an expansion index (EI) of 20 or less determined in accordance with ASTM D4829. The on-site silty to clayey sands are expected to meet this expansion index criteria. However, the on-site sandy clay is not expected to meet the expansion index criteria.

8.1.4 Compacted Fill

Prior to placing fill, the exposed surface should be scarified to a depth of 12 inches, moisture conditioned to near optimum moisture content, and compacted to at least 90% relative compaction. Excavated material, except for vegetation, debris, soils with an EI greater than 20, or rocks greater than 6 inches can be used as compacted fill. 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. Fill should be moisture conditioned to near optimum moisture content and compacted to at least 90% relative compaction. The maximum density and optimum moisture content for the evaluation of relative compaction should be determined in accordance with ASTM D1557. The top 12 inches of subgrade beneath pavements subjected to vehicular traffic should be compacted to at least 95%.

8.1.5 Imported Soil

Imported soil should consist of predominately granular soil free of organic matter and rocks greater than 6 inches. Imported soil should be observed and, if appropriate, tested by SCST prior to transport to the site to determine suitability for the intended use.

8.1.6 Excavation Characteristics

It is anticipated that excavations can be achieved with conventional earthwork equipment in good working order. Difficult excavation should be anticipated in cemented zones within the very old paralic deposits. Gravel and cobbles should also be anticipated.

8.1.7 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 of off-site.

8.1.8 Temporary Excavations

Temporary excavations 3 feet deep or less can be made vertically. Deeper temporary excavations in fill should be laid back no steeper than 1:1 (horizontal:vertical). Deeper temporary excavations in formational materials should be laid back no steeper than ¾:1

(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. 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 require shoring. Soldier piles and lagging, internally braced shoring, or trench boxes could be used. If trench boxes are used, the soil immediately adjacent to the trench box is not directly supported. Ground surface deformations immediately adjacent to the pit or trench could be greater where trench boxes are used compared to other methods of shoring.

As an alternative to shoring/underpinning, maximum 10-foot-wide slots can be excavated and immediately backfilled adjacent to existing structures and improvements. Care should be taken to not undermine existing footings. Slot excavations should be filled prior to performing adjacent excavations.

8.1.9 Temporary Shoring

For design of cantilevered shoring with level backfill, an active earth pressure equal to a fluid weighing 35 pounds per cubic foot (pcf) can be used. An additional 20 pcf should be added for shoring with 2:1 sloping ground. The surcharge loads on shoring from traffic and construction equipment working 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 350 pounds per square foot (psf) per foot of embedment over two times the pile diameter up to a maximum of 5,000 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 can be limited to a maximum value of 400 psf.

8.1.10 Slopes

Permanent slopes should be constructed no steeper than 2:1 (horizontal:vertical). Faces of fill slopes should be compacted either by rolling with a sheepsfoot 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). In our opinion, slopes constructed no steeper than 2:1 (horizontal:vertical) will possess an adequate factor of safety. An engineering geologist should observe cut slopes during grading to ascertain that no unforeseen adverse geologic conditions are encountered that require revised recommendations. 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.

8.1.11 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.

8.1.12 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 PAVEMENT SECTION RECOMMENDATIONS

The pavement support characteristics of the fill soils encountered during our investigation are considered poor. An R-value of 5 was used for design of preliminary pavement sections based on R-value testing conducted from on-site soils sampled. The actual R-value of the subgrade soils should be determined after grading, and the final pavement sections should be provided.

Based on an R-value of 5, the following preliminary pavement structural sections are provided for the assumed Traffic Indexes.

Traffic Type	Traffic Index	Asphalt Concrete (inches)	Portland Cement Concrete (inches)
Bikeways and Light Vehicles	4.5	3 AC / 8 AB	6 PCC
Medium Trucks	6.0	5½ AC / 9 AB	7 PCC / 6 AB

AC - Asphalt Concrete
AB - Aggregate Base
PCC - Portland Cement Concrete

The top 12 inches of subgrade should be scarified, moisture conditioned to near optimum moisture content, and compacted to at least 95% relative compaction. Soft or yielding areas should be stabilized or 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. Materials and methods of construction should conform to good engineering practices and the minimum local standards.

8.3 PERVIOUS PAVEMENT SECTION RECOMMENDATIONS

Pervious pavement section recommendations are based on Caltrans (2014) pavement structural design guidelines. The pavement sections below are based on the strength of the materials. However, the actual thickness of the sections may be controlled by the reservoir layer design, which the project civil engineer should determine.

Pervious Asphalt Pavement

Traffic Type	Category	*Asphalt Treated Permeable Base (ATPB) (inches)	Class 4 Aggregate Base (inches)
Landscape Areas, Sidewalks and Bike path (no vehicular access)	A	0**	6
Bike path and Light Vehicles	B	6	10

***1¼ inches of an open-graded friction course (OGFC) should be placed on top of the ATPB.**
****2½ inches of an open-graded friction course (OGFC) should be placed on top of the Class 4 Agg Base.**

Pervious Concrete Pavement

Traffic Type	Category	Pervious Concrete (inches)	Class 4 Aggregate Base (inches)
Landscape Areas, Sidewalks and Bike path (no vehicular access)	A	4½	0
Bike path and Light Vehicles	B	6	8½

Permeable Interlocking Concrete Pavers (PICP)

Traffic Type	Category	PICP (inches)	Class 3 Permeable (inches)	Class 4 Aggregate Base (inches)
Landscape Areas, Sidewalks and Bike path (no vehicular access)	A	2⅜*	4½	0
Bike path and Light Vehicles	B	3⅛*	4½	8½

***2 inches of bedding layer should be placed between Class 3 permeable material and pavers.**

The top 12 inches of subgrade should be scarified, moisture conditioned to near optimum moisture content, and compacted to at least 95% relative compaction. Soft or yielding subgrade areas should be stabilized or removed and replaced with compacted fill or permeable base. Materials and methods of construction should conform to good engineering practices and the minimum local standards.

Deepened curbs or vertical cutoff membranes consisting of 30 mil HDPE or PVC should be installed at the edges of pervious pavements to reduce the potential for water-related distress to adjacent structures or improvements.

8.4 CONCRETE PEDESTRIAN WALKS

Exterior concrete slabs should be underlain by at least 2 feet of material with an EI of 20 or less. Exterior slabs not subjected to vehicular weight 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. The corrosion potential of on-site soils with respect to reinforced concrete will need to be taken into account in concrete mix design. Coarse and fine aggregate in concrete should conform to the “Greenbook” Standard Specifications for Public Works Construction.

8.5 CONVENTIONAL RETAINING WALLS

8.5.1 Foundations

The planned retaining walls can be supported on spread footings with bottom levels on compacted fill or very old paralic deposits. Footings should extend at least 18 inches below lowest adjacent finished grade and be at least 24 inches wide. Footings located adjacent to or within slopes should be extended to a depth such that a minimum horizontal distance of 7 feet exists between the lower outside footing edge and the face of the slope.

8.5.2 Allowable Soil Bearing

An allowable bearing capacity of 2,500 psf can be used. The allowable 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 5,000 psf. The bearing value can be increased by ⅓ when considering the total of all loads, including wind or seismic forces.

8.5.3 Resistance to Lateral Loads

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 350 psf per foot of depth below the ground surface for level ground conditions. 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.

8.5.4 Settlement Characteristics

Total foundation settlements are estimated to be less than 1 inch. Differential settlements across continuous footings are estimated to be less than ¾ inch over a distance of 40 feet. Settlements should be completed shortly after structural loads are applied.

8.5.5 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.

8.5.6 Foundation Excavation Observations

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

8.5.7 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 35 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 55 pcf. These values assume a granular and drained backfill condition. Higher lateral earth pressures would apply if walls retain clay soils. 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 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. The backdrain can 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 damp proofing specifications and details. Figure 6 presents typical conventional retaining wall backdrain details.

8.5.8 Seismic Earth Pressure

If required, the seismic earth pressure can be taken as equivalent to the pressure of a fluid weighing 20 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.

8.5.9 Backfill

Wall backfill should consist of granular, free-draining material having a sand equivalent of 20 or more. The backfill zone is defined by a 1:1 plane projected upward from the heel of the wall. 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. 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, utilities supported on backfill should be designed to tolerate differential settlement.

8.6 MECHANICALLY STABILIZED EARTH RETAINING WALLS

The following soil parameters can be used for design of mechanically stabilized earth (MSE) retaining walls.

MSE Wall Design Parameters

Soil Parameter	Reinforced Soil	Retained Soil	Foundation Soil
Internal Friction Angle (degrees)	32°	32°	32°
Cohesion (psf)	0	0	0
Moist Unit Weight (pcf)	130	130	130

The reinforced soil should consist of granular, free-draining material with an expansion index of 20 or less. The bottom of MSE walls should extend to such a depth that a total of 5 feet exists between the bottom of the wall and the face of the slope. Figure 7 presents a typical MSE retaining wall backdrain detail. MSE retaining walls may experience lateral movement over time. The wall engineer should review the configuration of proposed improvements adjacent to the wall and provide measures to help reduce the potential for distress to these improvements from lateral movement.

8.7 PIPELINES

8.7.1 Thrust Blocks

For level ground conditions, a passive earth pressure of 350 psf per foot of depth below the lowest adjacent final grade can be used to compute allowable thrust block resistance. A value of 150 psf per foot should be used below groundwater level, if encountered.

8.7.2 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.

8.7.3 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 20 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 on-site 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.

8.8 SOIL CORROSIVITY

Representative samples of the on-site soil were 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.

8.9 INFILTRATION FEASIBILITY

Figure 2 shows the approximate locations of the three borehole percolation tests we performed to assess stormwater infiltration feasibility. Appendix III presents the field data and test results. The table below presents the observed tested infiltration rates.

Infiltration Rate Test Results

Test Location	Test Depth (feet)	Material Type at Test Depth	Infiltration Rate (inch/hour)
P-1	3	Very Old Paralic Deposits: Silty Sandstone	0.0
P-2	3	Very Old Paralic Deposits: Silty Sandstone	0.0
P-3	3	Very Old Paralic Deposits: Silty Sandstone	0.0

The observed tested infiltration rates do not support stormwater infiltration in an appreciable quantity. Based on our test results, the feasibility screening category is No Infiltration. BMP facilities should be lined with an impermeable geomembrane to reduce the potential for water-related distress to adjacent structures or improvements. A subdrain system should be installed at the bottom of BMP facilities. Foundations should be set back at least 10 feet from BMP facilities, or the foundation should be depended to a depth that extends below the bottom of the BMP.

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 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 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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California Department of Transportation (2015), Standard Specifications.

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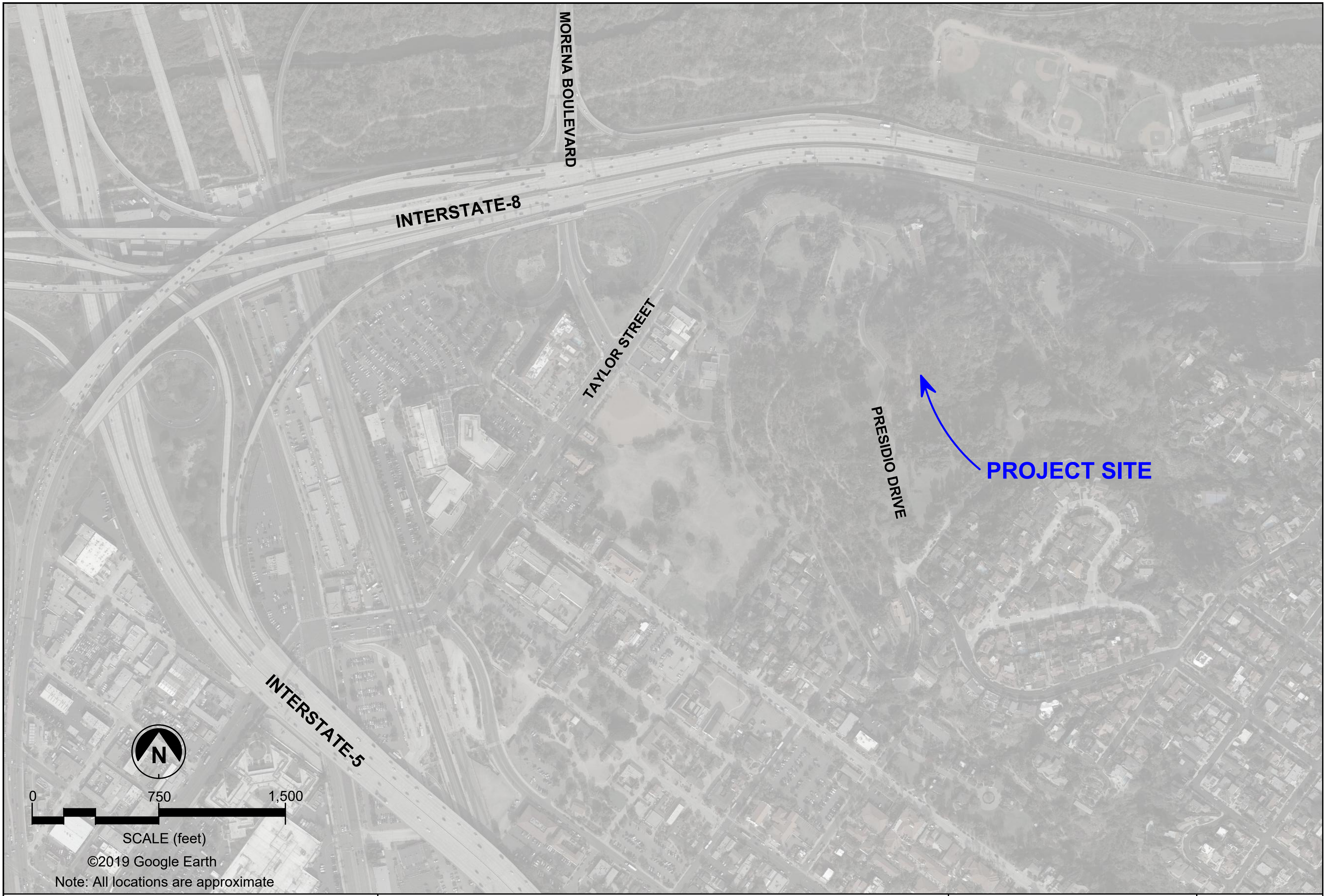

©2019 Google Earth

Note: All locations are approximate

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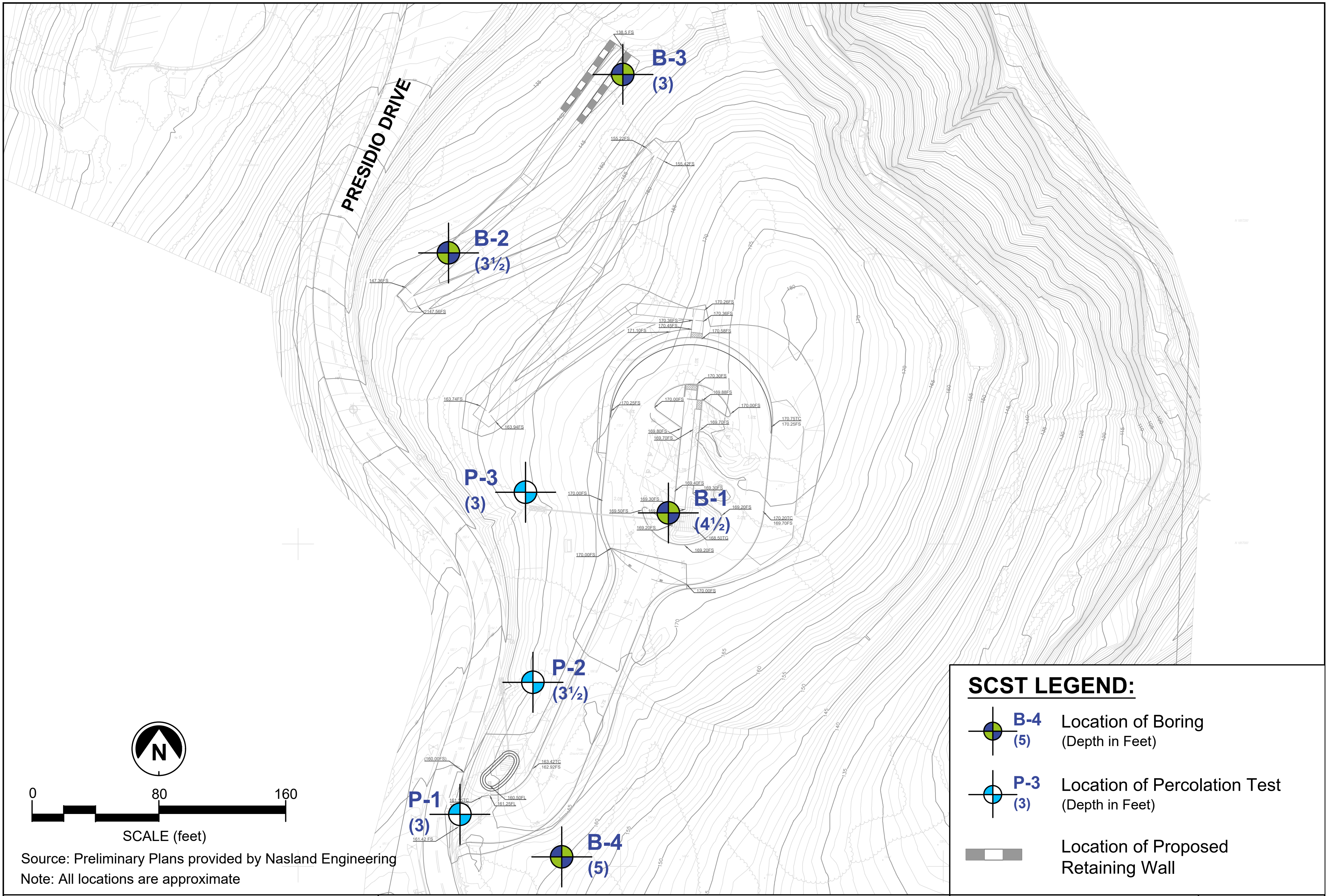
SITE VICINITY MAP

Junipero Serra Museum ADA Improvements
San Diego, California

Date:	March, 2019
By:	NDK/NNW
Job No.:	180320P4.1

Figure:
1



Source: Preliminary Plans provided by Nasland Engineering
Note: All locations are approximate

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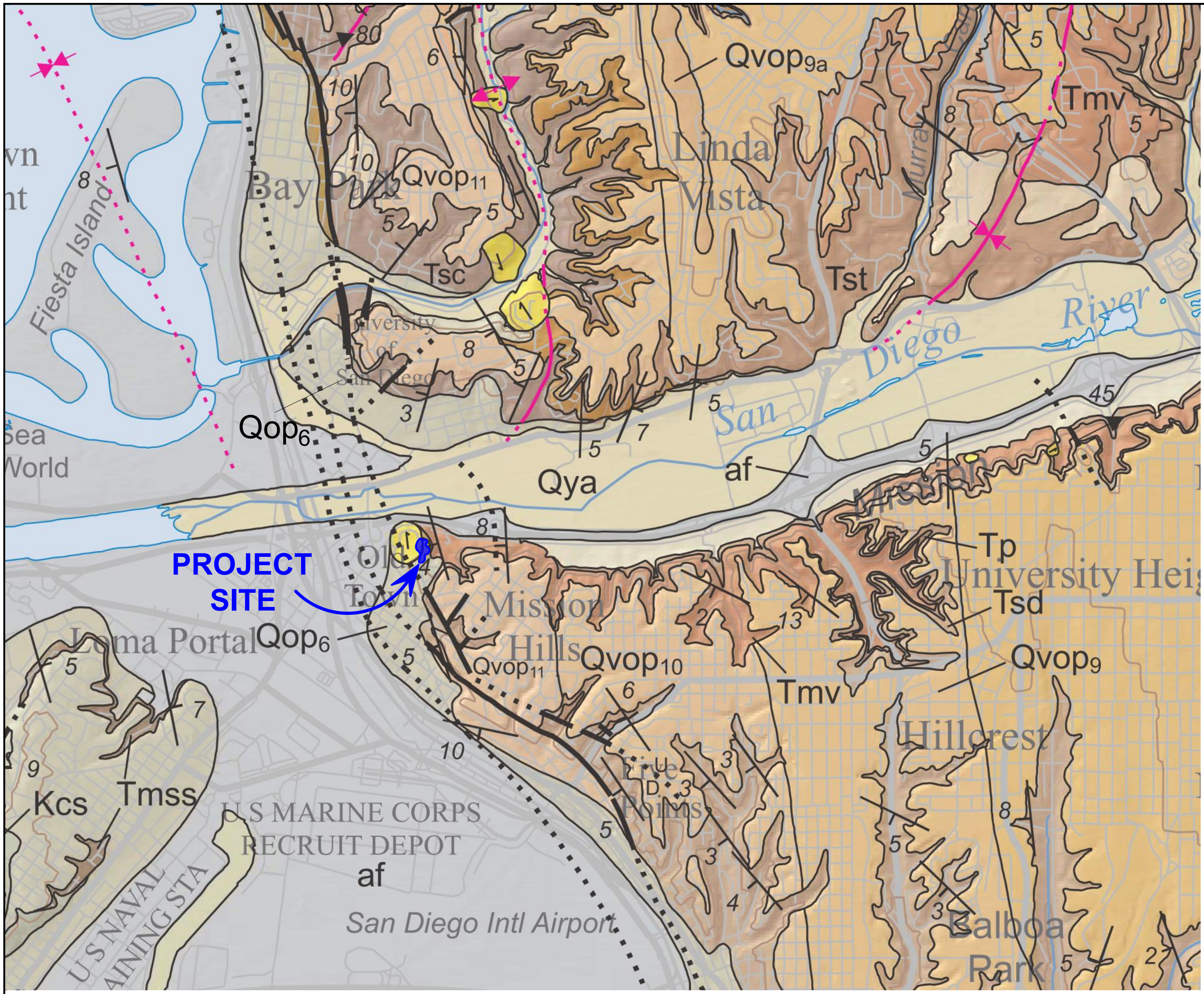
SUBSURFACE EXPLORATION MAP

Junipero Serra Museum ADA Improvements
San Diego, California

Date: March, 2019
By: NDK/NNW
Job No.: 180320P4.1

Figure:
2



EXPLANATION:

af	Artificial fill
Qya	Young alluvial flood-plain deposits
Qop$_6$	Old paralic deposits, undivided Unit 6
Qvop	Very old paralic deposits, undivided
Tsd	San Diego Formation, undivided
Tp	Pomerado Conglomerate
Tmv	Mission Valley Formation
Tsc	Scripps Formation
Tmss	Mount Soledad Formation, sandstone
Kcs	Cabrillo Formation, sandstone
	Anticline Fold - Solid where well defined; short dash where inferred
	Syncline Fold - Solid where well defined; short dash where inferred
4 ┴	**Strike** and **dip** of beds Inclined
Qls?	**Landslide** - Arrows indicate principal direction of movement. Queried where existence is questionable.

N

0 1.5 3.0

SCALE (miles)

Note: All locations are approximate

Reference:
Kennedy, M.P. and Tan, S.S. (2008), Geologic Map of the San Diego 30' x 60' Quadrangle, California, California Geological Survey, Scale 1:100,000

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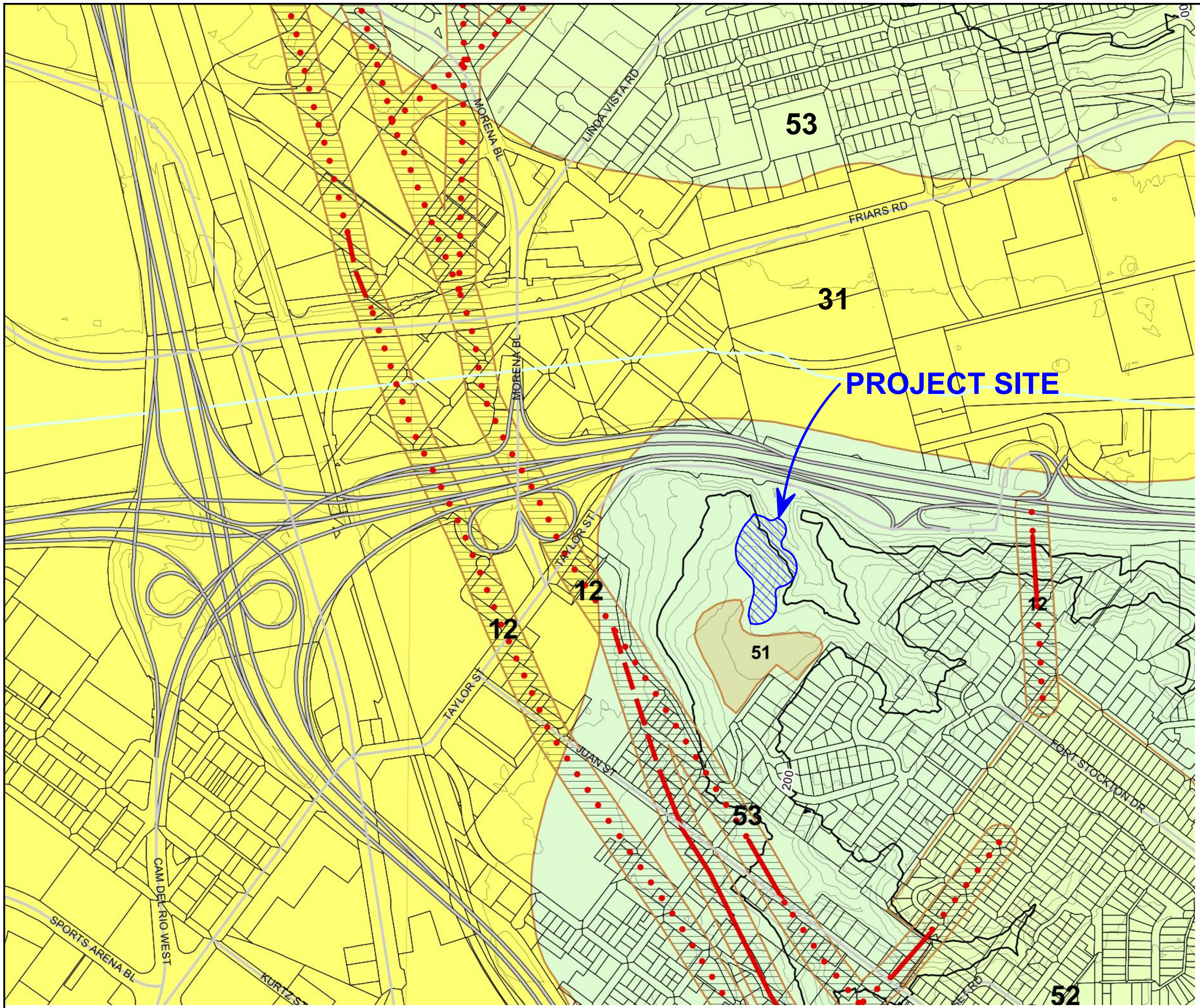
REGIONAL GEOLOGY MAP

Junipero Serra Museum ADA Improvements
San Diego, California

Date:	March, 2019
By:	NDK/NNW
Job No.:	180320P4.1

Figure:
3



EXPLANATION:

FAULT ZONES

11	Active, Alquist-Priolo Earthquake Fault Zone
12	Potentially Active, Inactive, Presumed Inactive, or Activity Unknown

LIQUEFACTION

31	High Potential -- shallow groundwater; major drainages, hydraulic fills

OTHER TERRAIN

51	Level mesas -- underlain by terrace deposits and bedrock; nominal risk
52	Other level areas, gently sloping to steep terrain, favorable geologic structure; Low risk
53	Level or sloping terrain, unfavorable geologic structure; Low to moderate risk

FAULTS

Fault

Inferred Fault

Concealed Fault

N

0 1,000 2,000

SCALE (feet)

Note: All locations are approximate

Reference:
City of San Diego (2008), Seismic Safety Study, Geologic Hazards and Faults,
Grid Tile: **20**, Development Services Department, April 3, Scale 1:800.

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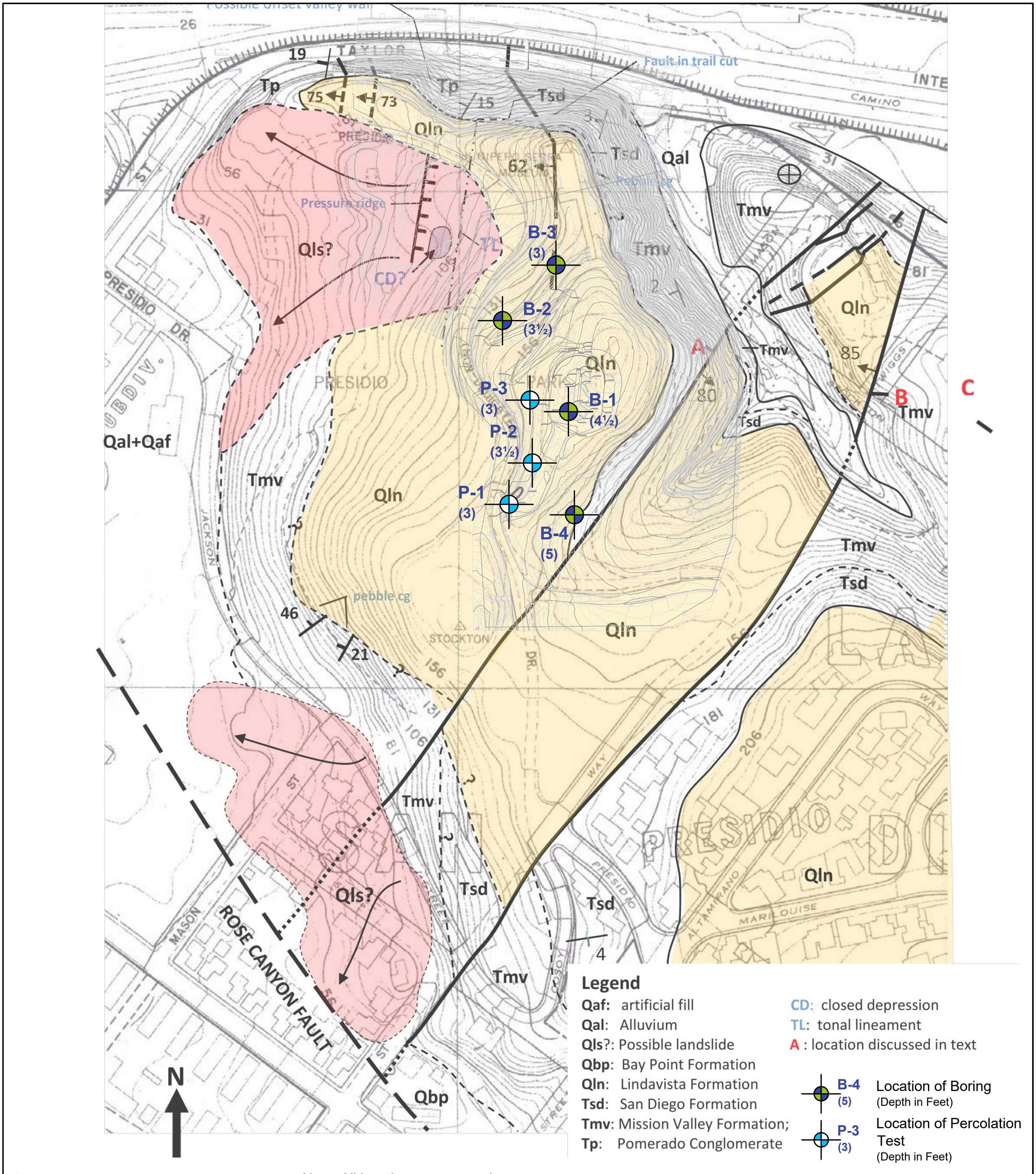
CITY OF SAN DIEGO SEISMIC SAFETY STUDY
Junipero Serra Museum ADA Improvements
San Diego, California

Date: March, 2019
By: NDK/NNW
Job No.: 180320P4.1

Figure:
4



Legend

- **Qaf:** artificial fill
- **Qal:** Alluvium
- **Qls?:** Possible landslide
- **Qbp:** Bay Point Formation
- **Qln:** Lindavista Formation
- **Tsd:** San Diego Formation
- **Tmv:** Mission Valley Formation;
- **Tp:** Pomerado Conglomerate
- **CD:** closed depression
- **TL:** tonal lineament
- **A** : location discussed in text
- B-4 (5) Location of Boring (Depth in Feet)
- P-3 (3) Location of Percolation Test (Depth in Feet)

0 250 500

SCALE (feet)

Note: All locations are approximate.
Reference: Hart, MW. Geologic Map Presidio Park, San Diego California, Figure 1

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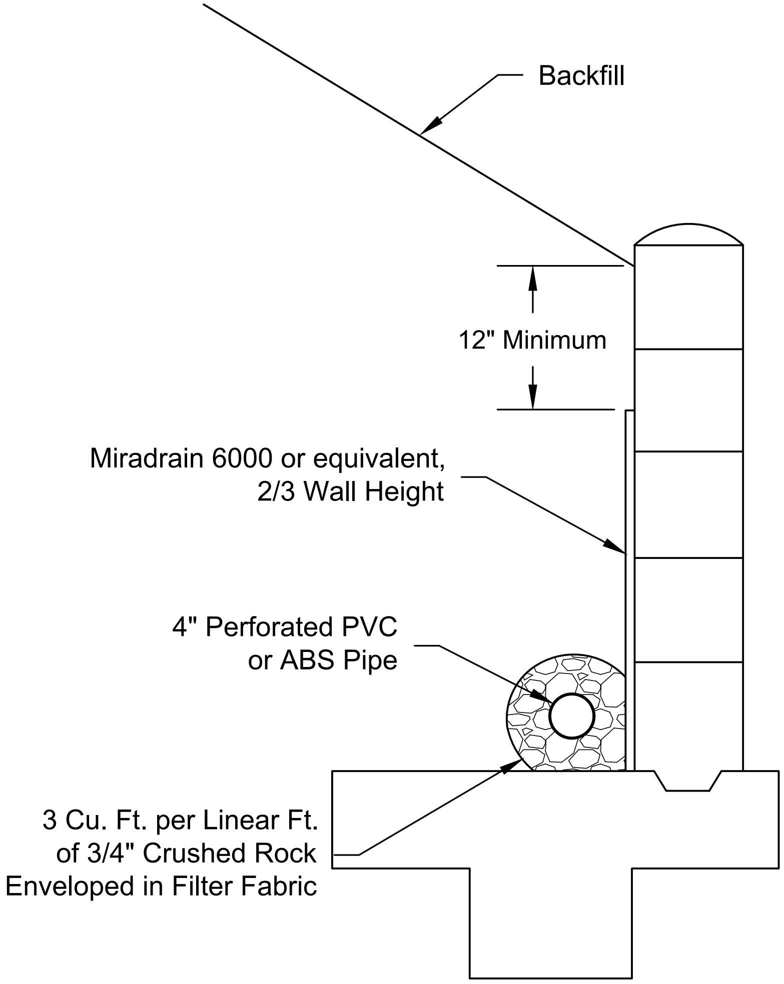
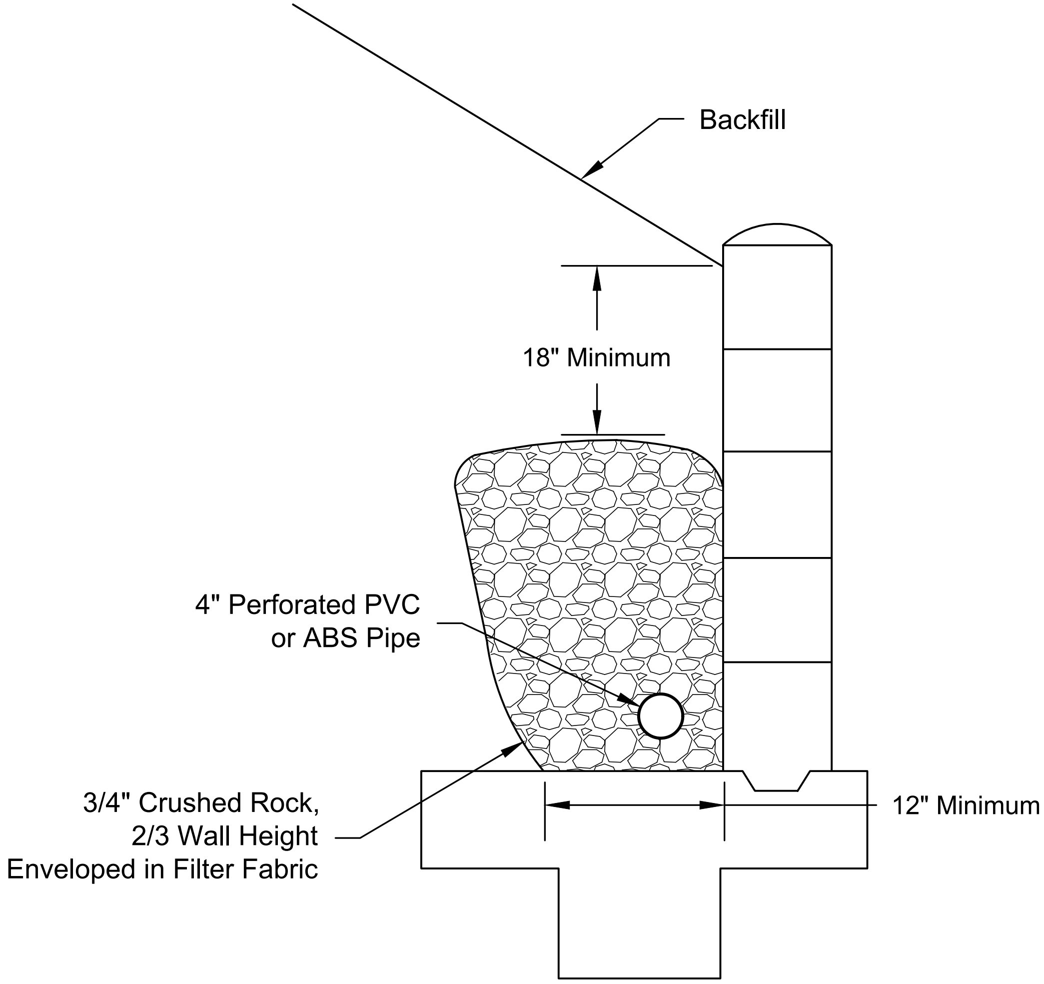
GEOLOGIC MAP

Junipero Serra Museum
ADA Improvements
San Diego, California

Date: March, 2019
By: DTC
Job No.: 180320P4-1

Figure: 5





NOT TO SCALE

NOTES:

1) Dampproof or waterproof back of wall following architect's specifications.
2) 4" minimum perforated pipe, SDR35 or equivalent, holes down, 1% fall to outlet. Provide solid outlet pipe at suitable locations.
3) Drain installation and outlet connection should be observed by the geotechnical consultant.

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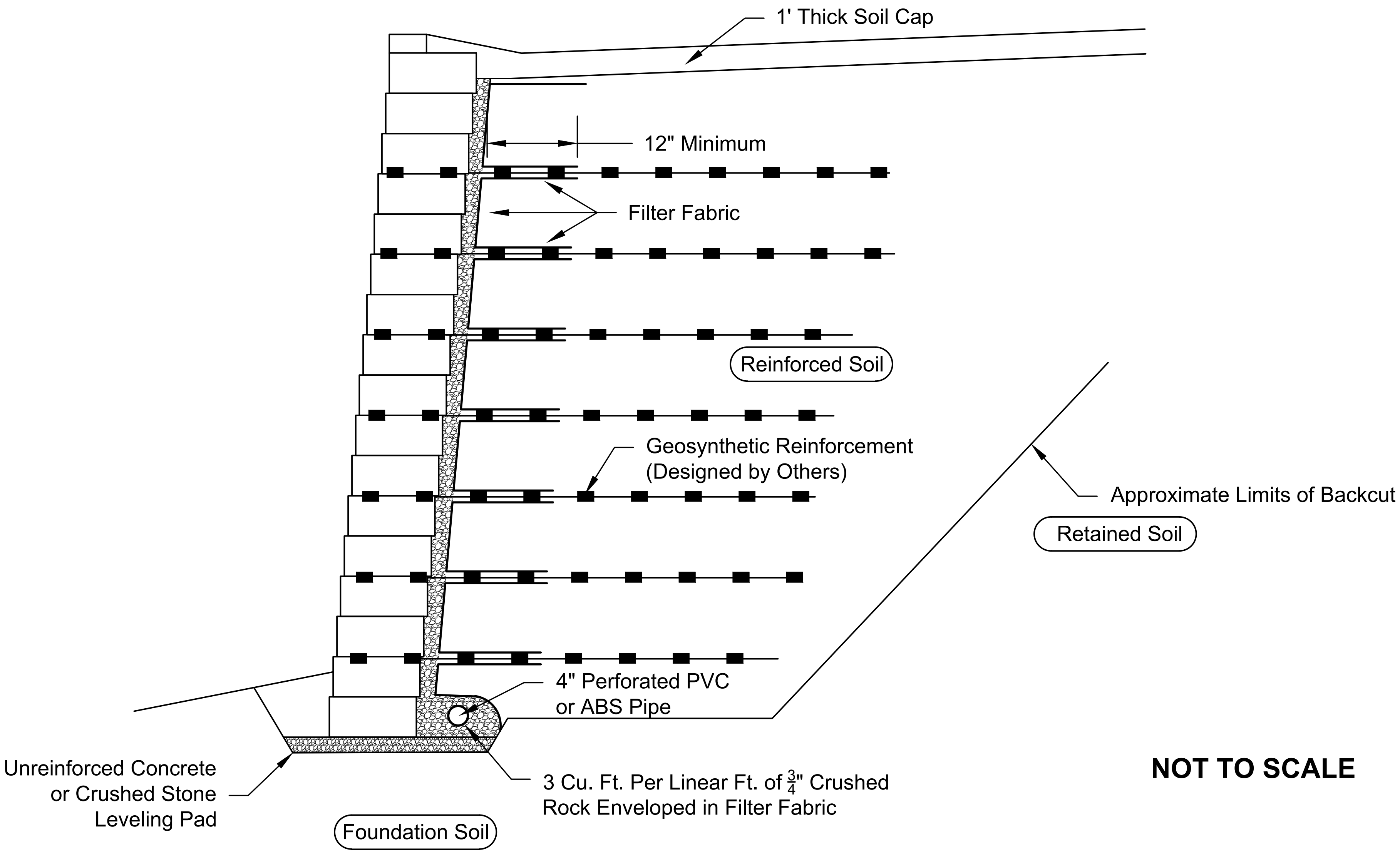
TYPICAL RETAINING WALL BACKDRAIN DETAILS
Junipero Serra Museum ADA Improvements
San Diego, California

Date: March, 2019
By: NDK/NNW
Job No.: 180320P4.1

Figure:
6



NOT TO SCALE

NOTES:

1) Backcut as recommended by the geotechnical report or field evaluation
2) Additional drain at excavation backcut may be recommended base on conditions observed during construction.
3) Filter fabric should be installed between crushed rock and soil. Filter fabric should consist of Mirafi 140N or equivalent. Filter fabric should be overlapped approximately 6 inches.
4) Perforated pipe should outlet through a solid pipe to an appropriate gravity outfall. Perforated pipe and outlet pipe should have a fall of at least 1%.

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TYPICAL MSE RETAINING WALL DETAIL
Junipero Serra Museum ADA Improvements
San Diego, California

Date: March, 2019
By: NDK/NNW
Job No.: 180320P4.1

Figure:
7

APPENDIX I

APPENDIX I
FIELD INVESTIGATION

Our field investigation consisted of a visual reconnaissance of the site and drilling four borings and three percolation tests borings on February 25, 2019 to a depth of about 3 to 5 feet below the existing ground surface using a hand auger. Auger refusal was encountered in all but one of the borings (B-4). Figure 2 presents the approximate locations of the borings. Our field investigation was performed under the observation of an SCST geologist who also logged the borings and obtained samples of the materials encountered. Disturbed bulk samples were obtained from the drill cuttings. The soils are classified in accordance with the Unified Soil Classification System as illustrated on Figure I-1. Logs of the borings are presented in the following Figures I-2 through I-8.

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
CON - Consolidation
COR - Corrosivity Tests
(Resistivity, pH, Chloride, Sulfate)
DS - Direct Shear
EI - Expansion Index
MAX - Maximum Density
RV - R-Value
SA - Sieve Analysis

SCST, LLC

Junipero Serra Museum ADA Improvements
San Diego, California

By:	CLF/DJM	Date:	March, 2019
Job Number:	180320P4.1	Figure:	I-1

LOG OF BORING B-1

Date Drilled: 2/25/2019
Equipment: 6-Inch Hand Auger
Elevation (ft): 175 MSL

Logged by: DJM
Reviewed by: DR
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 2	CL	**FILL (Qf)**: SANDY lean CLAY, soft to medium stiff, dark reddish brown, moist, fine to coarse grained, trace gravel.		☒					AL SA EI RV COR
3 4		**VERY OLD PARALIC DEPOSITS (Qvop)**: SILTY SANDSTONE, reddish brown, moist, strongly cemented, weathered.	CAL	☒			22.1	98.6	
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20		**REFUSAL ENCOUNTERED AT 4½ FEET ON CEMENTED HORIZON**							

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Junipero Serra Museum ADA Improvements
San Diego, California

By:	CLF/DJM	Date:	March, 2019
Job Number:	180320P4.1	Figure:	I-2

LOG OF BORING B-2

Date Drilled: 2/25/2019
Equipment: 6-Inch Hand Auger
Elevation (ft): 145 MSL

Logged by: DJM
Reviewed by: DR
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 2	SM	**FILL (Qf)**: SILTY SAND, loose to medium dense, brown, moist, fine to coarse grained, trace gravel.		☒					EI COR
3 4		**VERY OLD PARALIC DEPOSITS (Qvop)**: SILTY SANDSTONE, reddish brown, moist, strongly cemented, weathered.	CAL				6.1	111.4	
5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20		**REFUSAL ENCOUNTERED AT 3½ FEET ON CEMENTED HORIZON AND COBBLES**							

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Junipero Serra Museum ADA Improvements
San Diego, California

By: CLF/DJM
Date: March, 2019
Job Number: 180320P4.1
Figure: I-3

LOG OF BORING B-3

Date Drilled: 2/25/2019
Equipment: 6-Inch Hand Auger
Elevation (ft): 145 MSL

Logged by: DJM
Reviewed by: DR
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	**<u>FILL (Qf)</u>:** SILTY SAND, loose to medium dense, brown, moist, fine to coarse grained, few gravel, few cobbles.							
1		**<u>VERY OLD PARALIC DEPOSITS (Qvop)</u>:** SILTY SANDSTONE, light gray to yellowish brown, moist, strongly cemented, weathered.		☒					SA
2									
3			CAL				11.5	81.4	
		REFUSAL ENCOUNTERED AT 3 FEET ON CEMENTED HORIZON							
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

SCST, LLC

Junipero Serra Museum ADA Improvements
San Diego, California

By:	CLF/DJM	Date:	March, 2019
Job Number:	180320P4.1	Figure:	I-4

LOG OF BORING B-4

Date Drilled: 2/25/2019
Equipment: 6-Inch Hand Auger
Elevation (ft): 148 MSL

Logged by: DJM
Reviewed by: DR
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
	SC	**FILL (Qf):** CLAYEY SAND, loose to medium dense, brown, moist, fine to coarse grained, few gravel.		☒					
1									
2									SA RV
3		Medium dense, trace cobble, more clay.							
4									
	CL	SANDY lean CLAY, stiff, brown, moist, fine to medium grained.	CAL				18.3	92.9	
5		**BORING TERMINATED AT 5 FEET**							
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

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Junipero Serra Museum ADA Improvements
San Diego, California

By:	CLF/DJM	Date:	March, 2019
Job Number:	180320P4.1	Figure:	I-5

LOG OF PERCOLATION BORING P-1

Date Drilled: 2/25/2019
Equipment: 6-Inch Hand Auger
Elevation (ft): 160

Logged by: DJM
Reviewed by: DR
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		**<u>VERY OLD PARALIC DEPOSITS (Qvop)</u>**: SILTY SANDSTONE, reddish brown, moist, weakly cemented, weathered.							
2				☒					
3		Strongly cemented, weathered, oxidized.							
		REFUSAL ENCOUNTERED AT 3 FEET ON CEMENTED HORIZON							
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

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Junipero Serra Museum ADA Improvements
San Diego, California

By:	CLF/DJM	Date:	March, 2019
Job Number:	180320P4.1	Figure:	I-6

LOG OF PERCOLATION BORING P-2

Date Drilled: 2/25/2019
Equipment: 6-Inch Hand Auger
Elevation (ft): 169 MSL

Logged by: DJM
Reviewed by: DR
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					
	SM	**FILL (Qf):** SILTY SAND, loose to medium dense, brown, moist, fine to coarse grained, few gravel, some cobbles							
1									
2									
		VERY OLD PARALIC DEPOSITS (Qvop): SILTY SANDSTONE, reddish brown, moist, moderately cemented, weathered, oxidized.		☒					
3									
4		**REFUSAL ENCOUNTERED AT 3½ FEET ON CEMENTED HORIZON**							
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

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Junipero Serra Museum ADA Improvements
San Diego, California

By: CLF/DJM
Date: March, 2019
Job Number: 180320P4.1
Figure: I-7

LOG OF PERCOLATION BORING P-3

Date Drilled: 2/25/2019
Equipment: 6-Inch Hand Auger
Elevation (ft): 167 MSL

Logged by: DJM
Reviewed by: DR
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	**FILL (Qf)**: SILTY SAND, loose to medium dense, brown, moist, fine to coarse grained, trace gravel.							
1	SC	CLAYEY SAND, medium dense, reddish brown, moist, fine to medium grained, few gravel.							
2									
3		**VERY OLD PARALIC DEPOSITS (Qvop)**: SILTY SANDSTONE, light reddish brown, moist, moderately cemented, weathered.		☒					
4		**REFUSAL ENCOUNTERED AT 3 FEET**							
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

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Junipero Serra Museum ADA Improvements
San Diego, California

By:	CLF/DJM	Date:	March, 2019
Job Number:	180320P4.1	Figure:	I-8

APPENDIX II

APPENDIX II
LABORATORY TESTING

Laboratory tests were performed to provide geotechnical parameters for engineering analyses. The following tests were performed:

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

- **IN SITU MOISTURE AND DENSITY:** The in situ moisture content and dry unit weight were evaluated on samples collected from the borings. The test results are presenting on the boring logs in Appendix I.

- **PARTICLE-SIZE DISTRIBUTION:** The particle-size distribution was determined on selected soil samples in accordance with ASTM D6913.

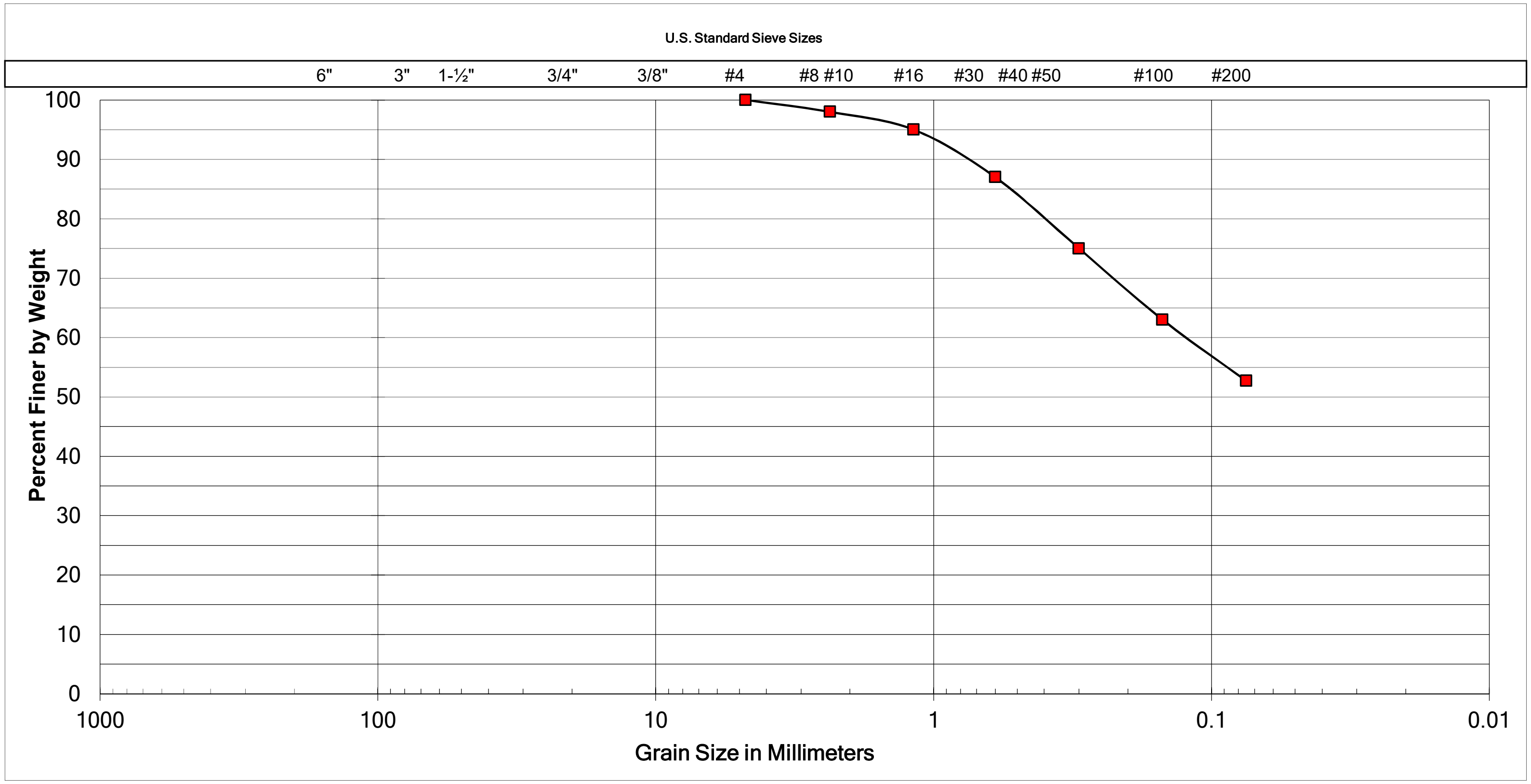
- **ATTERBERG LIMITS:** The Atterberg limits were determined on one soil sample in accordance with ASTM D4318.

- **R-VALUE:** R-value tests were performed on selected soil samples in accordance with California Test Method 301.

- **EXPANSION INDEX:** The expansion index was determined on selected soil samples in accordance with ASTM D4829.

- **CORROSIVITY**: Corrosivity tests were performed on selected soil samples. The pH and minimum resistivity were determined in accordance with California Test 643 and ASTM G51. The total chloride ion content was determined in accordance with California Test 422. The soluble sulfate content was determined in accordance with California Test 417.

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-1 at 0 to 3 Feet
SAMPLE NUMBER
38757

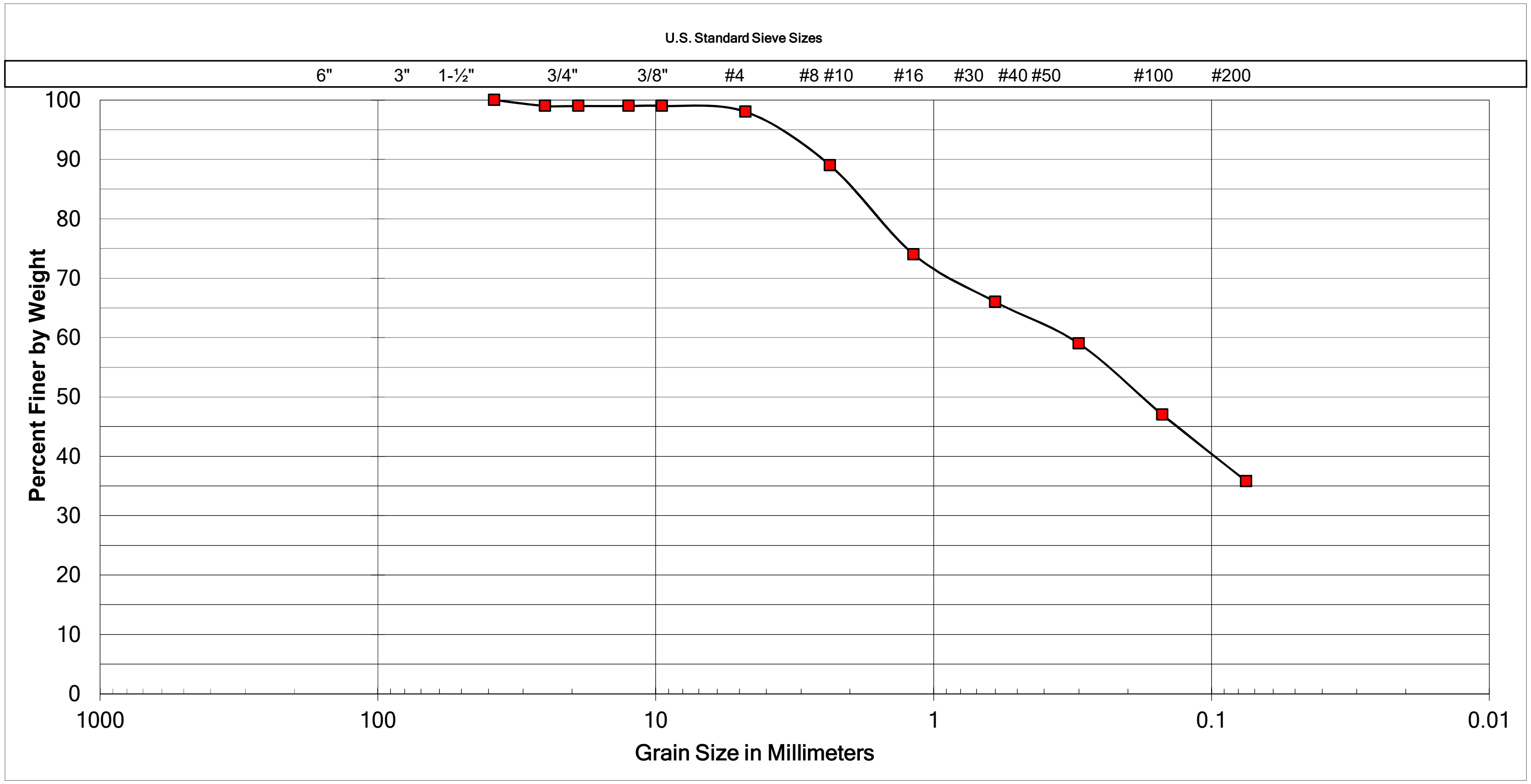
UNIFIED SOIL CLASSIFICATION:	CL
DESCRIPTION	SANDY lean CLAY

ATTERBERG LIMITS	
LIQUID LIMIT	48
PLASTIC LIMIT	19
PLASTICITY INDEX	29

SCST, LLC

Junipero Serra Museum ADA Improvements
San Diego, California

By:	CLF	Date:	March, 2019
Job Number:	180320P4.1	Figure:	II-1



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE LOCATION
B-3 at 1 to 2 ½ Feet
SAMPLE NUMBER
38761

UNIFIED SOIL CLASSIFICATION:	SM
DESCRIPTION	SILTY SAND

ATTERBERG LIMITS	
LIQUID LIMIT	-
PLASTIC LIMIT	-
PLASTICITY INDEX	-

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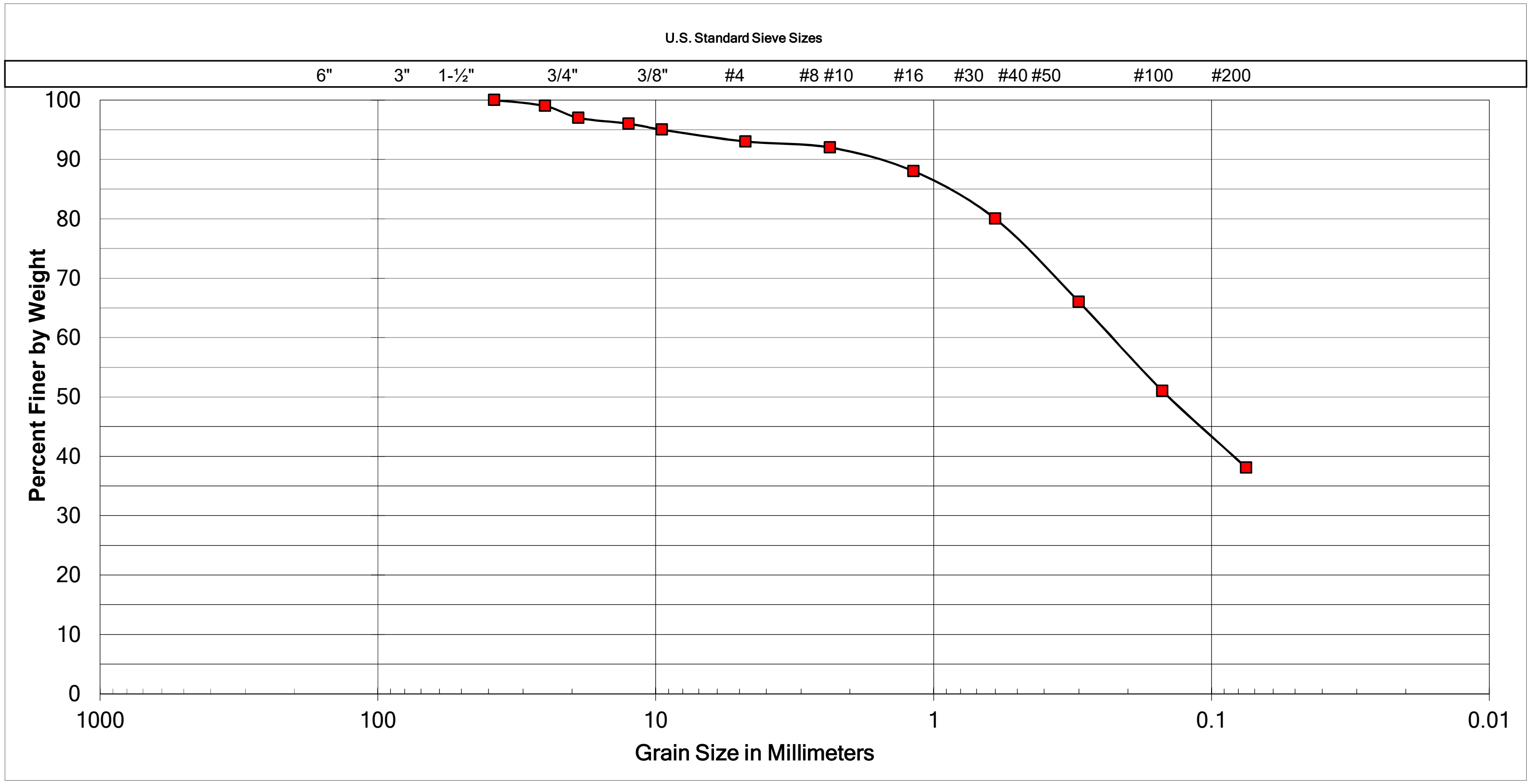
Junipero Serra Museum ADA Improvements
San Diego, California

By:	CLF	Date:	March, 2019
Job Number:	180320P4.1	Figure:	II-2



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE LOCATION
B-4 at 0 to 4½ Feet
SAMPLE NUMBER
38763

UNIFIED SOIL CLASSIFICATION:	SC
DESCRIPTION	CLAYEY SAND

ATTERBERG LIMITS	
LIQUID LIMIT	-
PLASTIC LIMIT	-
PLASTICITY INDEX	-

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Junipero Serra Museum ADA Improvements
San Diego, California

By:	CLF	Date:	March, 2019
Job Number:	180320P4.1	Figure:	II-3

EXPANSION INDEX

ASTM D2489

SAMPLE	DESCRIPTION	EI
B-1 at 0 to 3 Feet	SANDY lean CLAY	59
B-2 at 0 to 3 Feet	SILTY SAND	6

Classification of Expansive Soil [1]

EXPANSIVE INDEX	POTENTIAL EXPANSION
1-20	Very Low
21-50	Low
51-90	Medium
91-130	High
Above 130	Very High

1. ASTM - D4829

R-VALUE

CALIFORNIA TEST 301

SAMPLE	DESCRIPTION	R-VALUE
B-1 at 0 to 3 Feet	SANDY lean CLAY	<5
B-4 at 0 to 4½ Feet	CLAYEY SAND	14

RESISTIVITY, pH, SOLUBLE CHLORIDE and SOLUBLE SULFATE

pH & Resistivity (Cal 643, ASTM G51)

Soluble Chlorides (Cal 422)

Soluble Sulfate (Cal 417)

SAMPLE	RESISTIVITY (Ω-cm)	pH	CHLORIDE (%)	SULFATE (%)
B-1 at 0 to 3 Feet	206	7.28	0.109	0.384
B-2 at 0 to 3 Feet	2180	6.36	0.017	0.001

WATER-SOLUBLE SULFATE (SO_4^{2-}) EXPOSURE

Modified from ACI 318-14 Table 19.3.1.1 and Table 19.3.2.1

Water-soluble sulfate (SO_4^{2-}) in soil, percent by weight	Exposure Severity	Exposure Class	Cement Type (ASTM C150)	Max. w/cm	Min. f_c' (psi)
$SO_4^{2-} < 0.10$	Not applicable	S0	No type restriction	N/A	2,500
$0.10 \leq SO_4^{2-} < 0.20$	Moderate	S1	II	0.50	4,000
$0.20 \leq SO_4^{2-} < 2.00$	Severe	S2	V	0.45	4,500
$SO_4^{2-} > 2.00$	Very Severe	S3	V plus pozzolan or slag cement	0.45	4,500

APPENDIX III
INFILTRATION RATE TEST RESULTS

We performed borehole percolation testing at three locations (P-1 through P-3) in general conformance with the City of San Diego BMP Design Manual. Prior to starting the testing, the test hole was presoaked with clean potable water for about 24 hours. The infiltration test was performed after presoaking by placing clean potable water in the hole and measuring the drop in the water level. Figures III-1 through III-3 present the results of the testing.

Report of Borehole Percolation Testing

Storm Water Infiltration

Project Name: Junipero Serra Museum ADA Improvements
Job Number: 180320P4.1
Date Drilled: 2/25/2019
Drilling Method: 6" Hand Auger
Drilled Depth (feet): 3.0
Test Hole Diameter (inches): 6
Gravel Pack: Y
Pipe Diameter (inches): 3

Test Number: **P-1**
Tested By: DJM
Date Tested: 2/26/2019
Presoak Time: 18 HR

Trial No.	Time	Time Interval, ΔT (min)	Initial Water Height, H_o (ft)	Final Water Height, H_f (ft)	Change in Water Height, ΔH (in)	Percolation Rate (min/in)
1	9:30 10:00	0:30	1.25	1.25	0.00	0
2	10:00 10:30	0:30	1.25	1.25	0.00	0

Observed Percolation Rate:	0 min/in 0.0 in/hr
Gravel Correction Factor:	1.98
Corrected Percolation Rate:	0 min/in 0.0 in/hr
***Tested Infiltation Rate, I_t:**	**0.0 in/hr**

*Tested infiltration rate using the Porchet Method:

$$I_t = \frac{\Delta H(60r)}{\Delta T(r + 2H_{avg})}$$

ΔH = Change in water head height over the time interval [in] = 0.0

r = Test hole radius [in] = 3

ΔT = Time interval [min] = 30

H_{avg} = Average water height over time interval = $12(H_o + H_f)/2$ [in] = 15.0

SCST, LLC

Junipero Serra Museum ADA Improvements San Diego, California			
By:	CLF	Date:	March, 2019
Job No:	180320P4.1	Figure:	III-1

Report of Borehole Percolation Testing

Storm Water Infiltration

Project Name:	Junipero Serra Museum ADA Improvements	Test Number:	**P-2**
Job Number:	180320P4.1	Tested By:	DJM
Date Drilled:	2/25/2019	Date Tested:	2/26/2019
Drilling Method:	6" Hand Auger	Presoak Time:	18 HR
Drilled Depth (feet):	3.0		
Test Hole Diameter (inches):	6		
Gravel Pack:	Y		
Pipe Diameter (inches):	3		

Trial No.	Time	Time Interval, ΔT (min)	Initial Water Height, H_o (ft)	Final Water Height, H_f (ft)	Change in Water Height, ΔH (in)	Percolation Rate (min/in)
1	10:33 11:03	0:30	0.58	0.58	0.00	0
2	11:05 11:35	0:30	0.58	0.58	0.00	0
Observed Percolation Rate:					0 min/in 0.0 in/hr	
Gravel Correction Factor:					1.98	
Corrected Percolation Rate:					0 min/in 0.0 in/hr	
***Tested Infiltation Rate, I_t:**					**0.0 in/hr**	

*Tested infiltration rate using the Porchet Method:

$$I_t = \frac{\Delta H(60r)}{\Delta T(r + 2H_{avg})}$$

ΔH = Change in water head height over the time interval [in] = 0.0

r = Test hole radius [in] = 3

ΔT = Time interval [min] = 30

H_{avg} = Average water height over time interval = $12(H_o + H_f)/2$ [in] = 7.0

SCST, LLC	Junipero Serra Museum ADA Improvements San Diego, California		
By:	CLF	Date:	March, 2019
Job No:	180320P4.1	Figure:	III-2

Report of Borehole Percolation Testing

Storm Water Infiltration

Project Name: Junipero Serra Museum ADA Improvements
Job Number: 180320P4.1
Date Drilled: 2/25/2019
Drilling Method: 6" HSA
Drilled Depth (feet): 3.0
Test Hole Diameter (inches): 6
Gravel Pack: Y
Pipe Diameter (inches): 3

Test Number: **P-3**
Tested By: DJM
Date Tested: 2/26/2019
Presoak Time: 18 HR

Trial No.	Time	Time Interval, ΔT (min)	Initial Water Height, H_o (ft)	Final Water Height, H_f (ft)	Change in Water Height, ΔH (in)	Percolation Rate (min/in)
1	10:50 11:20	0:30	1.54	1.54	0.00	0
2	11:20 11:50	0:30	1.54	1.54	0.00	0

Observed Percolation Rate:	0 min/in 0.0 in/hr
Gravel Correction Factor:	1.98
Corrected Percolation Rate:	0 min/in 0.0 in/hr
***Tested Infiltation Rate, I_t:**	**0.0 in/hr**

*Tested infiltration rate using the Porchet Method:

$$I_t = \frac{\Delta H(60r)}{\Delta T(r + 2H_{avg})}$$

ΔH = Change in water head height over the time interval [in] = 0.0

r = Test hole radius [in] = 3

ΔT = Time interval [min] = 30

H_{avg} = Average water height over time interval = $12(H_o + H_f)/2$ [in] = 18.5

SCST, LLC

Junipero Serra Museum ADA Improvements
San Diego, California

By:	CLF	Date:	March, 2019
Job No:	180320P4.1	Figure:	III-3

APPENDIX IV
FORM I-8A

This appendix is the form from the City of San Diego's BMP Design Manual filled out for this project. It is used to help evaluate infiltration conditions.

Worksheet C.4-1: Categorization of Infiltration Feasibility Condition Based on Geotechnical Conditions[9]

Categorization of Infiltration Feasibility Condition based on Geotechnical Conditions	Worksheet C.4-1: Form I-8A[10]
Part 1 - Full Infiltration Feasibility Screening Criteria	
DMA(s) Being Analyzed:	Project Phase:
Junipero Serra Museum ADA Improvements	Planning
Criteria 1: Infiltration Rate Screening	
1A	Is the mapped hydrologic soil group according to the NRCS Web Soil Survey or UC Davis Soil Web Mapper Type A or B and corroborated by available site soil data[11]? ☐ Yes; the DMA may feasibly support full infiltration. Answer "Yes" to Criteria 1 Result or continue to Step 1B if the applicant elects to perform infiltration testing. ☐ No; the mapped soil types are A or B but is not corroborated by available site soil data (continue to Step 1B). ☒ No; the mapped soil types are C, D, or "urban/unclassified" and is corroborated by available site soil data. Answer "No" to Criteria 1 Result. ☐ No; the mapped soil types are C, D, or "urban/unclassified" but is not corroborated by available site soil data (continue to Step 1B).
1B	Is the reliable infiltration rate calculated using planning phase methods from Table D.3-1? ☐ Yes; Continue to Step 1C. ☐ No; Skip to Step 1D.
1C	Is the reliable infiltration rate calculated using planning phase methods from Table D.3-1 greater than 0.5 inches per hour? ☐ Yes; the DMA may feasibly support full infiltration. Answer "Yes" to Criteria 1 Result. ☐ No; full infiltration is not required. Answer "No" to Criteria 1 Result.
1D	**Infiltration Testing Method.** Is the selected infiltration testing method suitable during the design phase (see Appendix D.3)? Note: Alternative testing standards may be allowed with appropriate rationales and documentation. ☐ Yes; continue to Step 1E. ☐ No; select an appropriate infiltration testing method.

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[9] Note that it is not required to investigate each and every criterion in the worksheet, a single "no" answer in Part 1, Part 2, Part 3, or Part 4 determines a full, partial, or no infiltration condition.

[10] This form must be completed each time there is a change to the site layout that would affect the infiltration feasibility condition. Previously completed forms shall be retained to document the evolution of the site storm water design.

[11] Available data includes site-specific sampling or observation of soil types or texture classes, such as obtained from borings or test pits necessary to support other design elements.

Categorization of Infiltration Feasibility Condition based on Geotechnical Conditions	Worksheet C.4-1: Form I-8A[10]
1E	**Number of Percolation/Infiltration Tests.** Does the infiltration testing method performed satisfy the minimum number of tests specified in Table D.3-2? ☐ Yes; continue to Step 1F. ☐ No; conduct appropriate number of tests.
IF	**Factor of Safety.** Is the suitable Factor of Safety selected for full infiltration design? See guidance in D.5; Tables D.5-1 and D.5-2; and Worksheet D.5-1 (Form I-9). ☐ Yes; continue to Step 1G. ☐ No; select appropriate factor of safety.
1G	**Full Infiltration Feasibility.** Is the average measured infiltration rate divided by the Factor of Safety greater than 0.5 inches per hour? ☐ Yes; answer "Yes" to Criteria 1 Result. ☐ No; answer "No" to Criteria 1 Result.
Criteria 1 Result	Is the estimated reliable infiltration rate greater than 0.5 inches per hour within the DMA where runoff can reasonably be routed to a BMP? ☐ Yes; the DMA may feasibly support full infiltration. Continue to Criteria 2. ☒ No; full infiltration is not required. Skip to Part 1 Result.

Summarize infiltration testing methods, testing locations, replicates, and results and summarize estimates of reliable infiltration rates according to procedures outlined in D.5. Documentation should be included in project geotechnical report.

Soils mapped as D and corroborated by our 3 borehole percolation tests performed on the west and southwest areas of project. See project geotechnical report.

Categorization of Infiltration Feasibility Condition based on Geotechnical Conditions		Worksheet C.4-1: Form I-8A[10]	
Criteria 2: Geologic/Geotechnical Screening			
2A	If all questions in Step 2A are answered "Yes," continue to Step 2B. For any "No" answer in Step 2A answer "No" to Criteria 2, and submit an "Infiltration Feasibility Condition Letter" that meets the requirements in Appendix C.1.1. The geologic/geotechnical analyses listed in Appendix C.2.1 do not apply to the DMA because one of the following setbacks cannot be avoided and therefore result in the DMA being in a no infiltration condition. The setbacks must be the closest horizontal radial distance from the surface edge (at the overflow elevation) of the BMP.		
2A-1	Can the proposed full infiltration BMP(s) avoid areas with existing fill materials greater than 5 feet thick below the infiltrating surface?	☐ Yes	☐ No
2A-2	Can the proposed full infiltration BMP(s) avoid placement within 10 feet of existing underground utilities, structures, or retaining walls?	☐ Yes	☐ No
2A-3	Can the proposed full infiltration BMP(s) avoid placement within 50 feet of a natural slope (>25%) or within a distance of 1.5H from fill slopes where H is the height of the fill slope?	☐ Yes	☐ No
2B	When full infiltration is determined to be feasible, a geotechnical investigation report must be prepared that considers the relevant factors identified in Appendix C.2.1. If all questions in Step 2B are answered "Yes," then answer "Yes" to Criteria 2 Result. If there are "No" answers continue to Step 2C.		
2B-1	**Hydroconsolidation.** Analyze hydroconsolidation potential per approved ASTM standard due to a proposed full infiltration BMP. Can full infiltration BMPs be proposed within the DMA without increasing hydroconsolidation risks?	☐ Yes	☐ No
2B-2	**Expansive Soils.** Identify expansive soils (soils with an expansion index greater than 20) and the extent of such soils due to proposed full infiltration BMPs. Can full infiltration BMPs be proposed within the DMA without increasing expansive soil risks?	☐ Yes	☐ No

Categorization of Infiltration Feasibility Condition based on Geotechnical Conditions		Worksheet C.4-1: Form I-8A[10]	
2B-3	**Liquefaction**. If applicable, identify mapped liquefaction areas. Evaluate liquefaction hazards in accordance with Section 6.4.2 of the City of San Diego's Guidelines for Geotechnical Reports (2011 or most recent edition). Liquefaction hazard assessment shall take into account any increase in groundwater elevation or groundwater mounding that could occur as a result of proposed infiltration or percolation facilities. Can full infiltration BMPs be proposed within the DMA without increasing liquefaction risks?	☐ Yes	☐ No
2B-4	**Slope Stability**. If applicable, perform a slope stability analysis in accordance with the ASCE and Southern California Earthquake Center (2002) Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California to determine minimum slope setbacks for full infiltration BMPs. See the City of San Diego's Guidelines for Geotechnical Reports (2011) to determine which type of slope stability analysis is required. Can full infiltration BMPs be proposed within the DMA without increasing slope stability risks?	☐ Yes	☐ No
2B-5	**Other Geotechnical Hazards.** Identify site-specific geotechnical hazards not already mentioned (refer to Appendix C.2.1). Can full infiltration BMPs be proposed within the DMA without increasing risk of geologic or geotechnical hazards not already mentioned?	☐ Yes	☐ No
2B-6	**Setbacks.** Establish setbacks from underground utilities, structures, and/or retaining walls. Reference applicable ASTM or other recognized standard in the geotechnical report. Can full infiltration BMPs be proposed within the DMA using established setbacks from underground utilities, structures, and/or retaining walls?	☐ Yes	☐ No

Categorization of Infiltration Feasibility Condition based on Geotechnical Conditions		Worksheet C.4-1: Form I-8A[10]	
2C	**Mitigation Measures.** Propose mitigation measures for each geologic/geotechnical hazard identified in Step 2B. Provide a discussion of geologic/geotechnical hazards that would prevent full infiltration BMPs that cannot be reasonably mitigated in the geotechnical report. See Appendix C.2.1.8 for a list of typically reasonable and typically unreasonable mitigation measures. Can mitigation measures be proposed to allow for full infiltration BMPs? If the question in Step 2 is answered "Yes," then answer "Yes" to Criteria 2 Result. If the question in Step 2C is answered "No," then answer "No" to Criteria 2 Result.	☐ Yes	☐ No
Criteria 2 Result	Can infiltration greater than 0.5 inches per hour be allowed without increasing risk of geologic or geotechnical hazards that cannot be reasonably mitigated to an acceptable level?	☐ Yes	☐ No

Summarize findings and basis; provide references to related reports or exhibits.

Part 1 Result – Full Infiltration Geotechnical Screening [12]	Result
If answers to both Criteria 1 and Criteria 2 are "Yes", a full infiltration design is potentially feasible based on Geotechnical conditions only. If either answer to Criteria 1 or Criteria 2 is "No", a full infiltration design is not required.	☐ Full infiltration Condition ☒ Complete Part 2

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[12] To be completed using gathered site information and best professional judgement considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by City Engineer to substantiate findings.

Categorization of Infiltration Feasibility Condition based on Geotechnical Conditions	Worksheet C.4-1: Form I-8A[10]
Part 2 – Partial vs. No Infiltration Feasibility Screening Criteria	
DMA(s) Being Analyzed:	Project Phase:
Junipero Serra Museum ADA Improvements	Planning
Criteria 3 : Infiltration Rate Screening	
3A	**NRCS Type C, D, or “urban/unclassified”:** Is the mapped hydrologic soil group according to the NRCS Web Soil Survey or UC Davis Soil Web Mapper is Type C, D, or “urban/unclassified” and corroborated by available site soil data? ☐ Yes; the site is mapped as C soils and a reliable infiltration rate of 0.15 in/hr. is used to size partial infiltration BMPS. Answer “Yes” to Criteria 3 Result. ☐ Yes; the site is mapped as D soils or “urban/unclassified” and a reliable infiltration rate of 0.05 in/hr. is used to size partial infiltration BMPS. Answer “Yes” to Criteria 3 Result. ☒ No; infiltration testing is conducted (refer to Table D.3-1), continue to Step 3B.
3B	**Infiltration Testing Result:** Is the reliable infiltration rate (i.e. average measured infiltration rate/2) greater than 0.05 in/hr. and less than or equal to 0.5 in/hr? ☐ Yes; the site may support partial infiltration. Answer “Yes” to Criteria 3 Result. ☒ No; the reliable infiltration rate (i.e. average measured rate/2) is less than 0.05 in/hr., partial infiltration is not required. Answer “No” to Criteria 3 Result.
Criteria 3 Result	Is the estimated reliable infiltration rate (i.e., average measured infiltration rate/2) greater than or equal to 0.05 inches/hour and less than or equal to 0.5 inches/hour at any location within each DMA where runoff can reasonably be routed to a BMP? ☐ Yes; Continue to Criteria 4. ☒ No: Skip to Part 2 Result.
Summarize infiltration testing and/or mapping results (i.e. soil maps and series description used for infiltration rate).	

Categorization of Infiltration Feasibility Condition based on Geotechnical Conditions		Worksheet C.4-1: Form I-8A[10]	
Criteria 4: Geologic/Geotechnical Screening			
4A	If all questions in Step 4A are answered "Yes," continue to Step 2B. For any "No" answer in Step 4A answer "No" to Criteria 4 Result, and submit an "Infiltration Feasibility Condition Letter" that meets the requirements in Appendix C.1.1. The geologic/geotechnical analyses listed in Appendix C.2.1 do not apply to the DMA because one of the following setbacks cannot be avoided and therefore result in the DMA being in a no infiltration condition. The setbacks must be the closest horizontal radial distance from the surface edge (at the overflow elevation) of the BMP.		
4A-1	Can the proposed partial infiltration BMP(s) avoid areas with existing fill materials greater than 5 feet thick?	☐ Yes	☐ No
4A-2	Can the proposed partial infiltration BMP(s) avoid placement within 10 feet of existing underground utilities, structures, or retaining walls?	☐ Yes	☐ No
4A-3	Can the proposed partial infiltration BMP(s) avoid placement within 50 feet of a natural slope (>25%) or within a distance of 1.5H from fill slopes where H is the height of the fill slope?	☐ Yes	☐ No
4B	When full infiltration is determined to be feasible, a geotechnical investigation report must be prepared that considers the relevant factors identified in Appendix C.2.1 If all questions in Step 4B are answered "Yes," then answer "Yes" to Criteria 4 Result. If there are any "No" answers continue to Step 4C.		
4B-1	**Hydroconsolidation.** Analyze hydroconsolidation potential per approved ASTM standard due to a proposed full infiltration BMP. Can partial infiltration BMPs be proposed within the DMA without increasing hydroconsolidation risks?	☐ Yes	☐ No
4B-2	**Expansive Soils.** Identify expansive soils (soils with an expansion index greater than 20) and the extent of such soils due to proposed full infiltration BMPs. Can partial infiltration BMPs be proposed within the DMA without increasing expansive soil risks?	☐ Yes	☐ No

Categorization of Infiltration Feasibility Condition based on Geotechnical Conditions		Worksheet C.4-1: Form I-8A[10]	
4B-3	**Liquefaction**. If applicable, identify mapped liquefaction areas. Evaluate liquefaction hazards in accordance with Section 6.4.2 of the City of San Diego's Guidelines for Geotechnical Reports (2011). Liquefaction hazard assessment shall take into account any increase in groundwater elevation or groundwater mounding that could occur as a result of proposed infiltration or percolation facilities. Can partial infiltration BMPs be proposed within the DMA without increasing liquefaction risks?	☐ Yes	☐ No
4B-4	**Slope Stability**. If applicable, perform a slope stability analysis in accordance with the ASCE and Southern California Earthquake Center (2002) Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Landslide Hazards in California to determine minimum slope setbacks for full infiltration BMPs. See the City of San Diego's Guidelines for Geotechnical Reports (2011) to determine which type of slope stability analysis is required. Can partial infiltration BMPs be proposed within the DMA without increasing slope stability risks?	☐ Yes	☐ No
4B-5	**Other Geotechnical Hazards.** Identify site-specific geotechnical hazards not already mentioned (refer to Appendix C.2.1). Can partial infiltration BMPs be proposed within the DMA without increasing risk of geologic or geotechnical hazards not already mentioned?	☐ Yes	☐ No
4B-6	**Setbacks.** Establish setbacks from underground utilities, structures, and/or retaining walls. Reference applicable ASTM or other recognized standard in the geotechnical report. Can partial infiltration BMPs be proposed within the DMA using recommended setbacks from underground utilities, structures, and/or retaining walls?	☐ Yes	☐ No
4C	**Mitigation Measures.** Propose mitigation measures for each geologic/geotechnical hazard identified in Step 4B. Provide a discussion on geologic/geotechnical hazards that would prevent partial infiltration BMPs that cannot be reasonably mitigated in the geotechnical report. See Appendix C.2.1.8 for a list of typically reasonable and typically unreasonable mitigation measures. Can mitigation measures be proposed to allow for partial infiltration BMPs? If the question in Step 4C is answered "Yes," then answer "Yes" to Criteria 4 Result. If the question in Step 4C is answered "No," then answer "No" to Criteria 4 Result.	☐ Yes	☐ No

Categorization of Infiltration Feasibility Condition based on Geotechnical Conditions		Worksheet C.4-1: Form I-8A[10]	
Criteria 4 Result	Can infiltration of greater than or equal to 0.05 inches/hour and less than or equal to 0.5 inches/hour be allowed without increasing the risk of geologic or geotechnical hazards that cannot be reasonably mitigated to an acceptable level?	☐ Yes	☐ No
Summarize findings and basis; provide references to related reports or exhibits.			

Part 2 – Partial Infiltration Geotechnical Screening Result[13]	Result
If answers to both Criteria 3 and Criteria 4 are "Yes", a partial infiltration design is potentially feasible based on geotechnical conditions only. If answers to either Criteria 3 or Criteria 4 is "No", then infiltration of any volume is considered to be infeasible within the site.	☐ Partial Infiltration Condition ☒ No Infiltration Condition

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[13] To be completed using gathered site information and best professional judgement considering the definition of MEP in the MS4 Permit. Additional testing and/or studies may be required by City Engineer to substantiate findings.