GEOTECHNICAL INVESTIGATION

POINT LOMA WASTEWATER TREATMENT PLANT SITE IMPROVEMENTS

San Diego, California

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Subject: Geotechnical Investigation
Point Loma Wastewater Treatment Plant Site Improvements
San Diego, California

Dear Ms. Masutani:

Atlas (formerly 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 revised proposal dated December 18, 2019. 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,

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1. INTRODUCTION

This report presents the results of the geotechnical investigation Atlas (formerly SCST) performed for the subject project. We understand that the project includes the design and construction of storm water site improvements. The purpose of our work is to provide conclusions and recommendations regarding the geotechnical aspects of the project. Figure 1 presents a site vicinity map.

2. SCOPE OF WORK

We conducted this investigation in general conformance with the scope of work presented in our Proposal No. 19-0830R2 dated December 18, 2019. Our scope of work consisted of the following.

2.1 Subsurface Exploration

We explored the subsurface conditions by drilling five borings (B-1 through B-4 and B-6) to depths between about 4 and 20 feet below the existing ground surface using a truck-mounted drill rig equipped with a hollow stem auger. We were not able to drill one of the planned borings (B-5) due to existing utilities. Figure 2 shows the approximate locations of the borings. Two Atlas engineers logged the borings and collected samples of the materials encountered for laboratory testing. The 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

Selected samples obtained from the borings were tested to evaluate pertinent soil classification and engineering properties and enable development of geotechnical conclusions and recommendations. The laboratory tests consisted of in situ moisture and density, particle-size distribution, Atterberg limits, corrosivity, expansion index and direct shear. The results of the laboratory tests and brief explanations of the test procedures are presented in Appendix II.

2.3 Analysis and Report

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

- Subsurface conditions beneath the site
- Groundwater levels and the necessity for dewatering
- Potential geologic hazards
- Criteria for seismic design in accordance with the 2019 California Building Code (CBC)
- Site preparation and grading
- Foundation alternatives and geotechnical engineering criteria for foundation design
- Estimated foundation settlements
- Support for concrete slabs-on-grade
- Excavation characteristics of the subsurface materials encountered

- Backfill recommendations and the suitability of excavated materials for use as backfill
- Allowable temporary excavation side slope and shoring recommendations
- Lateral earth pressures and resistance to lateral loads
- Support for the pipeline
- Potential pipeline settlements
- Appropriate types of bedding and backfill materials as well as placement and compaction procedures
- Suitability of excavated materials for use as backfill
- Soil modulus E' for pipeline design
- Corrosivity

3. SITE DESCRIPTION

The planned project is located at the Point Loma Wastewater Treatment Plant, at 1902 Gatchell Road, on Point Loma San Diego, California. The site is generally bound by the Pacific Ocean to the west, a hillside to the east, military property to the north and Cabrillo National Monument to the south. Existing improvements consist of pavements, hardscape, pipelines and the facility buildings. Site elevations range from about 18 feet on the west side of the site to about 95 feet MSL on the south and east portions of the site.

4. PROPOSED DEVELOPMENT

Based on our review of the provided schematic site plans and discussions with the team, we understand the project will consist of the design and construction of storm water site improvements including pipelines, force mains, various drains, catch basins, and two pump stations.

5. GEOLOGY AND SUBSURFACE CONDITIONS

The site is located within the Peninsular Ranges Geomorphic Province of California, which stretches from the Los Angeles basin to the tip of Baja California. This province is characterized as a series of northwest trending mountain ranges separated by subparallel fault zones and a coastal plain of subdued landforms. The mountain ranges are underlain primarily by Mesozoic metamorphic rocks that were intruded by plutonic rocks of the southern California batholith, while the coastal plain is underlain by subsequently deposited marine and non-marine sedimentary formations. The site is located in the coastal plain and is underlain by fill, very old paralic deposits and Cabrillo Formation. Descriptions of the materials encountered are presented below. Figure 3 presents a geologic cross-section. Figure 4 presents the regional geology in the vicinity of the site.

- **Fill (Qf):** Fill was encountered beneath the existing pavement sections in borings B-1 through B-4, and at the ground surface in boring B-6. As encountered, the fill generally consisted of loose to very dense silty and clayey sand and hard sandy clay with varying amounts of gravel and cobbles. Soil cement was encountered in boring B-2 from depths between about 1 foot and 6 feet below the existing ground surface. Sand cement slurry was encountered in boring B-4 from about 1½ to 4 feet below the ground surface.

- **Very Old Paralic Deposits (Qvop):** Very old paralic deposits were encountered underlying the fill in boring B-2 and consisted of weakly to strongly cemented clayey and silty sandstone.
- **Cabrillo Formation (Kcs):** Cabrillo Formation was encountered beneath the very old paralic deposits in boring B-2, and beneath the fill in boring B-3. As encountered, the Cabrillo Formation generally consisted of strongly indurated claystone and moderately cemented silty sandstone. Interbedded sandstone and claystone layers were observed.
- **Groundwater:** Groundwater was not encountered in the borings. However, groundwater levels may fluctuate in the future due to tides, 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

The site is not located within an area previously known for significant geologic hazards. Evidence of active faulting, liquefiable soils, or collapsible soils was also not observed during our investigation. A discussion of existing and potential geologic hazards follows.

6.1 Faulting and Surface Rupture

The closest known active fault is the Newport-Inglewood-Rose Canyon fault zone, located about 2½ miles east of the site. The closest mapped fault is the potentially active Point Loma Fault, which trends through the site. The Point Loma Fault is not known to have offset Holocene sediments, indicating it is not active. The State of California does not consider this fault to be active, and as such, an Alquist-Priolo Earthquake Fault Zone has not been established. In our opinion and according to the guidelines of the State of California, the fault is not a potential source of seismic shaking or ground rupture. No active faults are known to underlie or project toward the site; therefore, the probability of fault rupture is low.

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. Based on the subsurface conditions encountered during our investigation, the area near the proposed northern pump station (in the vicinity of boring B-4) may be classified as a Site Class C. The area near the proposed southern pump station (in the vicinity of boring B-6) may be classified as a Site Class D. The mapped site coefficients and maximum considered earthquake (MCE_R) spectral response acceleration parameters in accordance with the ASCE 7-16 (SEAOC, 2020) are presented in Tables 1 and 2.

Table 1 – ASCE 7-16 Mapped Site Coefficients, Northern Pump Station

Site Coordinates	
Latitude: 32.67854°	Longitude: -117.24723°
Site Coefficients and Spectral Response Acceleration Parameters	**Value**
Site Class	C
Site Coefficients, F_a	1.200
Site Coefficients, F_v	1.500
Mapped Spectral Response Acceleration at Short Period, S_s	1.231g
Mapped Spectral Response Acceleration at 1-Second Period, S_1	0.424g
Mapped Design Spectral Acceleration at Short Period, S_{DS}	0.985g
Design Spectral Acceleration at 1-Second Period, S_{D1}	0.424g
Site Peak Ground Acceleration, PGA_M	0.655g

Table 2 – ASCE 7-16 Mapped Site Coefficients, Southern Pump Station

Site Coordinates	
Latitude: 32.67732°	Longitude: -117.24647°
Site Coefficients and Spectral Response Acceleration Parameters	**Value**
Site Class	D
Site Coefficients, F_a	1.006
Site Coefficients, F_v	*See Note 1
Mapped Spectral Response Acceleration at Short Period, S_s	1.236g
Mapped Spectral Response Acceleration at 1-Second Period, S_1	0.425g
Mapped Design Spectral Acceleration at Short Period, S_{DS}	0.829g
Design Spectral Acceleration at 1-Second Period, S_{D1}	*See Note 1
Site Peak Ground Acceleration, PGA_M	0.604g

*** Note 1 – ASCE 7-16, Section 11.4.8. A site-specific ground motion analysis is required to be performed in accordance with Section 21 unless exempted in accordance with Section 20.3.1**

For a Site Class D, a site-specific ground motion analysis is required to be performed in accordance with the requirements of ASCE 7-16. However, we assume that a site-specific ground motion analysis is likely not needed for the proposed southern pump station at this time. If a site-specific analysis is required, a report addendum can be issued at a later date.

6.3 City of San Diego Seismic Safety Study

Figure 5 shows the site location on the City of San Diego Seismic Safety Study Map (City of San Diego, 2008). The project site is located in Geologic Hazard Categories 12, 44, and 53. Geologic Hazard Category 12 is a fault zone defined as potentially active, inactive, presumed inactive, or activity unknown. Geologic Hazard Category 44 is a coastal bluff defined as moderately stable, mostly stable formations, and local high erosion. Geologic Hazard Category 53 is defined as level or sloping terrain with unfavorable geologic structure and a low to moderate risk. Unfavorable geologic structure was not observed during our investigation. In our opinion, the geologic risks for the site are moderate to high.

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 behave like liquid, resulting in large total and differential ground surface settlements and possible lateral spreading during an earthquake. Due to the relatively dense nature of the materials beneath the site, the potential for liquefaction and dynamic settlement to occur is considered low.

6.5 Landslides

Evidence of landslides or slope instabilities was not observed during our investigation. The potential for landslides or slope instabilities to occur at the site is considered low. The site is not mapped within a known landslide area (California Department of Conservation, 2015).

6.6 Slope Stability Analysis

The slope stability analyses were performed using SLIDE v. 6.0, a product of Rocscience, Inc. (2016). SLIDE is a two-dimensional, limit equilibrium slope stability program that evaluates the factor of safety of soil and rock slopes against both circular and non-circular failure surfaces. The Spencer's method was used. This method of analysis provides the factor of safety based on both force and moment equilibrium. Bishop's simplified method and Janbu's simplified method were also evaluated to compare and consider the results. The analyses were performed to examine both the global and local stability of the slope under static and pseudostatic conditions.

Traffic loads from existing access roads along the slope were represented as a uniform surcharge load of 250 pounds per square foot (psf) in general accordance with 2014 AASHTO LRFD. Additionally, a 100 psf distributed live load was assumed for the existing south throttling facility. The unit weight of water was also adjusted to 64 pounds per cubic foot (pcf) to account for the presence of salt water.

Three different materials were defined to represent the subsurface conditions. These materials include Cabrillo formation, very old paralic deposits and existing undocumented fill. The properties of the materials selected for the analyses are listed in Table 3.

Table 3 – Strength Parameters for Slope Stability Analyses

Material Name	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (deg)
Undocumented Fill (Qf)	120	100	30
Very Old Paralic Deposits (Qvop)	127	470	37
Cabrillo Formation (Kcs)	130	670	35

The shear strength parameters were derived from laboratory test results and our experience with similar materials on previous projects in the site area.

Analyses of the existing conditions were performed on Cross-Section A-A' (Figure 3). The results are presented in Appendix III and summarized in Table 4.

Table 4 – Slope Stability Analyses Results

Cross Section	Factor of Safety	
	Static	Pseudostatic
A-A' (Global)	2.158	1.533
A-A' (Local 1)	2.166	1.650
A-A' (Local 2)	1.602	1.199

Factors of safety of 1.5 (static) and 1.15 (pseudostatic) are considered adequate in standard geotechnical practice.

6.7 Flooding, Tsunamis, and Seiches

It should be noted that the tsunami inundation line runs north-south along the west side of the site (CAL EMA, 2009). However, the site is not located within a mapped tsunami inundation area on the State of California Tsunami Inundation Maps (Cal EMA, 2009); therefore, damage due to tsunami inundation 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 any lakes or confined bodies of water; therefore, the potential for a seiche to affect the site is considered low. The site is mapped within an area of minimal flood hazard (FEMA, 2019).

6.8 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.

6.9 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 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. In our opinion, the site conditions are suitable to construct the proposed improvements. The main geotechnical considerations affecting the proposed construction are the presence of potentially compressible soils, cut/fill transitions, and difficult excavations in soil cement, very old paralic deposits and Cabrillo Formation. We understand that project plans are not available at this time, and the locations and depths of the proposed pump stations have not been finalized. We anticipate that the proposed pump stations may be supported on shallow spread footings with bottom levels bearing either entirely on compacted fill, or entirely on formation (very old paralic deposits or Cabrillo Formation). Remedial grading is recommended to reduce the potential for distress to the proposed improvements. Remedial grading recommendations are provided herein. The recommendations presented herein may need to be updated once final plans are developed.

8. RECOMMENDATIONS

The remainder of this report presents recommendations regarding earthwork construction as well as geotechnical recommendations for the design of the proposed structure and improvements. These recommendations are based on empirical and analytical methods typical of the standard of practice in southern California. If these recommendations appear not to address a specific feature of the project, please contact our office for additions or revisions to the recommendations.

8.1 Earthwork

Earthwork is anticipated to include site preparation, remedial grading, excavations for foundations, temporary excavations for underground utilities, and placement and compaction of fill and backfill. Grading and earthwork should be conducted in accordance with the CBC and with the recommendations of this report. The following recommendations are provided regarding specific aspects of the proposed earthwork construction. These recommendations should be considered subject to revision based on field conditions observed by the geotechnical consultant during construction.

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 – Pump Station Pads

Beneath the proposed pump station pads, we recommend over-excavating a minimum of 3 feet below planned subgrade elevation, or 3 feet below the proposed footing bottoms, whichever is deeper. The removal and recompaction should extend at least 5 feet outside the pump station footprint. At Atlas representative should observe the conditions exposed in the bottom of excavations to assess if additional excavation is recommended.

Additionally, the proposed pump stations should not be underlain by cut/fill transitions or transitions from shallow fill to deep fill. Where such transitions are encountered, the formational materials should be over-excavated and replaced with compacted fill to provide a relatively uniform thickness of compacted fill beneath the entire structure and reduce the potential for differential settlement. The over-excavation depth should be at least 3 feet below the planned finished pad elevation, at least 2 feet below the deepest planned footing bottom elevation, or to a depth of H/2, whichever is deeper, where H is the greatest depth of fill beneath the structure. Horizontally, the over-excavation should extend at least 5 feet outside the planned footing perimeter or up to existing improvements, whichever is less. Where practical, the bottom of excavations should be sloped toward the fill portion of the site and away from its center. Alternatively, individual pump stations can be supported on spread footings with bottoms levels bearing entirely on formational materials or on 2-sack sand/cement slurry extending down to formational materials.

8.1.3 Expansive Soil

The on-site soils tested have expansion indexes of 19 and 34, classified as very low to low expansion potential. To reduce the potential for expansive heave, the top 2 feet of material beneath footings and slabs-on-grade should have an expansion index (EI) of 50 or less determined in accordance with ASTM D4829. Horizontally, the soils having an EI of 50 or less should extend at least 2 feet outside the planned improvement or up to existing improvements, whichever is less. Based on our laboratory test results, we expect that most of the on-site silty sand, clayey sand, and clayey gravel is expected to meet the expansion index criteria. The on-site sandy clay is not expected to meet the expansion index criteria. Import material may be needed.

8.1.4 Compacted Fill

The material exposed in the bottom of excavations should be scarified to a depth of 6 inches, moisture conditioned to near optimum moisture content, and compacted to at least 90% relative compaction. Where gravel is provided for the stabilization of the bottom of excavation, a non-woven filter fabric should be placed between the gravel and overlying 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 evaluated in accordance with ASTM D1557. The top 12 inches of subgrade beneath vehicular pavements should be compacted to at least 95% relative compaction.

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 Atlas prior to transport to the site to evaluate 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 the soil cement fill, slurry, very old paralic deposits and Cabrillo Formation. Excavations may generate oversized material that will require extra effort to crush or haul off site.

8.1.7 Oversized Material

Excavations have the potential to 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, landscape material, or disposed of off site.

8.1.8 Temporary Excavations and Shoring

Temporary excavations will be required for open cut and cover trenching. 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. 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 trench.

Excavated materials should not be stockpiled behind temporary excavations within a distance equal to the depth of the excavation. Atlas 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 the slopes to prevent runoff water from entering the excavation and eroding the slope faces.

Slopes steeper than those described above will require shoring. Soldier piles and lagging, sheet piles, 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 adjacent to the pit or trench could be greater where trench boxes are used compared to other methods of shoring.

For design of cantilevered shoring with level backfill, the active earth pressure can be taken as equivalent to a fluid weighing 40 pcf. An additional 25 pcf should be added for shoring with 2:1 sloping ground or braced shoring. 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.

8.1.9 Groundwater Seepage

Groundwater seepage may occur locally and should be anticipated in excavations.

8.1.10 Slopes

Long-term 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 structures should be graded so that surface water flows rapidly away from the structures without ponding. In general, we recommend that the ground adjacent to the structures 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

Atlas 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

The foundation recommendations provided herein are considered generally consistent with methods typically used in southern California. Other alternatives may be available. Our recommendations are only minimum criteria based on geotechnical factors and should not be considered a structural design, or to preclude more restrictive criteria of governing agencies or by the structural engineer. The design of the foundation system should be performed by the project structural engineer, incorporating the geotechnical parameters described herein and the requirements of applicable building codes.

We understand that project plans are not available at this time, and the locations and depths of the proposed pump stations have not been finalized. However, we anticipate that the proposed pump stations may be supported on shallow spread footings with bottom levels bearing either entirely on compacted fill, or entirely on formation (very old paralic deposits or Cabrillo Formation). If the foundations are to bear entirely on formation, and isolated areas of fill exist below footings, concrete or a 2-sack sand/cement slurry can be placed between the formation and design bottom of footing elevation.

8.2.1 Spread Footings

Footings should extend at least 18 inches below lowest adjacent finished grade. A minimum width of 12 inches is recommended for continuous footings and 24 inches for isolated footings. An allowable bearing capacity of 2,500 psf can be used for spread footings supported on granular compacted fill. An allowable bearing capacity of 3,500 psf can be used for spread footings supported on formation (very old paralic deposits or Cabrillo Formation). 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 4,000 psf on compacted fill or 6,000 psf on formation. The bearing value can be increased by ⅓ when considering the total loads, including wind or seismic forces. 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.

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. An allowable passive pressure of 350 psf per foot of depth below the ground surface can be used for level ground conditions. The allowable passive pressure should be reduced for sloping ground conditions. The passive pressure can be increased by ⅓ when considering the total 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 - Compacted Fill or Old Paralic Deposits

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 ¾ inch over a distance of 40 feet. Settlements should be completed shortly after structural loads are applied.

8.2.3 Settlement Characteristics - Undocumented Fill

If the proposed pump stations are planned to be constructed in areas with relatively deep undocumented fill, Atlas should be notified so that the estimated total and differential foundation settlements may be quantified.

8.2.4 Foundation Plan Review

Atlas 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.

8.2.5 Foundation Excavation Observations

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

8.3 Conventional Retaining Walls

Conventional retaining walls can be supported on spread footings. The recommendations for spread footings provided in the foundation section of this report are also applicable to conventional retaining walls.

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 wall with level backfill can be taken as equivalent to the pressure of a fluid weighing 60 pcf. These values assume a granular and drained backfill condition. Higher lateral earth pressures would apply if walls retain clay soils. An additional 25 pcf should be added to these values for walls with 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, Atlas 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 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 waterproofing specifications and details. Figure 6 presents typical conventional retaining wall backdrain details.

If required, the seismic earth pressure can be taken as equivalent to the pressure of a fluid weighing 28 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.

Wall backfill should consist of granular, free-draining material having an expansion index of 20 or less. 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. We anticipate that the on-site soils will not be suitable for wall backfill. 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, any utilities supported on backfill should be designed to tolerate differential settlement.

8.4 Pipelines

8.4.1 Pipeline Support

It is anticipated that some of the materials along the pipeline alignment will not provide adequate support for the pipe, as loose, soft, and otherwise unsuitable materials should be anticipated. Unsuitable materials encountered near trench bottom levels, as evaluated during construction by the engineer, should be excavated 1 to 3 feet as evaluated by the geotechnical consultant and replaced as compacted fill or with crushed gravel. Unsuitable materials should be removed from the full width of the trench. The bottoms of the excavations should be observed by the geotechnical consultant prior to placement of pipe bedding. The use of a stabilizing fabric such as Mirafi® HP 570 can also be used to stabilize the bottom of the excavations, if needed.

8.4.2 Modulus of Soil Reaction

A modulus of soil reaction (E') of 1,400 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.

8.4.3 Thrust Blocks

For level ground conditions, a passive earth pressure of 330 psf per foot of depth below the lowest adjacent final grade can be used to compute allowable thrust block resistance. A value of 140 psf per foot should be used below groundwater level, if encountered.

8.4.4 Pipe Bedding

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 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.

8.4.5 Trench Backfill

Excavated material free of organic debris and rocks greater than 6 inches in largest dimension are generally expected to be suitable for use as trench backfill. Imported material should not contain rocks greater than 6 inches in largest dimension or organic debris. Imported material should have an expansion index of 20 or less. Atlas should observe and, if appropriate, test proposed imported materials before they are delivered to the site. 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. All references to optimum moisture content and relative compaction in this report are based on ASTM D1557 test method. The upper 12 inches of soil beneath subgrade for pavements should be compacted to at least 95% relative compaction. We recommend that the soils in the top 24 inches below hardscape have an expansion index of 20 or less. Atlas should observe and, if appropriate, test the soils to be used within this backfill zone.

8.5 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.

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. Atlas should be present during grading and construction to verify the consistency of subsurface conditions across the site with the areas explored during our subsurface evaluation. If the conditions encountered during construction differ from those anticipated based on the subsurface exploration program, the presence of Atlas during construction will enable an evaluation of the exposed conditions. Subsequently, modifications of the recommendations in this report or development of additional recommendations will be provided upon request and in a timely manner.

10. CLOSURE

Atlas 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 project 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

American Concrete Institute (ACI) (2018), Building Code Requirements for Structural Concrete (ACI 318-19) and Commentary, June.

California Emergency Management Agency, California Geological Survey, University of Southern California (Cal EMA) (2009), Tsunami Inundation Map for Emergency Planning, Point Loma Quadrangle: dated June 1.

California Department of Conservation (2015), Landslide Inventory (Beta), accessed September https://maps.conservation.ca.gov/cgs/lsi/.

City of San Diego (2008), Seismic Safety Study, Geologic Hazards and Faults, Grid Tile: 12, dated April 3.

FEMA (2019), Flood Insurance Rate Maps, National Flood Hazard Layer FIRMette, Map No. 06073C1886H: dated December 20.

International Code Council (2018), 2019 California Building Code, Based on the 2018 International Building Code, Effective Date: January 1, 2020.

Jennings, C.W. and Bryant, W.A. (2010), Fault Activity Map of California, California Geologic Survey, Geologic Data Map No. 6.

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

Public Works Standards, Inc. (2018), “Greenbook” Standard Specifications for Public Works Construction, 2018 Edition.

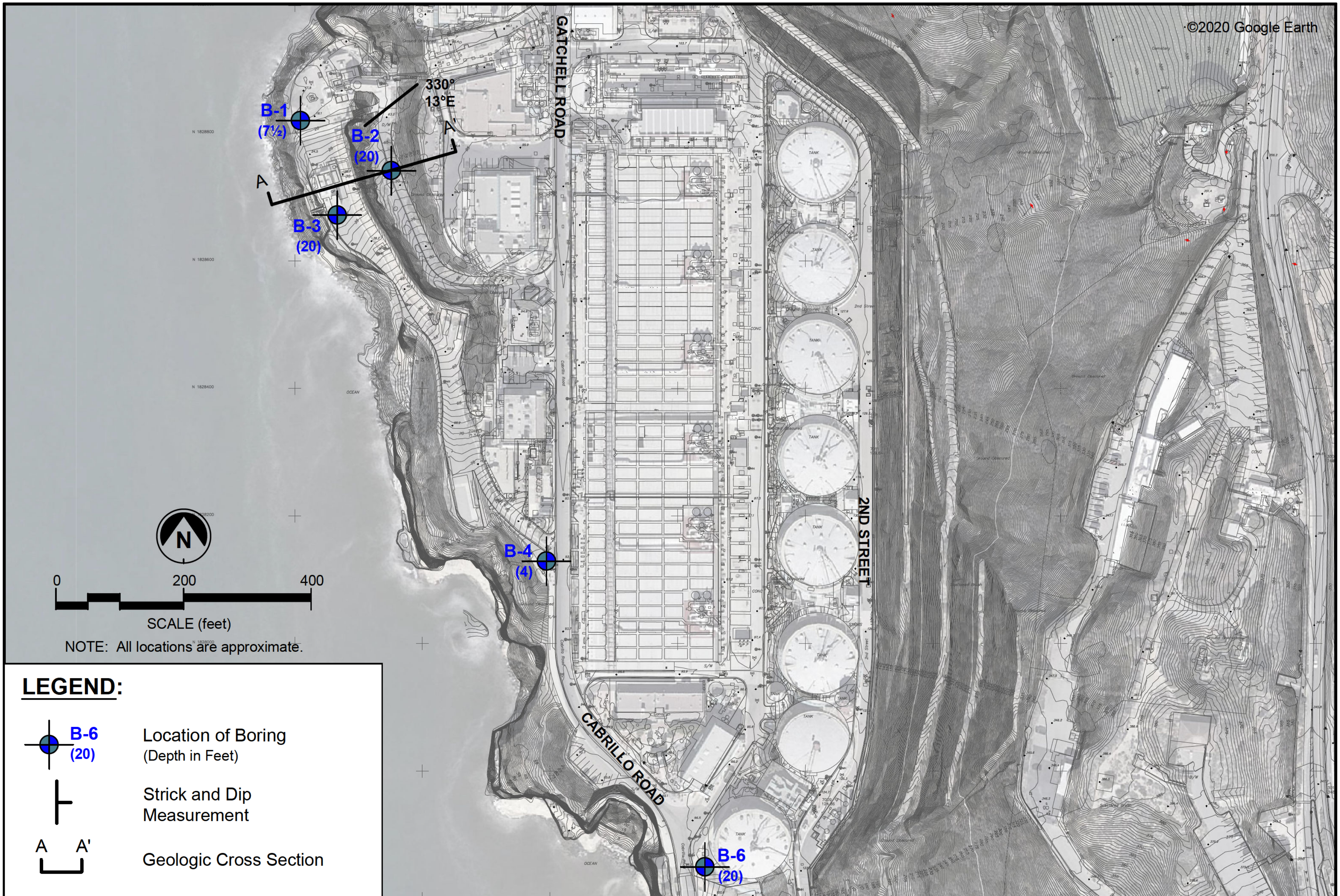
Tan, S.S., Giffen, D.G., 1995, Landslide Hazards in the Southern Part of the San Diego Metropolitan Area, San Diego County, California, Point Loma Quadrangle, DMG Open-File Report 95-03, Map No. 33: Scale 1:24,000.

ATLAS

SITE VICINITY MAP
Point Loma Wastewater Treatment Plant
Site Improvements
San Diego, California

Date:	September, 2020
By:	ACF
Job No.:	190329P4.3-1

Figure:
1

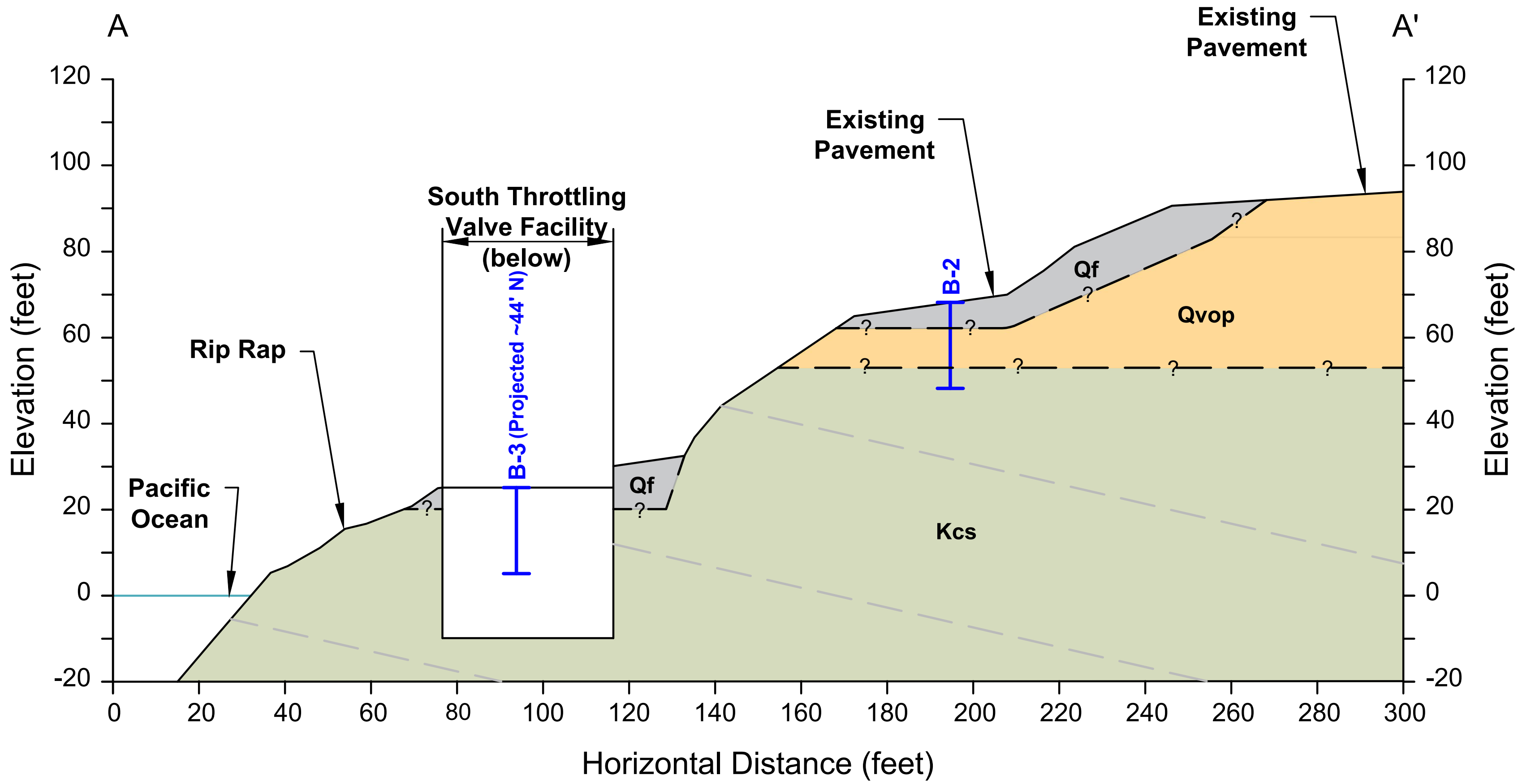


ATLAS

SUBSURFACE EXPLORATION MAP
Point Loma Wastewater Treatment Plant
Site Improvements
San Diego, California

Date:	September, 2020
By:	ACF
Job No.:	190329P4.3-1

Figure:
2



LEGEND:

B-3 Location of Boring

Attitude of measured geologic units

Qf Fill

Qvop Very old paralic deposits

Kcs Cabrillo Formation

—?— Geologic Contact, Queried Where Uncertain

0 40 80

SCALE (feet)

NOTE: All locations and depths are approximate.

ATLAS

GEOLOGIC CROSS-SECTION A-A'

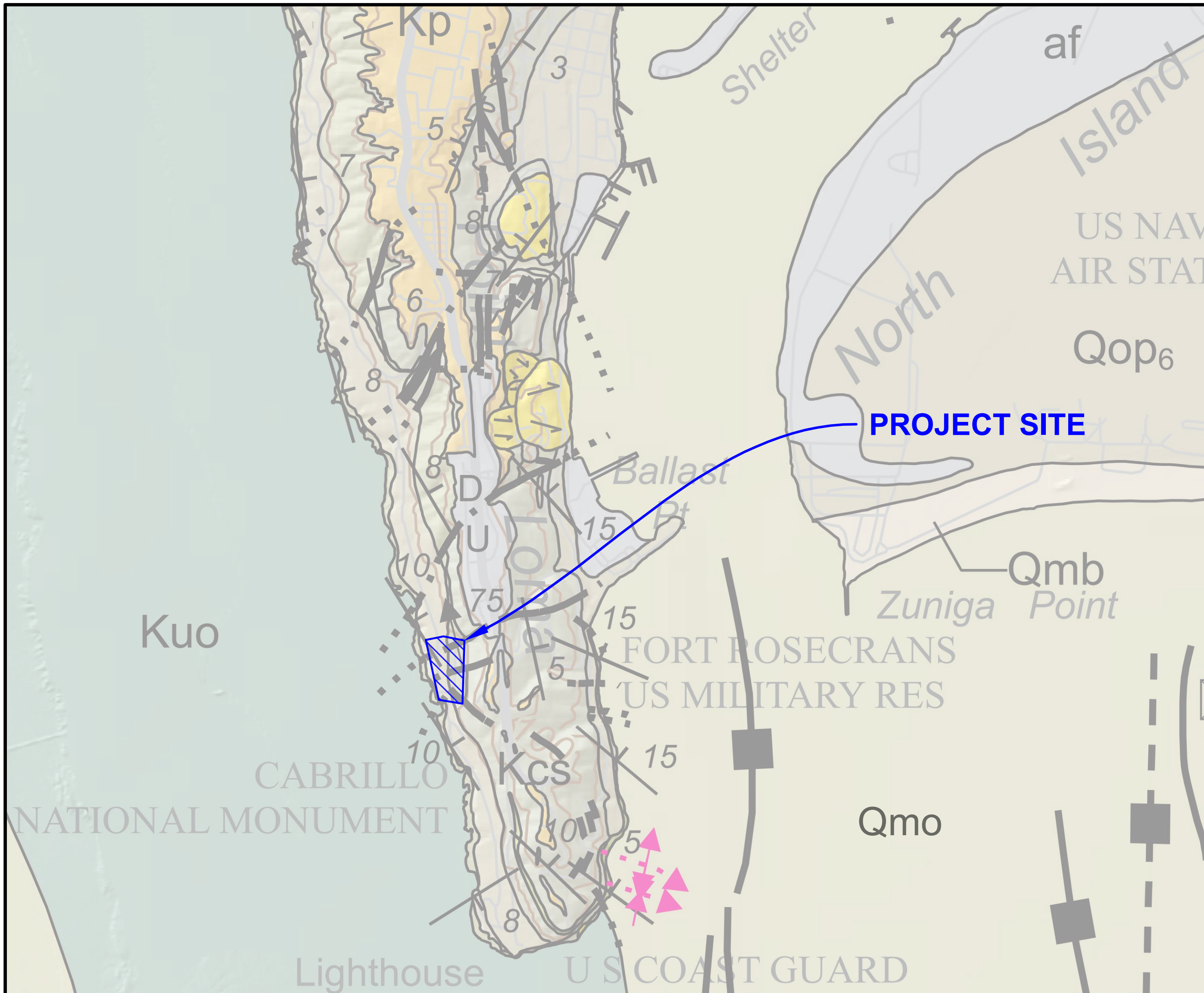
Point Loma Wastewater Treatment Plant

Site Improvements

San Diego, California

Date:	September, 2020
By:	ACF
Job No.:	190329P4.3-1

Figure: 3



EXPLANATION:

af	Artificial fill (late Holocene)
Qmb	Marine beach deposits
Qmo	Undivided marine deposits in offshore region
Qop_6	Old paralic deposits, undivided (late to middle Pleistocene), unit 6
Kcs	Cabrillo Formation, sandstone
Kp	Point Loma Formation
Kuo	Undivided rocks of the Rosario Group in the offshore area

Anticline Fold - Solid where well defined; short dash where inferred

Syncline Fold - Solid where well defined; short dash where inferred

70 U D

Fault - Solid where accurately located; dashed where approximately located; dotted where concealed. U = upthrown block, D = downthrown block. Arrow and number indicate direction and angle of dip of fault plane.

Landslide - Arrows indicate principal direction of movement. Queried where existence is questionable.

N

0 3,000 6,000

SCALE (feet)

NOTE: All locations are approximate.

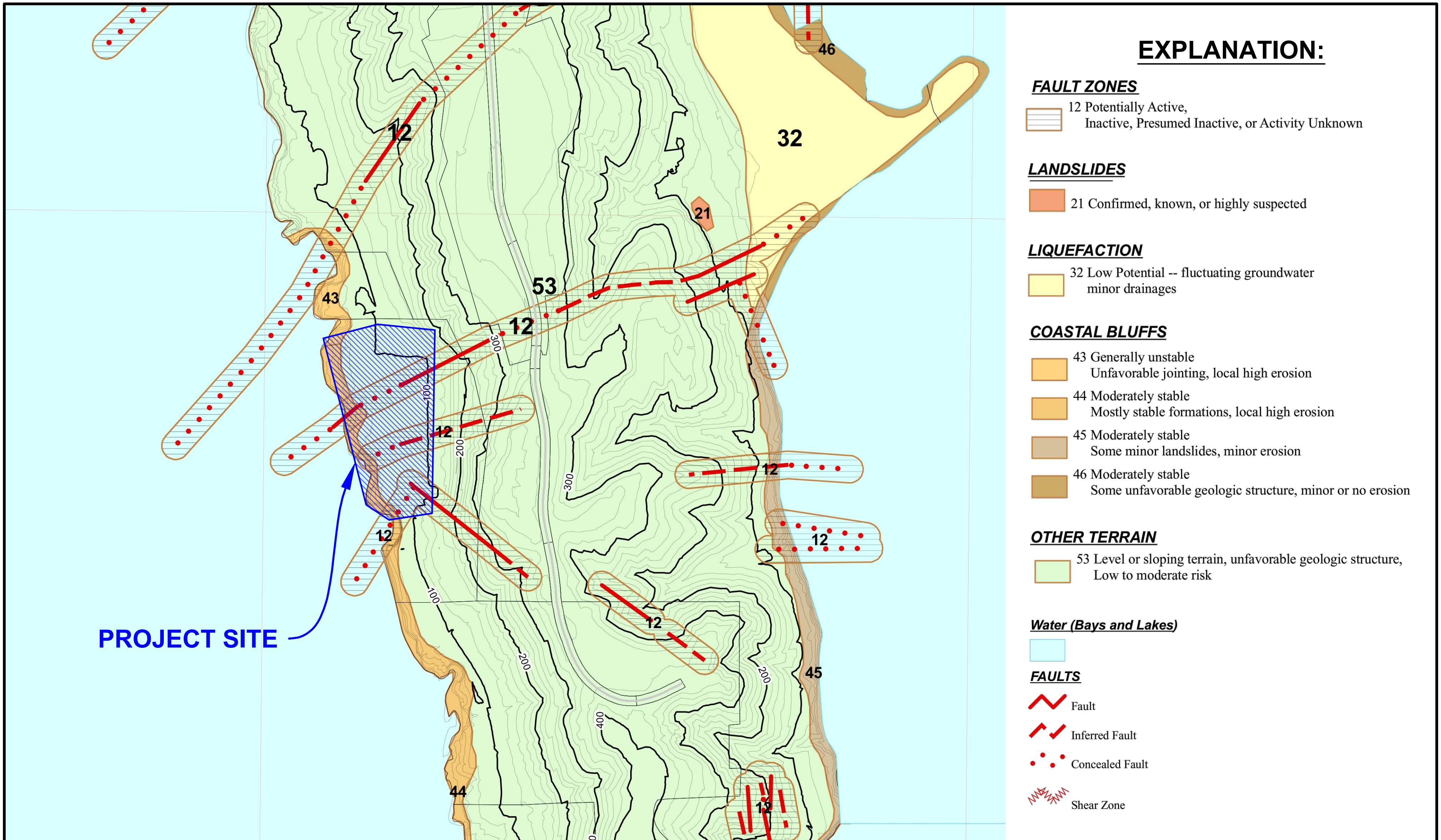
Reference:
Kennedy, M.P. and Tan, S.S. (2008), Geologic Map of the San Diego 30' x 60' Quadrangle, California, California Geological Survey, Scale 1:100,000

ATLAS

REGIONAL GEOLOGY MAP
Point Loma Wastewater Treatment Plant
Site Improvements Project
San Diego, California

Date: August, 2020
By: ACF
Job No.: 190329P4.3-1

Figure:
4



N

0 1,000 2,000

SCALE (feet)

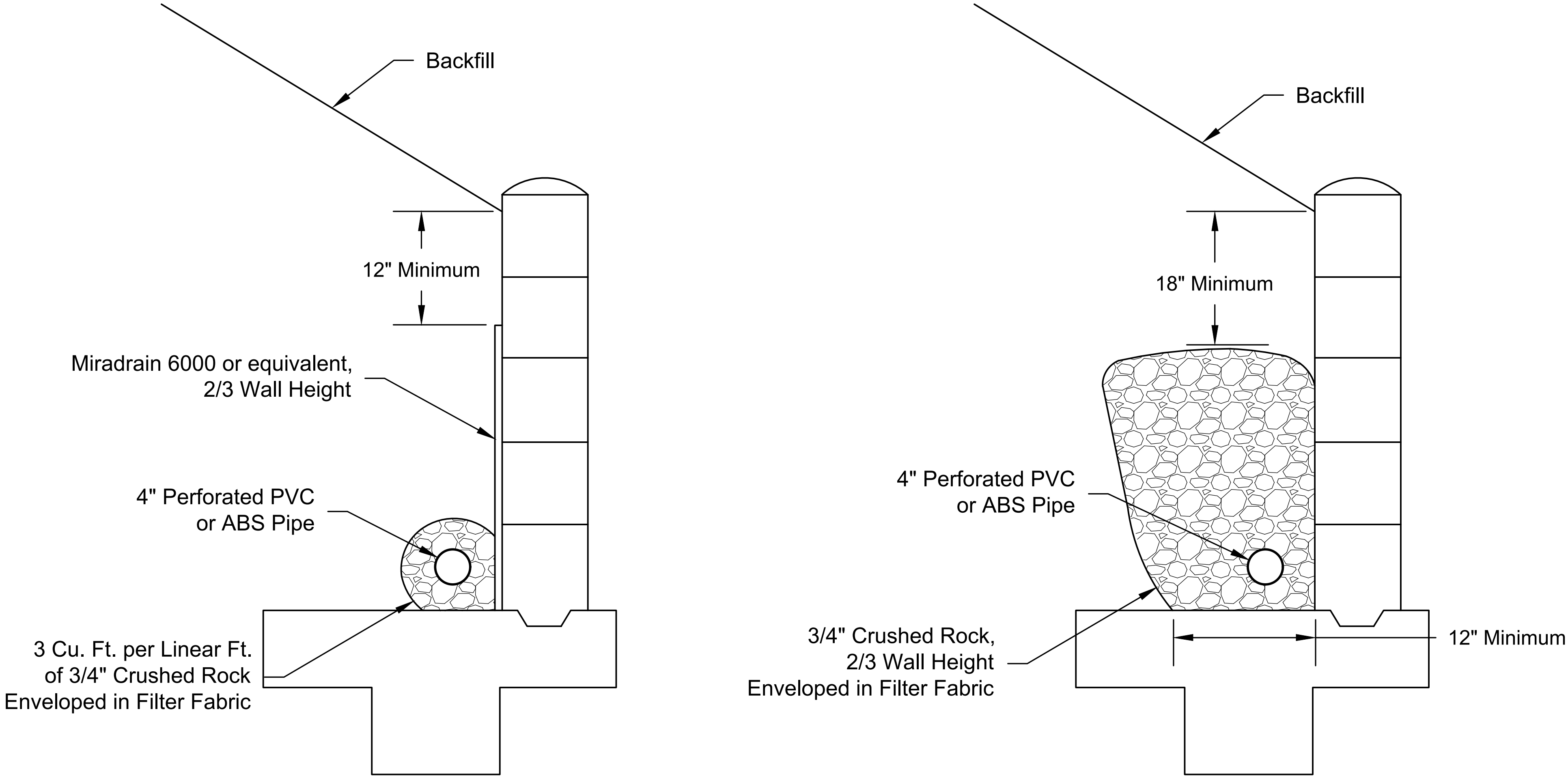
Reference:
City of San Diego (2008), Seismic Safety Study, Geologic Hazards and Faults,
Grid Tile: 12 Development Services Department, April 3, Scale 1:800.

ATLAS

CITY OF SAN DIEGO SEISMIC SAFETY STUDY MAP
Point Loma Wastewater Treatment Plant
Site Improvements
San Diego, California

Date:	September, 2020
By:	ACF
Job No.:	190329P4.3-1

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.

ATLAS	**TYPICAL RETAINING WALL BACKDRAIN DETAILS** Point Loma Wastewater Treatment Plant Site Improvements San Diego, California	Date: September, 2020 By: ACF Job No.: 190329P4.3-1	Figure: 6

APPENDIX I
FIELD INVESTIGATION

Our subsurface exploration consisted of drilling five borings on August 3, 2020 to depths between about 4 feet and 20 feet below the existing ground surface using a truck-mounted drill rig equipped with a hollow stem auger. Figure 2 shows the approximate locations of the borings. Our subsurface exploration was performed under the observation of two Atlas engineers who also logged the borings and obtained samples of the materials encountered.

Relatively undisturbed samples were obtained using a modified California (CAL) sampler, which is a 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 boring logs as “Driving Resistance (blows/ft 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. Disturbed bulk samples were obtained from the SPT sampler and 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 on Figures I-2 through I-6.

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)
CBR - California Bearing Ratio
DS - Direct Shear
EI - Expansion Index
MAX - Maximum Density
RV - R-Value
PD - Particle-size Distribution
SC - Soil-Cement Suitability
SS - Soluble Sulfate

Point Loma Wastewater Treatment Plant Site Improvements San Diego, California			
By:	THC/PFL	Date:	September, 2020
Job Number:	190329P4.3-1	Figure:	I-1

LOG OF BORING B-1

Date Drilled: 8/3/2020
Equipment: CME 95 with 8-Inch HSA
Elevation (ft): 18½

Logged by: THC
Reviewed by: AKN
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
		7 inches of Asphalt Concrete over 6 inches of Aggregate Base							
1	SM	**<u>FILL (Qf)</u>:** SILTY SAND with GRAVEL, loose, brown, moist, fine to coarse grained, trace cobbles.		X					
2	GC	CLAYEY GRAVEL with SAND, medium dense, light brown to brown, moist, fine to coarse grained, trace cobbles.		X					SA AL EI
3									
4									
5									
6			SPT		50/2"	50/2"			
7		Very dense. Very difficult drilling, fragments of broken Rip-Rap encountered.	SPT		50/1"	50/1"			
8		**AUGER REFUSAL ON RIP-RAP AT 7½ FEET**							
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

LOG OF BORING B-2

Date Drilled: 8/3/2020
Equipment: CME 95 with 8-Inch HSA
Elevation (ft): 68

Logged by: THC
Reviewed by: AKN
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 (pc	LABORATORY TESTS
		5 inches of Asphalt Concrete over 8 inches of Aggregate Base							
1	SM	**<u>FILL/ SOIL CEMENT (Qf)</u>:** SILTY SAND with GRAVEL, very dense, brown, moist, fine to coarse grained.							
2									
3									
4									
5									
6			CAL		93/10"	>50	5.9	120.8	DS
6		**<u>VERY OLD PARALIC DEPOSITS (Qvop)</u>:** CLAYEY SANDSTONE, reddish brown, moist, fine to medium grained, slightly weathered, strongly cemented, oxidized.							
7									
8									
9									
10		SILTY SANDSTONE, light brown, moist, intensely weathered, weakly cemented, fine to medium grained.							
11			SPT		40	47			
12									
13									
14									
15		**<u>CABRILLO FORMATION (Kcs)</u>:** CLAYSTONE, gray, moist, slightly weathered, strongly indurated, fine grained, interbedded sandstone layers.							
16			CAL		50/4"	>50			
17									
18									
19									
20			CAL		50/5"	>50	16.0	112.2	DS

BORING TERMINATED AT 20 FEET

Point Loma Wastewater Treatment Plant Site Improvements San Diego, California			
By:	THC/PFL	Date:	September, 2020
Job Number:	190329P4.3-1	Figure:	I-3

LOG OF BORING B-3

Date Drilled: 8/3/2020
Equipment: CME 95 with 8-Inch HSA
Elevation (ft): 33

Logged by: PFL
Reviewed by: AKN
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 (pc	LABORATORY TESTS
0–0.75		**9 inches of Asphalt Concrete over 6 inches Aggregate Base**							
1	SC	**FILL(Qf):** CLAYEY SAND with GRAVEL, medium dense, brown, moist, fine to coarse grained, trace cobbles.		X					
2				X					
3		Dense. Fragments of Cabrillo formation and concrete.		X					
4		**CABRILLO FORMATION (Kcs):** CLAYSTONE, gray to light brown, moist, slightly weathered, strongly indurated and cemented, fine grained, interbedded sandstone.							
5			CAL		50/1"	>50			
6			SPT		85/8"	85/8"			COR
7									
8									
9									
10			CAL		50/3"	>50			
11									
12									
13									
14									
15		SILTY SANDSTONE, yellowish brown, moist, intensely weathered, moderately cemented, fine grained.	SPT		50/6"	50/6"			
16									
17									
18									
19		Interbedded claystone layers.	SPT		75	88			
20									

BORING TERMINATED AT 20 FEET

ATLAS

Point Loma Wastewater Treatment Plant Site Improvements
San Diego, California

By:	THC/PFL	Date:	September, 2020
Job Number:	190329P4.3-1	Figure:	I-4

LOG OF BORING B-4

Date Drilled: 8/3/2020
Equipment: CME 95 with 8-Inch HSA
Elevation (ft): 93

Logged by: PFL
Reviewed by: AKN
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
		6 inches of Portland Cement Concrete							
1	SM	**FILL (Qf):** SILTY SAND with GRAVEL, very dense, light brown, moist, fine to coarse grained, trace cobbles, concrete debris.							
2		SAND CEMENT SLURRY							
3									
4		**AUGER REFUSAL AT 4 FEET ON POSSIBLE UTILITY**							
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									

ATLAS

Point Loma Wastewater Treatment Plant Site Improvements
San Diego, California

By:	THC/PFL	Date:	September, 2020
Job Number:	190329P4.3-1	Figure:	I-5

LOG OF BORING B-6

Date Drilled: 8/3/2020
Equipment: CME 95 with 8-Inch HSA
Elevation (ft): 97

Logged by: PFL
Reviewed by: AKN
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
0–2	SM	**FILL (Qf):** SILTY SAND with GRAVEL, medium dense, brown, moist, fine to coarse grained, trace cobbles.		X					
2–5	SC	CLAYEY SAND, medium dense to dense, reddish brown, moist, fine to coarse grained, trace cobbles.		X					SA AL COR EI
5–15	CL	SANDY CLAY, hard, gray to brown, moist, fine to coarse grained, few gravel.	SPT		34	40			
		Mangansese staining.	CAL		91	70			
15–20	SC	CLAYEY SAND, medium dense, reddish brown, moist, fine to coarse grained, trace gravel.	SPT		21	25			
		Micaceous.	CAL		31	24			

BORING TERMINATED AT 20 FEET

ATLAS

Point Loma Wastewater Treatment Plant Site Improvements
San Diego, California

By:	THC/PFL	Date:	September, 2020
Job Number:	190329P4.3-1	Figure:	I-6

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 presented on the boring logs in Appendix I.

- **PARTICLE-SIZE DISTRIBUTION:** The particle-size distribution was evaluated on two selected soil samples in accordance with ASTM D6913. Figures II-1 and II-2 present the test results.

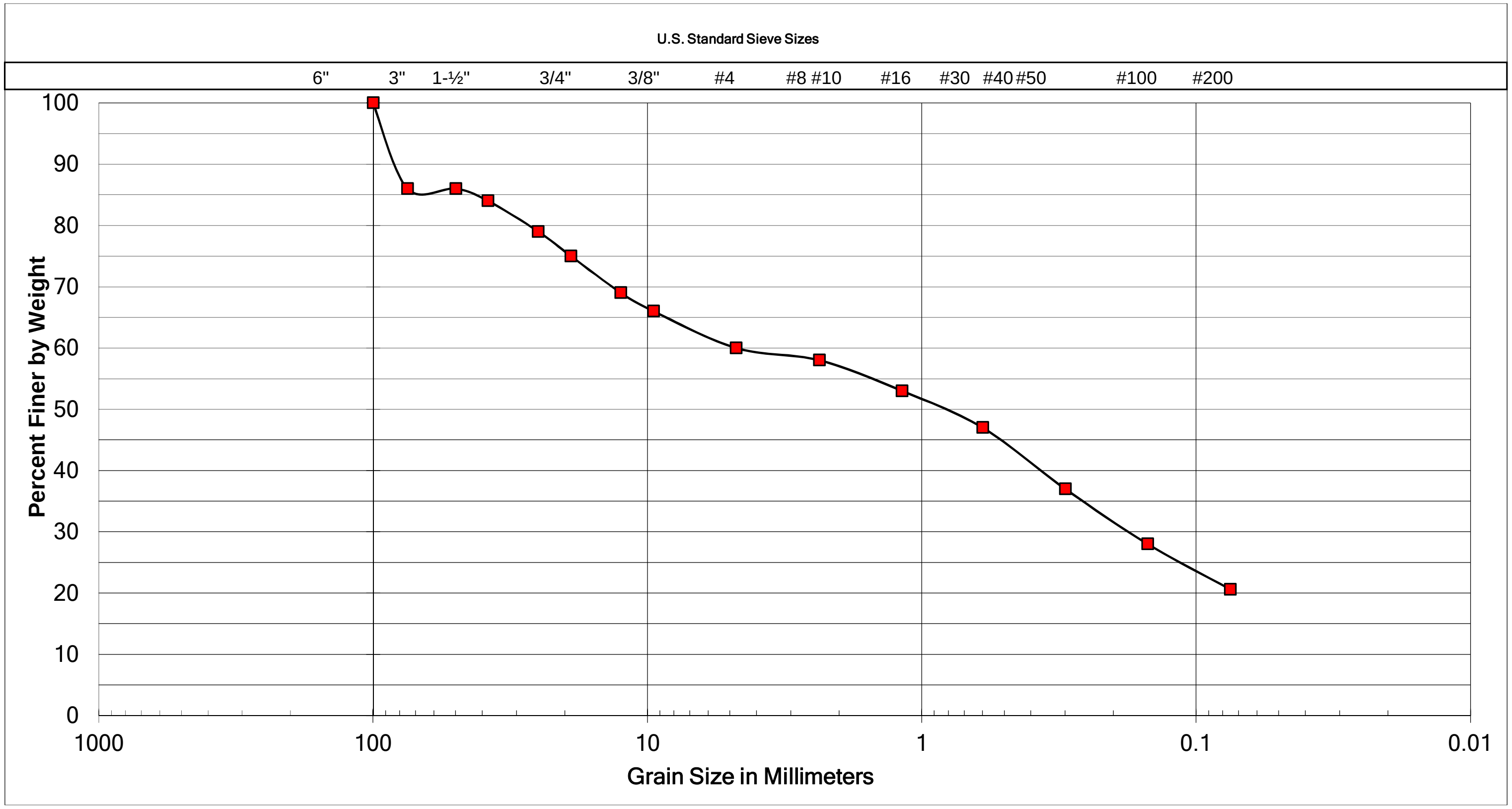
- **ATTERBERG LIMITS:** The Atterberg limits were evaluated on two selected soil samples in accordance with ASTM D4318. Figures II-1 and II-2 present the test results.

- **CORROSIVITY**: Corrosivity tests were performed on two selected soil samples. The pH and minimum resistivity were evaluated in general accordance with California Test 643. The soluble sulfate content was evaluated in accordance with California Test 417. The total chloride ion content was evaluated in accordance with California Test 422. Figure II-3 presents the test results.

- **EXPANSION INDEX:** The expansion indices were determined on two selected samples in accordance with ASTM D4829. Figure II-3 presents the test results.

- **DIRECT SHEAR:** The shear strengths were evaluated on two selected soil samples in accordance with ASTM D3080. The shear stress was applied at a constant rate of strain of 0.003 inches per minute. Figures II-4 and II-5 present the test results.

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 2 to 4 Feet
SAMPLE NUMBER
56706

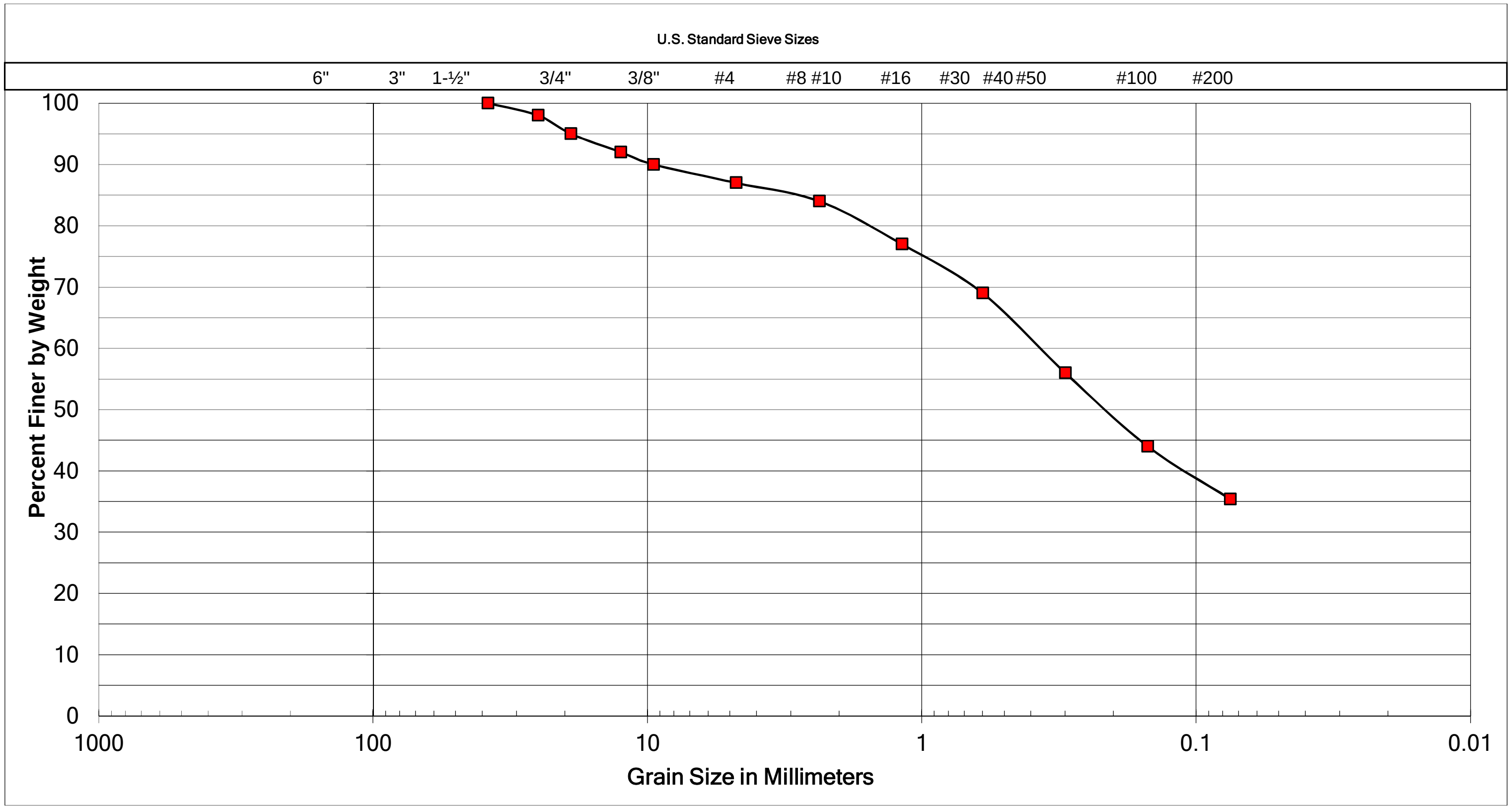
UNIFIED SOIL CLASSIFICATION:	GC
DESCRIPTION	CLAYEY GRAVEL with SAND

ATTERBERG LIMITS	
LIQUID LIMIT	29
PLASTIC LIMIT	15
PLASTICITY INDEX	14

ATLAS

Point Loma Wastewater Treatment Plant Site Improvements
San Diego, California

By:	DJM	Date:	September, 2020
Job Number:	190329P4.3-1	Figure:	II-1



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

SAMPLE LOCATION
B-6 at 2 to 4 Feet
SAMPLE NUMBER
56712

UNIFIED SOIL CLASSIFICATION:	SC
DESCRIPTION	CLAYEY SAND

ATTERBERG LIMITS	
LIQUID LIMIT	44
PLASTIC LIMIT	15
PLASTICITY INDEX	29

ATLAS

Point Loma Wastewater Treatment Plant Site Improvements San Diego, California			
By:	DJM	Date:	September, 2020
Job Number:	190329P4.3-1	Figure:	II-2

EXPANSION INDEX

ASTM D4829

SAMPLE	DESCRIPTION	EXPANSION INDEX
B-1 at 2 to 4 Feet	CLAYEY GRAVEL with SAND	19
B-6 at 2 to 4 Feet	CLAYEY SAND	34

Classification of Expansive Soil [1]

Expansion Index	Expansion Potential
1-20	Very Low
21-50	Low
51-90	Medium
91-130	High
Above 130	Very High

1. ASTM - D4829

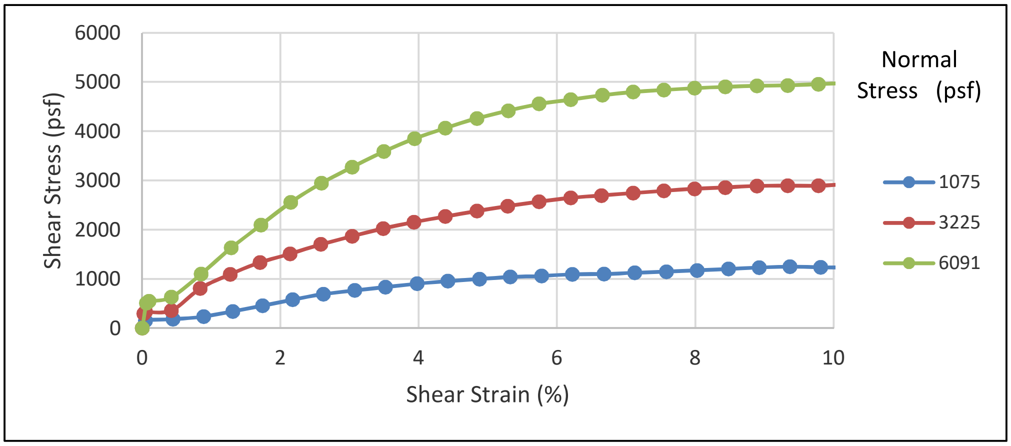
RESISTIVITY, pH, SOLUBLE CHLORIDE and SOLUBLE SULFATE

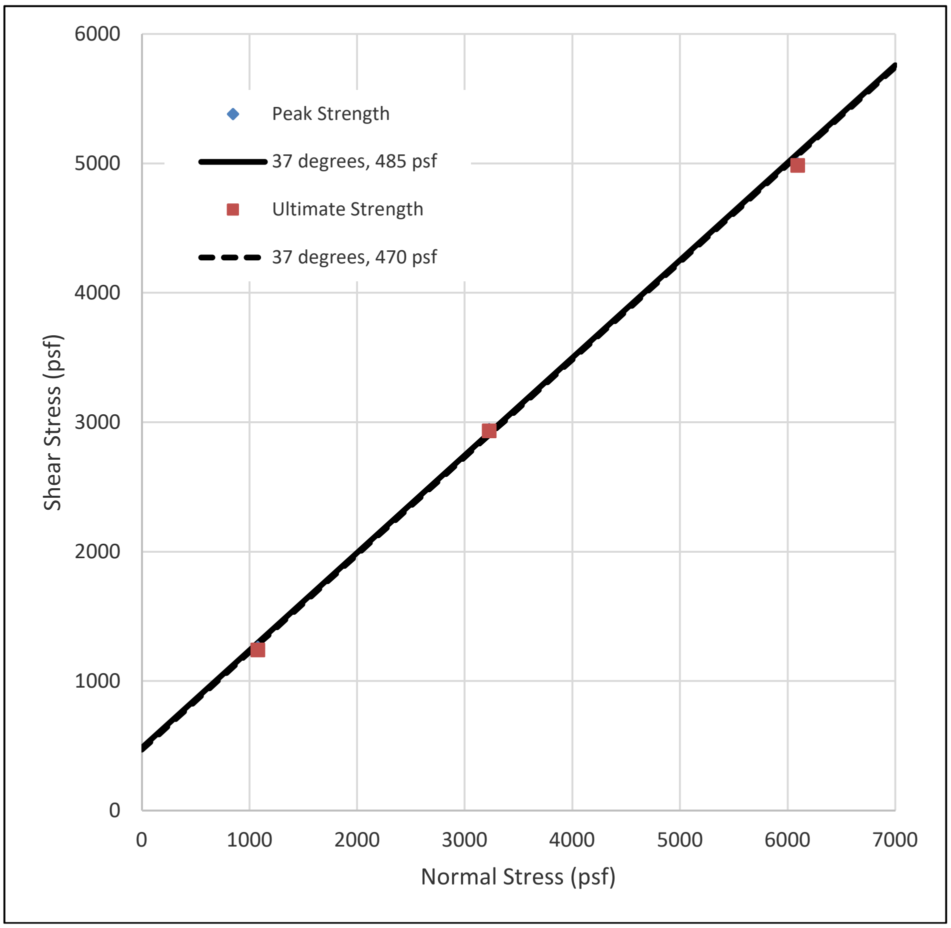
SAMPLE	RESISTIVITY (Ω-cm)	pH	CHLORIDE (%)	SULFATE (%)
B-3 at 6 to 6½ Feet	290	8.10	0.104	0.030
B-6 at 2 to 4 Feet	389	8.18	0.092	0.015

Water-Soluble Sulfate Exposure [2]

Water-Soluble Sulfate (SO_4) in soil (percent by weight)	Exposure Severity	Exposure Class	Cement Type (ASTM C150)	Max. W/C	Min. f_c' (psi)
$SO_4 < 0.10$	N/A	S0	No type restriction	N/A	2,500
$0.10 \leq SO_4 < 0.20$	Moderate	S1	II	0.50	4,000
$0.20 \leq SO_4 \leq 2.00$	Severe	S2	V	0.45	4,500
$SO_4 > 2.00$	Very Severe	S3	V plus pozzolan or slag cement	0.45	4,500

2. Modified from ACI 318-14 Table 19.3.1.1 and Table 19.3.2.1





SAMPLE ID: B-2 at 6 to 6½ Feet

<u>VERY OLD PARALIC DEPOSITS (Qvop)</u>: CLAYEY SANDSTONE

NOTES: Insitu

Strain Rate: 0.003 in/min

Sample was consolidated and drained

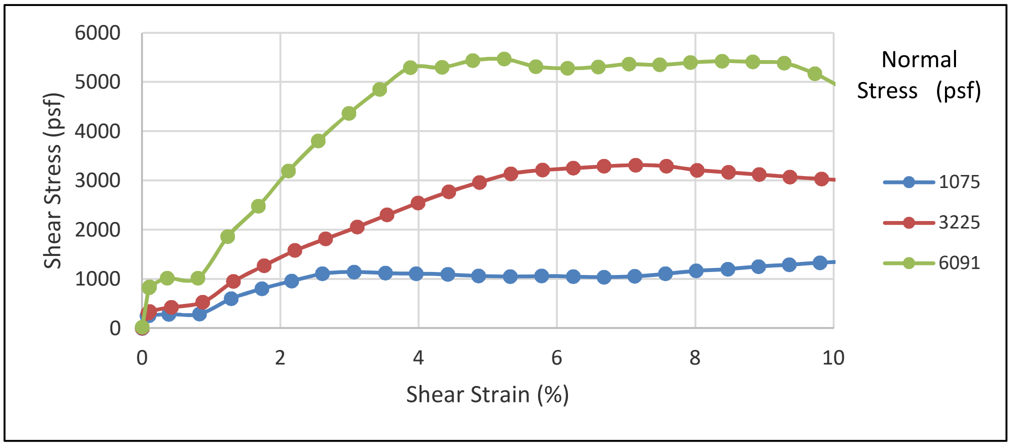
	Peak	Ultimate
Φ	37 °	37 °
c	485 psf	470 psf

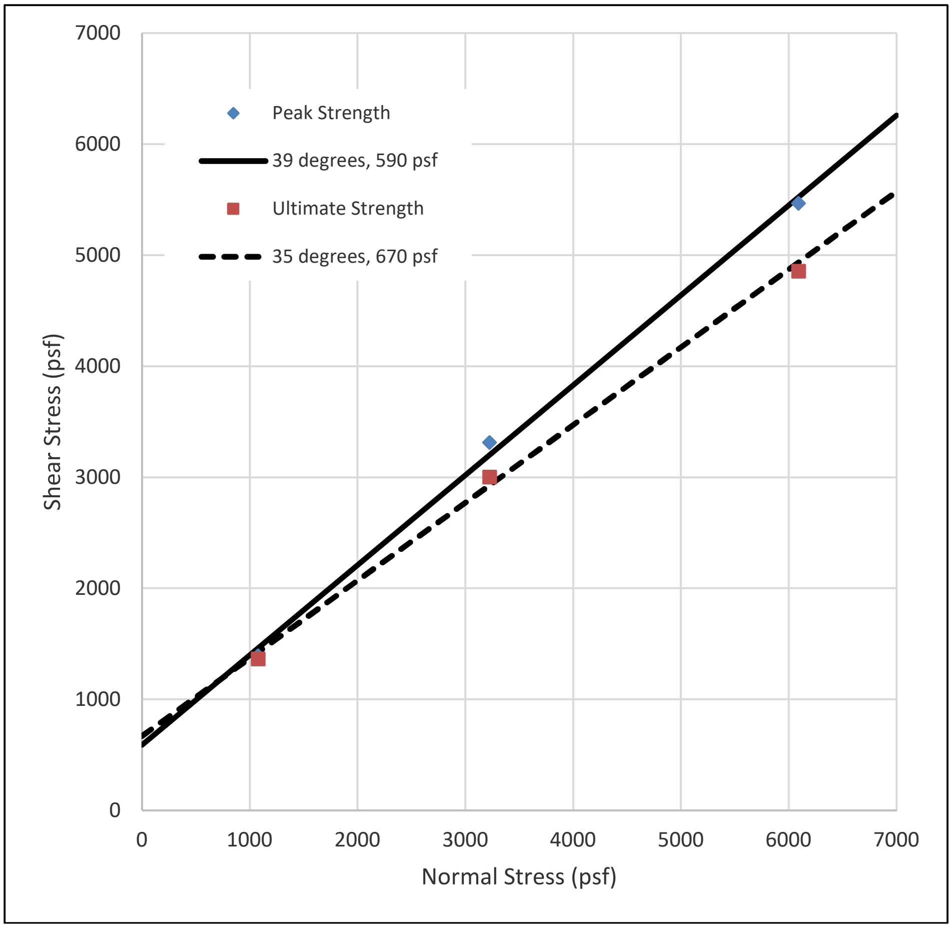
	Initial	Final
γ_d	120.8 pcf	120.8 pcf
w_c	5.9 %	13.8 %
Saturation	41 %	96 %

ATLAS

Point Loma Wastewater Treatment Plant Site Improvements
San Diego, California

By:	PFL	Date:	September, 2020
Job Number:	190329P4.3-1	Figure:	II-4





SAMPLE ID: B-2 at 19½ to 20 Feet

CABRILLO FORMATION (Kcs): CLAYSTONE

NOTES: Insitu
Strain Rate: 0.003 in/min
Sample was consolidated and drained

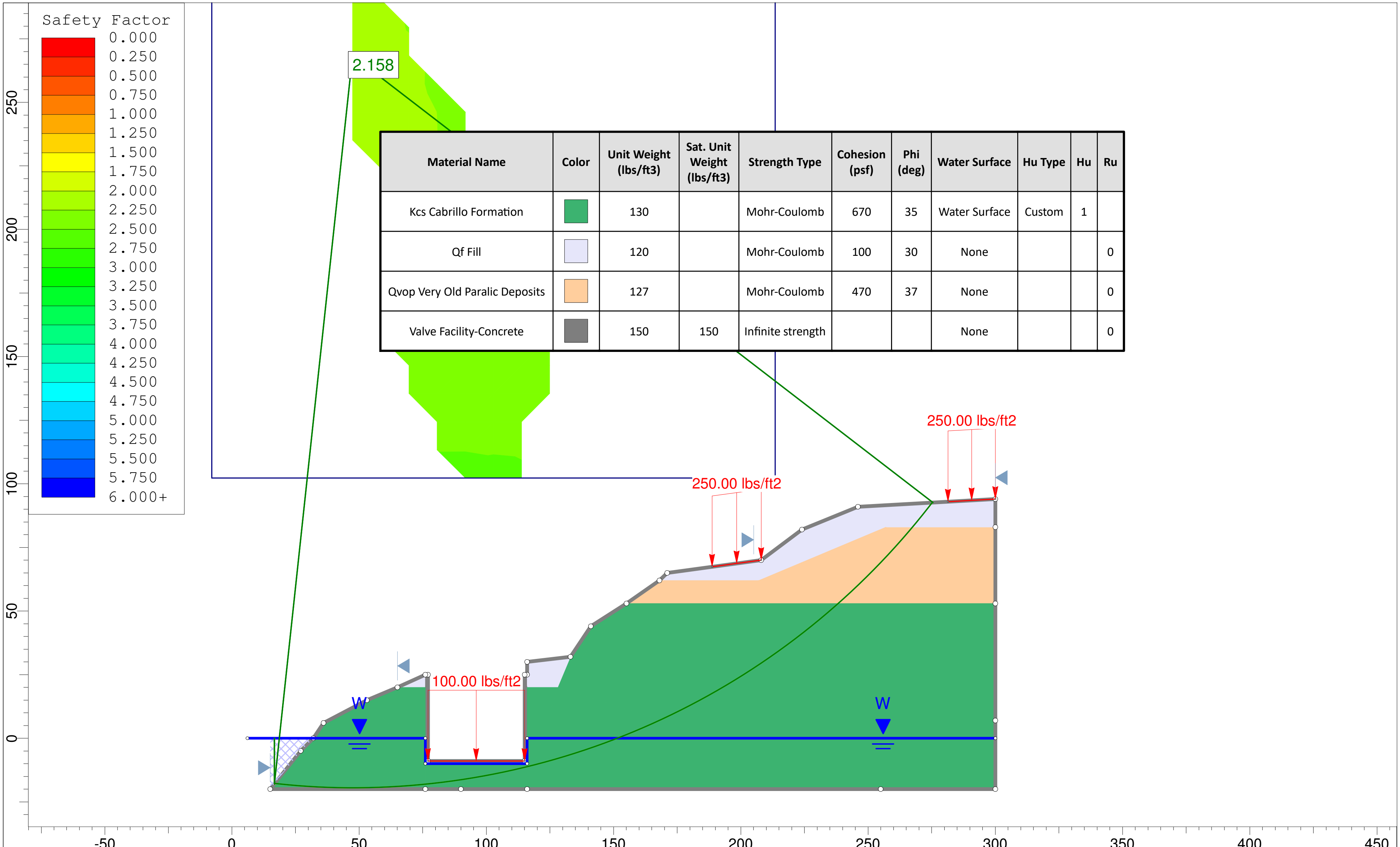
	Peak	Ultimate
Φ	39 °	35 °
c	590 psf	670 psf

	Initial	Final
γ_d	112.2 pcf	112.2 pcf
w_c	16.0 %	20.9 %
Saturation	88 %	100 %

ATLAS

Point Loma Wastewater Treatment Plant Site Improvements San Diego, California			
By:	PFL	Date:	September, 2020
Job Number:	190329P4.3-1	Figure:	II-5

APPENDIX III
SLOPE STABILITY ANALYSIS

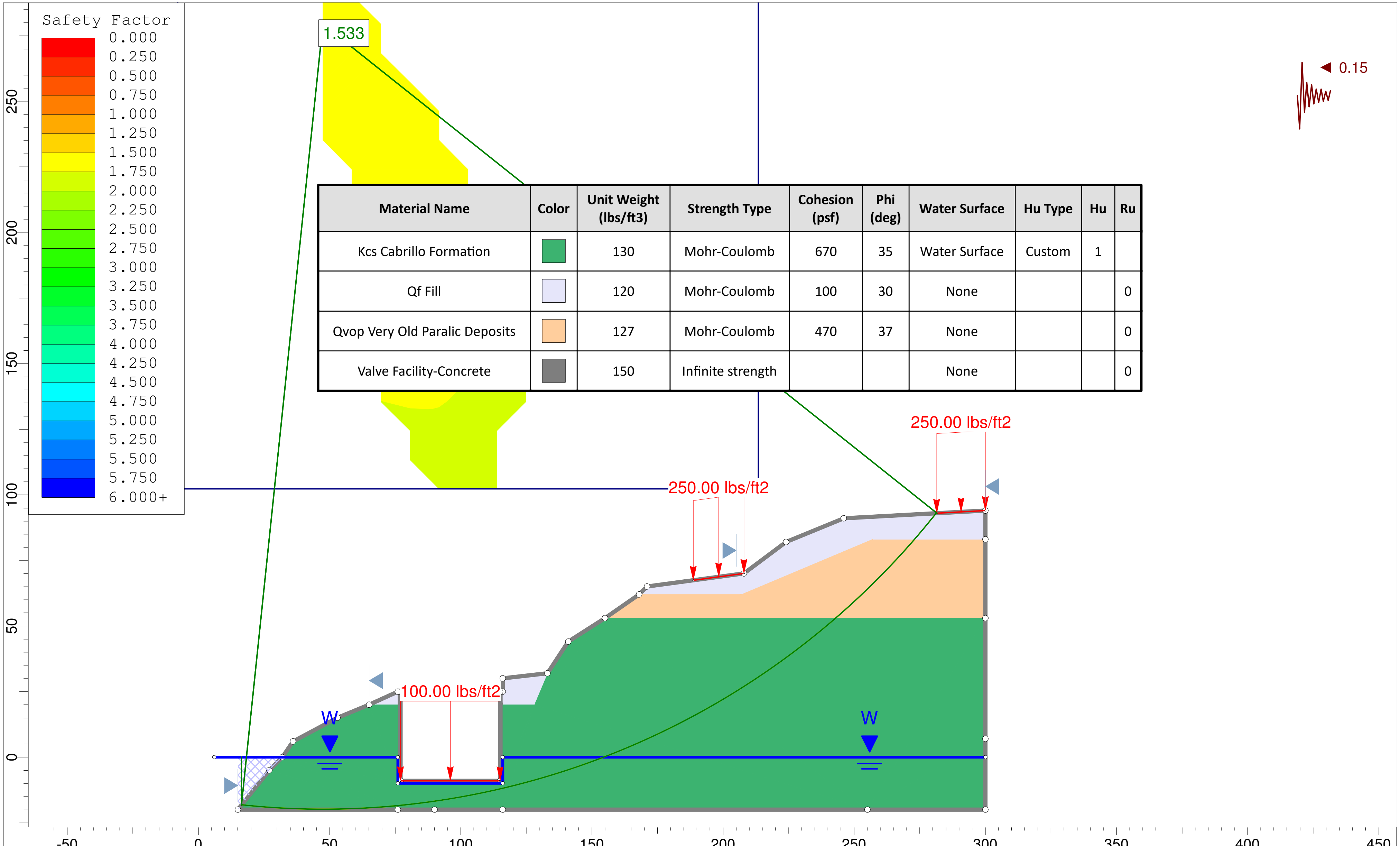


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Kcs Cabrillo Formation		130		Mohr-Coulomb	670	35	Water Surface	Custom	1	
Qf Fill		120		Mohr-Coulomb	100	30	None			0
Qvop Very Old Paralic Deposits		127		Mohr-Coulomb	470	37	None			0
Valve Facility-Concrete		150	150	Infinite strength			None			0

ATLAS

Cross Section A-A': Global

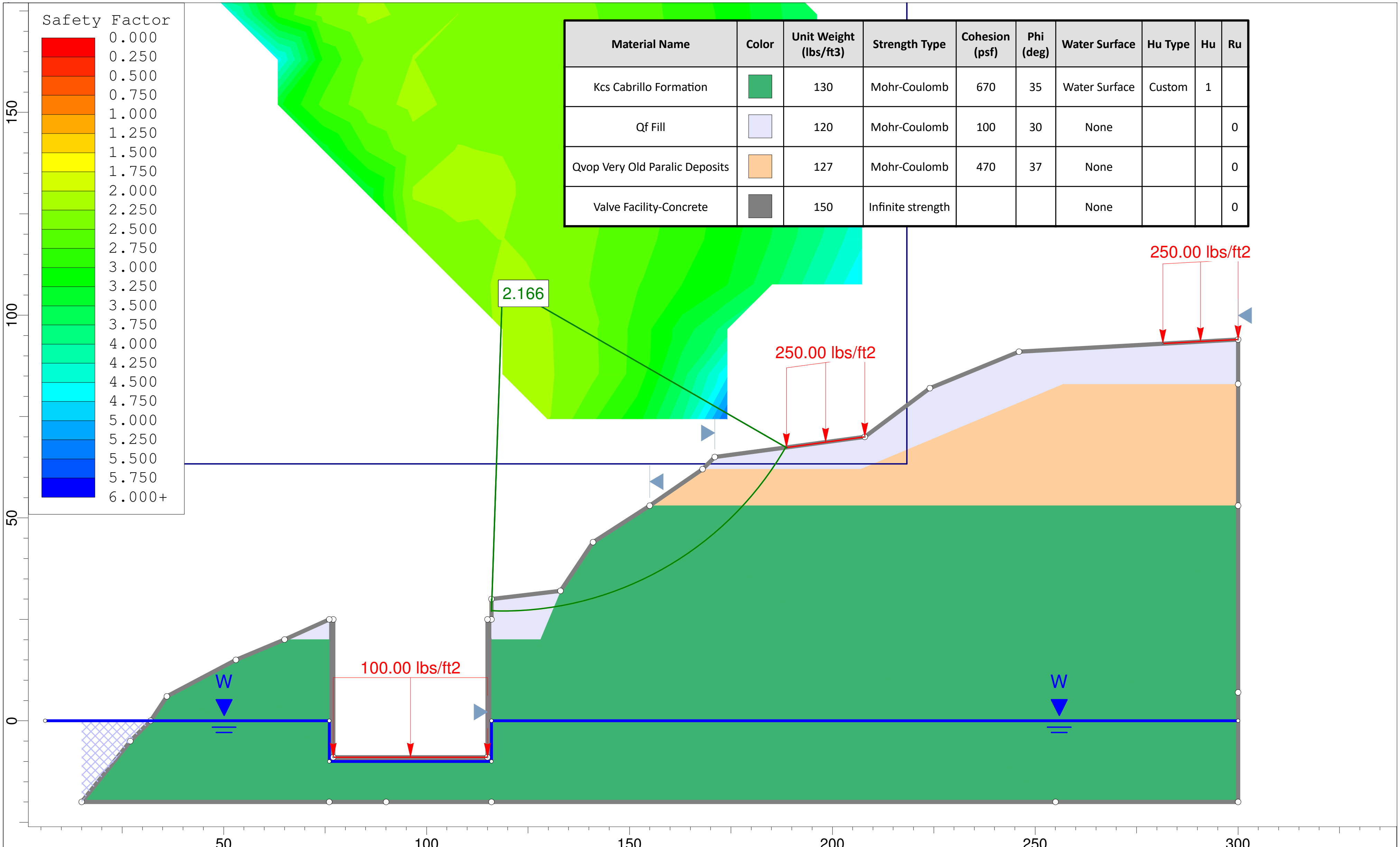
Project: Point Loma Wastewater Treatment Plant	Location: San Diego, California
Analysis Method: Spencer Method - Static Analysis	Client: HDR
Date: September, 2020	Analysis By: THC
Job No.: 190329P4.3	Figure No.: III-1



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Kcs Cabrillo Formation		130	Mohr-Coulomb	670	35	Water Surface	Custom	1	
Qf Fill		120	Mohr-Coulomb	100	30	None			0
Qvop Very Old Paralic Deposits		127	Mohr-Coulomb	470	37	None			0
Valve Facility-Concrete		150	Infinite strength			None			0

Cross Section A-A': Global

Project: Point Loma Wastewater Treatment Plant	Location: San Diego, California
Analysis Method: Spencer Method - Pseudostatic Analysis	Client: HDR
Date: September, 2020 / Analysis By: THC	Job No.: 190329P4.3 / Figure No.: III-2

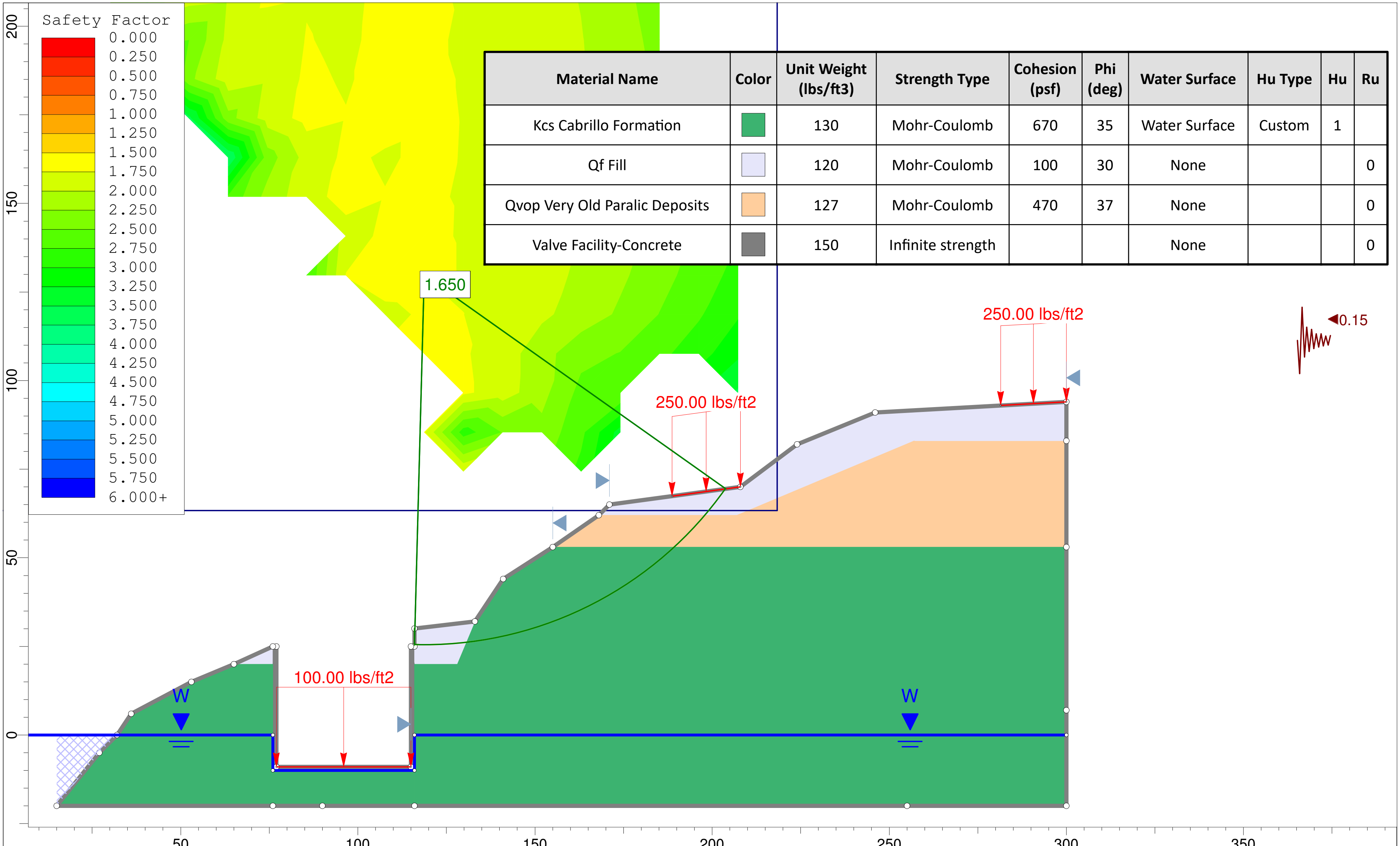


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Kcs Cabrillo Formation		130	Mohr-Coulomb	670	35	Water Surface	Custom	1	
Qf Fill		120	Mohr-Coulomb	100	30	None			0
Qvop Very Old Paralic Deposits		127	Mohr-Coulomb	470	37	None			0
Valve Facility-Concrete		150	Infinite strength			None			0

ATLAS

Cross Section A-A': Local 1

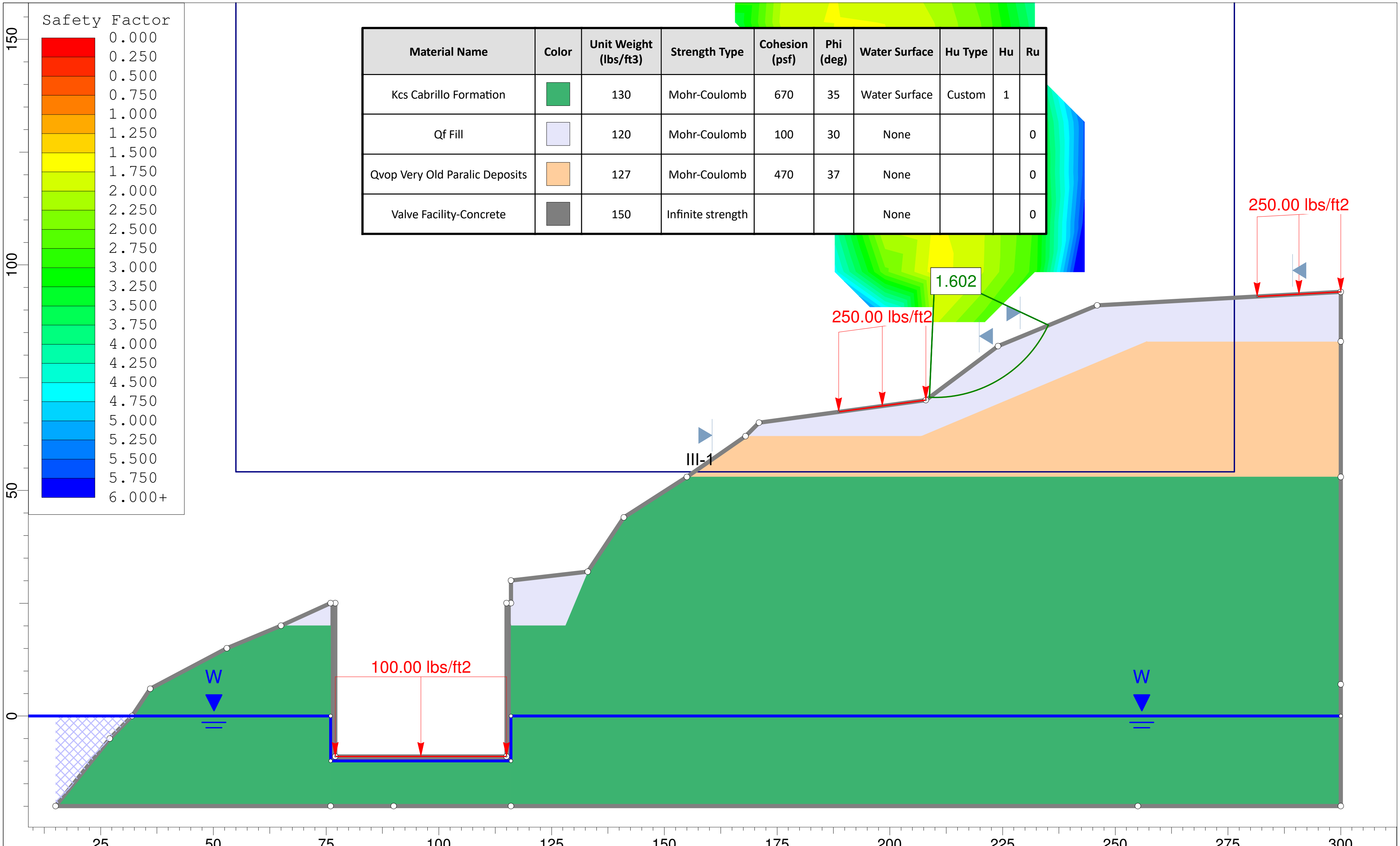
Project: Point Loma Wastewater Treatment Plant	Location: San Diego, California
Analysis Method: Spencer Method - Static Analysis	Client: HDR
Date: September, 2020 / Analysis By: THC	Job No.: 190329P4.3 / Figure No.: III-3



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Kcs Cabrillo Formation		130	Mohr-Coulomb	670	35	Water Surface	Custom	1	
Qf Fill		120	Mohr-Coulomb	100	30	None			0
Qvop Very Old Paralic Deposits		127	Mohr-Coulomb	470	37	None			0
Valve Facility-Concrete		150	Infinite strength			None			0

Cross Section A-A': Local 1

Project: Point Loma Wastewater Treatment Plant	Location: San Diego, California
Analysis Method: Spencer Method - Pseudostatic Analysis	Client: HDR
Date: September, 2020 / Analysis By: THC	Job No.: 190329P4.3 / Figure No.: III-4

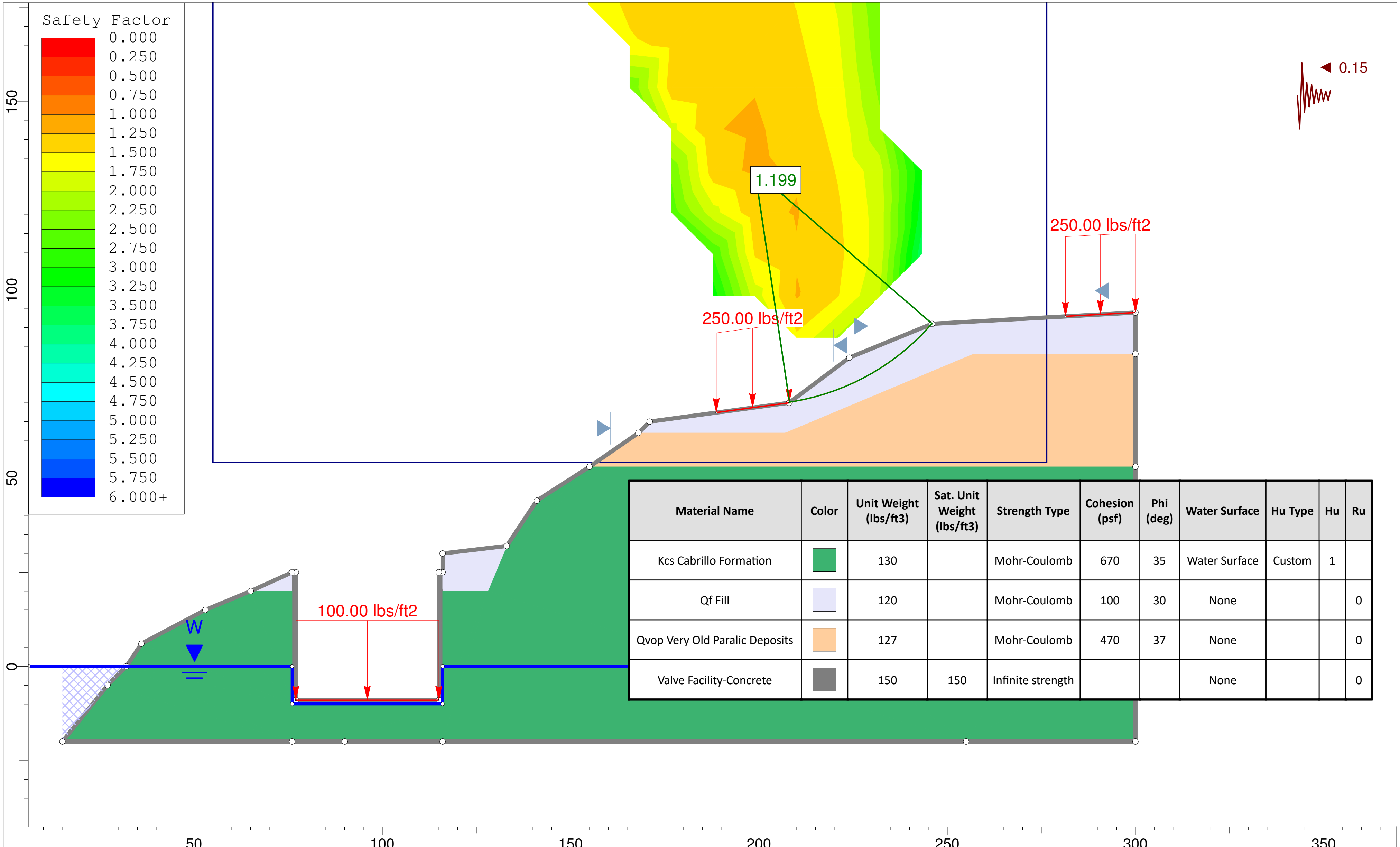


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Kcs Cabrillo Formation		130	Mohr-Coulomb	670	35	Water Surface	Custom	1	
Qf Fill		120	Mohr-Coulomb	100	30	None			0
Qvop Very Old Paralic Deposits		127	Mohr-Coulomb	470	37	None			0
Valve Facility-Concrete		150	Infinite strength			None			0

ATLAS

Cross Section A-A': Local 2

Project: Point Loma Wastewater Treatment Plant	Location: San Diego, California
Analysis Method: Spencer Method - Static Analysis	Client: HDR
Date: September, 2020 / Analysis By: THC	Job No.: 190329P4.3 / Figure No.: III-5



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Kcs Cabrillo Formation		130		Mohr-Coulomb	670	35	Water Surface	Custom	1	
Qf Fill		120		Mohr-Coulomb	100	30	None			0
Qvop Very Old Paralic Deposits		127		Mohr-Coulomb	470	37	None			0
Valve Facility-Concrete		150	150	Infinite strength			None			0

Cross Section A-A': Local 2

Project: Point Loma Wastewater Treatment Plant	Location: San Diego, California
Analysis Method: Spencer Method - Pseudostatic Analysis	Client: HDR
Date: September, 2020 — Analysis By: THC	Job No.: 190329P4.3 — Figure No.: III-6