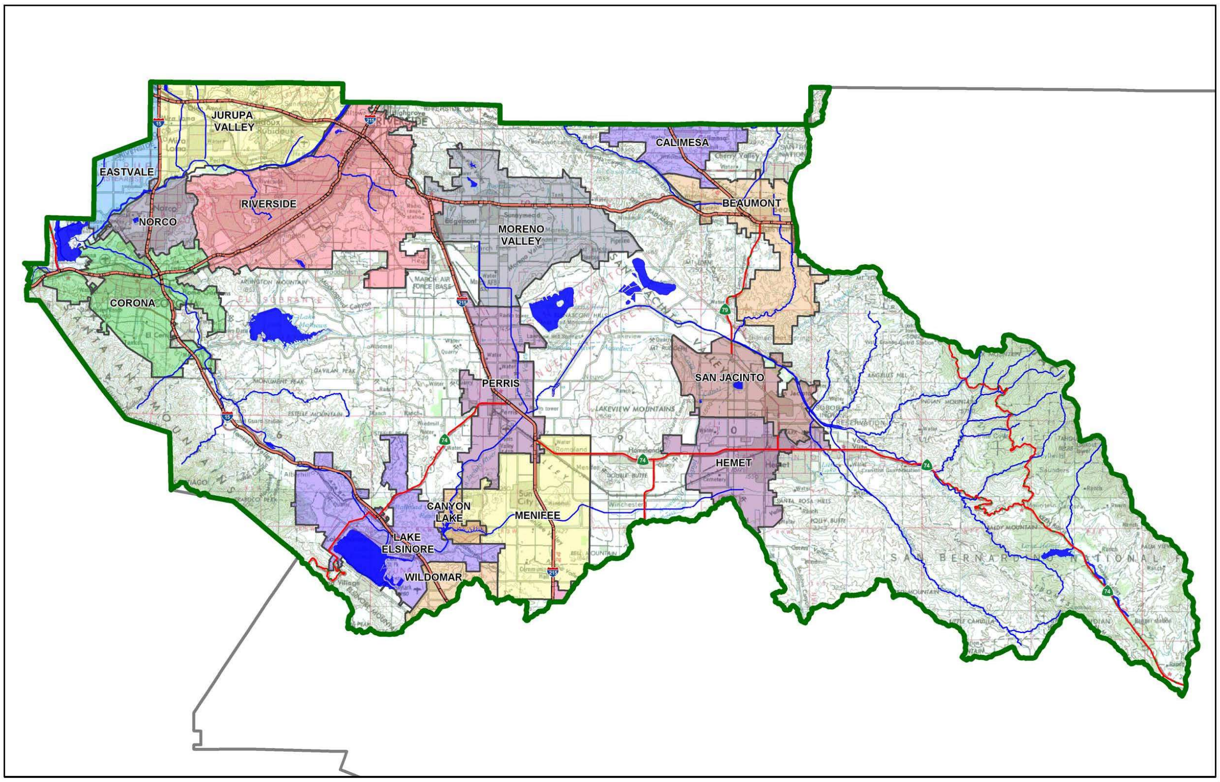
Project Specific Water Quality Management Plan

*A Template for Projects located within the **Santa Ana Watershed** Region of Riverside County*

Project Title: Stoneridge Industrial

Development No: Insert text here

Design Review/Case No: SP00239A01



☒ **Preliminary**
☐ **Final**

Original Date Prepared: June 5, 2020

Revision Date(s): August 12, 2021

Prepared for Compliance with
Regional Board Order No. **R8-2010-0033**
Template revised June 30, 2016

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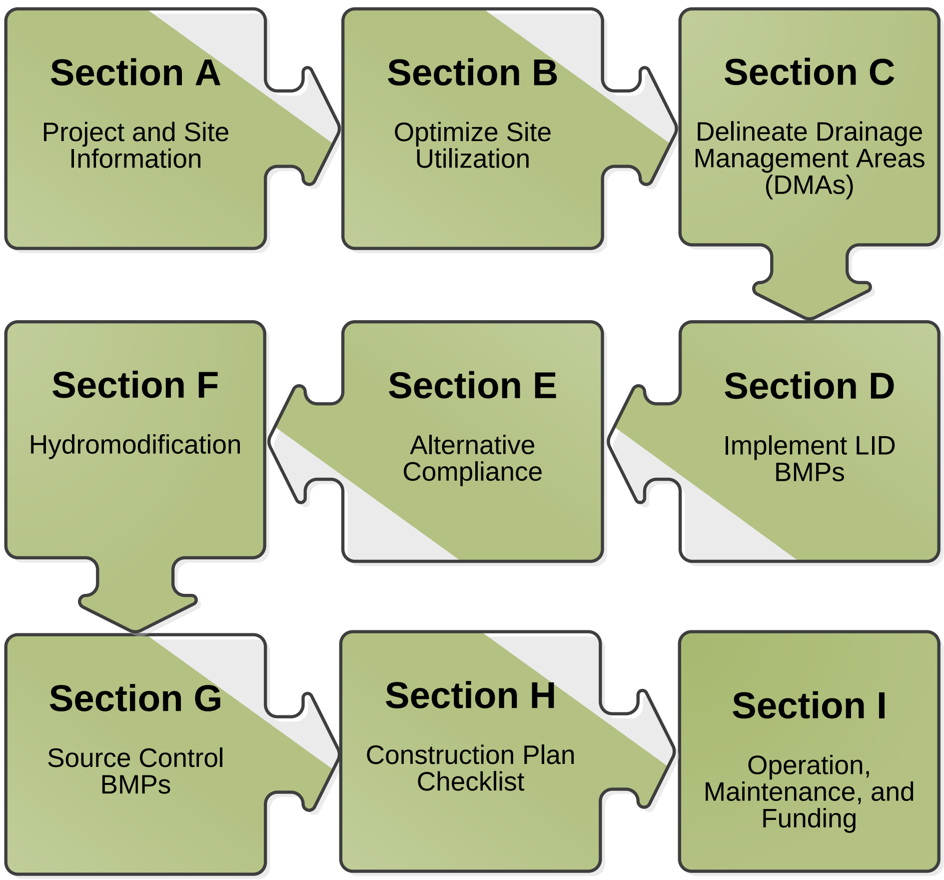
A Brief Introduction

This Project-Specific WQMP Template for the **Santa Ana Region** has been prepared to help guide you in documenting compliance for your project. Because this document has been designed to specifically document compliance, you will need to utilize the WQMP Guidance Document as your "how-to" manual to help guide you through this process. Both the Template and Guidance Document go hand-in-hand, and will help facilitate a well prepared Project-Specific WQMP. Below is a flowchart for the layout of this Template that will provide the steps required to document compliance.



OWNER'S CERTIFICATION

This Project-Specific Water Quality Management Plan (WQMP) has been prepared for Richland Communities by Hunsaker & Associates Irvine, Inc. for the Stoneridge project.

This WQMP is intended to comply with the requirements of County of Riverside for Ordinance 754 which includes the requirement for the preparation and implementation of a Project-Specific WQMP.

The undersigned, while owning the property/project described in the preceding paragraph, shall be responsible for the implementation and funding of this WQMP and will ensure that this WQMP is amended as appropriate to reflect up-to-date conditions on the site. In addition, the property owner accepts responsibility for interim operation and maintenance of Stormwater BMPs until such time as this responsibility is formally transferred to a subsequent owner. This WQMP will be reviewed with the facility operator, facility supervisors, employees, tenants, maintenance and service contractors, or any other party (or parties) having responsibility for implementing portions of this WQMP. At least one copy of this WQMP will be maintained at the project site or project office in perpetuity. The undersigned is authorized to certify and to approve implementation of this WQMP. The undersigned is aware that implementation of this WQMP is enforceable under the County of Riverside Water Quality Ordinance (Municipal Code Section 754).

"I, the undersigned, certify under penalty of law that the provisions of this WQMP have been reviewed and accepted and that the WQMP will be transferred to future successors in interest."

Owner's Signature	Date
Owner's Printed Name	Owner's Title/Position

PREPARER'S CERTIFICATION

"The selection, sizing and design of stormwater treatment and other stormwater quality and quantity control measures in this plan meet the requirements of Regional Water Quality Control Board Order No. **R8-2010-0033** and any subsequent amendments thereto."

Preparer's Signature	Date
Preparer's Printed Name	Preparer's Title/Position

Preparer's Licensure:

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Section A: Project and Site Information

PROJECT INFORMATION			
Type of Project:	Industrial		
Planning Area:			
Community Name:	Stoneridge		
Development Name:	Stoneridge		
PROJECT LOCATION			
Latitude & Longitude (DMS): 33.818411, -117.165483			
Project Watershed and Sub-Watershed: Santa Ana			
Gross Acres: 694 acres			
APN(s): 307-070-003 thru 005, 307-080-003 thru 006, 307-090-001 thru 002, 307-090-004 thru 006, 307-100-001, 307-100-003 thru 005, 307-110-003, 307110-007 thru 008, 307-220-001, 307-230-017, 307-230-019 thru 020			
Map Book and Page No.: Page 778, D4, D5, D6, D7, E4, E5, E6, E7, F4, F5, F6			
PROJECT CHARACTERISTICS			
Proposed or Potential Land Use(s)	Industrial		
Proposed or Potential SIC Code(s)	1541		
Area of Impervious Project Footprint (SF)	8,598,000		
Total Area of <u>proposed</u> Impervious Surfaces within the Project Footprint (SF)/or Replacement	8,598,000		
Does the project consist of offsite road improvements?	☐ Y	☒ N	
Does the project propose to construct unpaved roads?	☐ Y	☒ N	
Is the project part of a larger common plan of development (phased project)?	☐ Y	☒ N	
EXISTING SITE CHARACTERISTICS			
Total area of <u>existing</u> Impervious Surfaces within the Project limits Footprint (SF)	0		
Is the project located within any MSHCP Criteria Cell?	☐ Y	☒ N	
If so, identify the Cell number:			
Are there any natural hydrologic features on the project site?	☐ Y	☒ N	
Is a Geotechnical Report attached?	☒ Y	☐ N	
If no Geotech. Report, list the NRCS soils type(s) present on the site (A, B, C and/or D)			
What is the Water Quality Design Storm Depth for the project?	0.65		

The project site is generally located 4 miles east of Interstate 215 and south of Ramona Expressway. The site is bound to the north by Ramona Expressway, to the east by vacant land, to the south by Nuevo Road and to the west by vacant land. Tentative Tract Map No. 32372 is located in an unincorporated area of Riverside County. Previously, the site was proposed for a mixed-use development featuring commercial, residential, sports park, open space and associated improvements. The proposed development will consist of industrial, retail and associated open space/landscaping, streets and supporting infrastructure. The proposed industrial and mixed use development will consist of approximately 22 buildings. Additionally, the project will have conservation/floodplain areas on the easterly portion of the development and conservation areas on the westerly portion of the development.

A.1 Maps and Site Plans

When completing your Project-Specific WQMP, include a map of the local vicinity and existing site. In addition, include all grading, drainage, landscape/plant palette and other pertinent construction plans in Appendix 2. At a **minimum**, your WQMP Site Plan should include the following:

- Drainage Management Areas
- Proposed Structural BMPs
- Drainage Path
- Drainage Infrastructure, Inlets, Overflows
- Source Control BMPs
- Buildings, Roof Lines, Downspouts
- Impervious Surfaces
- Standard Labeling
- BMP Locations (Lat/Long)

Use your discretion on whether or not you may need to create multiple sheets or can appropriately accommodate these features on one or two sheets. Keep in mind that the Co-Permittee plan reviewer must be able to easily analyze your project utilizing this template and its associated site plans and maps.

A.2 Identify Receiving Waters

Using Table A.1 below, list in order of upstream to downstream, the receiving waters that the project site is tributary to. Continue to fill each row with the Receiving Water's 303(d) listed impairments (if any), designated beneficial uses, and proximity, if any, to a RARE beneficial use. Include a map of the receiving waters in Appendix 1.

Table A.1 Identification of Receiving Waters

Receiving Waters	EPA Approved 303(d) List Impairments	Designated Beneficial Uses	Proximity to RARE Beneficial Use
San Jacinto River	None	MUN, AGR, GWR, REC1, REC2, WARM, WILD	N/A
Canyon Lake	Nutrients, Pathogens	MUN, AGR, GWR, REC1, REC2, WARM, WILD	N/A
Lake Elsinore	Nutrients, Organic Enrichment/Low Dissolved Oxygen, PCBs, Sediment Toxicity,	REC1, REC2, WARM, WILD	N/A

A.3 Additional Permits/Approvals required for the Project:

Table A.2 Other Applicable Permits

Agency	Permit Required	
State Department of Fish and Game, 1602 Streambed Alteration Agreement	☐ Y	☒ N
State Water Resources Control Board, Clean Water Act (CWA) Section 401 Water Quality Cert.	☐ Y	☒ N
US Army Corps of Engineers, CWA Section 404 Permit	☐ Y	☒ N
US Fish and Wildlife, Endangered Species Act Section 7 Biological Opinion	☐ Y	☒ N
Statewide Construction General Permit Coverage	☒ Y	☐ N
Statewide Industrial General Permit Coverage	☐ Y	☒ N
Western Riverside MSHCP Consistency Approval (e.g., JPR, DBESP)	☐ Y	☒ N
Other *(please list in the space below as required)*	☒ Y	☐ N

County of Riverside Grading Permits		

If yes is answered to any of the questions above, the Co-Permittee may require proof of approval/coverage from those agencies as applicable including documentation of any associated requirements that may affect this Project-Specific WQMP.

Section B: Optimize Site Utilization (LID Principles)

Review of the information collected in Section 'A' will aid in identifying the principal constraints on site design and selection of LID BMPs as well as opportunities to reduce imperviousness and incorporate LID Principles into the site and landscape design. For example, constraints might include impermeable soils, high groundwater, groundwater pollution or contaminated soils, steep slopes, geotechnical instability, high-intensity land use, heavy pedestrian or vehicular traffic, utility locations or safety concerns. Opportunities might include existing natural areas, low areas, oddly configured or otherwise unbuildable parcels, easements and landscape amenities including open space and buffers (which can double as locations for bioretention BMPs), and differences in elevation (which can provide hydraulic head). Prepare a brief narrative for each of the site optimization strategies described below. This narrative will help you as you proceed with your LID design and explain your design decisions to others.

The 2010 Santa Ana MS4 Permit further requires that LID Retention BMPs (Infiltration Only or Harvest and Use) be used unless it can be shown that those BMPs are infeasible. Therefore, it is important that your narrative identify and justify if there are any constraints that would prevent the use of those categories of LID BMPs. Similarly, you should also note opportunities that exist which will be utilized during project design. Upon completion of identifying Constraints and Opportunities, include these on your WQMP Site plan in Appendix 1.

Consideration of "highest and best use" of the discharge should also be considered. For example, Lake Elsinore is evaporating faster than runoff from natural precipitation can recharge it. Requiring infiltration of 85% of runoff events for projects tributary to Lake Elsinore would only exacerbate current water quality problems associated with Pollutant concentration due to lake water evaporation. In cases where rainfall events have low potential to recharge Lake Elsinore (i.e. no hydraulic connection between groundwater to Lake Elsinore, or other factors), requiring infiltration of Urban Runoff from projects is counterproductive to the overall watershed goals. Project proponents, in these cases, would be allowed to discharge Urban Runoff, provided they used equally effective filtration-based BMPs.

Site Optimization

The following questions are based upon Section 3.2 of the WQMP Guidance Document. Review of the WQMP Guidance Document will help you determine how best to optimize your site and subsequently identify opportunities and/or constraints, and document compliance.

Did you identify and preserve existing drainage patterns? If so, how? If not, why?

In the existing condition, a majority of the northern portion of the site drains northerly towards Ramona Expressway and a small portion of the site drains to the south towards Nuevo Road.

Did you identify and protect existing vegetation? If so, how? If not, why?

The site is currently vacant with sparse vegetation. The proposed development will incorporate landscaping/open in accordance with the County of Riverside landscaping standards.

Did you identify and preserve natural infiltration capacity? If so, how? If not, why?

Based on the infiltration tests conducted for the project, observed infiltration rates ranged from 0.1 to 0.5 inches per hour. Therefore, preserving natural infiltration is not conducive to the proposed development.

Did you identify and minimize impervious area? If so, how? If not, why?

The development's buildings and streets will be designed to the minimum standards.

Did you identify and disperse runoff to adjacent pervious areas? If so, how? If not, why?

The project's grading and drainage design has been developed to convey runoff from impervious areas to pervious areas to the maximum extent practicable.

Section C: Delineate Drainage Management Areas (DMAs)

Utilizing the procedure in Section 3.3 of the WQMP Guidance Document which discusses the methods of delineating and mapping your project site into individual DMAs, complete Table C.1 below to appropriately categorize the types of classification (e.g., Type A, Type B, etc.) per DMA for your project site. Upon completion of this table, this information will then be used to populate and tabulate the corresponding tables for their respective DMA classifications.

Table C.1 DMA Classifications

DMA Name or ID	Surface Type(s)[12]	Area (Sq. Ft.)	DMA Type
DMA 1	Mixed Surface Type	658,627	D
DMA 2	Mixed Surface Type	128,502	D
DMA 3	Mixed Surface Type	304,484	D
DMA 4	Mixed Surface Type	492,663	D
DMA 5	Mixed Surface Type	124,146	D
DMA 6	Mixed Surface Type	463,478	D
DMA 7	Mixed Surface Type	3,326,241	D
DMA 8	Mixed Surface Type	714,819	D
DMA 9	Concrete or Asphalt	564,537	D
DMA 10	Mixed Surface Type	3,014,787	D
DMA 11	Mixed Surface Type	1,537,232	D
DMA 12	Mixed Surface Type	471,319	D
DMA 13	Concrete or Asphalt	36,590	D
DMA 14	Ornamental Landscaping	21,780	D
DMA 15	Mixed Surface Type	226,512	D
DMA 16	Mixed Surface Type	228,254	D
DMA 17	Mixed Surface Type	186,436	D
DMA 18	Mixed Surface Type	120,225	D
DMA 19	Mixed Surface Type	117,176	D
DMA 20	Mixed Surface Type	105,415	D
DMA 21	Mixed Surface Type	141,570	D
DMA 22	Concrete or Asphalt	104,544	D
DMA 23	Mixed Surface Type	456,944	D
DMA 24	Concrete or Asphalt	298,821	D
DMA 25	Concrete or Asphalt	65,340	D
DMA 26	Mixed Surface Type	397,702	D
DMA 27	Mixed Surface Type	1,146,934	D
DMA 28	Mixed Surface Type	240,075	D
DMA 29	Concrete or Asphalt	261,360	D
DMA 30	Concrete or Asphalt	36,590	D
DMA 31	Mixed Surface Type	307,098	D
DMA 32	Mixed Surface Type	203,425	D
DMA 33	Mixed Surface Type	211,701	D
DMA 34	Mixed Surface Type	202,554	D
DMA 35	Mixed Surface Type	228,254	D
DMA 36	Mixed Surface Type	273,992	D

[1]Reference Table 2-1 in the WQMP Guidance Document to populate this column
[2]If multi-surface provide back-up

Table C.2 Type 'A', Self-Treating Areas

DMA Name or ID	Area (Sq. Ft.)	Stabilization Type	Irrigation Type (if any)

Table C.3 Type 'B', Self-Retaining Areas

Self-Retaining Area				Type 'C' DMAs that are draining to the Self-Retaining Area		
DMA Name/ ID	Post-project surface type	Area (square feet) [A]	Storm Depth (inches) [B]	DMA Name / ID	[C] from Table C.4 = [C]	Required Retention Depth (inches) [D]

$$[D] = [B] + \frac{[B] \cdot [C]}{[A]}$$

Table C.4 Type 'C', Areas that Drain to Self-Retaining Areas

DMA					Receiving Self-Retaining DMA		
DMA Name/ ID	Area (square feet) [A]	Post-project surface type	Impervious fraction [B]	Product [C] = [A] x [B]	DMA name /ID	Area (square feet) [D]	Ratio [C]/[D]

Table C.5 Type ‘D’, Areas Draining to BMPs

DMA Name or ID	BMP Name or ID	MWS Sizing and Capacity (cfs)
DMA 1	Modular Wetland System	2 - 8’x24’ (1.38) & 1- 8’x16’ (0.462)
DMA 2	Modular Wetland System	1 - 8’x16’ (0.462)
DMA 3	Modular Wetland System	1 - 8’x24’ (0.693) & 1 - 4’x8’ (0.114)
DMA 4	Modular Wetland System	2 - 8'x24' (1.386) 1 - 4'x4' (0.052)
DMA 5	Modular Wetland System	1 - 8'x12' (0.346)
DMA 6	Modular Wetland System	2 - 8'x24' (1.386)
DMA 7	Modular Wetland System	13 - 8'x24' (9.0) & 1 - 4'x17' (0.206)
DMA 8	Modular Wetland System	3 - 8'x24' (2.07)
DMA 9	Modular Wetland System	3 - 8'x24' (2.07) & 1 - 4'x19' (0.237)
DMA 10	Modular Wetland System	12 - 8'x24' (8.316)
DMA 11	Modular Wetland System	6 - 8'x24' (4.15) & 1 - 4'x4' (0.052)
DMA 12	Modular Wetland System	2 - 8'x24' (1.386)
DMA 13	Modular Wetland System	1 - 4'x8' (0.115)
DMA 14	Modular Wetland System	
DMA 15	Modular Wetland System	1 - 8'x24' (0.693)
DMA 16	Modular Wetland System	1 - 8'x24' (0.693)
DMA 17	Modular Wetland System	1 - 8'x20' (0.577)
DMA 18	Modular Wetland System	1 - 8'x12' (0.346)
DMA 19	Modular Wetland System	1 - 8'x12' (0.346)
DMA 20	Modular Wetland System	1 - 8'x12' (0.346)
DMA 21	Modular Wetland System	1 - 8'x16' (0.462)
DMA 22	Modular Wetland System	1 - 8'x16' (0.462)
DMA 23	Modular Wetland System	2 - 8'x24' (1.386)
DMA 24	Modular Wetland System	1 - 8'x24' (0.693) & 1 - 8'x16' (0.577)
DMA 25	Modular Wetland System	1 - 8'x12' (0.346)
DMA 26	Modular Wetland System	1 - 8'x24' (0.693) & 1 - 8'x16' (0.462)
DMA 27	Modular Wetland System	4 - 8'x24' (2.772) & 1 - 8'x16' (0.462)
DMA 28	Modular Wetland System	1 - 8'x24' (0.693) & 1 - 4'x4' (0.052)
DMA 29	Modular Wetland System	1- 8'x24' (0.693) & 1 - 8'x16' (0.462)
DMA 30	Modular Wetland System	1 - 4'x8' (0.115)
DMA 31	Modular Wetland System	1 - 4'x8' (0.115)
DMA 32	Modular Wetland System	1 - 8'x24' (0.693)
DMA 33	Modular Wetland System	1 - 8'x24' (0.693)
DMA 34	Modular Wetland System	1 - 8'x24' (0.693)
DMA 35	Modular Wetland System	1 - 8'x24' (0.693)
DMA 36	Modular Wetland System	1 - 8'x24' (0.692) & 1 - 4'x8' (0.115)

Note: More than one drainage management area can drain to a single LID BMP, however, one drainage management area may not drain to more than one BMP.

Section D: Implement LID BMPs

D.1 Infiltration Applicability

Is there an approved downstream 'Highest and Best Use' for stormwater runoff (see discussion in Chapter 2.4.4 of the WQMP Guidance Document for further details)? ☐ Y ☐ N

If yes has been checked, Infiltration BMPs shall not be used for the site; proceed to section D.3

If no, continue working through this section to implement your LID BMPs. It is recommended that you contact your Co-Permittee to verify whether or not your project discharges to an approved downstream 'Highest and Best Use' feature.

Geotechnical Report

A Geotechnical Report or Phase I Environmental Site Assessment may be required by the Copermittee to confirm present and past site characteristics that may affect the use of Infiltration BMPs. In addition, the Co-Permittee, at their discretion, may not require a geotechnical report for small projects as described in Chapter 2 of the WQMP Guidance Document. If a geotechnical report has been prepared, include it in Appendix 3. In addition, if a Phase I Environmental Site Assessment has been prepared, include it in Appendix 4.

Is this project classified as a small project consistent with the requirements of Chapter 2 of the WQMP Guidance Document? ☐ Y ☒ N

Infiltration Feasibility

Table D.1 below is meant to provide a simple means of assessing which DMAs on your site support Infiltration BMPs and is discussed in the WQMP Guidance Document in Chapter 2.4.5. Check the appropriate box for each question and then list affected DMAs as applicable. If additional space is needed, add a row below the corresponding answer.

Table D.1 Infiltration Feasibility

Does the project site…	YES	NO
…have any DMAs with a seasonal high groundwater mark shallower than 10 feet?		x
If Yes, list affected DMAs:		
…have any DMAs located within 100 feet of a water supply well?		x
If Yes, list affected DMAs:		
…have any areas identified by the geotechnical report as posing a public safety risk where infiltration of stormwater could have a negative impact?		x
If Yes, list affected DMAs:		
…have measured in-situ infiltration rates of less than 1.6 inches / hour?	x	
If Yes, list affected DMAs: DMA's 1 and 2 have observed infiltration rates ranging from 0.1 to 0.5 inches per hour.		
…have significant cut and/or fill conditions that would preclude in-situ testing of infiltration rates at the final infiltration surface?		x
If Yes, list affected DMAs:		
…geotechnical report identify other site-specific factors that would preclude effective and safe infiltration?		x
Describe here:		

If you answered "Yes" to any of the questions above for any DMA, Infiltration BMPs should not be used for those DMAs and you should proceed to the assessment for Harvest and Use below.

D.2 Harvest and Use Assessment

Please check what applies*:*

☒ Reclaimed water will be used for the non-potable water demands for the project.

☐Downstream water rights may be impacted by Harvest and Use as approved by the Regional Board (verify with the Copermittee).

☐The Design Capture Volume will be addressed using Infiltration Only BMPs. In such a case, Harvest and Use BMPs are still encouraged, but it would not be required if the Design Capture Volume will be infiltrated or evapotranspired.

If any of the above boxes have been checked, Harvest and Use BMPs need not be assessed for the site. If none of the above criteria applies, follow the steps below to assess the feasibility of irrigation use, toilet use and other non-potable uses (e.g., industrial use).

Irrigation Use Feasibility

Complete the following steps to determine the feasibility of harvesting stormwater runoff for Irrigation Use BMPs on your site:

Step 1: Identify the total area of irrigated landscape on the site, and the type of landscaping used.

Total Area of Irrigated Landscape: Insert Area (Acres)

Type of Landscaping (Conservation Design or Active Turf): List Landscaping Type

Step 2: Identify the planned total of all impervious areas on the proposed project from which runoff might be feasibly captured and stored for irrigation use. Depending on the configuration of buildings and other impervious areas on the site, you may consider the site as a whole, or parts of the site, to evaluate reasonable scenarios for capturing and storing runoff and directing the stored runoff to the potential use(s) identified in Step 1 above.

Total Area of Impervious Surfaces: Insert Area (Acres)

Step 3: Cross reference the Design Storm depth for the project site (see Exhibit A of the WQMP Guidance Document) with the left column of Table 2-3 in Chapter 2 to determine the minimum area of Effective Irrigated Area per Tributary Impervious Area (EIATIA).

Enter your EIATIA factor: EIATIA Factor

Step 4: Multiply the unit value obtained from Step 3 by the total of impervious areas from Step 2 to develop the minimum irrigated area that would be required.

Minimum required irrigated area: Insert Area (Acres)

Step 5: Determine if harvesting stormwater runoff for irrigation use is feasible for the project by comparing the total area of irrigated landscape (Step 1) to the minimum required irrigated area (Step 4).

Minimum required irrigated area (Step 4)	Available Irrigated Landscape (Step 1)
Insert Area (Acres)	Insert Area (Acres)

Toilet Use Feasibility

Complete the following steps to determine the feasibility of harvesting stormwater runoff for toilet flushing uses on your site:

Step 1: Identify the projected total number of daily toilet users during the wet season, and account for any periodic shut downs or other lapses in occupancy:

Projected Number of Daily Toilet Users: Number of daily Toilet Users

Project Type: Enter 'Residential', 'Commercial', 'Industrial' or 'Schools'

Step 2: Identify the planned total of all impervious areas on the proposed project from which runoff might be feasibly captured and stored for toilet use. Depending on the configuration of buildings and other impervious areas on the site, you may consider the site as a whole, or parts of the site, to evaluate reasonable scenarios for capturing and storing runoff and directing the stored runoff to the potential use(s) identified in Step 1 above.

Total Area of Impervious Surfaces: Insert Area (Acres)

Step 3: Enter the Design Storm depth for the project site (see Exhibit A) into the left column of Table 2-2 in Chapter 2 to determine the minimum number or toilet users per tributary impervious acre (TUTIA).

Enter your TUTIA factor: TUTIA Factor

Step 4: Multiply the unit value obtained from Step 3 by the total of impervious areas from Step 2 to develop the minimum number of toilet users that would be required.

Minimum number of toilet users: Required number of toilet users

Step 5: Determine if harvesting stormwater runoff for toilet flushing use is feasible for the project by comparing the Number of Daily Toilet Users (Step 1) to the minimum required number of toilet users (Step 4).

Minimum required Toilet Users (Step 4)	**Projected number of toilet users (Step 1)**
Insert Area (Acres)	Insert Area (Acres)

Other Non-Potable Use Feasibility

Are there other non-potable uses for stormwater runoff on the site (e.g. industrial use)? See Chapter 2 of the Guidance for further information. If yes, describe below. If no, write N/A.

Insert narrative description here.

Step 1: Identify the projected average daily non-potable demand, in gallons per day, during the wet season and accounting for any periodic shut downs or other lapses in occupancy or operation.

Average Daily Demand: Projected Average Daily Use (gpd)

Step 2: Identify the planned total of all impervious areas on the proposed project from which runoff might be feasibly captured and stored for the identified non-potable use. Depending on the configuration of buildings and other impervious areas on the site, you may consider the site as a whole, or parts of the site, to evaluate reasonable scenarios for capturing and storing runoff and directing the stored runoff to the potential use(s) identified in Step 1 above.

Total Area of Impervious Surfaces: Insert Area (Acres)

Step 3: Enter the Design Storm depth for the project site (see Exhibit A) into the left column of Table 2-4 in Chapter 2 to determine the minimum demand for non-potable uses per tributary impervious acre.

Enter the factor from Table 2-4: Enter Value

Step 4: Multiply the unit value obtained from Step 3 by the total of impervious areas from Step 2 to develop the minimum number of gallons per day of non-potable use that would be required.

Minimum required use: Minimum use required (gpd)

Step 5: Determine if harvesting stormwater runoff for other non-potable use is feasible for the project by comparing the projected average daily use (Step 1) to the minimum required non-potable use (Step 4).

Minimum required non-potable use (Step 4)	**Projected average daily use (Step 1)**
Minimum use required (gpd)	Projected Average Daily Use (gpd)

If Irrigation, Toilet and Other Use feasibility anticipated demands are less than the applicable minimum values, Harvest and Use BMPs are not required and you should proceed to utilize LID Bioretention and Biotreatment per Section 3.4.2 of the WQMP Guidance Document.

D.3 Bioretention and Biotreatment Assessment

Other LID Bioretention and Biotreatment BMPs as described in Chapter 2.4.7 of the WQMP Guidance Document are feasible on nearly all development sites with sufficient advance planning.

Select one of the following:

☒ LID Bioretention/Biotreatment BMPs will be used for some or all DMAs of the project as noted below in Section D.4 (note the requirements of Section 3.4.2 in the WQMP Guidance Document).

☐ A site-specific analysis demonstrating the technical infeasibility of all LID BMPs has been performed and is included in Appendix 5. If you plan to submit an analysis demonstrating the technical infeasibility of LID BMPs, request a pre-submittal meeting with the Copermittee to discuss this option. Proceed to Section E to document your alternative compliance measures.

D.4 Feasibility Assessment Summaries

From the Infiltration, Harvest and Use, Bioretention and Biotreatment Sections above, complete Table D.2 below to summarize which LID BMPs are technically feasible, and which are not, based upon the established hierarchy.

Table D.2 LID Prioritization Summary Matrix

DMA Name/ID	LID BMP Hierarchy				No LID (Alternative Compliance)
	1. Infiltration	2. Harvest and use	3. Bioretention	4. Biotreatment	
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐
	☐	☐	☐	☐	☐

For those DMAs where LID BMPs are not feasible, provide a brief narrative below summarizing why they are not feasible, include your technical infeasibility criteria in Appendix 5, and proceed to Section E below to document Alternative Compliance measures for those DMAs. Recall that each proposed DMA must pass through the LID BMP hierarchy before alternative compliance measures may be considered.

D.5 LID BMP Sizing

Each LID BMP must be designed to ensure that the Design Capture Volume will be addressed by the selected BMPs. First**,** calculate the Design Capture Volume for each LID BMP using the V_{BMP} worksheet in Appendix F of the LID BMP Design Handbook. Second**,** design the LID BMP to meet the required V_{BMP} using a method approved by the Copermittee. Utilize the worksheets found in the LID BMP Design Handbook or consult with your Copermittee to assist you in correctly sizing your LID BMPs. Complete Table D.3 below to document the Design Capture Volume and the Proposed Volume for each LID BMP. Provide the completed design procedure sheets for each LID BMP in Appendix 6. You may add additional rows to the table below as needed.

Table D.3 DCV Calculations for LID BMPs

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Enter BMP Name / Identifier Here*		
	[A]		[B]	[C]	[A] x [C]			
						Design Storm Depth (in)	*Design Capture Volume,* **V_{BMP}** *(cubic feet)*	*Proposed Volume on Plans (cubic feet)*

[B], [C] is obtained as described in Section 2.3.1 of the WQMP Guidance Document

[E] is obtained from Exhibit A in the WQMP Guidance Document

[G] is obtained from a design procedure sheet, such as in LID BMP Design Handbook and placed in Appendix 6

Section E: Alternative Compliance (LID Waiver Program)

LID BMPs are expected to be feasible on virtually all projects. Where LID BMPs have been demonstrated to be infeasible as documented in Section D, other Treatment Control BMPs must be used (subject to LID waiver approval by the Copermittee). Check one of the following Boxes:

☐ LID Principles and LID BMPs have been incorporated into the site design to fully address all Drainage Management Areas. No alternative compliance measures are required for this project and thus this Section is not required to be completed.

- *Or* -

☐ The following Drainage Management Areas are unable to be addressed using LID BMPs. A site-specific analysis demonstrating technical infeasibility of LID BMPs has been approved by the Co-Permittee and included in Appendix 5. Additionally, no downstream regional and/or sub-regional LID BMPs exist or are available for use by the project. The following alternative compliance measures on the following pages are being implemented to ensure that any pollutant loads expected to be discharged by not incorporating LID BMPs, are fully mitigated.

E.1 Identify Pollutants of Concern

Utilizing Table A.1 from Section A above which noted your project's receiving waters and their associated EPA approved 303(d) listed impairments, cross reference this information with that of your selected Priority Development Project Category in Table E.1 below. If the identified General Pollutant Categories are the same as those listed for your receiving waters, then these will be your Pollutants of Concern and the appropriate box or boxes will be checked on the last row. The purpose of this is to document compliance and to help you appropriately plan for mitigating your Pollutants of Concern in lieu of implementing LID BMPs.

Table E.1 Potential Pollutants by Land Use Type

Priority Development Project Categories and/or Project Features (check those that apply)	General Pollutant Categories							
	Bacterial Indicators	Metals	Nutrients	Pesticides	Toxic Organic Compounds	Sediments	Trash & Debris	Oil & Grease
☐ Detached Residential Development	P	N	P	P	N	P	P	P
☐ Attached Residential Development	P	N	P	P	N	P	P	P(2)
☒ Commercial/Industrial Development	P(3)	P	P(1)	P(1)	P(5)	P(1)	P	P
☐ Automotive Repair Shops	N	P	N	N	P(4, 5)	N	P	P
☐ Restaurants (>5,000 ft²)	P	N	N	N	N	N	P	P
☐ Hillside Development (>5,000 ft²)	P	N	P	P	N	P	P	P
☐ Parking Lots (>5,000 ft²)	P(6)	P	P(1)	P(1)	P(4)	P(1)	P	P
☐ Retail Gasoline Outlets	N	P	N	N	P	N	P	P
Project Priority Pollutant(s) of Concern	☐	☒	☒	☒	☒	☒	☒	☒

P = Potential
N = Not Potential
(1) A potential Pollutant if non-native landscaping exists or is proposed onsite; otherwise not expected
(2) A potential Pollutant if the project includes uncovered parking areas; otherwise not expected
(3) A potential Pollutant is land use involving animal waste
(4) Specifically petroleum hydrocarbons
(5) Specifically solvents
(6) Bacterial indicators are routinely detected in pavement runoff

E.2 Stormwater Credits

Projects that cannot implement LID BMPs but nevertheless implement smart growth principles are potentially eligible for Stormwater Credits. Utilize Table 3-8 within the WQMP Guidance Document to identify your Project Category and its associated Water Quality Credit. If not applicable, write N/A.

Table E.2 Water Quality Credits

Qualifying Project Categories	Credit Percentage[2]
Total Credit Percentage[1]	

[1]Cannot Exceed 50%
[2]Obtain corresponding data from Table 3-8 in the WQMP Guidance Document

E.3 Sizing Criteria

After you appropriately considered Stormwater Credits for your project, utilize Table E.3 below to appropriately size them to the DCV, or Design Flow Rate, as applicable. Please reference Chapter 3.5.2 of the WQMP Guidance Document for further information.

Table E.3 Treatment Control BMP Sizing

DMA Type/ID	**DMA Area (square feet)**	**Post-Project Surface Type**	**Effective Impervious Fraction, I_f**	**DMA Runoff Factor**	**DMA Area x Runoff Factor**		***Enter BMP Name / Identifier Here***		
	[A]		[B]	[C]	[A] x [C]				
						Design Storm Depth (in)	*Minimum Design Capture Volume or Design Flow Rate (cubic feet or cfs)*	*Total Storm Water Credit % Reduction*	*Proposed Volume or Flow on Plans (cubic feet or cfs)*
	$A_T = \Sigma[A]$				$\Sigma= [D]$	[E]	$[F] = \frac{[D]x[E]}{[G]}$	[F] X (1-[H])	[I]

[B], [C] is obtained as described in Section 2.3.1 from the WQMP Guidance Document
[E] is for Flow-Based Treatment Control BMPs [E] = .2, for Volume-Based Control Treatment BMPs, [E] obtained from Exhibit A in the WQMP Guidance Document
[G] is for Flow-Based Treatment Control BMPs [G] = 43,560, for Volume-Based Control Treatment BMPs, [G] = 12
[H] is from the Total Credit Percentage as Calculated from Table E.2 above
[I] as obtained from a design procedure sheet from the BMP manufacturer and should be included in Appendix 6

E.4 Treatment Control BMP Selection

Treatment Control BMPs typically provide proprietary treatment mechanisms to treat potential pollutants in runoff, but do not sustain significant biological processes. Treatment Control BMPs must have a removal efficiency of a medium or high effectiveness as quantified below:

- **High**: equal to or greater than 80% removal efficiency
- **Medium**: between 40% and 80% removal efficiency

Such removal efficiency documentation (e.g., studies, reports, etc.) as further discussed in Chapter 3.5.2 of the WQMP Guidance Document, must be included in Appendix 6. In addition, ensure that proposed Treatment Control BMPs are properly identified on the WQMP Site Plan in Appendix 1.

Table E.4 Treatment Control BMP Selection

Selected Treatment Control BMP Name or ID[1]	Priority Pollutant(s) of Concern to Mitigate[2]	Removal Efficiency Percentage[3]

[1] Treatment Control BMPs must not be constructed within Receiving Waters. In addition, a proposed Treatment Control BMP may be listed more than once if they possess more than one qualifying pollutant removal efficiency.
[2] Cross Reference Table E.1 above to populate this column.
[3] As documented in a Co-Permittee Approved Study and provided in Appendix 6.

Section F: Hydromodification

F.1 Hydrologic Conditions of Concern (HCOC) Analysis

Once you have determined that the LID design is adequate to address water quality requirements, you will need to assess if the proposed LID Design may still create a HCOC. Review Chapters 2 and 3 (including Figure 3-7) of the WQMP Guidance Document to determine if your project must mitigate for Hydromodification impacts. If your project meets one of the following criteria which will be indicated by the check boxes below, you do not need to address Hydromodification at this time. However, if the project does not qualify for Exemptions 1, 2 or 3, then additional measures must be added to the design to comply with HCOC criteria. This is discussed in further detail below in Section F.2.

HCOC EXEMPTION 1: The Priority Development Project disturbs less than one acre. The Copermittee has the discretion to require a Project-Specific WQMP to address HCOCs on projects less than one acre on a case by case basis. The disturbed area calculation should include all disturbances associated with larger common plans of development.

Does the project qualify for this HCOC Exemption? ☐ Y ☐ N

If Yes, HCOC criteria do not apply.

HCOC EXEMPTION 2: The volume and time of concentration[1] of storm water runoff for the post-development condition is not significantly different from the pre-development condition for a 2-year return frequency storm (a difference of 5% or less is considered insignificant) using one of the following methods to calculate:

- Riverside County Hydrology Manual
- Technical Release 55 (TR-55): Urban Hydrology for Small Watersheds (NRCS 1986), or derivatives thereof, such as the Santa Barbara Urban Hydrograph Method
- Other methods acceptable to the Co-Permittee

Does the project qualify for this HCOC Exemption? ☐ Y ☐ N

If Yes, report results in Table F.1 below and provide your substantiated hydrologic analysis in Appendix 7.

Table F.1 Hydrologic Conditions of Concern Summary

	2 year – 24 hour		
	Pre-condition	**Post-condition**	**% Difference**
Time of Concentration	INSERT VALUE	INSERT VALUE	INSERT VALUE
Volume (Cubic Feet)	INSERT VALUE	INSERT VALUE	INSERT VALUE

[1] Time of concentration is defined as the time after the beginning of the rainfall when all portions of the drainage basin are contributing to flow at the outlet.

HCOC EXEMPTION 3: All downstream conveyance channels to an adequate sump (for example, Prado Dam, Lake Elsinore, Canyon Lake, Santa Ana River, or other lake, reservoir or naturally erosion resistant feature) that will receive runoff from the project are engineered and regularly maintained to ensure design flow capacity; no sensitive stream habitat areas will be adversely affected; or are not identified on the Co-Permittees Hydromodification Susceptibility Maps.

Does the project qualify for this HCOC Exemption? ☐ Y ☐ N

If Yes, HCOC criteria do not apply and note below which adequate sump applies to this HCOC qualifier:

INSERT TEXT HERE

F.2 HCOC Mitigation

If none of the above HCOC Exemption Criteria are applicable, HCOC criteria is considered mitigated if they meet one of the following conditions:

a. Additional LID BMPS are implemented onsite or offsite to mitigate potential erosion or habitat impacts as a result of HCOCs. This can be conducted by an evaluation of site-specific conditions utilizing accepted professional methodologies published by entities such as the California Stormwater Quality Association (CASQA), the Southern California Coastal Water Research Project (SCCRWP), or other Co-Permittee approved methodologies for site-specific HCOC analysis.

b. The project is developed consistent with an approved Watershed Action Plan that addresses HCOC in Receiving Waters.

c. Mimicking the pre-development hydrograph with the post-development hydrograph, for a 2-year return frequency storm. Generally, the hydrologic conditions of concern are not significant, if the post-development hydrograph is no more than 10% greater than pre-development hydrograph. In cases where excess volume cannot be infiltrated or captured and reused, discharge from the site must be limited to a flow rate no greater than 110% of the pre-development 2-year peak flow.

Be sure to include all pertinent documentation used in your analysis of the items a, b or c in Appendix 7.

Section G: Source Control BMPs

Source control BMPs include permanent, structural features that may be required in your project plans — such as roofs over and berms around trash and recycling areas — and Operational BMPs, such as regular sweeping and "housekeeping", that must be implemented by the site's occupant or user. The MEP standard typically requires both types of BMPs. In general, Operational BMPs cannot be substituted for a feasible and effective permanent BMP. Using the Pollutant Sources/Source Control Checklist in Appendix 8, review the following procedure to specify Source Control BMPs for your site:

1. ***Identify Pollutant Sources***: Review Column 1 in the Pollutant Sources/Source Control Checklist. Check off the potential sources of Pollutants that apply to your site.

2. ***Note Locations on Project-Specific WQMP Exhibit***: Note the corresponding requirements listed in Column 2 of the Pollutant Sources/Source Control Checklist. Show the location of each Pollutant source and each permanent Source Control BMP in your Project-Specific WQMP Exhibit located in Appendix 1.

3. ***Prepare a Table and Narrative***: Check off the corresponding requirements listed in Column 3 in the Pollutant Sources/Source Control Checklist. In the left column of Table G.1 below, list each potential source of runoff Pollutants on your site (from those that you checked in the Pollutant Sources/Source Control Checklist). In the middle column, list the corresponding permanent, Structural Source Control BMPs (from Columns 2 and 3 of the Pollutant Sources/Source Control Checklist) used to prevent Pollutants from entering runoff. **Add additional narrative** in this column that explains any special features, materials or methods of construction that will be used to implement these permanent, Structural Source Control BMPs.

4. ***Identify Operational Source Control BMPs:*** To complete your table, refer once again to the Pollutant Sources/Source Control Checklist. List in the right column of your table the Operational BMPs that should be implemented as long as the anticipated activities continue at the site. Copermittee stormwater ordinances require that applicable Source Control BMPs be implemented; the same BMPs may also be required as a condition of a use permit or other revocable Discretionary Approval for use of the site.

Table G.1 Permanent and Operational Source Control Measures

Potential Sources of Runoff pollutants	Permanent Structural Source Control BMPs	Operational Source Control BMPs
On-site storm drain inlets	Mark all inlets with the words "Only Rain Down the Storm Drain" or similar. Catch Basin Makers may be available from the Riverside County Flood Control and Water Conservation District, call 951.955.1200 to verify.	Maintain and periodically repaint or replace inlet markings. Provide stormwater pollution prevention information to new site owners, lessees, or operators. See applicable operational BMPs in Fact Sheet SC-44, "Drainage System Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com Include the following in lease agreements: "Tenant shall not allow

		anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains.”
Landscape/Outdoor Pesticide Use	Preserve, existing native trees, shrubs, and ground cover to the maximum extent possible. Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution. Where landscaping areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions. Consider using pest-resistant plants, especially to hardscape. To insure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.	Maintain landscaping using minimum or no pesticides. See applicable operation BMPs in “What you show know for Landscaping and Gardening” Provide IPM information to new owners, lessees and operators.
Food Service		
Refuse Areas		
Industrial processes		
Fire Sprinkler Test Water	Provide a means to drain fire sprinkler test water to the sanitary sewer	See the note in Fact Sheet SC-41, “Building and Grounds Maintenance,” in the CASQA Stormwater Quality Handbooks at www. Cabmphandbooks.com
Plazas, sidewalks, and parking lots		

Section H: Construction Plan Checklist

Populate Table H.1 below to assist the plan checker in an expeditious review of your project. The first two columns will contain information that was prepared in previous steps, while the last column will be populated with the corresponding plan sheets. This table is to be completed with the submittal of your final Project-Specific WQMP.

Table H.1 Construction Plan Cross-reference

BMP No. or ID	BMP Identifier and Description	Corresponding Plan Sheet(s)	BMP Location (Lat/Long)

Note that the updated table — or Construction Plan WQMP Checklist — is **only a reference tool** to facilitate an easy comparison of the construction plans to your Project-Specific WQMP. Co-Permittee staff can advise you regarding the process required to propose changes to the approved Project-Specific WQMP.

Section I: Operation, Maintenance and Funding

The Copermittee will periodically verify that Stormwater BMPs on your site are maintained and continue to operate as designed. To make this possible, your Copermittee will require that you include in Appendix 9 of this Project-Specific WQMP:

1. A means to finance and implement facility maintenance in perpetuity, including replacement cost.
2. Acceptance of responsibility for maintenance from the time the BMPs are constructed until responsibility for operation and maintenance is legally transferred. A warranty covering a period following construction may also be required.
3. An outline of general maintenance requirements for the Stormwater BMPs you have selected.
4. Figures delineating and designating pervious and impervious areas, location, and type of Stormwater BMP, and tables of pervious and impervious areas served by each facility. Geo-locating the BMPs using a coordinate system of latitude and longitude is recommended to help facilitate a future statewide database system.
5. A separate list and location of self-retaining areas or areas addressed by LID Principles that do not require specialized O&M or inspections but will require typical landscape maintenance as noted in Chapter 5, pages 85-86, in the WQMP Guidance. Include a brief description of typical landscape maintenance for these areas.

Your local Co-Permittee will also require that you prepare and submit a detailed Stormwater BMP Operation and Maintenance Plan that sets forth a maintenance schedule for each of the Stormwater BMPs built on your site. An agreement assigning responsibility for maintenance and providing for inspections and certification may also be required.

Details of these requirements and instructions for preparing a Stormwater BMP Operation and Maintenance Plan are in Chapter 5 of the WQMP Guidance Document.

Maintenance Mechanism: POA

Will the proposed BMPs be maintained by a Home Owners' Association (HOA) or Property Owners Association (POA)?

☒ Y ☐ N

Include your Operation and Maintenance Plan and Maintenance Mechanism in Appendix 9. Additionally, include all pertinent forms of educational materials for those personnel that will be maintaining the proposed BMPs within this Project-Specific WQMP in Appendix 10.

Appendix 1: Maps and Site Plans

Location Map, WQMP Site Plan and Receiving Waters Map

LEGEND

- TRACT BOUNDARY
- NAP — NOT A PART
- DRAINAGE MANAGEMENT AREA (DMA) LIMITS
- DMA / ACRE — DMA DESIGNATION AND ACREAGE
- PROJECT FLOW DIRECTION
- OFFSITE FLOW DIRECTION
- PROPOSED STORM DRAIN SYSTEM
- PROJECT CATCH BASIN
- BUILDING OUTLINE AREA
- OPEN SPACE/LANDSCAPE AREAS
- MODULAR WETLAND SYSTEM
- PROPOSED WATER QUALITY
- PROPOSED DRAINAGE BASIN

DMA Name or ID	BMP Name or ID	MWS Sizing and Capacity (cfs)
DMA 1	Modular Wetland System	2 - 8'x24' (1.38) & 1- 8'x16' (0.462)
DMA 2	Modular Wetland System	1 - 8'x16' (0.462)
DMA 3	Modular Wetland System	1 - 8'x24' (0.693) & 1 - 4'x8' (0.114)
DMA 4	Modular Wetland System	2 - 8'x24' (1.386) 1 - 4'x4' (0.052)
DMA 5	Modular Wetland System	1 - 8'x12' (0.346)
DMA 6	Modular Wetland System	2 - 8'x24' (1.386)
DMA 7	Modular Wetland System	13 - 8'x24' (9.0) & 1 - 4'x17' (0.206)
DMA 8	Modular Wetland System	3 - 8'x24' (2.07)
DMA 9	Modular Wetland System	3 - 8'x24' (2.07) & 1 - 4'x19' (0.237)
DMA 10	Modular Wetland System	12 - 8'x24' (8.316)
DMA 11	Modular Wetland System	6 - 8'x24' (4.15) & 1 - 4'x4' (0.052)
DMA 12	Modular Wetland System	2 - 8'x24' (1.386)
DMA 13	Modular Wetland System	1 - 4'x8' (0.115)
DMA 14	Modular Wetland System	
DMA 15	Modular Wetland System	1 - 8'x24' (0.693)
DMA 16	Modular Wetland System	1 - 8'x24' (0.693)
DMA 17	Modular Wetland System	1 - 8'x20' (0.577)
DMA 18	Modular Wetland System	1 - 8'x12' (0.346)
DMA 19	Modular Wetland System	1 - 8'x12' (0.346)
DMA 20	Modular Wetland System	1 - 8'x12' (0.346)
DMA 21	Modular Wetland System	1 - 8'x16' (0.462)
DMA 22	Modular Wetland System	1 - 8'x16' (0.462)
DMA 23	Modular Wetland System	2 - 8'x24' (1.386)
DMA 24	Modular Wetland System	1 - 8'x24' (0.693) & 1 - 8'x16' (0.577)
DMA 25	Modular Wetland System	1 - 8'x12' (0.346)
DMA 26	Modular Wetland System	1 - 8'x24' (0.693) & 1 - 8'x16' (0.462)
DMA 27	Modular Wetland System	4 - 8'x24' (2.772) & 1 - 8'x16' (0.462)
DMA 28	Modular Wetland System	1 - 8'x24' (0.693) & 1 - 4'x4' (0.052)
DMA 29	Modular Wetland System	1- 8'x24' (0.693) & 1 - 8'x16' (0.462)
DMA 30	Modular Wetland System	1 - 4'x8' (0.115)
DMA 31	Modular Wetland System	1 - 4'x8' (0.115)
DMA 32	Modular Wetland System	1 - 8'x24' (0.693)
DMA 33	Modular Wetland System	1 - 8'x24' (0.693)
DMA 34	Modular Wetland System	1 - 8'x24' (0.693)
DMA 35	Modular Wetland System	1 - 8'x24' (0.693)
DMA 36	Modular Wetland System	1 - 8'x24' (0.692) & 1 - 4'x8' (0.115)

GRAPHIC SCALE
0 175 350 700
(IN FEET)
1 INCH = 350 FT.

PRELIMINARY
WATER QUALITY MANAGEMENT PLAN
SITE PLAN

APPLICANT:
RICHLAND
3161 MICHELSON DRIVE, SUITE 425
IRVINE, CA 92612
(949) 261-7010

PREPARED BY:
HUNSAKER & ASSOCIATES
IRVINE, INC.
PLANNING • ENGINEERING • SURVEYING
Three Hughes • Irvine, CA 92618 • PH: (949) 583-1010 • FX: (949) 583-0759

"STONERIDGE INDUSTRIAL"
TENTATIVE TRACT MAP NO. TBD
SOUTHEAST OF RAMONA EXPRESSWAY AND EAST RIDER STREET
COUNTY OF RIVERSIDE, CA

DRAFTED BY: TIH	DATE: 06/03/2020	W.O. NO: 3763-7	SHEET NO: 1 OF 1

DATE: Jun. 03, 2020 03:25:31 PM FILE: C:\Users\jake\Desktop\Stoneridge\WQMP\PWQMP_SP STONERIDGE.dwg

Appendix 2: Construction Plans

Grading and Drainage Plans

Appendix 3: Soils Information

Geotechnical Study and Other Infiltration Testing Data

LGC Geotechnical, Inc.

September 12, 2019 Project No: 13092-01

Mr. Brian Hardy
Richland Communities, Inc.
3161 Michelson Drive, Suite 425
Irvine, CA 92626

Subject: ***Updated Geotechnical Evaluation, Proposed "Stoneridge" Industrial and Mixed-Use Development, Tentative Tract Map No. 32372, Unincorporated Area of Riverside County, California***

In accordance with your request and authorization, LGC Geotechnical, Inc. has performed an updated geotechnical evaluation for the proposed "Stoneridge" industrial and mixed-use development, Tentative Tract Map No. 32372, located in an unincorporated area of Riverside County, California. The purpose of our study was to evaluate the existing onsite geotechnical conditions, confirm that the site can be developed from a geotechnical perspective, and provided updated recommendations regarding the proposed design.

Should you have any questions regarding this report, please do not hesitate to contact our office. We appreciate this opportunity to be of service.

Respectfully Submitted,

LGC Geotechnical, Inc.

Ryan Douglas, RCE 84840
Project Engineer

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Appendices

1.0 INTRODUCTION

1.1 Purpose and Scope of Services

This report presents the results of our updated geotechnical evaluation for the proposed "Stoneridge" industrial and mixed-use development, Tentative Tract Map No. 32372, located in an unincorporated area of Riverside County, California. The conclusions and recommendations included herein supersede those provided in our previous reports (LGC Geotechnical, 2017a & 2017b).

The purpose of our study was to evaluate the existing onsite geotechnical conditions, confirm that the site can be developed from a geotechnical perspective, and provided updated recommendations regarding the proposed design. Our services consisted of a limited subsurface geotechnical evaluation and review of previous geotechnical reports, preliminary site plans and readily available geotechnical information including in-house maps and reports.

1.2 Existing Conditions

The proposed "Stoneridge" industrial/mixed use development includes multiple undeveloped parcels equaling approximately 680-acres. The irregular-shaped site is located approximately 4 miles east of Interstate-215 and just south of Ramona Expressway (see Figure 1 – Site Location Map). In general, the site is bound to the north by Ramona Expressway, to the east by undeveloped land associated with the San Jacinto River floodplains, to the south by Nuevo Road, and to the west by undeveloped land. The site is generally situated along the eastern flank of some relatively small hills associated with plutonic rocks of the Peninsular Ranges geomorphic province. In general, the site gently slopes southeast toward the San Jacinto River. Topographically, the elevations on the site range from approximately 1420 feet above mean sea level (msl) in the east portion of the site to approximately 1630 feet above msl in the northwest portion of the site.

1.3 Background and Project Description

Previously the subject site was proposed for a mixed-use development, featuring commercial spaces, 781 single-family residential lots of medium/medium high density, a sports park, trails, open space, water quality basins and associated street improvements. A portion of the subject site was evaluated with regards to the first phase of the previously proposed development (LGC Geotechnical, 2017a) which would have included approximately 285 single-family residential lots, interior roadways, a detention basin and other associated improvements. The previous subsurface evaluation consisted of the excavation of thirteen hollow-stem auger borings (HS-1 through HS-13), ten backhoe test pits (T-1 through T-10), and eleven cone penetration tests (CPT-1 through CPT-11) to evaluate onsite geotechnical conditions.

The approximate locations of all the borings, test pits, and cone penetration tests are included on the Geotechnical Map (Sheets 1 through 3). Exploratory boring, test pit, and cone penetration test logs are presented in Appendix B and laboratory test results are included in Appendix C.

Based on our review of the updated site plan prepared by Architects Orange (2019), the proposed industrial and mixed-use development of the subject site includes the construction of approximately 20 industrial buildings with footprints up to approximately 1,700,000 square feet (sf) and several lots for mixed-use development including a hotel, retail buildings, multi-tenant commercial buildings, commercial buildings and retail/business park lots. In addition, it is our understanding that site development will include the construction of underground utilities, streets, parking areas, open space, conservation areas and water quality basins.

Maximum design cuts and fills are anticipated to be on the order of approximately 60 and 35 feet, respectively. Additionally, the maximum design cut and fill slope heights are both anticipated to be on the order of approximately 90 feet.

1.4 ***Subsurface Geotechnical Evaluation***

LGC Geotechnical performed a subsurface geotechnical evaluation of the subject site consisting of the excavation of twelve hollow-stem auger borings, twelve backhoe test pits, thirteen cone penetration tests, and two infiltration tests to evaluate onsite geotechnical conditions of areas not previously evaluated. In addition, five seismic fraction lines were performed in the northwestern portion of the site to evaluate the potential for near surface hard rock.

Twelve hollow-stem borings (HS-14 through HS-25) were drilled by 2R Drilling under subcontract to LGC Geotechnical. The total depth drilled of the hollow-stem borings ranged from approximately 20 to 50 feet below existing grade. An LGC Geotechnical representative observed the drilling operations, logged the borings, and collected soil samples for laboratory testing. The borings were excavated using a truck mounted drill rig equipped with 8-inch-diameter hollow-stem augers. Driven soil samples were collected by means of the Standard Penetration Test (SPT) and Modified California Drive (MCD) sampler. Samples were generally obtained at 2.5-foot vertical increments in the upper ten feet and at 5-foot vertical increments below ten feet. The MCD is a split-barrel sampler with a tapered cutting tip and lined with a series of 1-inch-tall brass rings. The SPT sampler and MCD sampler were driven using a 140-pound automatic hammer falling 30 inches to advance the sampler a total depth of 18 inches or until refusal. The blow counts for each 6-inch increment of penetration were recorded on the boring logs. Bulk samples were also collected and logged at select depths for laboratory testing. At the completion of drilling the borings were backfilled with cuttings.

Twelve exploratory test pits (T-11 through T-22) were excavated, sampled, and logged to depths ranging from approximately 5 to 10 feet below the existing ground surface. The test pits were geotechnically logged and sampled by a representative of LGC Geotechnical, Inc. Soil descriptions are presented in the test pit logs, which are included in Appendix B. The test pit excavations were backfilled and compacted with the excavated materials to the ground surface. Please note that some settlement of the backfill may occur over time and the excavations should be topped off as needed.

Thirteen Cone Penetration Test (CPT) soundings (CPT-12 through CPT-24) were performed by Gregg Drilling & Testing, Inc. under subcontract with LGC Geotechnical. The CPT probe was pushed to target depths or refusal at each test location in general accordance with the current ASTM standards (ASTM D5778 and ASTM D3441). The CPT equipment consists of a cone penetrometer assembly mounted at the end of a series of hollow sounding rods. The interior of the cone penetrometer is instrumented with strain gauges that allow the simultaneous measurement of cone tip and friction sleeve resistance during penetration. The cone penetration assembly is continuously pushed into the soil by a set of hydraulic rams at a standard rate of approximately 0.8-inch per second while the cone tip resistance and sleeve friction resistance are recorded at approximately every 2 inches and stored in digital form. A specially designed all-wheel drive 25-ton truck provides the required reaction weight for pushing the cone assembly.

Two additional borings (I-1 and I-2) were excavated to approximately 10 and 5 feet below the existing ground surface, respectively. Subsequent to excavation, the borings were converted into infiltration test wells. Test well installation consisted of placing a 3-inch diameter perforated PVC pipe in each excavated borehole and backfilling the annulus with crushed rock including the placement of approximately 2 inches of crushed rock at the bottom of each borehole. Infiltration testing was performed in accordance with guidelines set forth by the County of Riverside (2011). The PVC pipes were removed and the holes were subsequently backfilled with native soils at the completion of testing.

The five seismic refraction lines (S-1 through S-5) were performed by Terra Geosciences in order to assess the general seismic velocity characteristics of the underlying bedrock materials with regards to rippability during grading. The seismic refraction lines were performed in proposed cut areas with dense bedrock and line lengths were maximized based on access and topography in order to achieve anticipated maximum cut depths. The line lengths were on the order of approximately 150 feet which resulted in a maximum obtainable depth of approximately 60 feet below existing ground.

The approximate locations of borings, trenches, CPTs, infiltration tests, and seismic lines are presented on the Geotechnical Map (Sheets 1 through 3). Boring logs, test pit logs, and CPT outputs are presented in Appendix B. Laboratory test results are presented in Appendix C. A report summarizing the findings and conclusions of the seismic refraction lines is presented in Appendix D.

1.5 <u>Laboratory Testing</u>

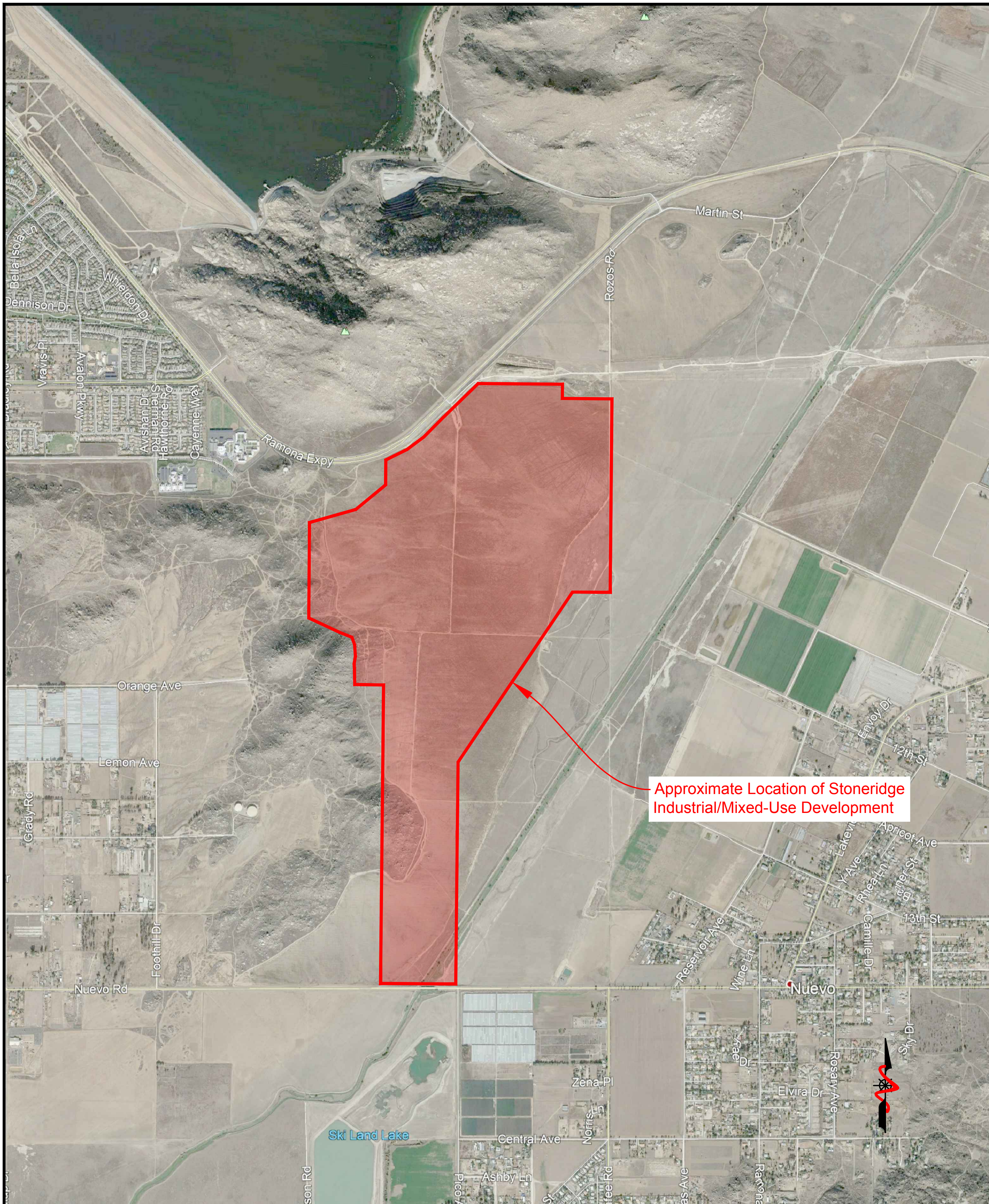
Representative samples were retained for laboratory testing during our field evaluation. Laboratory testing included in-situ moisture and density tests, fines content/sieve analysis, Atterberg Limits (liquid limit and plastic limits), consolidation, collapse/swell, direct shear, expansion index, laboratory compaction and corrosion (sulfate, chloride content, pH, and minimum resistivity).

The following is a brief summary of the laboratory test results:

- Dry density of the samples collected ranged from approximately 100 pounds per cubic foot (pcf) to 137 pcf, with an average of 124 pcf. Field moisture contents ranged from approximately 1 to 39 percent, with an average of 6 percent.
- Twelve fines content tests were performed and indicated fines contents (passing No. 200 sieve) ranging from 8 to 39 percent. Based on the Unified Soils Classification System (USCS), the tested samples range from "coarse-grained".

- Three Atterberg Limit (liquid limit and plastic limit) tests were performed. Results indicated a Plasticity Index (PI) values of NP (not plastic), 4 and 14.
- Two consolidation tests were performed. The load versus deformation plots are provided in Appendix C.
- Four collapse/swell tests were performed. The load versus deformation plots are provided in Appendix C.
- Eight laboratory compaction test of near surface samples were performed. Results are presented in Appendix C.
- Expansion potential testing indicated expansion index values ranging from 0 to 33, corresponding to "Very Low" to "Low" expansion potential.
- Four direct shear tests were performed. Plots are presented in Appendix C.
- Corrosion testing indicated soluble sulfate content less than 0.02 percent, chloride contents ranging from approximately 31 to 104 parts per million (ppm), pH values ranging from approximately 5.78 to 7.90, and minimum resistivity values of approximately 1,146 to 15,000 ohm-cm.

A summary of the laboratory test results is presented in Appendix C. The moisture and dry density results are presented on the boring logs in Appendix B.



LGC Geotechnical, Inc.

FIGURE 1
Site Location Map

PROJECT NAME	Stoneridge
PROJECT NO.	13092-01
ENG. / GEOL.	RLD / KAD
SCALE	Not to Scale
DATE	September 2019

2.0 GEOTECHNICAL CONDITIONS

2.1 Regional Geology

The property is regionally located in the Peninsular Ranges geomorphic province which extends from the Los Angeles Basin south to Baja California. The province is characterized by numerous southwest trending mountain ranges and valleys that are geologically controlled by a series of paralleling major active faults. More specifically, the site is located in the northern portion of the Perris block which is bordered to the northeast by the San Jacinto Fault Zone and to the southwest by the Chino/Elsinore Fault Zone. The Peninsular Ranges batholith is comprised of Cretaceous aged plutonic rocks mainly of tonalitic composition. Near the site, the plutonic rocks are associated with the Lakeview Mountain Pluton which primarily consists of biotite-hornblende tonalite characterized by ubiquitous schlieren and the lack of potassium feldspar (CGS, 2003). The site is situated on the western margin of an alluvial flood plain associated with the San Jacinto River. Most of the alluvial areas west of the San Jacinto River consists of Pleistocene age fluvial deposits similar to those observed at the subject site. These alluvial materials generally form the large area flanking the Perris Valley and the west side of the San Jacinto River Valley.

2.2 Site-Specific Geology

Based on the Geologic Map of the 7.5-foot Perris Quadrangle (CGS, 2003) the subject site is underlain by Very Old Fan Deposits of the late Pleistocene. In addition, Lakeview Mountain plutonic bedrock is present along and adjacent to the western boundary of the subject site. The presence of some minor amounts of artificial fill (not mapped) associated with existing "dirt" roadway construction and past agricultural uses should be anticipated. The approximate lateral limits of the geologic units are depicted on the Geotechnical Map (Sheets 1 through 3).

2.2.1 Quaternary Very Old Fan Deposits (Map Symbol - Qvof)

Quaternary Very Old Fan deposits generally flank steep bedrock slopes and consist of reddish brown, well indurated sand deposits (CGS, 2003). During our subsurface field evaluation, these deposits were observed to generally consist of brown, gray brown, and reddish-brown sand, silty sand and clayey sand. The upper approximately 1-foot of the alluvial material was observed to be desiccated and contained rootlets.

2.2.2 Cretaceous Lakeview Mountain Tonalite (Map Symbol – Klmt)

The Lakeview Mountain Tonalite is descried as a medium to coarse grained biotite-hornblende tonalite with an absence of potassium (alkali) feldspar (CGS, 2003). During our subsurface field evaluation, these materials were observed to generally be gray to brown, medium to coarse grained rock with abundant hornblende and biotite. The bedrock ranged from moderately to slightly weathered.

2.3 Geologic Structure

Both the Quaternary Old Fan deposits and the Cretaceous Lake View Mountain Tonalite were observed to be massive and lacking any significant geologic structure during our subsurface exploration.

2.4 Groundwater

Groundwater was not encountered during our subsurface field evaluation to the maximum explored depth of approximately 50 feet below existing ground. Based on nearby available well data (CDWR, 2018), recent high groundwater for Well 337981N1171695W001 south of the subject site was measured at an elevation of approximately 1357 feet above mean sea level (msl) in March of 2013. This corresponds to depth of approximately 63 below existing grades in the southeastern (lowest) portion of the subject site.

Seasonal fluctuations of groundwater elevations should be expected over time. In general, groundwater levels fluctuate with the seasons and local zones of perched groundwater may be present within the near-surface deposits due to local seepage or during rainy seasons. Local perched groundwater conditions or surface seepage may develop once site development is completed and landscape irrigation commences.

2.5 Landslides, Debris Flows and Rock Falls

Review of readily available geologic resources and field observations of the surficial conditions do not indicate the presence of landslides on the site or in the immediate vicinity. In general, the site consists of relatively flat-lying very old fan deposits which are not considered susceptible to landslides, seismically-induced landslides, or other mass wasting processes (debris flows, rockfalls, etc.).

In general, the cause of debris flows is a combination of heavy rainfall, loose soil, and steep slope conditions. Based on reviewed documents (USGS, 1975 and Weber, 1979), debris flows have the potential to occur on slopes that have a gradient steeper than approximately 18 degrees which is approximately equivalent to a 3:1 (horizontal to vertical) slope ratio. Debris flows are most common and have higher flow velocity on slopes with gradients ranging from approximately 2:1 to 1:1 (horizontal to vertical). Generally, the steeper the slope, the more prone it is to developing a fast moving, violent debris flow. In addition, debris flows generally begin at drainage heads where there is a concentration of water during heavy rainfall. Approximately 2:1 (horizontal to vertical) cut and fill slopes are proposed for the "Stoneridge" industrial and mixed-use development. Cut and fill slopes will consist of either hard Lakeview Tonalite Bedrock or dense compacted fill soils, respectfully. These slopes are considered surficially stable as long as they are designed and constructed with proper surface drainage (purview of civil engineer) and are properly maintained after construction. Therefore, it is our opinion that the potential for the development of a rapid debris flow event on a slope associated with or adjacent to the proposed development is considered very low.

A rockfall is a fragment of rock, or block of rocks, that detaches from a vertical to sub-vertical cliff or bluff in a downward motion. Boulder outcrops are present within the subject site along the western boundary. The natural slopes along the western boundary, where outcrops are observed, generally have a slope gradient of 3:1 (horizontal to vertical) or shallower. During grading a majority of the western boundary will be cut in order to produce an approximately 2:1 (vertical to horizontal) slope exposing dense Lakeview Tonalite Bedrock. Due to the shallow slope gradients of the existing slopes and proposed manufactured slopes, the potential for rockfalls to impact the proposed development is considered low. Loose boulders and/or "corestones" at or near design grade should be removed during slope grading in order to further mitigate potential rockfalls.

2.6 Seiche

A seiche is an underwater wave that oscillates through a body of water which may be triggered by earthquakes or landslides. In general, seiches are small (on the order of a few inches) and are present in larger lakes as a result of the depth, temperature, and contours of the body of water. Due to the lack of an onsite body of water the potential for the subject site to be impacted by seiches is considered low.

2.7 Subsidence

Per the County Interactive Geographic Information Services (RCIT, 2019), the proposed development is located within an area considered to be potentially susceptible to subsidence. A specific ground subsidence evaluation was previously performed by Western Technologies, Inc. (1990) due to the observation of well-defined fissures within and nearby the subject site. Based on the report prepared by Western Technologies (1990), the observed fissure was located in the eastern central portion of the proposed development and trended approximately north-south, near parallel with the San Jacinto River. Previous subsurface evaluations found that the observed fissure extended to a maximum depth of approximately 17 feet below the existing ground surface (Aragon, 1989). Aerial photograph review indicated that the fissure "daylighted" to the surface relatively rapidly between 1974 to 1976 and has been followed by a slower rate of modification since that time (Western, 1990). In addition, it was concluded that the observed fissuring is a result of localized subsidence from the horizontal shrinkage of fine-grained clayey floodplain sediments induced by historic groundwater withdrawal (Western, 1990). In general, potential constraints on the proposed development from the existing fissure may be mitigated utilizing specialized grading techniques, geotextile reinforcement, and requiring post-tension/stiffened building foundations within 25 feet of the existing fissure (Western, 1990).

Based on Figure No. 1 from the subsidence evaluation report (Western, 1990), at its closest the proposed industrial and mixed-use Stoneridge development is located approximately 700 feet northwest of the subject fissure (see Sheet 2 of 3 for approximate fissure location). Therefore, the observed fissure does not significantly impact the proposed development. However, if additional well-defined fissures are observed prior to or during grading operations, the geotechnical consultant of record should provide specific recommendations in order to mitigate any potential impact on the development. As mentioned above, recommendations for mitigation may consist of specialized grading techniques, geotextile reinforcement, and/or post-tension/stiffened foundations within the immediate area of an observed fissure. Recommendations should be provided on a case by case basis based on the subsurface conditions encountered during grading operations and proximity to proposed improvements.

As described on the county website, subsidence on a much larger regional scale is possible if groundwater resources are not managed properly. Mitigation against such a large-scale groundwater drawdown cannot be done by means of typical grading or construction methods within the limits of the proposed project, but instead "requires regional cooperation among all agencies" and, therefore, is not a site-specific geotechnical consideration. Based on our review, it appears that the majority of the areas located within the Lakeview Basin comprised of alluvial deposits are considered potentially susceptible to subsidence (RCIT, 2019). Surveys performed across the Lakeview Basin since 1967 indicate that regional subsidence is most likely continuing at a very slow and decreasing rate (Western, 1990). Thus, based on current conditions, the potential impact of regional subsidence on the proposed development is considered very low.

2.8 Field Infiltration Testing

Two field percolation tests were performed on Borings I-1 and I-2 to approximate depths of 10 and 5 feet below existing grade, respectively. Estimation of infiltration rates was performed in general accordance with guidelines set forth by the County of Riverside (2011). In general, a 3-inch diameter perforated PVC pipe was placed in each borehole to be tested and the annulus was backfilled with gravel, including placement of about 2 inches of gravel at the bottom of the borehole. The infiltration wells were pre-soaked prior to testing. Based on the County of Riverside methodology, the calculated (observed) infiltration rates are provided in Table 1. These infiltration rates do not include any factor of safety (to be determined by the project Civil Engineer); however, they have been normalized to correct the 3-D flow that occurs within the field test to 1-D flow out of the bottom of the boring only. The locations of the infiltration tests were coordinated with the civil engineer. The approximate infiltration test locations are shown on the Geotechnical Maps (Sheets 1 and 3) and the infiltration test data is included in Appendix E and summarized in Table 1 below.

TABLE 1

Summary of Infiltration Testing

Infiltration Test Location	Approximate Infiltration Test Depth Below Existing Grade (ft)	Observed Infiltration Rate* (Inch/Hr)
I-1	10	0.1
I-2	5	0.5

*Normalized to One-Dimensional Flow, does not include any Factor of Safety

It should be emphasized that infiltration test results are only representative of the location and depth where they are performed. Varying subsurface conditions may exist outside of the test locations which could alter the calculated infiltration rates indicated above. Infiltration tests are performed using relatively clean water free of particulates, silt, etc.

2.9 Preliminary Seismic Design Parameters

The site seismic characteristics were evaluated per the guidelines set forth in Chapter 16, Section 1613 of the 2016 California Building Code (CBC). Representative site coordinates of latitude 33.8297 degrees north and longitude -117.1570 degrees west were utilized in our analyses. Please note that these coordinates are generally considered representative of the site for preliminary planning purposes, however, their applicability must be verified with respect to a desired specific location within the site. The maximum considered earthquake (MCE) spectral response accelerations (S_{MS} and S_{M1}) and adjusted design spectral response acceleration parameters (S_{DS} and S_{D1}) for Site Class D are provided in Table 2 below.

TABLE 2

Seismic Design Parameters

Selected Parameters from 2016 CBC, Section 1613 - Earthquake Loads	Seismic Design Values
Site Class per Chapter 20 of ASCE 7	D
Risk-Targeted Spectral Acceleration for Short Periods (S_S)*	1.505g
Risk-Targeted Spectral Accelerations for 1-Second Periods (S_1)*	0.605g
Site Coefficient F_a per Table 1613.3.3(1)	1.000
Site Coefficient F_v per Table 1613.3.3(2)	1.500
Site Modified Spectral Acceleration for Short Periods (S_{MS}) for Site Class D [Note: $S_{MS} = F_aS_S$]	1.505g
Site Modified Spectral Acceleration for 1-Second Periods (S_{M1}) for Site Class D [Note: $S_{M1} = F_vS_1$]	0.907g
Design Spectral Acceleration for Short Periods (S_{DS}) for Site Class D [Note: $S_{DS} = (^2/_3)S_{MS}$]	1.003g
Design Spectral Acceleration for 1-Second Periods (S_{D1}) for Site Class D [Note: $S_{D1} = (^2/_3)S_{M1}$]	0.605g
Mapped Risk Coefficient at 0.2 sec Spectral Response Period, C_{RS} (per ASCE 7)	1.018
Mapped Risk Coefficient at 1 sec Spectral Response Period, C_{R1} (per ASCE 7)	0.988

* From SEAOC, 2019

Section 1803.5.12 of the 2016 CBC (per Section 11.8.3 of ASCE 7) states that the maximum considered earthquake geometric mean (MCE_G) Peak Ground Acceleration (PGA) should be used for liquefaction potential. The PGA_M for the site is equal to 0.575g (SEAOC, 2019).

A deaggregation of the PGA based on a 2,475-year average return period indicates that an earthquake magnitude of 7.5 at a distance of approximately 8.5 km from the site would contribute the most to this ground motion (USGS, 2008).

2.10 *Faulting and Seismic Hazards*

The subject site is not located within a State of California Earthquake Fault Zone (i.e., Alquist-Priolo Earthquake Fault Act Zone) and no active faults are known to cross the site. A fault is considered "Holocene-active" if evidence of surface rupture in Holocene time (the last approximately 11,000 years) is present. The possibility of damage due to ground rupture is considered low since no active faults are known to cross the site. The closest known active fault is the Casa Loma Fault of the San Jacinto Fault Zone located approximately 5 miles northeast of the subject site.

Secondary effects of seismic shaking resulting from large earthquakes on the major faults in the Southern California region, which may affect the site, include ground lurching and shallow ground rupture, soil liquefaction, and dynamic settlement. These secondary effects of seismic shaking are a possibility throughout the Southern California region and are dependent on the distance between the site and causative fault, and the onsite geology. A discussion of these secondary effects is provided in the following sections.

2.10.1 *Liquefaction and Dynamic Settlement*

Liquefaction is a seismic phenomenon in which loose, saturated, granular soils behave similarly to a fluid when subject to high-intensity ground shaking. Liquefaction occurs when three general conditions coexist: 1) shallow groundwater; 2) low density non-cohesive (granular) soils; and 3) high-intensity ground motion. Studies indicate that loose, saturated, near surface cohesionless soils exhibit the highest liquefaction potential, while dry, dense, cohesionless soils and cohesive soils exhibit low to negligible liquefaction potential. In general, cohesive soils are not considered susceptible to liquefaction, depending on their plasticity and moisture content (Bray & Sancio, 2006). Effects of liquefaction on level ground include settlement, sand boils, and bearing capacity failures below structures. Dynamic settlement of dry sands can occur as the sand particles tend to settle and densify as a result of a seismic event.

The site is located within a zone with a low to moderate potential for liquefaction according to maps prepared by the County of Riverside (2019). Site soils are not generally susceptible to liquefaction due to a lack of groundwater in the upper 50 feet and generally dense to very dense sandy soils. However, isolated layers may be susceptible to dry sand seismic settlement. Seismically induced dry sand settlements were estimated by the procedures outlined by Pradel (Pradel, 1998) using the PGA_M per the 2016 CBC and a moment magnitude of 7.5 (USGS, 2008).

Based on the data obtained from our field evaluation, seismic settlement due to dry sands is estimated to be on the order of about ½-inch or less. Differential settlement may be estimated as half of the total settlement over a horizontal span of 40 feet.

Seismic settlement calculations were performed using the program CLiq (GeoLogismiki, 2017) and are provided in Appendix F.

2.10.2 Lateral Spreading

Lateral spreading is a type of liquefaction-induced ground failure associated with the lateral displacement of surficial blocks of sediment resulting from liquefaction in a subsurface layer. Once liquefaction transforms the subsurface layer into a fluid mass, gravity plus the earthquake inertial forces may cause the mass to move downslope towards a free face (such as a river channel or an embankment). Lateral spreading may cause large horizontal displacements and such movement typically damages pipelines, utilities, bridges, and structures.

Due to the low probability of liquefaction, the potential for lateral spreading is also considered low.

2.11 Seismic Refraction Lines

To aid in evaluation of the rippability of the materials to be encountered within the proposed deeper cuts on the site, five seismic refraction lines were performed (see Geotechnical Map for locations). The data gathered via the seismic lines, provides estimated seismic velocities of the onsite materials to depths up to approximately 60 feet below the surface for this study. A detailed discussion of the methodology and graphic representation of the results are presented in Appendix D.

2.12 Rippability

In general, undocumented artificial fill, colluvium, and very old fan deposits are anticipated to be easily to moderately rippable utilizing conventional heavy-duty earth moving equipment (Caterpillar D9 with single shank or equivalent).

In general, the upper portions of site bedrock (Lakeview Mountain Tonalite) are anticipated to have a moderate to very difficult rippability utilizing heavy duty conventional earth moving equipment. Based on seismic refraction lines, excavation difficulty of these materials increases with depth. Blasting should be anticipated as non-rippable bedrock materials have been identified within the depth of the design cut. In general, the subsurface data collected indicates that the bedrock materials can be generally classified into three zones of rippability (rippable, marginally rippable, and non-rippable). Seismic refraction data is summarized below and the locations of the seismic lines are depicted on the Geotechnical Map (Sheet 2).

The estimated depths to the different rippability classifications (rippable, marginally rippable, and non-rippable) are based on the onsite seismic refraction topographic models and the seismic velocities are summarized below. In general, the site bedrock may be considered:

- Rippable (seismic velocity < 4,000 ft/sec) to depths ranging from approximately 0 to 15 feet below existing ground surface.

- Marginally Rippable (seismic velocity 4,000 ft/sec to 7,000 ft/sec) to depths ranging from approximately 15 to 25 feet below existing ground surface.
- Non-Rippable or Blasting (seismic velocity >7,000 ft/sec) at depths greater than approximately 25 to 50 feet below existing ground surface, with the exception of shallow core stones.

Please note that the velocity ranges of these classifications are approximate and that rock characteristics, including jointing and fracturing spacing and orientation, are a major factor in determining rippability. Isolated core stones consisting of generally non-rippable rock may be encountered at depths shallower than approximately 25 feet below existing ground surface in the bedrock areas.

Localized zones of potentially non-rippable bedrock should be anticipated to be encountered above the estimated non-rippable bedrock depths. It is recommended that contractors review the provided subsurface data and independently determine the potential heavy ripping/blasting depths, lateral extents, quantities, etc. based on their experience. For further details regarding rippability please refer to the seismic refraction survey report (Appendix D).

2.13 ***Oversized Material***

Oversized material (material larger than 8 inches in maximum dimension) may be generated during site grading. Recommendations are provided for appropriate handling of oversized materials in Appendix G. If feasible, crushing oversized materials onsite, incorporating them into "rock fills" (windrows, rock blankets or individual rock burial), or exporting oversized materials may be considered. Isolated core stones consisting of generally irreducible rock may be encountered in the bedrock areas. Special handling recommendations should be provided on a case-by-case basis, if encountered.

2.14 ***Settlement and Collapse/Swell Potential***

Static settlement of the site will be induced by subjecting the existing grades to design grades (adding fill) and by the proposed structural building loads. The underlying very old fan deposits encountered were found to be medium dense to very dense and are generally not considered susceptible to long term consolidation settlement. Due to the primarily coarse-grained nature and apparent density of the site soils, static settlement should occur immediately during increasing grades; therefore, static settlement from increasing grades should not affect the proposed structural improvements. Static foundation settlement due to structural building loads is discussed in Section 4.4. Recommendations for settlement monitoring of deep fills, greater than approximately 40 feet, are provided in Section 4.2.

In addition to static settlement, recent and previous laboratory testing indicates the presence of potentially collapsible native alluvial soils within the upper approximately 10 feet. Four of the six samples tested for collapse/consolidation experienced hydro-collapse and the resulting two experienced soil swell or expansion. The collapse potential (or hydro-collapse) of the four samples ranged from approximately 0 to 0.9 percent, which is considered to be slightly susceptible to hydro-collapse. To reduce the potential for adverse settlements in the proposed building areas, we recommend implementing our earthwork recommendations provided in Section 4.1.

2.15 Expansion Potential

Based on the results of laboratory testing, site soils are anticipated to have a "Very Low" to "Low" expansion potential. Final expansion potential of site soils should be determined at the completion of grading. Results of expansion testing at finish grades will be utilized to confirm final foundation design.

3.0 CONCLUSIONS

Based on the results of our subsurface evaluation and geotechnical review of the proposed plan, it is our opinion that the proposed improvements are feasible from a geotechnical standpoint, provided that the recommendations provided here and in future reports are incorporated during site grading and development. A summary of our geotechnical conclusions are as follows:

- The geologic units mapped on the site include Quaternary Very Old Fan deposits and Cretaceous Lakeview Mountain Tonalite. Localized zones of potentially compressible soils overlie portions of the site including undocumented artificial fill, topsoil and near-surface portions of the old fan deposits.
- Groundwater was not encountered during our subsurface field evaluation to the maximum explored depth of approximately 50 feet below existing ground and is not considered a significant issue with regards to future development.
- The subject study area is not located within a mapped State of California Earthquake Fault Zone, and based upon our review of published geologic mapping, no known active or potentially active faults are known to exist within or in the immediate vicinity of the site. Therefore, the potential for ground rupture as a result of faulting is considered very low. The closest known active fault is the Casa Loma Fault of the San Jacinto Fault Zone located approximately 5 miles northeast of the subject site.
- The main seismic hazard that may affect the site is from ground shaking from one of the active regional faults. The subject site will likely experience strong seismic ground shaking during its design life.
- According to the County of Riverside GIS website, portions of the site are located in mapped zones for low to moderate liquefaction susceptibility. Due to the generally dense to very dense nature of the soil and lack of groundwater in the upper 50 feet, site soils are generally not considered susceptible to liquefaction. However, isolated sandy layers may be susceptible to dry sand settlement. Total seismic settlement due to dry sand settlement is estimated to be on the order of about ½-inch or less. Differential seismic settlement may be estimated as half the total estimated seismic settlement over a horizontal span of 40 feet.
- Some of the site bedrock should be anticipated to be easily to very difficult to excavate (rippability) utilizing heavy-duty machinery. In general, the site bedrock is considered to be rippable to marginally rippable at depths shallower than approximately 25 feet below the existing ground surface and non-rippable (blasting) at depths greater than approximately 25 to 50 feet below existing ground surface, with the exception of shallow core stones.
- Oversize particles (larger than 8 inches in maximum dimension) will require reduction in size or placement in rock disposal areas. Rock disposal areas are generally located in areas that are deeper than 10 feet below finish design grades or approximately 2 feet below the deepest utility, whichever is deeper.
- Oversized core stones that will require special handling may be encountered throughout the bedrock.
- From a geotechnical perspective, the existing onsite soils are considered suitable material for use as general fill, provided that they are relatively free from oversize rocks (larger than 8 inches in maximum dimension), construction debris, and significant organic material.
- Design cut and fill slopes are anticipated to be both grossly and surficially stable, as long as they are constructed in accordance with our geotechnical recommendations and are properly landscaped and maintained throughout their design life.

- Total fill depths greater than approximately 40 feet require surface settlement monitoring be performed after grading is completed to ensure long-term fill settlement is within tolerable limits prior to commencement of building construction. The "total fill depth" refers to the depth of new fill or the cumulative depth of new fill placed over existing fill.
- Based on the results of laboratory testing, site soils have a "Very Low" to "Low" expansion potential. Mitigation measures will be required for any planned foundations and or site improvements to minimize the impacts of expansive soils. Final expansion potential of site soils should be determined at the completion of grading.
- Existing on-site soils are generally granular in nature and slope face compaction may be difficult to achieve. Additionally, erosion rills generally develop on slopes consisting of granular materials that are subject to heavy rain prior to establishment of properly designed and maintained landscaping. Completed cut and fill slopes should be immediately planted and irrigated, as vegetation has a positive effect on surficial stability.
- Existing native slopes surrounding the development are anticipated to be grossly stable; however, minor surficial failures may occur over time.

4.0 PRELIMINARY RECOMMENDATIONS

The following recommendations are to be considered preliminary, and should be confirmed upon completion of grading and earthwork operations. In addition, they should be considered minimal from a geotechnical viewpoint, as there may be more restrictive requirements from the architect, structural engineer, building codes, governing agencies, or the owner.

It should be noted that the following geotechnical recommendations are intended to provide sufficient information to develop the site in general accordance with the 2016 CBC requirements. With regard to the possible occurrence of potentially catastrophic geotechnical hazards such as seismic shaking, earthquake-induced landslides, liquefaction, etc. the following geotechnical recommendations should provide adequate protection for the proposed development to the extent required to reduce seismic risk to an "acceptable level." The "acceptable level" of risk is defined by the California Code of Regulations as "that level that provides reasonable protection of the public safety, though it does not necessarily ensure continued structural integrity and functionality of the project" [Section 3721(a)]. Therefore, repair and remedial work of the proposed improvements may be required after a significant seismic event. With regards to the potential for less significant geologic hazards to the proposed development such as expansive soils, fill settlement, groundwater seepage, etc, the recommendations contained herein are intended as a reasonable protection against potential damaging effects. It should be understood, however, that our recommendations are intended to maintain the structural integrity of the proposed development and structures given the site geotechnical conditions, but cannot preclude the potential for some cosmetic distress or nuisance issues to develop as a result of the site geotechnical conditions.

The geotechnical recommendations contained herein must be confirmed to be suitable or modified based on the actual as-graded conditions.

4.1 Site Earthwork

We anticipate that earthwork at the site will consist of rough grading followed by retaining wall construction, utility construction, foundation construction, and asphalt paving of the interior streets and drives. We recommend that earthwork onsite be performed in accordance with the following recommendations, the County of Riverside/2016 CBC requirements, and the General Earthwork and Grading Specifications for Rough Grading included in Appendix G. In case of conflict, the following recommendations shall supersede those included as part of Appendix G. The following recommendations should be considered preliminary and may be revised by the geotechnical consultant based on the actual conditions encountered during site grading.

4.1.1 Site Preparation

Prior to grading of areas to receive structural fill or engineered structures, the areas should be cleared of surface obstructions and unsuitable material (such as undocumented fill, colluvium, and topsoil). Vegetation and debris should be removed and properly disposed of offsite. Holes resulting from the removal of buried obstructions, which extend below proposed removal bottoms, should be replaced with suitable compacted fill material.

4.1.2 Removal and Recompaction

In order to provide a relatively uniform bearing condition for the planned building structures and improvements, we recommend the site soils be removed and recompacted. Unsuitable and potentially compressible materials not removed by design cuts should be excavated to competent very old fan deposit materials or bedrock and replaced with compacted fill soils. In general, this includes existing undocumented artificial fill, residual soil, and upper weathered/desiccated portions of the very old fan deposits. Subsurface site soils should be removed and recompacted according to the criteria outlined below. Updated recommendations may be required based on additional field evaluation, changes to building layouts and actual structural loads.

Industrial and Commercial Buildings: We recommend that soils within the proposed building pads be temporarily removed and recompacted to minimum depths of approximately 3 to 8 feet below existing grade or 2 feet beneath the base of the foundations, whichever is deeper. Estimated removal and recompaction depths are presented on the Geotechnical Maps (Sheets 1 through 3). Where adequate space is available, the base of removal and recompaction bottoms should extend laterally a minimum distance equal to the depth of removal and recompaction below finish grade or at a minimum distance of 5 feet beyond the edges of the proposed building foundations, whichever is larger.

Minor Site Structures: For minor site structures such as free-standing walls, screen walls, trash enclosures, etc., removal and recompaction should extend at least 5 feet beneath existing grade or 2 feet beneath the base of foundations, whichever is deeper. In general, the envelope for removal and recompaction should extend laterally a minimum distance of 5 feet beyond the edges of the proposed improvements mentioned above, where space permits.

Pavement: Within pavement areas, removal and recompaction should extend to a depth of at least 2 feet below the existing grade or 2 feet beneath the finished subgrade (i.e., beneath planned aggregate base/asphalt concrete or PCC), whichever is deeper. The envelope for removal and recompaction should extend laterally a minimum distance of 2 feet beyond the edges of pavement, where space permits.

Local conditions may be encountered during excavation that could require deep remedial grading beyond the above noted minimum in order to obtain an acceptable subgrade. The actual depths and lateral extents of grading will be determined by the geotechnical consultant, based on subsurface conditions encountered during grading. Removal and recompaction areas should be accurately staked in the field by the Project Surveyor.

Several methods will be utilized in determining the suitability of the material observed in the removal bottom excavations. Observation of material, proof rolling, probing, and occasional field density testing of the removal bottoms shall be performed by a field technician and/or field geologist. When field density test data is utilized for approval of material, an in-place relative compaction of 85 percent or greater and a degree of saturation of 85 percent or greater will be considered suitable.

4.1.3 Geologic Mapping

Removals, backcuts, and keyway excavations (where applicable) must be geologically mapped by the geotechnical consultant during earthwork construction to confirm the anticipated conditions. The grading contractor must trim the backcuts with a slope board to remove loose material to allow for confirmation mapping. Updated and/or revised geotechnical recommendations may be required based on observed conditions.

4.1.4 Over-excavation

In order to provide a uniform fill blanket beneath proposed structures, it is recommended that design cut and cut/fill transition pads be over-excavated a minimum of 3 feet below ultimate finish pad grade, or a minimum of 2 feet below planned footings, whichever is greater. A maximum 3:1 differential fill thickness, up to a maximum over-excavation depth of 10 feet, underneath individual building pads should be maintained in order to reduce the potential for future differential settlement. Over-excavation should extend laterally a minimum of 5 feet beyond proposed building footprints. The over-excavation bottoms should be graded with a minimum 2 percent tilt towards deeper fill areas in order to reduce the potential for ponding of water.

Minor site structure foundations (e.g., retaining wall footings, trash enclosure footings, etc.) located on cut or cut/fill transition areas should be over-excavated a minimum of 1-foot below and 2 feet beyond the edges of the proposed footings. In addition, streets in design cut areas should be over-excavated a minimum of 2 feet below design subgrade elevations. In order to avoid difficult excavation during utility installation, streets in bedrock cut areas may be over-excavated to a depth equivalent to 1-foot below the lowest utility, if desired. Extending the street over-excavation to 1-foot below deepest utility, in bedrock cut areas, will help mitigate potential excavation difficulties during underground utility installation.

Over-excavations/undercuts must be confirmed and mapped by the geotechnical consultant prior to subsequent fill placement. The actual depth and lateral extents of over-excavation should be determined by the geotechnical consultant, based on subsurface conditions encountered during grading. Over-excavation areas should be accurately staked in the field by the Project Surveyor. Please note that some estimated removals in the western portion of the site may extend deeper than the recommended over-excavation in order to remove unsuitable materials (see Removals Section).

4.1.5 Removal and Overexcavation Bottom Preparation

In general, removal bottoms, over-excavation/undercut bottoms, and areas to receive compacted fill should be scarified to a minimum depth of 6 to 8 inches, brought to a near-optimum moisture condition (generally within optimum and 2 percent above optimum moisture content) and re-compacted per project requirements.

Removal bottoms, over-excavation/undercut bottoms, and areas to receive fill should be observed and accepted by the geotechnical consultant prior to fill placement.

4.1.6 Material for Fill

From a geotechnical perspective, the onsite soils are generally considered suitable for use as general compacted fill, provided they are relatively free of organic materials and construction debris. Any encountered oversized material (material larger than 8 inches in maximum dimension) must be appropriately handled as outlined in Appendix G.

From a geotechnical perspective, any required import soils for general fill (i.e., not retaining wall backfill), should consist of clean, relatively granular soils of Very Low expansion potential (expansion index 20 or less based on ASTM D4829) and no particles larger than 3 inches in greatest dimension. Import for any required retaining wall backfill should meet the criteria outlined in the following paragraph. Source samples should be provided to the geotechnical consultant for laboratory testing a minimum of 3 working days prior to any planned importation.

Conventional (masonry) retaining wall backfill should consist of sandy soils with a maximum of 35 percent fines (passing the No. 200 sieve) per American Society for Testing and Materials (ASTM) Test Method D1140 (or ASTM D6913/D422) and a "Very Low" expansion potential (EI of 20 or less per ASTM D4829). Soils should also be screened of organic materials, construction debris, and any material greater than 3 inches in maximum dimension. Much of the site sandy soils should be suitable for retaining wall backfill once screened of material greater than 3 inches in maximum dimension; therefore, select grading and stockpiling of onsite soils meeting the criteria above will be required by the contractor for obtaining suitable retaining wall backfill soil. These preliminary findings should be confirmed during grading.

Aggregate base (crushed aggregate base or crushed miscellaneous base) should conform to the latest requirements of Section 200-2 of the Standard Specifications for Public Works Construction ("Greenbook") for untreated base materials (except processed miscellaneous base) or Caltrans Class 2 aggregate base.

The placement of demolition materials in compacted fill is acceptable from a geotechnical viewpoint provided the demolition material is broken up into pieces not larger than typically used for aggregate base (approximately 1-inch in maximum dimension) and well blended into fill soils with essentially no resulting voids. Demolition material placed in fills must be free of construction debris (wood, brick, etc.) and reinforcing steel. If asphalt concrete fragments will be incorporated into the demolition materials, approval from an environmental viewpoint may be required and is not the purview of the geotechnical consultant. From our previous experience, we recommend that asphalt concrete fragments be limited to fill areas within planned street areas below future utilities (i.e., not within building pad areas).

4.1.7 Fill Placement and Compaction

Material to be placed as fill should be brought to near optimum moisture content (generally at optimum to 2 percent above optimum moisture content) and recompacted to at least 90 percent relative compaction (per ASTM D1557). It is anticipated that moisture conditioning of site soils will be required in order to achieve adequate compaction. Some of the site soils will require additional moisture in order to achieve the required compaction. Very moist soils are also present that will require drying and or mixing prior to reusing the materials in compacted fills.

The optimum lift thickness to produce a uniformly compacted fill will depend on the type and size of compaction equipment used. In general, fill should be placed in uniform lifts not exceeding 8 inches in compacted thickness. Each lift should be thoroughly compacted and accepted prior to subsequent lifts. Generally, placement and compaction of fill should be performed in accordance with local grading ordinances and under observation and testing by LGC Geotechnical. Any encountered oversized material as previously defined must be appropriately handled (Appendix G).

Fill placed on any slopes greater than 5:1 (horizontal to vertical) should be properly keyed and benched into firm and competent soils as it is placed in lifts. During backfill of temporary excavations, fill should be properly benched into firm and competent soils as it is placed in lifts.

Fill slope faces should also be compacted to minimum project recommendations. This may require overbuilding of the slope face and trimming back to design grades. Placement of sand or gravel lacking cohesive soil for binder on the outer slope face should be avoided in order to reduce potential for surficial instability such as erosion rills. To improve surficial stability, vegetation specified by the landscape architect should be established on the slope face as soon as it is practical, refer to Section 4.3.1

Aggregate base material (crushed aggregate base and crushed miscellaneous base) should be compacted to a minimum of 95 percent relative compaction at or slightly above optimum moisture content per ASTM D1557. Subgrade below aggregate base should be compacted to a minimum of 90 percent relative compaction at near-optimum moisture content (generally within optimum and 2 percent above optimum moisture content) per ASTM D1557.

4.1.7.1 Oversized Placement and Compaction

Oversized material (material larger than 8 inches in maximum dimension) may be generated during site grading. Recommendations are provided for appropriate handling of oversized materials in General Earthwork & Grading Specifications, Appendix G. Oversize material should not be placed in deep fill areas where an increased minimum relative compaction is required. If feasible, crushing oversized materials or exporting to an offsite location may be considered.

4.1.8 Trench and Conventional Retaining Wall Backfill and Compaction

The onsite soils may generally be suitable as trench backfill, provided the soils are generally free of material greater than 6 inches in diameter and organic matter. If trenches are shallow or the use of conventional equipment may result in damage to the utilities, sand having a sand equivalent (SE) of 30 or greater (per CTM 217) may be used to bed and shade pipes. Sand backfill within the pipe bedding zone may be densified by jetting or flooding and then tamped to ensure adequate compaction. Subsequent trench backfill should be compacted in uniform lifts by mechanical means to at least the recommended minimum relative compaction (per ASTM D1557).

Conventional (masonry) retaining wall backfill should consist of sandy soils outlined in above Section 4.1.6. The limits of select sandy backfill should extend at minimum ½ the height of the retaining wall or the width of the heel (if applicable), whichever is greater, refer to Figure 2 (Rear of Text). Retaining wall backfill soils should be compacted in relatively uniform thin lifts to at least 90 percent relative compaction (per ASTM D1557). Jetting or flooding of retaining wall backfill materials should not be permitted.

In backfill areas where mechanical compaction of soil backfill is impractical due to space constraints, typically sand-cement slurry may be substituted for compacted backfill. The slurry should contain about one sack of cement per cubic yard. When set, such a mix typically has the consistency of compacted soil. Sand cement slurry placed near the surface within landscape areas should be evaluated for potential impacts on planned improvements.

A representative from LGC Geotechnical should observe, probe, and test the backfill to verify compliance with the project recommendations.

4.1.9 Shrinkage and Bulking

Volumetric changes in earth quantities will occur when excavated onsite earth materials are replaced as properly compacted fill. The following is an estimate of shrinkage factors for the various geologic units found onsite. These estimates are based on in-place densities of the various materials and on the estimated average degree of relative compaction that will be achieved during grading.

TABLE 3

Estimated Shrinkage

Soil Type	Allowance	Estimated Range
Qvof	Shrinkage/Bulking	-5 to 5 %
Klmt (within 5 feet from existing)	Bulking	5 to 10 %
Klmt (deeper than 5 feet from existing)	Bulking	15 to 20 %

Subsidence due to earthwork equipment is expected to be on the order of 0.1 feet. It should be stressed that these values are only estimates and that actual shrinkage factors are extremely difficult to predict. The effective shrinkage of onsite soils will depend primarily on the type of compaction equipment and method of compaction used onsite by the contractor. Additionally, the geology onsite varies; the above estimates are generalized groupings of similar lithologies and should be expected to vary across the site laterally and with depth. The above shrinkage estimates are intended as an aid for others in determining preliminary earthwork quantities. However, these estimates should be used with some caution since they are not absolute values.

Due to the combined variability in topographic surveys, inability to precisely model the removals and variability in on-site near-surface conditions, it is our opinion that the site will not balance at the end of grading. If importing/exporting a large volume of soils is not considered feasible or economical, we recommend a balance area be designated onsite that can fluctuate up or down based on the actual volume of soil. We recommend a "balance" area that can accommodate on the order of 5 to 10 percent (plus or minus) of the total grading volume be considered.

4.1.10 Temporary Excavations

Temporary excavations should be performed in accordance with project plans, specifications, and all Occupational Safety and Health Administration (OSHA) requirements. Excavations should be laid back or shored in accordance with OSHA requirements before personnel or equipment are allowed to enter. We anticipate temporary slopes required for removals, over-excavations and haul roads to be grossly stable at 1:1 (horizontal to vertical) or flatter.

The contractor must request observation of temporary excavations by a representative of LGC Geotechnical, not only to confirm the geotechnical conditions, but to also help provide observation of early warning signs of potential failures. Based on our field evaluation, the majority of site soils are anticipated to be OSHA Type "C" soils (refer to the attached boring logs). Sandy soils are present and should be considered susceptible to caving. Soil conditions should be regularly evaluated during construction to verify conditions are as anticipated. The contractor shall be responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Close coordination with the geotechnical consultant should be maintained to facilitate construction while providing safe excavations. Excavation safety is the sole responsibility of the contractor.

Surcharge loads (vehicular traffic, soil stockpiles, construction equipment, etc.) should be set back from the perimeter of excavations a minimum distance equivalent to a 1:1 projection from the bottom of the excavation or 5 feet, whichever is greater, unless the cut is properly shored and designed for the applicable surcharge load. Once an excavation has been initiated, it should be backfilled as soon as practical. Prolonged exposure of temporary excavations may result in some localized instability. Excavations should be planned so that they are not initiated without sufficient time to shore/fill them prior to weekends, holidays, or forecasted rain.

It should be noted that any excavation that extends below a 1:1 (horizontal to vertical) projection of an existing foundation will remove existing support of the structure foundation. If requested, temporary shoring parameters will be provided.

4.2 Settlement Monitoring

Fill soils are subject to post-grading settlement. This even occurs to properly compacted fill soils with properly constructed subdrains. Total fill depths greater than approximately 40 feet require surface settlement monitoring be performed after grading is completed to ensure long-term fill settlement is within tolerable limits prior to commencement of building construction. The total fill depth refers to the depth of new design fill or the cumulative depth of new design fill placed over older artificial fill.

Specific recommendations for installation of settlement monitoring equipment, settlement monitoring procedures, approximate number of settlement monitoring points, frequency of readings and estimated settlement monitoring period will be provided in a future report once actual grading plans are available.

4.3 Slope Stability

Based on the preliminary site plans, the findings of our limited geotechnical evaluation and previous experience with similar geotechnical conditions, design cut and fill slopes up to a maximum height of approximately 90 feet are anticipated to be both grossly and surficially stable as designed, as long as they are constructed in accordance with the recommendations provided in the Sections below and our General Earthwork and Grading Specifications for Rough Grading (Appendix G). Slope stability analysis should be performed once grading plans are available to confirm this.

4.3.1 Cut Slopes

Based on the preliminary grading plan (Hunsaker, 2019), cut slopes with a maximum inclination of approximately 2:1 (horizontal to vertical) are proposed in the site bedrock and very old fan deposits. Cut slopes within the site bedrock are considered grossly and surficially stable as designed. The owner may elect to construct stabilization fills for the proposed cut slopes in the very old fan deposits over 5 feet in height in accordance with the detail provided in Appendix G. Stabilization fills should be a minimum of 15 feet wide. They should be a minimum of 2 feet deep, determined from the lowest toe-of-slope elevation, and tilted back towards the heel a minimum 2 percent or 1-foot (whichever is greater).

Stabilization fill backcuts should be excavated so that at least a minimum 15-foot fill width is maintained for the entire height of the stability fill slope. In general, backcuts should be excavated at a maximum 1.5:1 (horizontal to vertical) inclination. Properly outletted back drains should be constructed along stabilization fill backcuts in accordance with the General Earthwork and Grading Specifications for Rough Grading included in

Appendix G. Flatter backcut inclinations may be required based on observed conditions during grading. The backcuts should not be initiated prior to forecasted rain or be left open for extended periods of time.

Backcuts and stabilization fill excavations must be geologically mapped by the geotechnical consultant during excavation to confirm the anticipated conditions. If adverse conditions are exposed, additional analysis and/or remediation measures may be required. The grading contractor must trim the backcuts with a slope board to remove loose material to allow for confirmational mapping. Updated and/or revised geotechnical recommendations may be required based on observed conditions.

4.3.2 Fill Slopes

Design fill slopes depicted on the preliminary grading plan (Hunsaker, 2019) are anticipated to be both grossly and surficially stable as designed provided they are constructed in accordance with the General Earthwork and Grading Specifications for Rough Grading included in Appendix G and properly maintained subsequent to construction (Section 4.3.3). Fill slopes should be constructed with a maximum slope ratio of 2:1 (horizontal to vertical). Slope faces should be compacted to project recommendations. To improve surficial stability, vegetation specified by the landscape architect should be established on the slope face as soon as it is practical.

4.3.3 Slope Maintenance Guidelines

It is recommended that any graded slopes be planted with groundcover vegetation as soon as practical to protect against erosion by reducing runoff velocity. Deep-rooted vegetation that requires little water and is able to survive local climate conditions should also be established to protect against surficial slumping. Under no circumstances should slopes be allowed to be bare of vegetation. Landscape vegetation must not be "trimmed" to root structures leaving no protection of the slopes. Irrigation levels should be kept to the minimum level necessary to establish healthy plant growth. Slopes must not be overwatered. If automatic sprinklers are used, they must be adjusted during periods of rainfall. A landscape professional must be consulted for landscape recommendations.

A program for the elimination of burrowing animals in both native and graded slope areas must be established to protect slope stability by reducing the potential for surface water to penetrate into the slope face. Continuous erosion control, rodent control, and maintenance are essential to the long-term stability of all slopes. Trenches excavated on a slope face for utility or irrigation lines and/or for any purpose must be properly backfilled and compacted to project recommendations to the slope face. Observation/testing and acceptance by the geotechnical consultant during trench backfill are recommended. V-ditches should be inspected and cleared of loose soil and/or debris on a routine basis, especially prior to and during the rainy season.

4.4 Subdrains

If unanticipated groundwater or areas of potential future groundwater seepage and/or accumulation are encountered during grading subdrain systems may be recommended by the geotechnical consultant. Subdrains are to be properly outletted and connected to a suitable discharge point.

A representative of the project civil engineer should survey the installed subdrains for alignment and grade prior to fill placement above the subdrains. The location and elevations of subdrains and subdrain outlets should be recorded on as-built plans and made available to future owners. It is the responsibility of the contractor to locate and protect subdrain outlets prior to the completion of work.

4.5 Preliminary Foundation Recommendations

The proposed structures may be supported on spread or continuous footings and conventional slabs, provided earthwork is performed in accordance with the recommendations presented in this report. All footings should be supported on properly compacted fill. Please note that the following foundation recommendations are preliminary and must be confirmed by LGC Geotechnical at the completion of grading.

Preliminary foundation recommendations are provided in the following sections. The foundation design must be performed by the structural engineer based on the following geotechnical parameters and minimum values provided.

4.5.1 Slab Design and Construction

Minimum slab thicknesses of 6 inches and 4 inches are recommended for new slabs in the truck bay/warehouse areas and office areas, respectively. Slabs are to be supported on compacted fill soils properly prepared in accordance with the recommendations provided in this report. Minimum slab reinforcement should be determined by the structural engineer based on the imposed loading, crack control, etc. Additional slab-on-grade recommendations can be provided for alternative building types upon request.

It is recommended that subgrade soils below slabs be moisture conditioned in order to maintain the recommended moisture content up to the time of concrete placement. The recommended moisture content of the slab subgrade soils should be approximately 2 percent above optimum moisture content to a minimum depth of 12 inches. The moisture content of the slab subgrade should be verified by the geotechnical engineer within 1 to 2 days prior to concrete placement. In addition, this moisture content should be maintained around the immediate perimeter of the slab during construction and up to occupancy of the building structures.

Some post-construction moisture migration should be expected below the foundation. The following recommendations should be applied for office areas and/or other portions of the proposed truck bays that may be sensitive to nuisance moisture migrating through the slab from the subgrade soils. The following recommendations are for informational purposes only, as they are unrelated to the geotechnical performance of the foundation. The following recommendations may be superseded by the foundation engineer and/or owner.

In general, interior floor slabs with moisture sensitive floor coverings should be underlain by a minimum 15 mil thick vapor retarder, which has a water vapor transmission rate (permeance) of less than 0.3 perms, as determined by ASTM E 96, and meets the applicable code requirements (ASTM E 1745).

It is the responsibility of the contractor to ensure that the moisture/vapor retarder systems are properly installed in accordance with the project plans and manufacturers specifications, and that the moisture/vapor retarder materials are free of tears and punctures prior to and as a result of concrete placement. Additional moisture reduction and/or prevention measures may be needed, depending on the performance requirements of future interior floor coverings.

The foundation/structural engineer should determine whether the use of a capillary break (sand or gravel layer) in conjunction with the vapor retarder is necessary or required by code. Sand layer thickness and location (above and/or below vapor retarder) should also be determined by the foundation/structural engineer. Sand layers should be installed, where applicable, in accordance with ACI Publication 302 – "Guide for Concrete Floor and Slab Construction."

4.5.2 Foundation Design Parameters

Provided our earthwork recommendations are implemented, the proposed buildings may be supported on shallow foundation systems. Minimum continuous wall and column footing widths are to be 12 inches and 24 inches, respectively. Minimum foundation embedment is to extend a minimum of 24 inches below the adjacent exterior grade. Interior column footings may be placed 12 inches beneath the floor slab. The following allowable bearing pressures for both continuous and column spread footings presented in Table 4 below are recommended for corresponding footing widths and embedments.

TABLE 4

Allowable Soil Bearing Pressures

Allowable Static Bearing Pressure (psf)	Minimum Footing Width (feet)	Minimum Footing Embedment* (feet)
4,000	5	2
3,500	3	2
2,500	1	1

* Refers to minimum depth measured below lowest adjacent grade, or slab if internal footing.

These allowable bearing values indicated above (exclusive of the weight of the footings) are for total dead loads and frequently applied live loads and may be increased by ⅓ for short duration loading (i.e., wind or seismic loads). The allowable bearing pressures are applicable for level (ground slope equal to or flatter than 5H:1V) conditions only.

In addition, it is recommended that the perimeter building foundations be continuous across all exterior doorways to reduce moisture migration beneath the slab.

In utilizing the above-mentioned allowable bearing capacity and provided our earthwork recommendations are implemented, foundation settlement due to structural loads is anticipated to be on the order of 1-inch or less. Differential static settlement may be taken as half of the static settlement (i.e., ½-inch over a horizontal span of 40 feet). Furthermore, seismic dry sand settlement is anticipated to be on the order of ½-inch or less. Differential seismic settlement may be taken as half of the seismic settlement (i.e., ¼-inch over a horizontal span of 40 feet).

4.5.3 <u>Foundation Construction</u>

The foundation is to be excavated into competent compacted artificial fill placed during grading operations. It is recommended that the foundation subgrade soils be evaluated by the geotechnical engineer prior to steel and/or concrete placement.

The geotechnical parameters provided herein assume that if the areas adjacent to the foundation are planted and irrigated, these areas will be designed with proper drainage and adequately maintained so that ponding, which causes significant moisture changes below the foundation, does not occur. Our recommendations do not account for excessive irrigation and/or incorrect landscape design. Plants should only be provided with sufficient irrigation for life and not overwatered to saturate subgrade soils. Sunken planters placed adjacent to the foundation should either be designed with an efficient drainage system or liners to prevent moisture infiltration below the foundation.

4.5.4 <u>Lateral Load Resistance</u>

Resistance to lateral loads can be provided by friction acting at the base of foundations and by passive earth pressure. For concrete/soil frictional resistance, an allowable coefficient of friction of 0.35 may be assumed with dead-load forces. For slabs constructed over a moisture retarder, the allowable friction coefficient should be provided by the manufacturer. An allowable passive lateral earth pressure of 275 psf per foot of depth (or pcf) to a maximum of 2,750 psf may be used for the sides of footings poured against properly compacted fill. Allowable passive pressure may be increased to 375 pcf (maximum of 3,750 psf) for short duration seismic loading. This passive pressure is applicable for level (ground slope equal to or flatter than 5H:1V) conditions. Frictional resistance and passive pressure may be used in combination without reduction. We recommend that the upper foot of passive resistance be neglected if finished grade will not be covered with concrete or asphalt. The provided allowable passive pressures are based on a factor of safety of 1.5 and 1.1 for static and seismic loading conditions, respectively.

4.6 Foundation Setback from Top-of-Slope and Bottom-of-Slope

Foundations should have adequate setback from top and bottom of slopes. Per the 2016 CBC, the minimum top-of-slope setback is H/3, with a maximum required setback of 40 feet, where H is the total height of the slope. The minimum bottom-of-slope setback is H/2, with a maximum required setback of 15 feet. Refer to Chapter 18 of the 2016 CBC. Foundation setback criteria should be reviewed based on the precise grading plans.

4.7 Lateral Earth Pressures for Conventional Retaining Wall Design

New retaining walls are expected to be required in truck dock (court) areas. Additionally, the proposed development may require some small retaining walls to facilitate the new site grades. The following may be used for design of site retaining walls. Lateral earth pressures are provided as equivalent fluid unit weights, in psf per foot of depth (or pcf). These values do not contain an appreciable factor of safety, so the retaining wall designer should apply the applicable factors of safety and/or load factors during design. A soil unit weight of 120 pcf may be assumed for calculating the actual weight of soil over the wall footing.

The following lateral earth pressures are presented in Table 5 below for approved onsite select sandy soils with a maximum of 35 percent fines (passing the No. 200 sieve per ASTM D-421/422) and a "Very Low" expansion potential (EI of 20 or less per ASTM D4829). Much of the site sandy soils should be suitable for retaining wall backfill once screened of material greater than 3 inches in maximum dimension; therefore, select grading and stockpiling of onsite soils meeting the criteria above will be required by the contractor for obtaining suitable retaining wall backfill soil. The retaining wall designer should clearly indicate on the retaining wall plans the required sandy backfill.

TABLE 5

Lateral Earth Pressures – Select Sandy Soils

Conditions	**Equivalent Fluid Unit Weight (pcf)**	
	Level Backfill	**2:1 Sloped Backfill**
	Select Sandy Backfill	**Select Sandy Backfill**
Active	35	55
At-Rest	55	70

If the wall can yield enough to mobilize the full shear strength of the soil, it can be designed for "active" pressure. If the wall cannot yield under the applied load, the earth pressure will be higher. This would include 90-degree corners of retaining walls. Such walls should be designed for “at-rest.” The equivalent fluid pressure values assume free-draining conditions and a drainage system will be installed and maintained to prevent the build-up of hydrostatic pressures. If conditions other than those assumed above are anticipated, the equivalent fluid pressure values should be provided on an individual-case basis by the geotechnical engineer.

Retaining wall structures should be provided with appropriate drainage and appropriately waterproofed. To reduce, but not eliminate, saturation of near-surface (upper approximate 1-foot) soils in front of the retaining walls, the perforated subdrain pipe should be located as low as possible behind the retaining wall. The outlet pipe should be sloped to drain to a suitable outlet. In general, we do not recommend retaining wall outlet pipes be connected to area drains. If subdrains are connected to area drains, special care should be taken to maintain these drains. Typical conventional retaining wall drainage is shown on Figure 3. It should be noted that the recommended subdrain does not provide protection against seepage through the face of the wall and/or efflorescence. Waterproofing and outlet systems are not the purview of the geotechnical consultant.

Surcharge loading effects from any adjacent structures should be evaluated by the retaining wall designer. In general, structural loads within a 1:1 (horizontal: vertical) upward projection from the bottom of the proposed retaining wall footing will surcharge the proposed retaining wall. In addition to the recommended earth pressure, retaining walls adjacent to streets should be designed to resist a uniform lateral pressure of 85 pounds per square foot (psf) due to normal street vehicle traffic, if applicable. Uniform lateral surcharges may be estimated using the applicable coefficient of lateral earth pressure using a rectangular distribution. A factor of 0.45 and 0.3 may be used for at-rest and active conditions, respectively. The retaining wall designer should contact the geotechnical consultant for any required geotechnical input in estimating surcharge loads.

If required, the retaining wall designer may use a seismic lateral earth pressure increment of 10 pcf for a level backfill condition. This increment should be applied in addition to the provided static lateral earth pressure using a triangular distribution with the resultant acting at H/3 in relation to the base of the retaining structure (where H is the retained height). Per Section 1803.5.12 of the 2016 CBC, the seismic lateral earth pressure is applicable to structures assigned to Seismic Design Category D through F for retaining wall structures supporting more than 6 feet of backfill height. The provided seismic lateral earth pressure should not be used for retaining walls exceeding 10 feet in height. If a retaining wall greater than 10 feet in height or a retaining wall with a sloping backfill condition is proposed, the retaining wall designer should contact the geotechnical engineer for specific seismic lateral earth pressure increments based on the configuration of the planned retaining wall structures. This seismic lateral earth pressure is estimated using the procedure outlined by the Structural Engineers Association of California (Lew, et al, 2010).

Soil bearing and lateral resistance (friction coefficient and passive resistance) are provided in Section 4.4. Earthwork considerations (temporary backcuts, backfill, compaction, etc.) for retaining walls are provided in Section 4.1 (Site Earthwork) and the subsequent earthwork related sub-sections.

4.8 Soil Corrosivity to Concrete and Metal

Although not corrosion engineers (LGC Geotechnical is not a corrosion consultant), several governing agencies in Southern California require the geotechnical consultant to determine the corrosion potential of soils on buried concrete and metal facilities. We therefore present the results of our testing with regard to corrosion for the use of the client and other consultants, as they determine necessary.

Preliminary corrosion testing of a near-surface bulk sample indicated a soluble sulfate content less than approximately 0.02 percent, chloride contents ranging from approximately 31 to 104 parts per million (ppm), pH values ranging from approximately 5.8 to 7.9, and minimum resistivities ranging from approximately 1,446 to 15,000 ohm-cm. Based on Caltrans Corrosion Guidelines (Caltrans, 2015), soils are considered corrosive to structural elements if the pH is 5.5 or less, or the chloride concentration is 500 ppm or greater, or the sulfate concentration is 2,000 ppm (0.2 percent) or greater. Based on the preliminary test results, soils are not considered corrosive using Caltrans criteria.

Based on preliminary laboratory test results of representative site soil samples, onsite soils are anticipated to have a designated sulfate exposure class of “S0” per ACI 318-14, Table 19.3.1.1. Concrete in direct contact with the onsite soils can be designed according to ACI 318, Table 19.3.2.1 using the “S0” sulfate classification.

Laboratory testing may need to be performed at the completion of grading by the project corrosion engineer to further evaluate the as-graded soil corrosivity characteristics. Accordingly, revision of the corrosion potential may be needed, should future test results differ substantially from the conditions reported herein. The client and/or other members of the development team should consider this during the design and planning phase of the project, and formulate an appropriate course of action.

4.9 Subsurface Water Infiltration

Recent regulatory changes have occurred that mandate that storm water be infiltrated below grade into subsurface soils rather than collected in a conventional storm drain system. Typically, a combination of methods are implemented to reduce surface water runoff and increase infiltration including; permeable pavements/pavers for roadways and walkways, directing surface water runoff to grass-lined swales, retention areas, drywells, etc.

It should be noted that collecting and concentrating surface water for the purpose of intentionally infiltrating below grade, conflicts with the geotechnical engineering objective of directing surface water away from slopes, structures and other improvements. The geotechnical stability and integrity of a site is reliant upon appropriately handling surface water. In general, we do not recommend that surface water be intentionally infiltrated into the subsurface soils.

Considering the low tested preliminary infiltration rates combined with the fact that the developed site will consist of compacted fill over dense native materials, we do not recommend that surface water be intentionally infiltrated into subsurface soils unless additional infiltration testing is performed in the proposed basin locations.

4.10 <u>*Control of Surface Water and Drainage Control*</u>

From a geotechnical perspective, we recommend that compacted finished grade soils adjacent to the proposed warehouse structures be sloped away from the proposed structures towards an approved drainage device or unobstructed swale. Drainage swales, wherever feasible, should not be constructed within 5 feet of buildings. Where lot and building geometry necessitates that the drainage swales be routed closer than 5 feet to structural foundations, we recommend the use of area drains together with drainage swales. Drainage swales used in conjunction with area drains should be designed by the project civil engineer <u>so that a properly constructed and maintained system will prevent ponding within 5 feet of the foundation.</u> Code compliance of grades is not the purview of the geotechnical consultant.

Planters with open bottoms adjacent to buildings should be avoided. Planters should not be designed adjacent to buildings unless provisions for drainage, such as catch basins, liners, and/or area drains, are made. Overwatering must be avoided.

4.11 <u>*Preliminary Asphalt Concrete Pavement Sections*</u>

Preliminary laboratory testing resulted in R-values of 67 and 43 for the onsite soils. Preliminary minimum street sections are provided in Table 6 below for Traffic Indices of 5.5, 6.0, 7.0 and 8.0 and a preliminary R-value of 40. Pavement sections are based on Caltrans Highway Design Manual (Caltrans, 2008) and the County of Riverside minimum pavement sections. These recommendations must be confirmed with additional R-value testing of representative near-surface soils at the completion of grading and after underground utilities have been installed and backfilled. Final street sections should be confirmed by the project civil engineer based upon the projected design Traffic Index. If requested, LGC Geotechnical will provide sections for alternate TI values.

<u>***TABLE 6***</u>

<u>***Preliminary Asphalt Concrete Paving Section Options***</u>

Assumed Traffic Index	5.0	6.0	7.0	8.0
R-Value Subgrade	40	40	40	40
AC Thickness	3.0 inches	4.0 inches	4.0 inches	5.0 feet
Aggregate Base Thickness	6.0 inches	6.0 inches	7.0 inches	8.0 feet

Aggregate base material (crushed aggregate base and crushed miscellaneous base) should be compacted to a minimum of 95 percent relative compaction at or slightly above optimum moisture content per ASTM D1557. Subgrade below aggregate base should be compacted to a minimum of 90 percent relative compaction at or slightly above optimum moisture content per ASTM D1557. Earthwork recommendations are provided in Section 4.1 “Site Earthwork” and the related sub-sections of this report.

The thicknesses shown are <u>minimum</u> thicknesses. Increasing the thickness of any or all of the above layers will reduce the likelihood of the pavement experiencing distress during its service life. The above recommendations are based on the assumption that proper maintenance and irrigation of areas adjacent to the roadway will occur through the design life of the pavement. Failure to maintain a proper maintenance and/or irrigation program may jeopardize the integrity of the pavement.

4.12 Preliminary Portland Cement Concrete Pavement Sections

Preliminary laboratory testing resulted in R-values of 67 and 43 for the onsite soils. Preliminary minimum Portland Cement Concrete (PCC) pavement street sections are provided below in Table 7 for Traffic Indices of 6.0, 7.0, and 8.0 to be utilized in the design of the truck parking/circulation areas or loading docks. These sections are based on a preliminary assumed R-value of 40. These recommendations must be confirmed with R-value testing of representative near-surface soils at the completion of grading and after underground utilities have been installed and backfilled. Final street sections should be confirmed by the project civil engineer based upon the projected design Traffic Index. If requested, LGC Geotechnical will provide sections for alternate TI values. The appropriate paving section must be selected by the project civil engineer/client based on design traffic indexes.

TABLE 7

Preliminary PCC Pavement Section Options

Provided Traffic Index	6.0	7.0	8.0
PCC Thickness	6.0 inches	8.0 inches	9.5 inches
95% Compacted Subgrade	12.0 inches	12.0 inches	12.0 inches

We recommend a PCC pavement section consisting of thicknesses presented above over 12 inches of compacted subgrade. The concrete should have a minimum compressive strength of 3,250 psi at the time the pavement is subjected to traffic. To reduce the potential (but not eliminate) for cracking, paving should provide control joints at regular intervals not exceeding 14 feet in each direction, depth of ⅓ the concrete thickness. Contraction and construction joints should include a joint filler/sealer to prevent migration of water into the subgrade soils. The type of joint sealer and filler material should be specified by the pavement designer and should be maintained throughout the life of the pavement. Dowels are recommended at joints to reduce potential offsets. The above section does not include steel reinforcement. Steel reinforcement (typically No. 3 rebars at 24 inches on-center each way) may be added to reduce the potential for cracking.

Subgrade below the PCC pavement should be compacted to a minimum of 95 percent relative compaction per ASTM D1557 near optimum moisture content (generally within optimum and 2 percent above optimum moisture content). Earthwork recommendations are provided in Section 4.1 “Site Earthwork” and the related sub-sections of this report.

The thicknesses shown are minimum thicknesses. Increasing the thickness of any or all of the above layers will reduce the likelihood of the pavement experiencing distress during its service life. The above recommendations are based on the assumption that proper maintenance and irrigation of the areas adjacent to the roadway will occur through the design life of the pavement. Failure to maintain a proper maintenance and/or irrigation program may jeopardize the integrity of the pavement.

4.13 Nonstructural Concrete Flatwork

Nonstructural concrete flatwork (such as walkways, patios, bicycle trails, etc.) has a high potential for cracking due to changes in soil volume related to soil-moisture fluctuations. To reduce the potential for excessive cracking and lifting, concrete should be designed in accordance with the minimum guidelines outlined in Table 8. These guidelines will reduce the potential for irregular cracking and promote cracking along construction joints, but will not eliminate all cracking or lifting. Thickening the concrete and/or adding additional reinforcement will further reduce cosmetic distress. Please note that these are preliminary recommendations that will need to be confirmed and/or modified based on as-graded conditions at the completion of grading.

TABLE 8

Minimum Guidelines for Nonstructural Concrete Flatwork for Very Low to Low Expansion Potential

	Private Drives	**Patios/ Entryways**	**City Sidewalk Curb and Gutters**
Minimum Thickness (in.)	4 (full)	4 (full)	City/Agency Standard
Presoaking	Wet down prior to placing	Wet down prior to placing	City/Agency Standard
Reinforcement	No. 3 at 24 inches on centers	No. 3 at 24 inches on centers	City/Agency Standard
Thickened Edge (in.)	8 x 8	—	City/Agency Standard
Crack Control Joints	Saw cut or deep open tool joint to a minimum of 1/3 the concrete thickness	Saw cut or deep open tool joint to a minimum of 1/3 the concrete thickness	City/Agency Standard
Maximum Joint Spacing	10 feet or quarter cut whichever is closer	6 feet	City/Agency Standard
Aggregate Base Thickness (in.)	—	—	City/Agency Standard

To reduce the potential for concrete flatwork to separate from the loading dock or building slab, the builder may elect to install dowels to tie these two elements together.

4.14 ***Grading, Foundation and Retaining Wall Plan Review***

When available, project plans (rough grading, precise grading, retaining wall, foundation, etc.) should be reviewed by LGC Geotechnical in order to verify our geotechnical recommendations are properly implemented. A 40-scale geotechnical grading plan review should be performed prior to construction of the proposed development. Updated recommendations and/or additional field work may be necessary in the future.

4.15 ***Geotechnical Observation and Testing During Construction***

The recommendations provided in this report are based on limited subsurface observations and geotechnical analysis. The interpolated subsurface conditions should be checked in the field during construction by a representative of LGC Geotechnical. Geotechnical observation and testing are required per Section 1705 of the 2016 California Building Code (CBC).

Geotechnical observation and/or testing should be performed by LGC Geotechnical at the following stages:

- During rough grading (removal/over-excavation bottoms, fill placement, etc.);
- Geologic mapping of temporary backcuts;
- During retaining wall backfill and compaction;
- During utility trench backfill and compaction;
- During precise grading;
- After presoaking building pads and other concrete-flatwork subgrades, and prior to placement of aggregate base or concrete;
- After building and wall footing excavation and prior to placement of steel reinforcement and/or concrete;
- Preparation of pavement subgrade and placement of aggregate base; and
- When any unusual soil conditions are encountered during any construction operation subsequent to issuance of this report.

5.0 LIMITATIONS

Our services were performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable soils engineers and geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the conclusions and professional advice included in this report.

This report is based on data obtained from limited observations of the site, which have been extrapolated to characterize the site. While the scope of services performed is considered suitable to adequately characterize the site geotechnical conditions relative to the proposed development, no practical evaluation can completely eliminate uncertainty regarding the anticipated geotechnical conditions in connection with a subject site. Variations may exist and conditions not observed or described in this report may be encountered during grading and construction.

The findings of this report are valid as of the present date. However, changes in the conditions of a site can and do occur with the passage of time, whether they be due to natural processes or the works of man on this or adjacent properties. The findings and conclusions presented in this report can be relied upon only if LGC Geotechnical has the opportunity to observe the subsurface conditions during grading and construction of the project, in order to confirm that our preliminary findings are representative for the site. This report is intended exclusively for use by the client, any use of or reliance on this report by a third party shall be at such party's sole risk.

In addition, changes in applicable or appropriate standards may occur, whether they result from legislation or the broadening of knowledge. Accordingly, the findings of this report may be invalidated wholly or partially by changes outside our control. Therefore, this report is subject to review and modification.

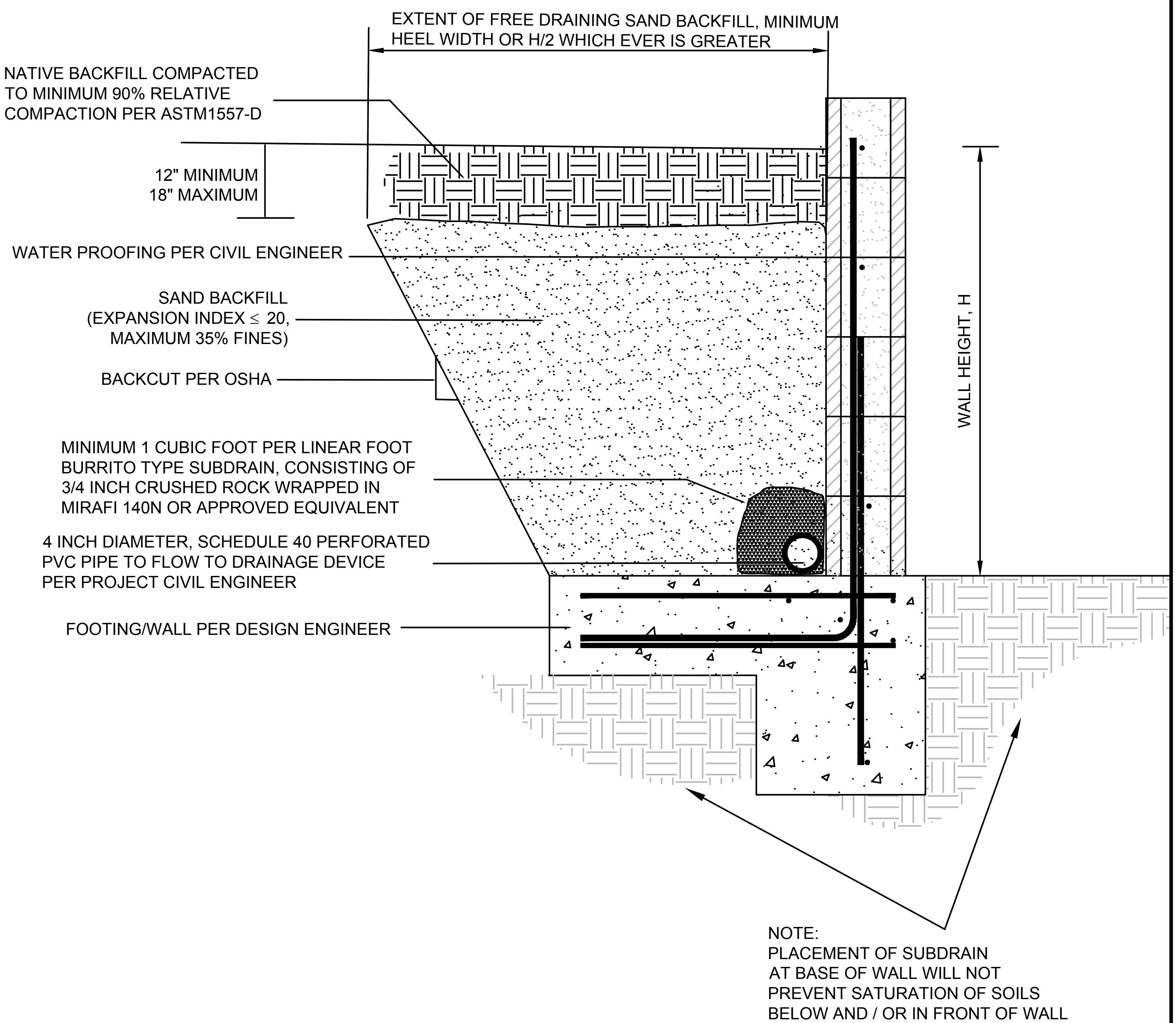


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FIGURE 2

Retaining Wall Backfill Detail

PROJECT NAME	Stoneridge
PROJECT NO.	13092-01
ENG. / GEOL.	RLD / KAD
SCALE	Not to Scale
DATE	September 2019

Appendix A
References

APPENDIX A

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Appendix B
Logs of Exploratory Borings, CPTs and Trenches

Geotechnical Boring Log Borehole HS-1

Date: 3/29/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1471' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 2

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1470	0	B-1			119.4	8.0	SM	**@0'-T.D. - Quaternary Very Old Fan Deposits** @0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	CR
			R-1	6 5 4			SC	@2.5' - Clayey SAND; dark brown, moist, fine to coarse grains with approx. 5% gravel, loose.	-200
1465	5		R-2	8 21 50/5"	133.8	8.4		@5' - Clayey SAND; dark brown, slightly moist, very dense.	
			R-3	18 30 50/5"	129.7	9.5		@7.5' - Clayey SAND; dark brown, slightly moist, very dense.	-200
1460	10		R-4	19 31 41	133.1	10.0		@10' - Clayey SAND; dark brown, slightly moist, very dense.	
1455	15		SPT-1	7 9 9		8.9		@15' - Clayey SAND; dark brown, medium dense, top inch and bottom 2 inches of sample contained reddish brown layers.	
1450	20		R-5	50/5"	112.2	7.1		@20' - Clayey SAND; dark brown, moist, loose, transitions to reddish brown, very dense.	
1445	25		SPT-2	23 34 40		5.8		@25' - Clayey SAND; dark brown, moist, very dense.	
	30								

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THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-1

Date: 3/29/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1471' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 2 of 2

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1440	30		R-6	12 33 34	121.5	4.4		@30' - Clayey SAND; dark brown, moist, very dense.	
1435	35		SPT-3	50/6"		5.2		@35' - Clayey SAND; dark brown, moist, very dense.	
1430	40		R-7	30 50/6"	123.8	5.2		@40' - Clayey SAND; dark brown, moist, very dense.	
1425	45		SPT-4	16 30 28		5.3		@45' - Clayey SAND; dark brown, moist, very dense.	
1420	50		R-8	25 50/6"	115.6	4.7		@50' - Clayey SAND; dark brown, moist, very dense.	
1415	55							Total Depth = 51.5' Groundwater Not Encountered Backfilled with Cuttings on 3/29/2016	
	60								

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Geotechnical Boring Log Borehole HS-2

Date: 3/29/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1471' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1470	0							**@0'-15.5' - Quaternary Very Old Fan Deposits**	
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
			R-1	6 4 3	118.1	7.7	SC	@2.5' - Clayey SAND; dark brown, moist, mica flakes, loose.	DS
1465	5		R-2	5 9 13	125.3	9.9		@5' - Clayey SAND; dark brown, moist, mica flakes, medium dense.	
			R-3	9 16 21	127.5	10.5		@7.5' - Clayey SAND; dark brown, moist, mica flakes, medium dense.	
1460	10		SPT-1	8 9 14		10.3		@10' - Clayey SAND; dark brown, slightly moist, dense, traces of bedrock parent material.	
1455	15		R-4	50/5"	110.1	8.6		@15' - Clayey SAND; dark brown, slightly moist, very dense, transition to bedrock.	
								@15.5'-T.D. - Cretaceous Lakeview Mountain Tonalite	
1450	20		SPT-2	50/4"		1.8		@20' - Excavates to SAND; gray to brown, moist, very dense; medium to coarse grained; white/black/orange.	
1445	25		R-5	50/3"	114.8	5.8		No Recovery	
	30							Total Depth = 26.5' Groundwater Not Encountered Backfilled with Cuttings on 3/29/2016	

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THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:
B BULK SAMPLE
R RING SAMPLE (CA Modified Sampler)
G GRAB SAMPLE
SPT STANDARD PENETRATION TEST SAMPLE
GROUNDWATER TABLE

TEST TYPES:
DS DIRECT SHEAR
MD MAXIMUM DENSITY
SA SIEVE ANALYSIS
S&H SIEVE AND HYDROMETER
EI EXPANSION INDEX
CN CONSOLIDATION
CR CORROSION
AL ATTERBERG LIMITS
CO COLLAPSE/SWELL
RV R-VALUE
-#200 % PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-3

Date: 3/29/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1463' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0	B-1						**@0'-8' - <u>Quaternary Very Old Fan Deposits</u>**	RV
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
1460			R-1	4 6 7	114.8	5.8	SC	@2.5' - Clayey SAND; dark brown, moist, medium dense, mica flakes.	
	5		R-2	7 9 50/6"	123.9	6.7		@5' - Clayey SAND; dark reddish brown, slightly moist, very dense, mica flakes.	
1455			R-3	30 50/3"	127.5	7.6		@7.5' - Clayey SAND; reddish brown with traces of bedrock parent material, very dense.	
	10		R-4	50\5"	117.5	3.8		**@8'-T.D. - <u>Cretaceous Lakeview Mountain Tonalite</u>** @10' - Excavates to SAND; gray to brown, moist, very dense, medium coarse grained; white/black/orange.	
1450									
	15		SPT-1	50/5"		2.3		@15' - Excavates to SAND; gray to brown, moist, very dense, medium coarse grained; white/black/orange.	
1445									
	20		R-5	50/3"				@20' - No Recovery	
1440								Total Depth = 21.5' Groundwater Not Encountered Backfilled with Cuttings on 3/29/2016	
	25								
1435									
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-4

Date: 3/29/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1549' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0	B-1						**@0' - 5.5' - Quaternary Very Old Fan Deposits**	CR, EI
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
1545			R-1	29 50/5"			SC	@2.5' - Clayey SAND; reddish brown, sligtly moist with approx 2% gravel, very dense, mica flakes.	
	5		R-2	33 50/3"				@5' - Clayey SAND; reddish brown, sligtly moist with approx 2% gravel, very dense, mica flakes, transitions to bedrock after 5".	
			SPT-1	50/6"				**@5.5' - T.D. - Cretaceous Lakeview Mountain Tonalite**	
1540								@7.5' - No Recovery	
	10							Total Depth = 9' Groundwater Not Encountered Backfilled with Cuttings on 3/29/2016	
1535	15								
1530	20								
1525	25								
1520	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Geotechnical Boring Log Borehole HS-5

Date: 3/29/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1489' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0	B-1						**@0'-10' - Quaternary Very Old Fan Deposits**	MD
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
1485			R-1	15 32 48	125.9	9.1	SC	@2.5' - Silty SAND; light brown, moist, very dense, mica flakes.	
	5		R-2	3 50/6"	127.9	8.5		@5' - Clayey SAND; brown, moist, very dense, mica flakes.	
1480			R-3	21 30 40	118.6	5.9		**@10'-T.D. - Cretaceous Lakeview Mountain Tonalite**	
	10		R-4	30 50/4"	120	3.9		@10' - Excavates to SAND; gray to brown, moist, very dense, medium coarse grained; white/black/orange, moderately to highly weathered.	
1475	15		SPT-1	35 50/4"		3.1		@15' - Excavates to SAND; gray to brown, moist, very dense, medium coarse grained; white/black/orange.	
1470	20							Total Depth = 16.5' Groundwater Not Encountered Backfilled with Cuttings on 3/29/2016	
1465	25								
1460	30								

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-6

Date: 3/29/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1499' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0'-7.5' - Quaternary Very Old Fan Deposits**	
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
			R-1	8 9 12	110.1	3.8			-200
1495							SC	@2.5' - Silty SAND; light brown, dry, medium dense, with approx 1% gravel.	
	5		R-2	22 19 30	132.3	8.2			DS
								@5' - Clayey SAND; dark brown, moist, dense, mica flakes.	
			R-3	12 17 19	115.9	11.6		**@7.5'-T.D. - Cretaceous Lakeview Mountain Tonalite**	-200
1490								@7.5' - Excavates to SAND; gray to brown, moist, dense, medium coarse grained; white/black/orange.	
	10		R-4	17 30 30	134.8	4.0		@10' - Excavates to SAND; gray to brown, moist, dense, medium coarse grained; white/black/orange.	
1485	15							Total Depth = 11.5' Groundwater Not Encountered Backfilled with Cuttings on 3/29/2016	
1480	20								
1475	25								
1470	30								

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THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-7

Date: 3/30/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1578' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0'-3' - Quaternary Very Old Fan Deposits**	
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
1575			R-1	25 50/5"	127.7	3.8		**@3'-T.D. - Cretaceous Lakeview Mountain Tonalite**	
	5		R-2	50/6"	122.5	2.6		@2.5' - Silty SAND; transitions to parent bedrock material.	
1570								@5' - Excavates to SAND; gray to brown, moist, very dense, medium coarse grained; white/black/orange.	
	10							Total Depth = 6.5' Groundwater Not Encountered Backfilled with Cuttings on 3/30/2016	
1565									
	15								
1560									
	20								
1555									
	25								
1550									
	30								

Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-8

Date: 3/30/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1546' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1545	0							**@0'-8' - Quaternary Very Old Fan Deposits**	
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
			R-1	10 19 19	130.2	10.3	SC	@2.5' - Clayey SAND; dark brown, slightly moist, medium dense, fine to coarse grain with approx 2% gravel.	
1540	5		R-2	10 21 24				@5' - increase to 5% gravel	
								@6'-T.D. - Cretaceous Lakeview Mountain Tonalite	
			R-3	11 50/5"				@7.5' - Excavates to SAND; gray to brown, moist, very dense, medium coarse grained; white/black/orange.	
1535	10		SPT-1	33 50/5"		4.1		@10' - Excavates to SAND; gray to brown, moist, very dense, medium coarse grained; white/black/orange.	
1530	15							Total Depth = 11.5' Groundwater Not Encountered Backfilled with Cuttings on 3/30/2016	
1525	20								
1520	25								
	30								

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-9

Date: 3/30/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1446' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1445	0	B-1						**@0'-8' - Quaternary Very Old Fan Deposits**	RV
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
			R-1	13 20 30	131.1	8.8	SC	@2.5' - Silty SAND; light brown, dry to slightly moist, mica flakes, dense.	
1440	5		R-2	10 11 13	121.8	5.2		@5' - Clayey SAND; dark brown, moist, medium dense.	
			R-3	13 50/5"	128.3	1.3		**@6'-T.D. - Cretaceous Lakeview Mountain Tonalite**	
								@7.5' - Sandy CLAY; dark brown, moist, dense, transitions to highly weathered bedrock.	
1435	10		SPT-1	19 50/5"		1.3		@10' - Excavates to SAND; gray to brown, moist, very dense, medium coarse grained; white/black/orange.	
1430	15							Total Depth = 11.5' Groundwater Not Encountered Backfilled with Cuttings on 3/30/2016	
1425	20								
1420	25								
	30								

LGC Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-10

Date: 3/30/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1446' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 2

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1445	0	B-1						**@0'-8' - <u>Quaternary Very Old Fan Deposits</u>**	
							SM	@0'-2' Silty SAND; brown,slightly moist, loose, wheat grass crops at surface.	
			R-1	3 3 3	109.2	3.8		@2.5' - Silty SAND; brown, slightly moist, mica flakes, loose.	
1440	5		R-2	13 15 20	128.5	8.3	SC	@5' - Clayey SAND; dark brown, moist, medium dense.	
			R-3	7 10 10	120.7	7.5		@7.5' - Clayey SAND; dark brown, moist, medium dense.	-200, CO
1435	10		SPT-1	5 5 10		10.8		@10' - Clayey SAND; dark brown, moist, medium dense.	
1430	15		R-4	17 32 40				@15' - Clayey SAND; dark brown, moist, very dense, approximately 2% gravel,	
1425	20		SPT-2	11 12 12		4.3	SP-SM	@20' - SAND with Silty SAND; reddish brown, slightly moist, dense.	
1420	25		R-5	16 23 40			SC	@25' - Clayey SAND; dark brown, moist, dense, difficulty drilling.	
	30								

LGC Geotechnical, Inc.

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SAMPLE TYPES:

B	BULK SAMPLE
R	RING SAMPLE (CA Modified Sampler)
G	GRAB SAMPLE
SPT	STANDARD PENETRATION TEST SAMPLE
▽	GROUNDWATER TABLE

TEST TYPES:

DS	DIRECT SHEAR
MD	MAXIMUM DENSITY
SA	SIEVE ANALYSIS
S&H	SIEVE AND HYDROMETER
EI	EXPANSION INDEX
CN	CONSOLIDATION
CR	CORROSION
AL	ATTERBERG LIMITS
CO	COLLAPSE/SWELL
RV	R-VALUE
-#200	% PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-10

Date: 3/30/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1446' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 2 of 2

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1415	30		SPT-3	17 22 44		6	SP-SM	@30' - SAND with SILTY SAND; dark brown, moist, very dense, difficulty drilling.	
1410	35							Total Depth = 31.5' Groundwater Not Encountered Backfilled with Cuttings on 3/30/2016	
1405	40								
1400	45								
1395	50								
1390	55								
	60								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Geotechnical Boring Log Borehole HS-11

Date: 3/30/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1426' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1425	0							**@0'-T.D. - <u>Quaternary Very Old Fan Deposits</u>**	
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
			R-1	6 8 8	113.8	5.4	SC	@3' - Clayey SAND; dark brown, moist, approx. 2% gravel, mica flakes, medium dense.	
1420	5							Total Depth = 5' Groundwater Not Encountered Backfilled with 3" perforated pipe with filter sock and gravel on 03/30/16 Backfilled with Cuttings on 3/31/2016	
1415	10								
1410	15								
1405	20								
1400	25								
	30								

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-12

Date: 3/30/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1430' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0'-T.D. - <u>Quaternary Very Old Fan Deposits</u>**	
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
			R-1	5 12 22	125.3	6.8			
1425	5						SC	@3' - Clayey SAND; dark brown, moist, approximately 2% gravel, mica flakes, medium dense.	
								Total Depth = 5' Groundwater Not Encountered Backfilled with 3" perforated pipe with filter sock and gravel on 03/30/16 Backfilled with Cuttings on 3/31/2016	
1420	10								
1415	15								
1410	20								
1405	25								
1410	30								

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- ⊽ GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-13

Date: 3/30/2016	**Drilling Company:** Cal Pac
Project Name: Richland - Stoneridge	**Type of Rig:** Limited Access
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1435' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CAC
Sampled By CAC
Checked By DJB

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0'-7.5' - Quaternary Very Old Fan Deposits**	
							SM	@0'-2' Silty SAND; brown, moist, loose, wheat grass crops at surface.	
1430	5								
			R-1	11 17 22	127.1	6.0	SC	@8' - Clayey SAND; dark brown, moist, mica flakes, dense.	
1425	10							Total Depth = 10' Groundwater Not Encountered Backfilled with 3" perforated pipe with filter sock and gravel on 03/30/16 Backfilled with Cuttings on 3/31/2016	
1420	15								
1415	20								
1410	25								
1405	30								

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 4/4/2016

Geotechnical Boring Log Borehole HS-14

Date: 6/24/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1436' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CNJ
Sampled By CNJ
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1435	0							**@0' to T.D. - <u>Quaternary Very Old Fan Deposits (Qvof)</u>**	
			R-1	14 24 21	122.1	2.3	SM	@2.5' - Silty SAND with trace Gravel: light reddish brown, dry to slightly moist, dense; indurated, pinhole porosity	
1430	5		R-2	24 50/5"	125.9	5.0	SC	@5' - Clayey SAND: reddish brown, slightly moist, very dense; well indurated, pinhole porosity	
			R-3	36 50/5"	132.8	5.7	SP-SC	@7.5' - SAND with Clay: brown, slightly moist to moist, very dense	
1425	10		R-4	32 50/5"	131.6	8.4		@10' - SAND with Clay: brown, moist, very dense	
1420	15		SPT-1	8 9 10		5.2		@15' - SAND with Clay: brown, slightly moist, medium dense	
1415	20		R-5	15 18 24	130.8	5.4	SC	@20' - Clayey SAND: brown, moist, dense	
1410	25							Total Depth Drilled = 20' Groundwater Not Encountered Backfilled with Cuttings on 6/24/2019	
	30								

Last Edited: 8/1/2019

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- ▽ GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Geotechnical Boring Log Borehole HS-15

Date: 6/24/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1479' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CNJ
Sampled By CNJ
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0' to T.D. - <u>Quaternary Very Old Fan Deposits (Qvof)</u>**	
			R-1	8 9 9	117.1	2.9	SM	@2.5' - Silty SAND: light brown, dry to slightly moist, medium dense; rootlets; pores	
1475	5		R-2	5 6 7	118.1	3.2		@5' - Silty SAND: light brown, slightly moist, medium dense; pores, rootlets	
			R-3	10 14 17	125.3	3.3	SC	@7.5' - Clayey SAND: brown, moist, medium dense	AL CN
1470	10		R-4	11 19 20	117.8	1.9	SW-SM	@10' - SAND with Silt: very light brown, dry to slightly moist, dense; coarse sand to fine gravel	-#200 CO
1465	15		R-5	11 14 20	118.0	1.6	SP	@15' - Sand with Gravel: very light brown, dry, medium dense	
1460	20		SPT-1	3 6 9		6.7	SC	@20' - Clayey SAND: brown, moist, medium dense	
1455	25							Total Depth Drilled = 20' Groundwater Not Encountered Backfilled with Cuttings on 6/24/2019	
1450	30								

LGC Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- ▽ GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/1/2019

Geotechnical Boring Log Borehole HS-16

Date: 6/24/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1450' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 2

Logged By CNJ
Sampled By CNJ
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0' to T.D. - Quaternary Very Old Fan Deposits (Qvof)**	
			R-1	15 13 13	122.2	1.3	SM	@2.5' - Silty SAND: brown, dry, medium dense; rootlets, pores, slightly indurated	
1445	5		R-2	14 17 24	119.0	3.0		@5' - Silty SAND: brown, dry to slightly moist, dense; roots, pores, indurated	
			R-3	17 20 24	127.0	3.4	SC	@7.5' - Clayey SAND: brown, slightly moist, dense	
1440	10		R-4	18 28 34	130.9	6.4		@10' - Clayey SAND: dark brown, slightly moist, dense, well indurated	
1435	15		SPT-1	10 13 16		10.2	CL	@15' - Sandy CLAY: brown, moist, hard	
1430	20		R-5	10 15 21	120.0	3.3	SP	@20' - SAND: dark brown, moist, medium dense	
1425	25		SPT-2	8 18 18		7.6	SC	@25' - Clayey SAND: reddish brown, slightly moist, dense	
	30								

Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
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- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
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- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/1/2019

Geotechnical Boring Log Borehole HS-16

Date: 6/24/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1450' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 2 of 2

Logged By CNJ
Sampled By CNJ
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	30		R-6	10 17 20	121.8	5.8	SM	@30' - Silty SAND: brown, slightly moist to moist, medium dense	
1420	35		SPT-3	6 7 10		8.9		@35' - Silty SAND: brown, slightly moist, medium dense	
1415	40		R-7	16 22 31	125.2	5.7	SC	@40' - Clayey SAND: brown, moist, dense	
1410	45		SPT-4	9 12 13		6.8	SM	@45' - Silty SAND: brown, slightly moist, medium dense	
1405	50		R-8	20 27 36	123.2	4.8		@50' - Silty SAND: brown, slightly moist, dense	
								Total Depth Drilled = 50' Groundwater Not Encountered Backfilled with Cuttings on 6/24/2019	
1400	55								
	60								

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Geotechnical Boring Log Borehole HS-17

Date: 6/24/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1450' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CNJ
Sampled By CNJ
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0' to T.D. - <u>Quaternary Very Old Fan Deposits (Qvof)</u>**	
			R-1	15 25 25	125.8	4.0	SM	@2.5' - Silty SAND: brown, dry, slightly moist, dense; roots	
1445	5		R-2	17 43 50/5"	125.9	3.9		@5' - Silty SAND: brown, slightly moist, very dense	
			R-3	17 25 32	131.0	4.7		@7.5' - Silty SAND: dark brown, moist, dense	
1440	10		R-4	23 50/5"	131.4	9.0	SC	@10' - Clayey SAND: dark brown, moist, very dense	
1435	15		SPT-1	11 12 12		6.6		@15' - Clayey SAND: reddish brown, moist, dense	
1430	20		R-5	11 16 23	117.8	7.6	SM	@20' - Silty SAND: dark brown, moist, dense	
								Total DepthDrilled = 20' Groundwater Not Encountered Backfilled with Cuttings on 6/24/2019	
1425	25								
	30								

Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/1/2019

Geotechnical Boring Log Borehole HS-18

Date: 6/24/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1450' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CNJ
Sampled By CNJ
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0	B-1						**@0' to T.D. - <u>Quaternary Very Old Fan Deposits (Qvof)</u>**	CR -#200 MD EI
			R-1	12 24 48	125.5	5.5	SM	@2.5' - Silty SAND: brown, dry, very dense	
1445	5		R-2	30 32 32	109.4	14.7	ML	@5' - Sandy SILT: brown, dry, hard	
			R-3	10 18 19	106.9	20.0		@7.5' - Sandy SILT: gray brown mottled, slightly moist to moist, very stiff	
1440	10		R-4	15 17 28	126.3	8.8	SM	@10' - Silty SAND: dark brown, moist, dense	
1435	15		R-5	10 25 39	131.6	7.9	CL	@15' - Sandy CLAY: red brown, slightly moist, hard	
1430	20		SPT-1	3 4 7		8.0	SC	@20' - Clayey SAND: red brown, slightly moist, medium dense	
1425	25							Total Depth Drilled = 20' Groundwater Not Encountered Backfilled with Cuttings on 6/24/2019	
	30								

LGC Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/1/2019

Geotechnical Boring Log Borehole HS-19

Date: 6/24/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1466' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CNJ
Sampled By CNJ
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1465	0							**@0' to 15' - Quaternary Very Old Fan Deposits (Qvof)**	
			R-1	27 50/5"	125.8	4.1	SC	@2.5' - Clayey SAND: red brown, slightly moist, very dense	
1460	5		R-2	27 43 50/5"	124.8	3.8		@5' - Clayey SAND: red brown, slightly moist, very dense	
			R-3	13 23 50/5"	131.9	3.5		@7.5' - Clayey SAND: reddish brown, slightly moist, very dense	
1455	10		R-4	11 21 50/5"	131.4	9.0		@10' - Clayey SAND: red brown, slightly moist, very dense	
								@15' to T.D. - Cretaceous Lakeview Mountain Tonalite (Klmt)	
1450	15		SPT-1	27 50/5"		6.2	SP	@15' - Tonalite excavates to SAND: light brown, dry, very dense	
1445	20		R-5	50/5"	119.1	3.1		@20' - Tonalite, excavates to SAND: light brown, dry, very dense, slightly disturbed sample	
								Total Depth Drilled = 20' Groundwater Not Encountered Backfilled with Cuttings on 6/24/2019	
1440	25								
	30								

Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/2/2019

Geotechnical Boring Log Borehole HS-20

Date: 6/27/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1439' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By KAD
Sampled By KAD
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0	B-1						**@0' to T.D. - <u>Quaternary Very Old Fan Deposits (Qvof)</u>**	CR -#200 MD EI DS
			R-1	8 11 15	117.7	3.1	SM	@2.5' - Silty SAND: brown to reddish brown, dry, medium dense	
1435	5		R-2	9 15 18	118.6	4.6		@5' - Silty SAND: reddish brown, slightly moist, medium dense	
			R-3	15 21 25	129.5	9.6		@7.5' - Silty SAND: brown to gray brown, slightly moist, dense	
1430	10		R-4	15 24 36	125.7	9.0		@10' - Silty SAND: reddish brown, slightly moist, dense	
1425	15		SPT-1	4 4 13		4.6		@15' - Silty SAND: reddish brown, slightly moist, medium dense	
1420	20		R-5	34 50/5"	126.8	5.5		@20' - Silty SAND: reddish brown, slightly moist, very dense	
								Total Depth Drilled = 20' Groundwater Not Encountered Backfilled with Cuttings on 6/27/2019	
1415	25								
1410	30								

Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/5/2019

Geotechnical Boring Log Borehole HS-21

Date: 6/27/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1451' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By KAD
Sampled By KAD
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
1450	0							**@0' to 20' - Quaternary Very Old Fan Deposits (Qvof)**	
			R-1	11 13 14	111.5	3.7	SM	@2.5' - Silty SAND: Reddish brown, dry, medium dense; trace rootlets	
1445	5		R-2	22 30 50	131.0	5.2		@5' - Silty SAND: reddish brown, slightly moist, very dense	
			R-3	27 43 50	132.8	10.0	SP-SC	@7.5' - SAND with Clay: reddish brown, slightly moist, very dense	
1440	10		R-4	26 36 22	127.9	6.7	SP	@10' - SAND: reddish brown to dark reddish brown, slightly moist, dense	
1435	15		SPT-1	20 21 18		6.5		@15' - SAND: reddish brown to brown, slightly moist, dense	
								@20' to T.D. - Cretaceous Lakeview Mountain Tonalite (Klmt)	
1430	20		R-5	30 50/3"	130.0	8.3	SP	@20' - SAND: grayish yellow, dry, very dense; yellowish weathering @22' - Refusal	
1425	25							Total Depth Drilled = 22' Groundwater Not Encountered Backfilled with Cuttings on 6/27/2019	
	30								

LGC Geotechnical, Inc.

THIS SUMMARY APPLIES ONLY AT THE LOCATION OF THIS BORING AND AT THE TIME OF DRILLING. SUBSURFACE CONDITIONS MAY DIFFER AT OTHER LOCATIONS AND MAY CHANGE AT THIS LOCATION WITH THE PASSAGE OF TIME. THE DATA PRESENTED IS A SIMPLIFICATION OF THE ACTUAL CONDITIONS ENCOUNTERED. THE DESCRIPTIONS PROVIDED ARE QUALITATIVE FIELD DESCRIPTIONS AND ARE NOT BASED ON QUANTITATIVE ENGINEERING ANALYSIS.

SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/5/2019

Geotechnical Boring Log Borehole HS-22

Date: 6/27/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1442' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 2

Logged By KAD
Sampled By KAD
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0' to T.D. - <u>Quaternary Very Old Fan Deposits (Qvof)</u>**	
1440			R-1	13 20 24	99.8	5.7	SM	@2.5' - Silty SAND: brown to reddish brown, dry, dense; trace rootlets	
	5		R-2	42 50/5"	126.9	4.8		@5' - Silty SAND: reddish brown, slightly moist, very dense	
1435			R-3	7 6 6	118.8	1.1	SP-SM	@7.5' - SAND with Silt: gray brown, dry to slightly moist, loose	-#200 CO
	10		R-4	40 50/4"	124.2	6.5	SM	@10' - Silty SAND: dark reddish brown, slightly moist, very dense	
1430									
	15		SPT-1	10 15 9		7.2		@15' - Silty SAND: reddish brown, slightly moist, medium dense	
1425									
	20		R-5	15 50/6"	126.9	5.7	SP-SM	@20' - SAND with SILT: reddish brown, slightly moist, very dense	
1420									
	25		SPT-2	17 21 32		8.4	SP	@25' - SAND: reddish brown, slightly moist, very dense	
1415									
	30								

LGC Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/5/2019

Geotechnical Boring Log Borehole HS-22

Date: 6/27/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1442' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 2 of 2

Logged By KAD
Sampled By KAD
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	30		R-6	50/6"	125.9	7.6	SP-SM	@30' - SAND with Silt: dark reddish brown, slightly moist to moist, very dense	
1410									
	35		SPT-3	28 50/6"		6.1	SM	@35' - Silty SAND: reddish brown, slightly moist, very dense	
1405									
	40		R-7	25 50/4"		6.5		@40' -Silty SAND: reddish brown, moist, very dense	
1400									
	45		SPT-4	18 26 27		4.6	SP	@45' - SAND: reddish brown, slightly moist, very dense	
1395									
	50		R-8	20 50/5"	129.4	6.5		@50' - SAND: gray brown, slightly moist, very dense	
1390								Total Depth Drilled = 50' Groundwater Not Encountered Backfilled with Cuttings on 6/27/2019	
	55								
1385									
	60								

LGC Geotechnical, Inc.

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SAMPLE TYPES:
B BULK SAMPLE
R RING SAMPLE (CA Modified Sampler)
G GRAB SAMPLE
SPT STANDARD PENETRATION TEST SAMPLE
GROUNDWATER TABLE

TEST TYPES:
DS DIRECT SHEAR
MD MAXIMUM DENSITY
SA SIEVE ANALYSIS
S&H SIEVE AND HYDROMETER
EI EXPANSION INDEX
CN CONSOLIDATION
CR CORROSION
AL ATTERBERG LIMITS
CO COLLAPSE/SWELL
RV R-VALUE
-#200 % PASSING # 200 SIEVE

Geotechnical Boring Log Borehole HS-23

Date: 6/27/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1438' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By KAD
Sampled By KAD
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0' to T.D. - Quaternary Very Old Fan Deposits (Qvof)**	
1435			R-1	15 24 25	122.0	4.4	SP	@2.5' - SAND: brown, dry, dense; trace rootlets	
	5		R-2	27 50/6"	131.7	5.3	SM	@5' - Silty SAND: gray brown, dry, very dense	
1430			R-3	40 50/6"	124.4	5.2		@7.5' - Silty SAND: brown to yellowish brown, slightly moist, very dense	
	10		R-4	25 50/6"	132.7	9.0	SC-SM	@10' - Silty Clayey SAND: dark brown, moist, very dense	AL CN
1425									
	15		SPT-1	9 6 11		8.0	SM	@15' - Silty SAND: reddish brown, slightly moist, medium dense	
1420								@20' - Silty SAND: reddish brown, yellowish brown, slightly moist, very dense	
	20		R-5	35 50/5"	124.2	9.3			
1415								Total Depth Drilled = 20' Groundwater Not Encountered Backfilled with Cuttings on 6/27/2019	
	25								
1410									
	30								

Last Edited: 8/6/2019

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SAMPLE TYPES:
B BULK SAMPLE
R RING SAMPLE (CA Modified Sampler)
G GRAB SAMPLE
SPT STANDARD PENETRATION TEST SAMPLE

GROUNDWATER TABLE

TEST TYPES:
DS DIRECT SHEAR
MD MAXIMUM DENSITY
SA SIEVE ANALYSIS
S&H SIEVE AND HYDROMETER
EI EXPANSION INDEX
CN CONSOLIDATION
CR CORROSION
AL ATTERBERG LIMITS
CO COLLAPSE/SWELL
RV R-VALUE
-#200 % PASSING # 200 SIEVE

Geotechnical Boring Log Borehole HS-24

Date: 6/27/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1540' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By KAD
Sampled By KAD
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0	B-1						**@0' to 10' - Quaternary Very Old Fan Deposits (Qvof)**	CR -#200 MD
			R-1	4 5 6	116.2	4.6	SP-SC	@2.5' - SAND with Clay: dark gray brown, slightly moist, loose	EI
1535	5		R-2	4 7 13	128.2	8.1	SC	@5' - Clayey SAND: dark gray brown, slightly moist, medium dense	-#200 CO
			R-3	20 30 42	136.5	5.5		@7.5' - Clayey SAND: gray brown, slightly moist, very dense	
								@10' to T.D. - Cretaceous Lakeview Mountain Tonalite (Klmt)	
1530	10		R-4	15 35 50/5"	104.2	12.6	SP	@10' - SAND: dark gray with reddish weathering, slightly moist, very dense	DS
1525	15		SPT-1	50/4"		1.7		@15' - Same as Above (R-4); medium to coarse grained	
								Total Depth Drilled = 15' Groundwater Not Encountered Backfilled with Cuttings on 6/27/2019	
1520	20								
1515	25								
	30								

LGC Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- ∇ GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/6/2019

Geotechnical Boring Log Borehole HS-25

Date: 6/27/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1525' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By KAD
Sampled By KAD
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0							**@0' to 10' - Quaternary Very Old Fan Deposits (Qvof)**	
			R-1	18 42 48	131.7	3.6	SM	@2.5' - Silty SAND: yellowish brown, dry, very dense; few rootlets	
1520	5		R-2	23 50/5"	122.2	3.3	SP-SM	@5' - SAND with Silt: light gray brown, dry to slightly moist, very dense	
			R-3	20 50/6"	125.5	4.2	SM	@7.5' - Silty SAND with Silt: yellowish brown, dry to slightly moist, very dense	
1515	10		R-4	50/5"	104.2	12.6	SP	**@10' to T.D. - Cretaceous Lakeview Mountain Tonalite (Klmt)** @10' - SAND: gray, dry, very dense	
1510	15		SPT-1	22 33 50/5"		6.1		@15' - Same as Above R-4; Coarse grained, less weathered	
								Total Depth Drilled = 15' Groundwater Not Encountered Backfilled with Cuttings on 6/27/2019	
1505	20								
1500	25								
	30								

Geotechnical, Inc.

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SAMPLE TYPES:
B BULK SAMPLE
R RING SAMPLE (CA Modified Sampler)
G GRAB SAMPLE
SPT STANDARD PENETRATION TEST SAMPLE
GROUNDWATER TABLE

TEST TYPES:
DS DIRECT SHEAR
MD MAXIMUM DENSITY
SA SIEVE ANALYSIS
S&H SIEVE AND HYDROMETER
EI EXPANSION INDEX
CN CONSOLIDATION
CR CORROSION
AL ATTERBERG LIMITS
CO COLLAPSE/SWELL
RV R-VALUE
-#200 % PASSING # 200 SIEVE

Last Edited: 8/6/2019

Geotechnical Boring Log Borehole I-1

Date: 6/24/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1428' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CNJ
Sampled By CNJ
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0						SM	**@0' to T.D. - <u>Quaternary Very Old Fan Deposits (Qvof)</u>** @0' - Generally Silty SAND: brown, dry	
1425									
	5								
1420			SPT-1	1 2 2		38.9	CL	@8.5' - CLAY: very light brown, slightly moist, medium stiff; trace scattered gravel	
	10							Total Depth = 10' Groundwater Not Encountered Backfilled with Cuttings Subsequent to Infiltration Testing	
1415									
	15								
1410									
	20								
1405									
	25								
1400									
	30								

LGC Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/6/2019

Geotechnical Boring Log Borehole I-2

Date: 6/24/2019	**Drilling Company:** 2R
Project Name: Stoneridge	**Type of Rig:** CME 75
Project Number: 13092-01	**Drop:** 30" **Hole Diameter:** 8"
Elevation of Top of Hole: ~1429' MSL	**Drive Weight:** 140 pounds
Hole Location: See Geotechnical Map	Page 1 of 1

Logged By CNJ
Sampled By CNJ
Checked By KAD

Elevation (ft)	Depth (ft)	Graphic Log	Sample Number	Blow Count	Dry Density (pcf)	Moisture (%)	USCS Symbol	DESCRIPTION	Type of Test
	0						SP-SM	**@0' to T.D. - <u>Quaternary Very Old Fan Deposits (Qvof)</u>** @0' - SAND with Silt: brown, dry, loose	
1425	5							Total Depth = 5' Groundwater Not Encountered Backfilled with Cuttings Subsequent to Infiltration Testing	
1420	10								
1415	15								
1410	20								
1405	25								
1400	30								

LGC Geotechnical, Inc.

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SAMPLE TYPES:
- B BULK SAMPLE
- R RING SAMPLE (CA Modified Sampler)
- G GRAB SAMPLE
- SPT STANDARD PENETRATION TEST SAMPLE
- GROUNDWATER TABLE

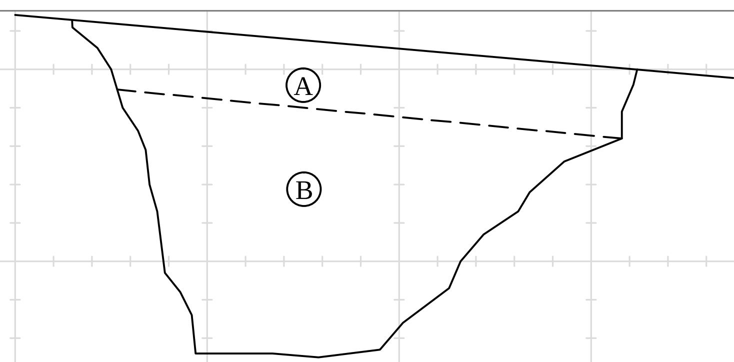
TEST TYPES:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- SA SIEVE ANALYSIS
- S&H SIEVE AND HYDROMETER
- EI EXPANSION INDEX
- CN CONSOLIDATION
- CR CORROSION
- AL ATTERBERG LIMITS
- CO COLLAPSE/SWELL
- RV R-VALUE
- -#200 % PASSING # 200 SIEVE

Last Edited: 8/6/2019

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-1	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 3/31/2016	**Engineering Properties:**	
Equipment: Backhoe - John Deere 310SK	Location: See Geotechnical Map		

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof	SP	B-1 4'-5'		
	A	@0'-1.8' SAND; brown, slightly moist, friable, upper 6" disturbed from agricultural use, roots + rootlets to ~4".					
	B	@1.8'-T.D. Silty SAND; brown to orange brown, moist, increased density, decomposed granitics, coarse to fine grained.		SM			

GRAPHICAL REPRESENTATION BELOW: Elevation : 1507 ' MSL Surface Slope: -5 deg. Trend: EW



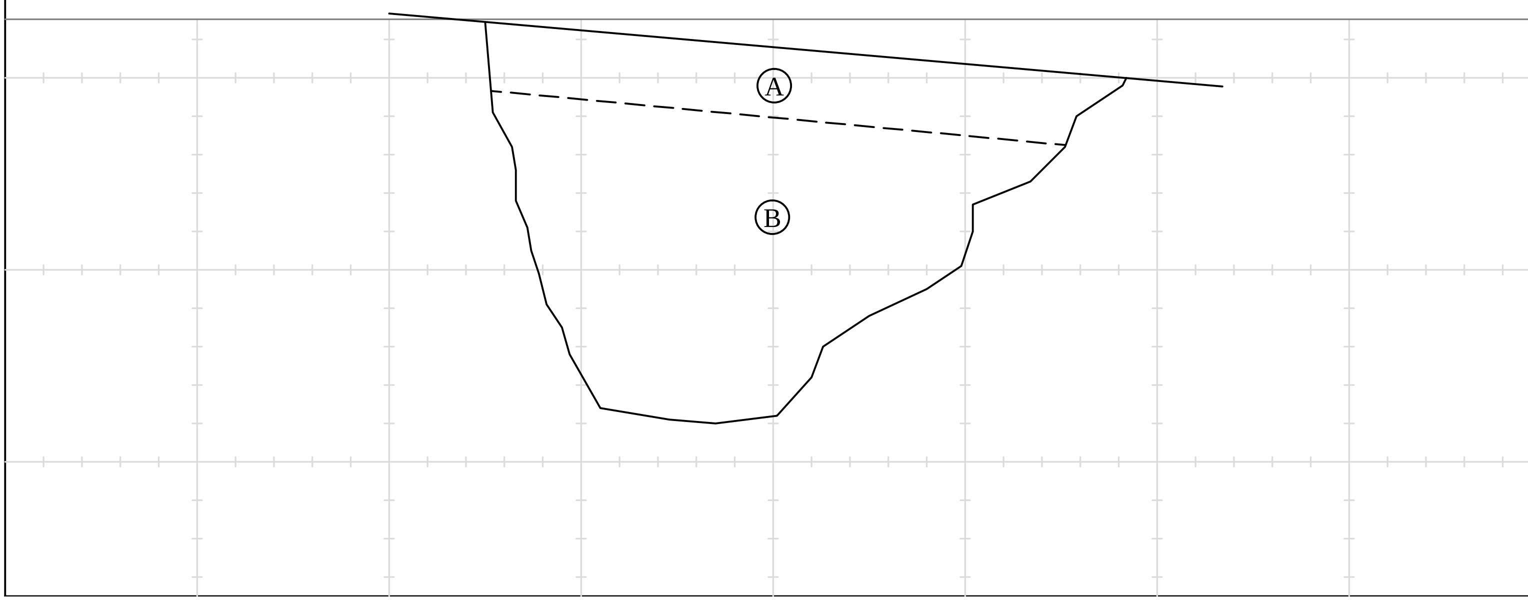
Total Depth: 7.5'
Groundwater: None
Backfilled: 3/31/2016

scale : 1 in = 5 ft

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-2	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 3/31/2016	**Engineering Properties:**	
Equipment: Backhoe - John Deere 310SK	Location: See Geotechnical Map		

Geologic Attitudes	**Unit**	**SOIL DESCRIPTION:**	**GEOLOGIC UNIT**	**USCS**	**SAMPLE No**	**MOISTURE (%)**	**DRY DENSITY (PCF)**
		Quaternary Very Old Fan Deposits	Qvof	SP			
	A	@0'-1.75' Silty SAND; brown, slightly moist, fine grained sand, upper 4"-6" disturbed by agricultural use, rootlets to approx. 5"-6".					
	B	@1.75'-T.D. Silty SAND to SAND; brown to orange brown, moist, dense, some caliche, very decomposed granitics, coarse to fine grained sand, some localized areas of increased fines, moderate hand excavation, becomes more sand with depth.		SM-SP			

GRAPHICAL REPRESENTATION BELOW: Elevation : 1512 ' MSL Surface Slope: -5 deg. Trend: EW



Total Depth: 9'
Groundwater: None
Backfilled: 3/31/2016

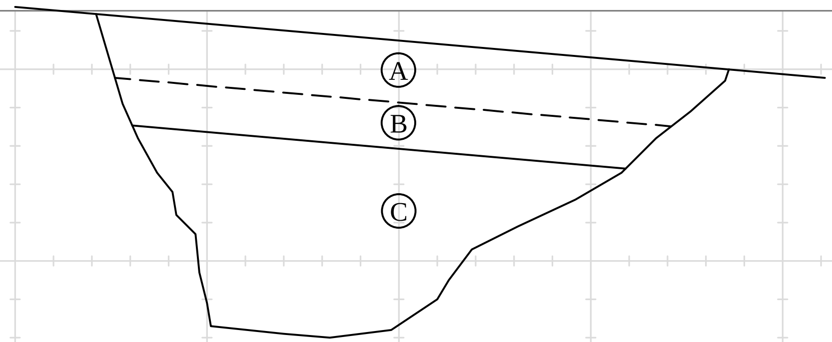
scale : 1 in = 5 ft

Last Edited: 4/5/2016

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-3	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 3/31/2016	**Engineering Properties:**	
Equipment: Backhoe - John Deere 310SK	Location: See Geotechnical Map		

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits					
	A	0'-0.8' Silty SAND; brown, slightly moist, fine grained sand, upper 4"-6" disturbed by agriculture use, rootlets to approz 5"-6".	Qvof	SM	B-1 2'-3'		
	B	0.8'-2' Decomposed Granitics - Clayey SAND to Silty SAND; red brown to gray, moist.		SC-SM			
		Cretaceous Lakeview Mountain Tonalite					
	C	2'-T.D. Granitic Bedrock; yellow brown to gray, slightly moist, coarse grained, very weathered, decrease in weathering with depth.	Klmt				

GRAPHICAL REPRESENTATION BELOW: Elevation : 1518 ' MSL Surface Slope: -5 deg. Trend: EW



Total Depth: 7'
Groundwater: None
Backfilled: 3/31/2016

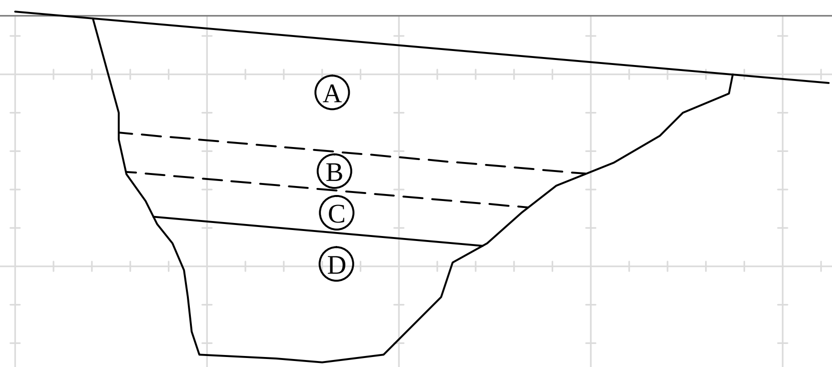
scale : 1 in = 5 ft

Last Edited: 4/5/2016

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-4	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 3/31/2016	**Engineering Properties:**	
Equipment: Backhoe - John Deere 310SK	Location: See Geotechnical Map		

Geologic Attitudes	**Unit**	**SOIL DESCRIPTION:**	**GEOLOGIC UNIT**	**USCS**	**SAMPLE No**	**MOISTURE (%)**	**DRY DENSITY (PCF)**
		Quaternary Very Old Fan Deposits					
	A	@0'-2' Clayey SAND; brown to gray brown, moist, rootlets upper 6", fine sand with some larger coarse grains.	Qvof	SC	B-1 0'-2'		
	B	@2'-3' Silty SAND; brown to gray brown, moist, dense.		SM			
	C	@3'-4.1' SAND; brown, moist, friable, fine to medium grained.		SP			
		Cretaceous Lakeview Mountain Tonalite					
	D	@4.1'-T.D. Granitic bedrock; orange to gray, slightly moist, moderately weathered, coarse grained.	Klmt				

GRAPHICAL REPRESENTATION BELOW: Elevation : 1558 ' MSL Surface Slope: -5 deg. Trend: EW



Total Depth: 7.5'
Groundwater: None
Backfilled: 3/31/2016

scale : 1 in = 5 ft

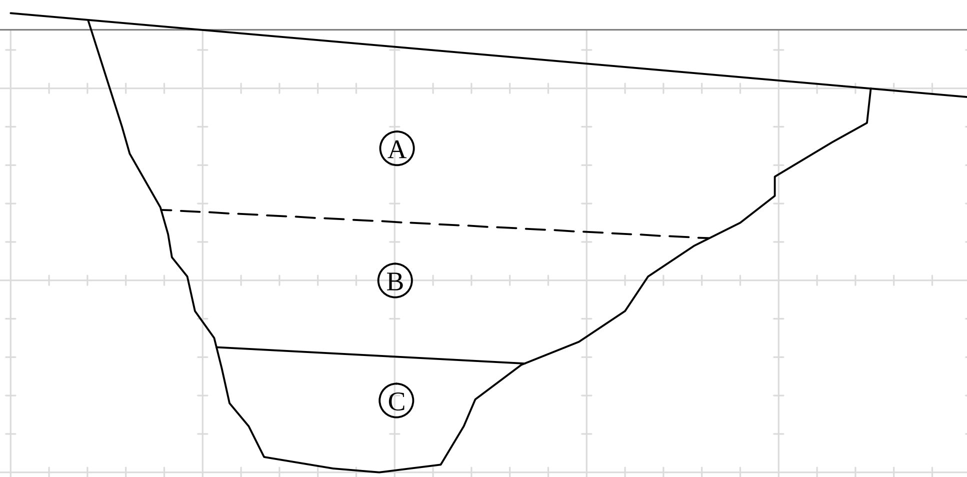
Last Edited: 4/5/2016

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-5
Project Number : 13092-01	Date : 3/31/2016	Engineering Properties:
Equipment: Backhoe - John Deere 310SK	Location: See Geotechnical Map	

LGC Geotechnical, Inc.

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits					
	A	@0'-3.5' Clayey SAND to Silty SAND; brown to gray brown, moist, upper 1' disturbed by agricultural use, abundant rootlets to approx. 7".	Qvof	SC			
	B	@3.5'-7' SAND; gray brown to orange brown, moist, predominately fine grained with some coarse grained sand.		SP			
		Cretaceous Lakeview Mountain Tonalite					
	C	@7'-T.D. Granitic Bedrock; gray to yellow brown, slightly moist, moderately weathered.	Klmt				

GRAPHICAL REPRESENTATION BELOW: Elevation : 1543 ' MSL Surface Slope: -5 deg. Trend: EW



Total Depth: 10'
Groundwater: None
Backfilled: 3/31/2016

scale : 1 in = 5 ft

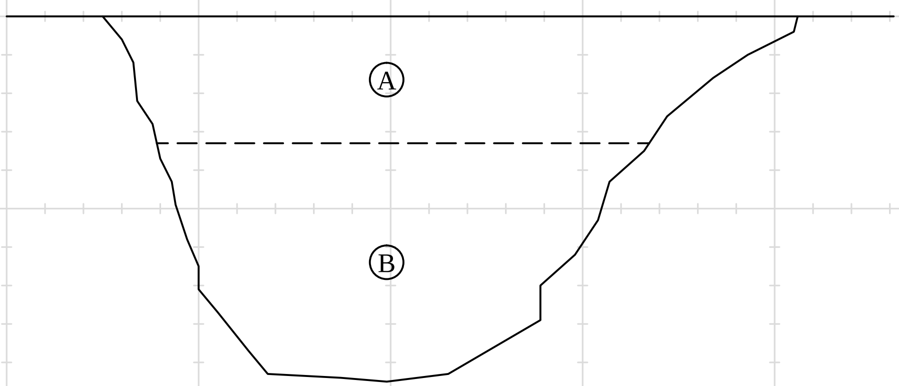
Last Edited: 4/5/2016

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-6
Project Number : 13092-01	Date : 3/31/2016	**Engineering Properties:**
Equipment: Backhoe - John Deere 310SK	Location: See Geotechnical Map	

LGC Geotechnical, Inc.

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits					
	A	@0'-3.3' Clayey SAND; dark brown to brown, moist, upper 1.5' disturbed by agricultural use, abundant rootlets to 1', predominately fine grained sand with some coarse grains.	Qvof	SC	B-1 2'-3'		
	B	@3.3'-T.D. Silty SAND; brown to gray brown, moist, fine grained sand.		SM			

GRAPHICAL REPRESENTATION BELOW: Elevation : 1450 ' MSL Surface Slope: 0 deg. Trend: EW



Total Depth: 9.5'
Groundwater: None
Backfilled: 3/31/2016

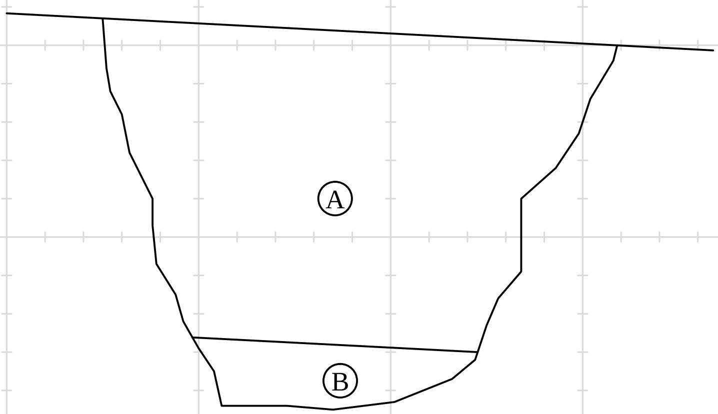
scale : 1 in = 5 ft

Last Edited: 4/5/2016

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-7	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 3/31/2016	**Engineering Properties:**	
Equipment: Backhoe - John Deere 310SK	Location: See Geotechnical Map		

Geologic Attitudes	**Unit**	**SOIL DESCRIPTION:**	**GEOLOGIC UNIT**	**USCS**	**SAMPLE No**	**MOISTURE (%)**	**DRY DENSITY (PCF)**
		Quaternary Very Old Fan Deposits					
	A	@0'-8' SAND; dark brown to reddish brown, moist, loose, very friable, micaceous, upper 10" disturbed by agricultural use with abundant rootlets, fine to medium grained.	Qvof	SP			
		Cretaceous Lakeview Mountain Tonalite					
	B	@8'-T.D. Granitic Bedrock; highly weathered	Klmt				

GRAPHICAL REPRESENTATION BELOW: Elevation : 1485 ' MSL Surface Slope: -3 deg. Trend: EW



Total Depth: 9.5'
Groundwater: None
Backfilled: 3/31/2016

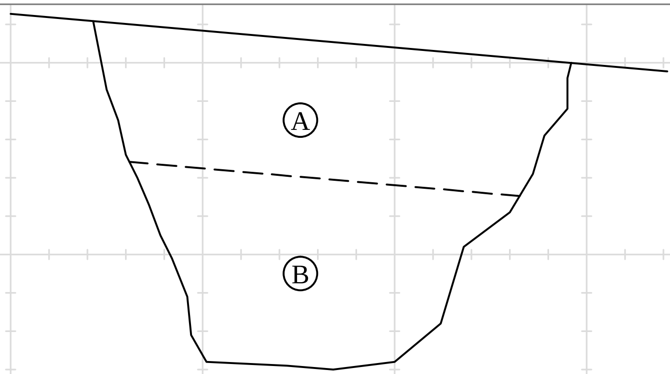
scale : 1 in = 5 ft

Last Edited: 4/5/2016

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-8	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 3/31/2016	**Engineering Properties:**	
Equipment: Backhoe - John Deere 310SK	Location: See Geotechnical Map		

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits					
	A	@0'-3' SAND with CLAY; dark brown to reddish brown, moist, medium dense, fine grained with some coarser grains, upper 9" disturbed by agricultural use, rootlets to approx 6".	Qvof	SP-SC			
	B	@3'-T.D. Silty SAND; reddish brown, moist, dense, fine grained sand. @6.5 ' increase density, moderately hard to excavate.		SM			

GRAPHICAL REPRESENTATION BELOW: Elevation : 1484 ' MSL Surface Slope: -5 deg. Trend: EW



Total Depth: 8'
Groundwater: None
Backfilled: 3/31/2016

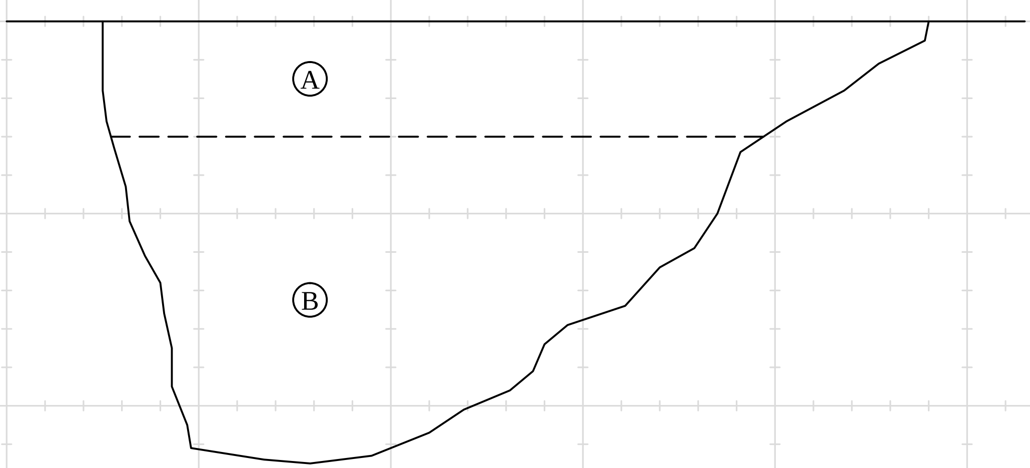
scale : 1 in = 5 ft

Last Edited: 4/5/2016

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-9	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 3/31/2016	**Engineering Properties:**	
Equipment: Backhoe - John Deere 310SK	Location: See Geotechnical Map		

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits					
	A	@0'-3' Clayey SAND to SAND with CLAY; brown to dark brown, moist, medium dense, upper 1' disturbed by agricultural use with abundant rootlets.	Qvof	SC	B-1 3'-4'		
	B	@3'-T.D. SAND to Silty SAND; reddish brown, moist, dense, predominately fine sand.		SP-SM			

GRAPHICAL REPRESENTATION BELOW: Elevation : 1454 ' MSL Surface Slope: 0 deg. Trend: EW



Total Depth: 11.5'
Groundwater: None
Backfilled: 3/31/2016

scale : 1 in = 5 ft

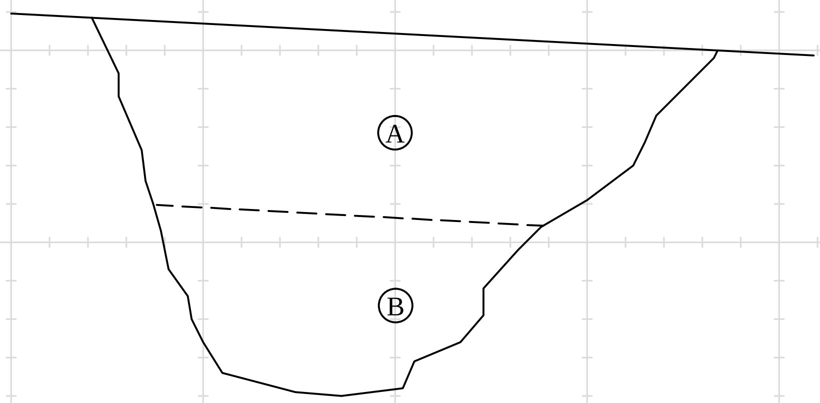
Last Edited: 4/5/2016

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-10
Project Number : 13092-01	Date : 3/31/2016	Engineering Properties:
Equipment: Backhoe - John Deere 310SK	Location: See Geotechnical Map	

LGC Geotechnical, Inc.

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits					
	A	@0'-4.3' Clayey SAND to SAND with CLAY; dark reddish brown, moist, medium dense, upper 10" disturbed by agricultural use, rootlets to depth of approx. 6"	Qvof	SC			
	B	@4.3'-T.D. SAND to Silty SAND; brown, moist, dense, fine grained sand. @6' becomes harder to excavate.		SP-SM			

GRAPHICAL REPRESENTATION BELOW: Elevation : 1481 ' MSL Surface Slope: -3 deg. Trend: EW



Total Depth: 9'
Groundwater: None
Backfilled: 3/31/2016

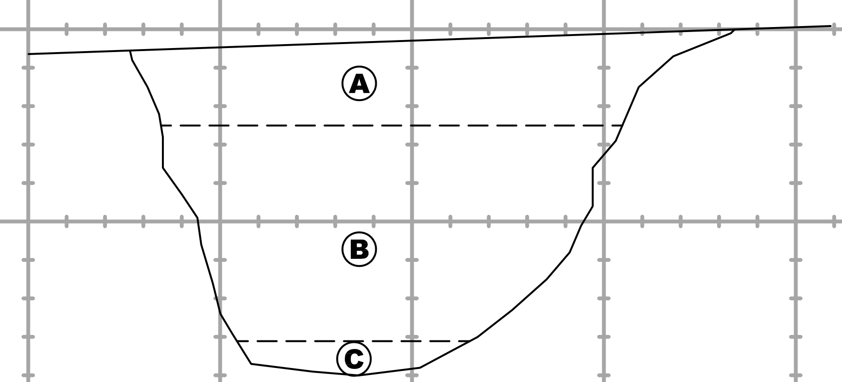
scale : 1 in = 5 ft

Last Edited: 4/5/2016

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-11	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 6/25/2019	Engineering Properties:	
Equipment: Deere 310J	Location: See Geotechnical Map		

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 2.5' Sand with Silt: light brown to brown, slightly moist, slightly indurated; upper 4"-6" dry and desiccated with abundant rootlets		SP-SM			
	B	@ 2.5' to 8' Sand: medium brown, slightly moist to moist, friable, trace rootlets		SP	B-1 @ 4'-5'		
	C	@8' to T.D. Sand: gray brown, slightly moist to moist; extremely weathered bedrock (?)					
		T.D.= 9'					

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1444 ' MSL** **Surface Slope: 2 deg.** **Trend: N15W**



Total Depth: 9'
Groundwater: None
Backfilled: 6/25/2019

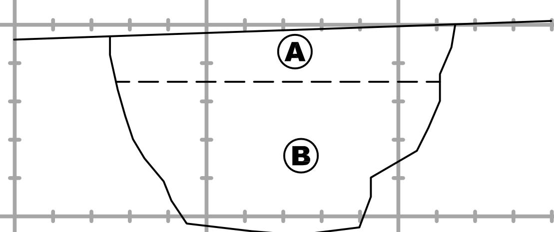
scale : 1 in = 5 ft

Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-12	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 6/25/2019	Engineering Properties:	
Equipment: Deere 310J	Location: See Geotechnical Map		

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 1.5' Sand with Silt: light to medium brown, dry, slightly indurated; upper 6" desiccated with abundant rootlets		SP-SM			
	B	@ 1.5' to T.D. Sand: dark red brown to gray dark brown, slightly moist to moist, moderately indurated, pinhole to pencil hole porosity T.D.=5.5'		SP	B-1 @ 3.5'-4'		

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1437 ' MSL** **Surface Slope: 2 deg.** **Trend: NS**



Total Depth: 5.5'
Groundwater: None
Backfilled: 6/25/2019

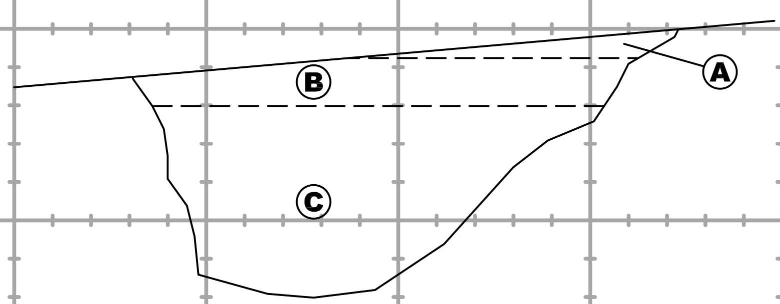
scale : 1 in = 5 ft

Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-13	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 6/25/2019	Engineering Properties:	
Equipment: Deere 310J	Location: See Geotechnical Map		

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 0.75' Sand: light gray to light brown, dry, loose; very friable, abundant rootlets		SP			
	B	@ 0.75' to 2' Sand with Silt to Silty Sand: light to medium brown, slightly moist, slightly indurated; pinhole porosity; some rootlets		SP to SM			
	C	@ 2' to T.D. Sand: dark reddish brown, slightly moist to moist; friable; pinhole porosity T.D.=7'		SP			

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1455 ' MSL** **Surface Slope: 5 deg.** **Trend: EW**



Total Depth: 7'
Groundwater: None
Backfilled: 6/25/2019

scale : 1 in = 5 ft

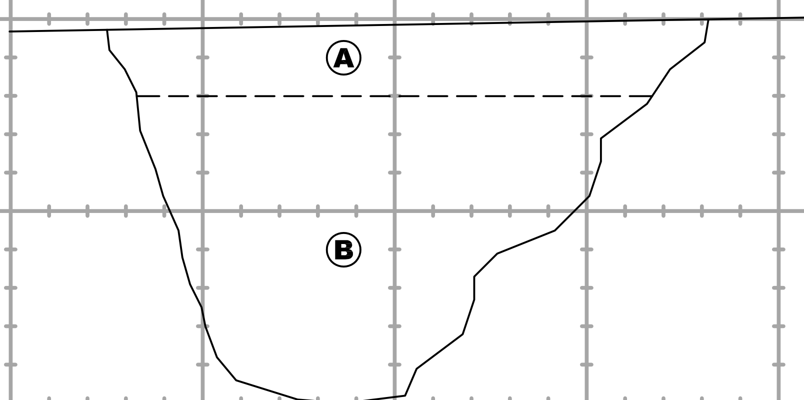
Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	**Logged By: KAD**	**Trench No: TP-14**
Project Number : 13092-01	**Date : 6/25/2019**	**Engineering Properties:**
Equipment: Deere 310J	**Location: See Geotechnical Map**	

LGC Geotechnical, Inc.

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 2' Sand with Silt: medium brown to red brown, dry to slightly moist; some rootlets; slightly to moderately indurated; upper 6"-8" desiccated with abundant roots		SP-SM	B-1 @ 1'-2'		
	B	@ 2' to T.D. Sand: reddish brown, slightly moist to moist; friable; fine to medium grained; trace rootlets T.D.=10'		SP			

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1469 ' MSL** **Surface Slope: 1 deg.** **Trend: EW**



Total Depth: 10'
Groundwater: None
Backfilled: 6/25/2019

scale : 1 in = 5 ft

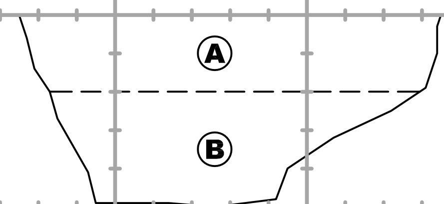
Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-15
Project Number : 13092-01	Date : 6/25/2019	Engineering Properties:
Equipment: Deere 310J	Location: See Geotechnical Map	

LGC Geotechnical, Inc.

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 1.5' Silty Sand: light brown, dry; friable; abundant rootlets and desiccated		SM			
	B	@ 1.5' to T.D. Sand: reddish dark brown, slightly moist; very well indurated; very difficult digging; pinhole porosity		SP			
		T.D.=5'					

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1430 ' MSL** **Surface Slope: 0 deg.** **Trend: NS**



Total Depth: 5'
Groundwater: None
Backfilled: 6/25/2019

scale : 1 in = 5 ft

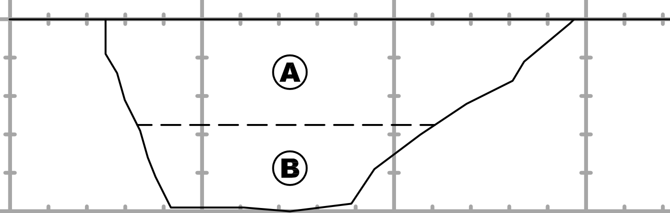
Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-16
Project Number : 13092-01	Date : 6/25/2019	Engineering Properties:
Equipment: Deere 310J	Location: See Geotechnical Map	

LGC Geotechnical, Inc.

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 2.75' Silty Sand: light to medium brown, dry to slightly moist; slightly indurated; upper 8"-12" desiccated with abundant rootlets		SM			
	B	@ 2.75' to T.D. Sand: dark reddish brown, slightly moist to moist; well indurated; difficult digging; pinhole porosity		SP			
		T.D.=5'					

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1430 ' MSL** **Surface Slope: 0 deg.** **Trend: EW**



Total Depth: 5'
Groundwater: None
Backfilled: 6/25/2019

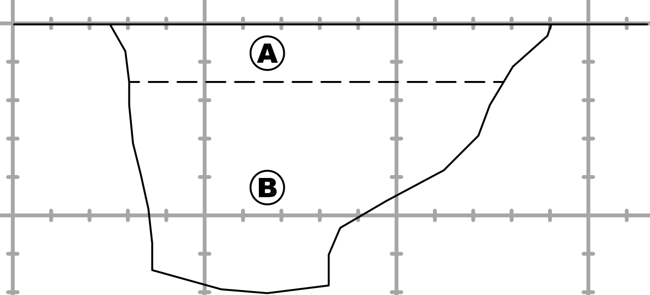
scale : 1 in = 5 ft

Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-17	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 6/25/2019	Engineering Properties:	
Equipment: Deere 310J	Location: See Geotechnical Map		

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 1.5' Silty Sand: light brown to light gray, dry; abundant roots and rootlets; desiccated		SM			
	B	@ 1.5' to T.D. Sand to Sand with Silt: medium brown to gray brown, slightly moist, slightly indurated; trace rootlets T.D.=7'		SP			

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1433 ' MSL** **Surface Slope: 0 deg.** **Trend: EW**



Total Depth: 7'
Groundwater: None
Backfilled: 6/25/2019

scale : 1 in = 5 ft

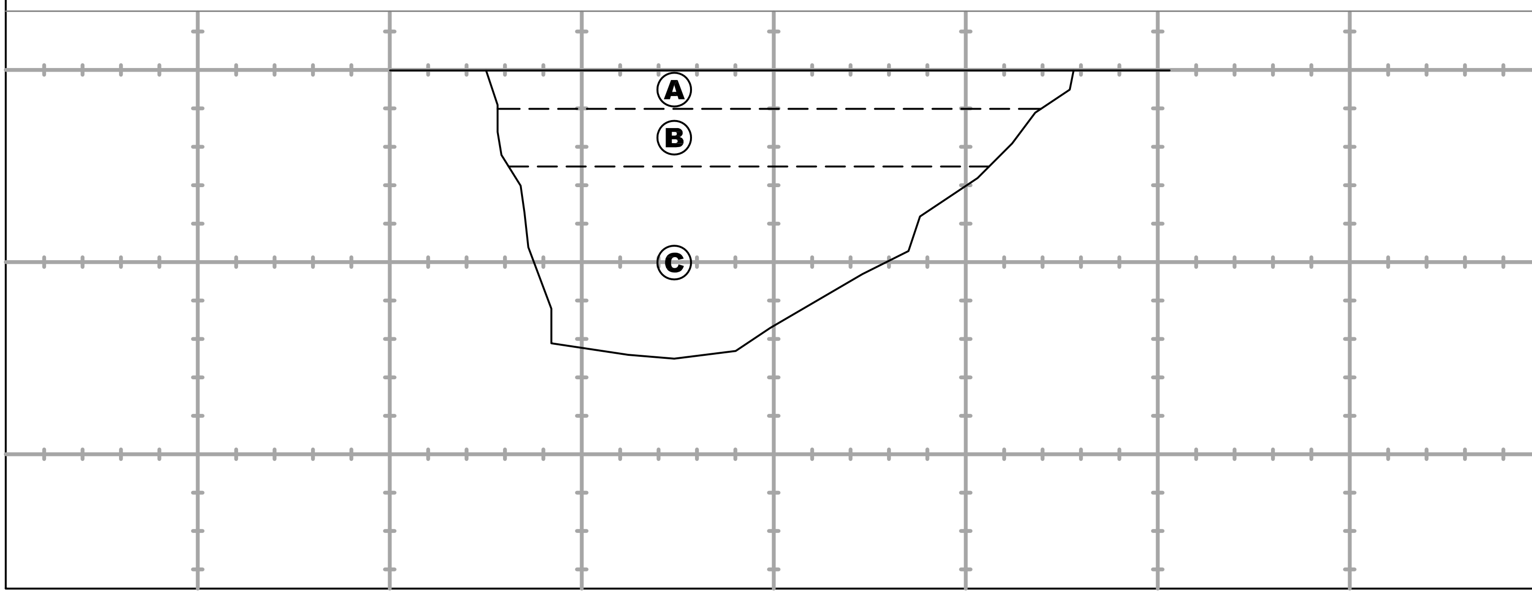
Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-18
Project Number : 13092-01	Date : 6/25/2019	Engineering Properties:
Equipment: Deere 310J	Location: See Geotechnical Map	

LGC Geotechnical, Inc.

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 1' Silty Sand to Sand: light brown to light gray, dry; abundant rootlets and desiccated; fine grained sand		SM to SP			
	B	@ 1' to 2.5' Sand: medium brown to gray brown, dry to slightly moist, slightly indurated; pinhole porosity; trace rootlets		SP			
	C	@ 2.5' to T.D. Sand to Sand with Silt: dark reddish brown to brown, slightly moist to moist; slightly friable; abundant pinhole porosity @5' increase in density; decrease porosity T.D.=7.5'		SP			

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1460 ' MSL** **Surface Slope: 0 deg.** **Trend: EW**



Total Depth: 7.5'
Groundwater: None
Backfilled: 6/25/2019

scale : 1 in = 5 ft

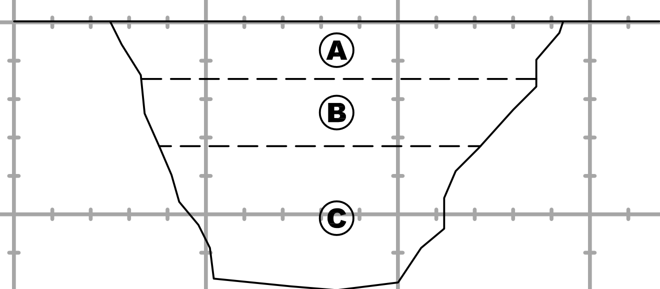
Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	**Logged By: KAD**	**Trench No: TP-19**
Project Number : 13092-01	**Date : 6/25/2019**	**Engineering Properties:**
Equipment: Deere 310J	**Location: See Geotechnical Map**	

LGC Geotechnical, Inc.

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 1.5' Silty Sand: light brown to light gray, dry; abundant rootlets; desiccated; friable; fine grained sand		SM			
	B	@ 1.5' to 3.25' Sand to Sand with Silt: brown to gray brown, slightly moist, slightly indurated; trace rootlets		SP			
	C	@ 3.25' to T.D. Sand: brown to reddish brown, slightly moist to moist; slightly friable; pinhole porosity		SP	B-1 @ 3.5'-4.5'		
		@5.5' darker coloration; increase in density					
		T.D.=7'					

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1480 ' MSL** **Surface Slope: 0 deg.** **Trend: N60W**



Total Depth: 7'
Groundwater: None
Backfilled: 6/25/2019

scale : 1 in = 5 ft

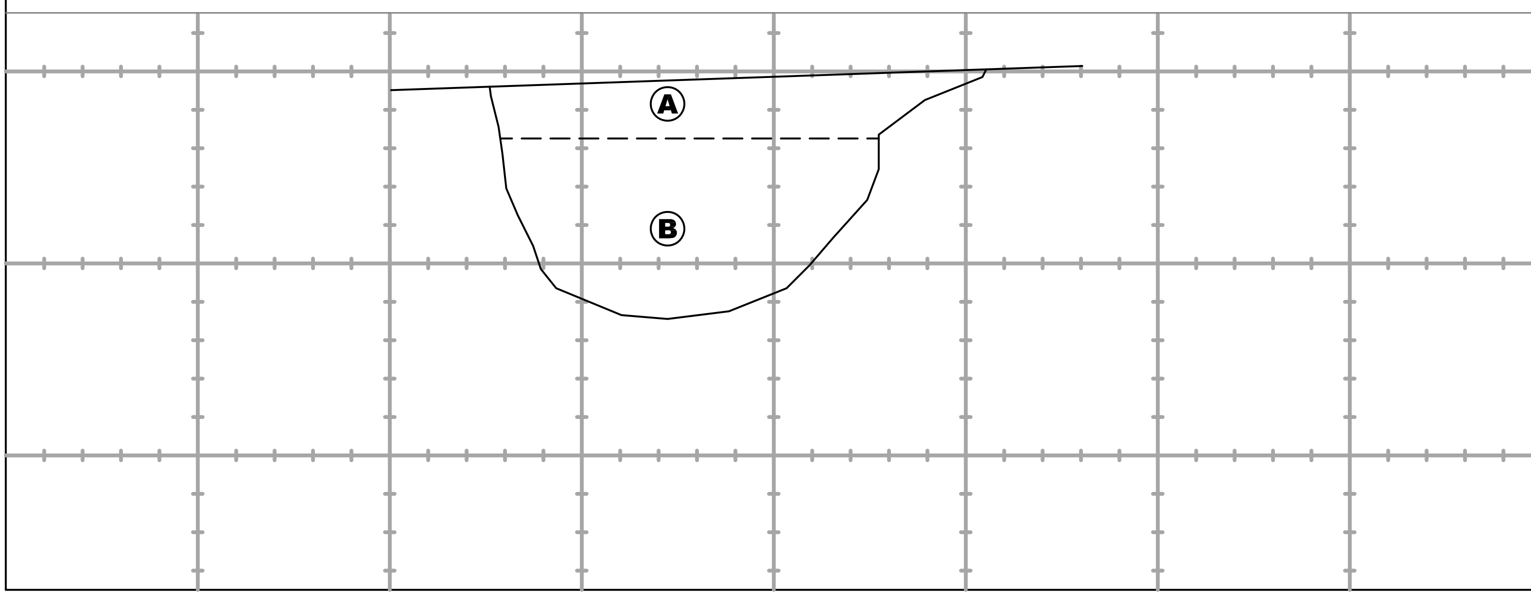
Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	**Logged By: KAD**	**Trench No: TP-20**
Project Number : 13092-01	**Date : 6/25/2019**	**Engineering Properties:**
Equipment: Deere 310J	**Location: See Geotechnical Map**	

LGC Geotechnical, Inc.

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 1.8' Silty Sand: light brown to light reddish brown, dry to slightly moist; upper 6" to 8" desiccated with abundant rootlets; slightly indurated		SM			
	B	@ 1.8' to T.D. Sand to Sand with Silt: dark brown to dark reddish brown, moist; well indurated; difficult digging; prominent white grains (Quartz) T.D.=6.5'		SP	B-1 @ 3'-4'		

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1507 ' MSL** **Surface Slope: 2 deg.** **Trend: EW**



Total Depth: 6.5'
Groundwater: None
Backfilled: 6/25/2019

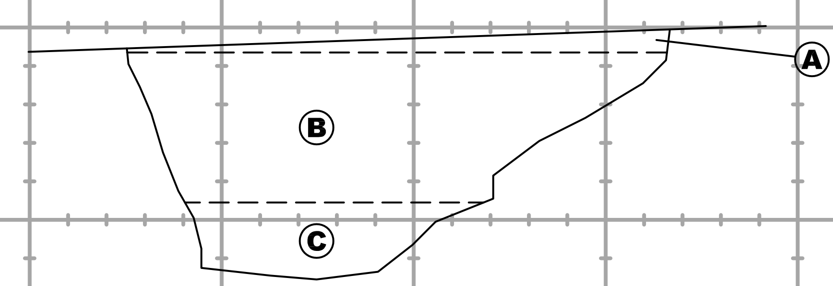
scale : 1 in = 5 ft

Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-21	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 6/25/2019	Engineering Properties:	
Equipment: Deere 310J	Location: See Geotechnical Map		

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 0.6' Sand: light gray, dry, loose; abundant rootlets; desiccated; fine grained		SP			
	B	@ 0.6' to 4.5' Sand: dark brown, slightly moist; micaceous; friable; fine to medium grained		SP	B-1 @ 2'-3'		
	C	***Lakeview Mountain Tonalite***	Klmt		B-2 @ 5'-6'		
		@ 4.5' to T.D. Excavates to Sand: gray and dark brown, slightly moist to moist; friable; decomposed tonalite		SP			
		@6.5' Practical Refusal					
		T.D.=6.5'					

GRAPHICAL REPRESENTATION BELOW: Elevation : 1527 ' MSL Surface Slope: 2 deg. Trend: N50E



Total Depth: 6.5'
Groundwater: None
Backfilled: 6/25/2019

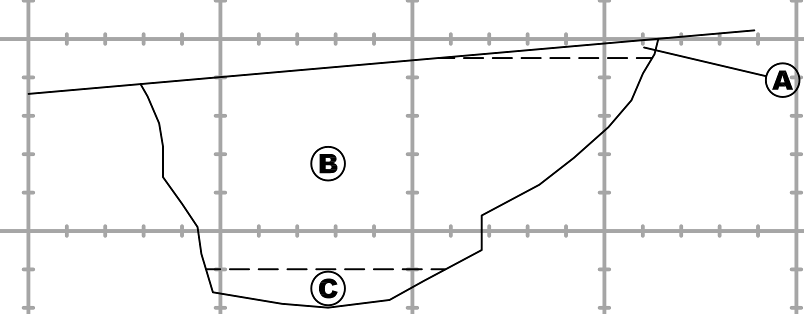
scale : 1 in = 5 ft

Last Edited: 8/5/2019

Project Name: Richland - Stoneridge	Logged By: KAD	Trench No: TP-22	LGC Geotechnical, Inc.
Project Number : 13092-01	Date : 6/25/2019	Engineering Properties:	
Equipment: Deere 310J	Location: See Geotechnical Map		

Geologic Attitudes	Unit	SOIL DESCRIPTION:	GEOLOGIC UNIT	USCS	SAMPLE No	MOISTURE (%)	DRY DENSITY (PCF)
		Quaternary Very Old Fan Deposits	Qvof				
	A	@ 0 to 0.5' Sand: light gray, dry, loose; abundant rootlets and desiccated; fine grained		SP			
	B	@ 0.5' to 6' Sand to Sand with Silt: dark brown, moist; friable; fine grained		SP			
	C	***Lakeview Mountain Tonalite***	Klmt				
		@ 6' to T.D. Excavates to Sand: gray and red brown, slightly moist; medium to coarse grained		SP			

GRAPHICAL REPRESENTATION BELOW: **Elevation : 1555 ' MSL** **Surface Slope: 5 deg.** **Trend: EW**



Total Depth: 7'
Groundwater: None
Backfilled: 6/25/2019

scale : 1 in = 5 ft

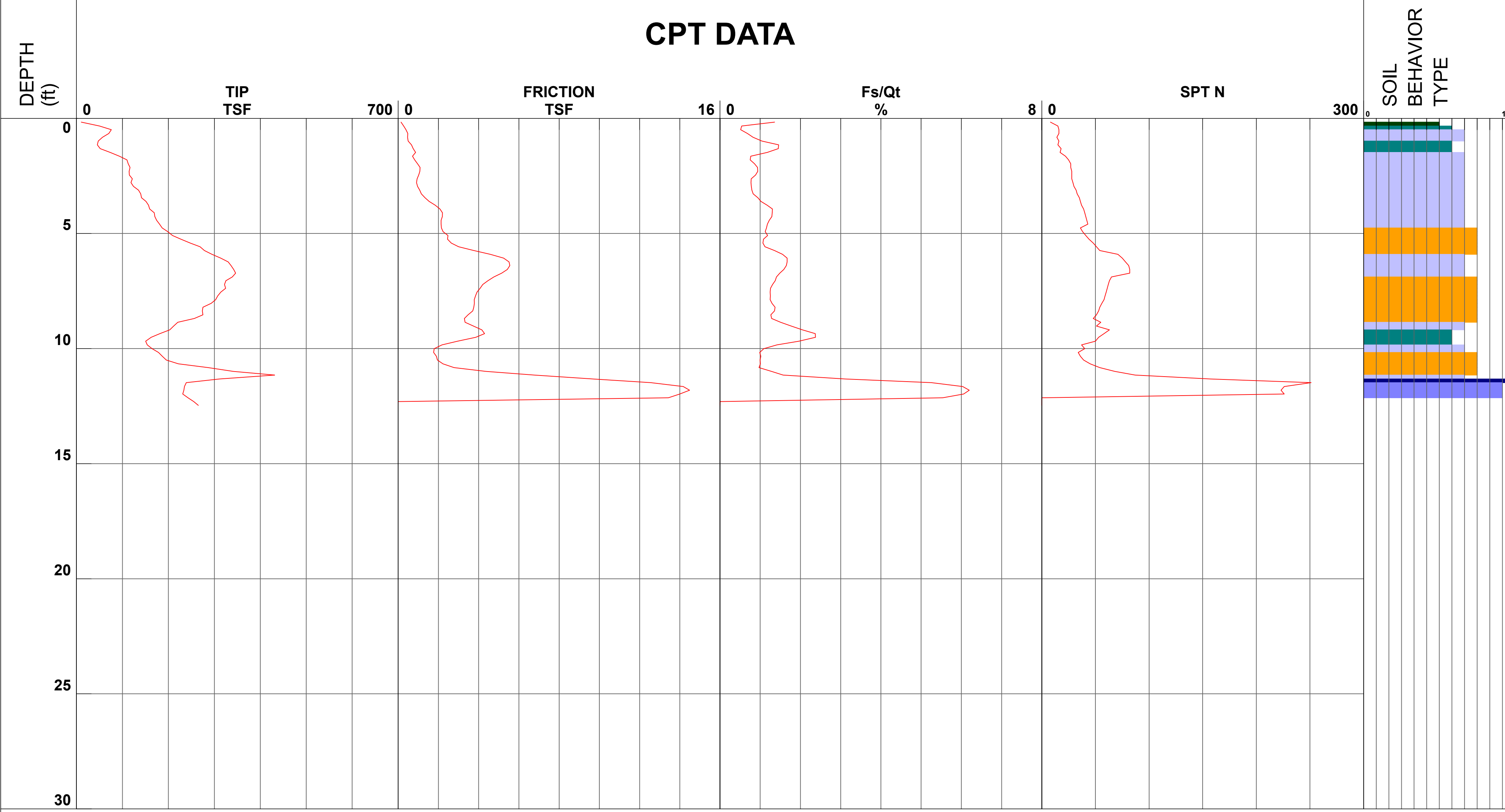
Last Edited: 8/5/2019

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(300).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-01	Date and Time	3/29/2016 9:42:05 AM	Maximum Depth	12.47 ft
EST GW Depth During Test		12.47 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

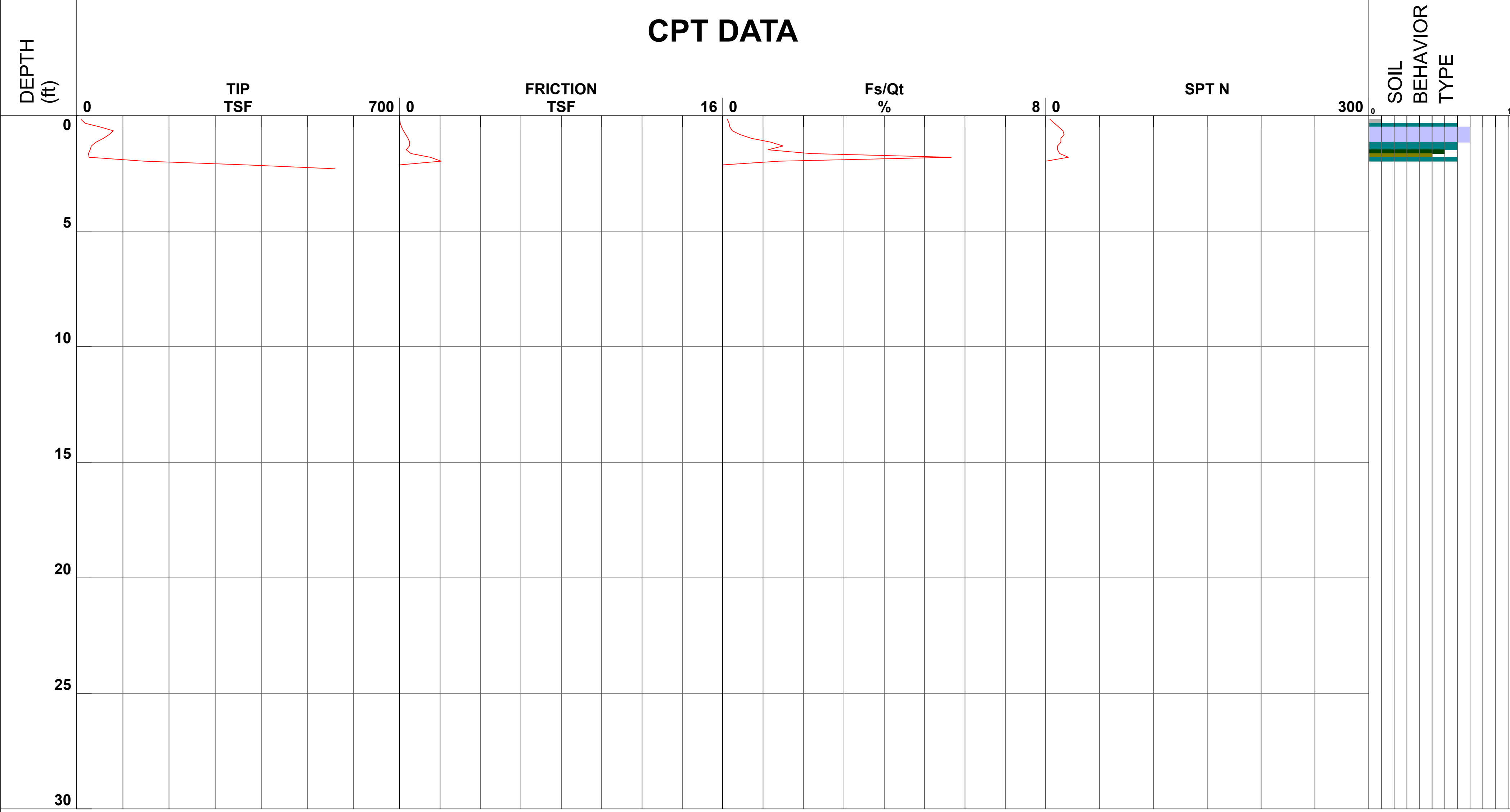
Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(301).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-02	Date and Time	3/29/2016 10:15:30 AM	Maximum Depth	2.30 ft
EST GW Depth During Test		2.30 ft			

Net Area Ratio .8



- 1 - sensitive fine grained
- 2 - organic material
- 3 - clay
- 4 - silty clay to clay
- 5 - clayey silt to silty clay
- 6 - sandy silt to clayey silt
- 7 - silty sand to sandy silt
- 8 - sand to silty sand
- 9 - sand
- 10 - gravelly sand to sand
- 11 - very stiff fine grained (*)
- 12 - sand to clayey sand (*)

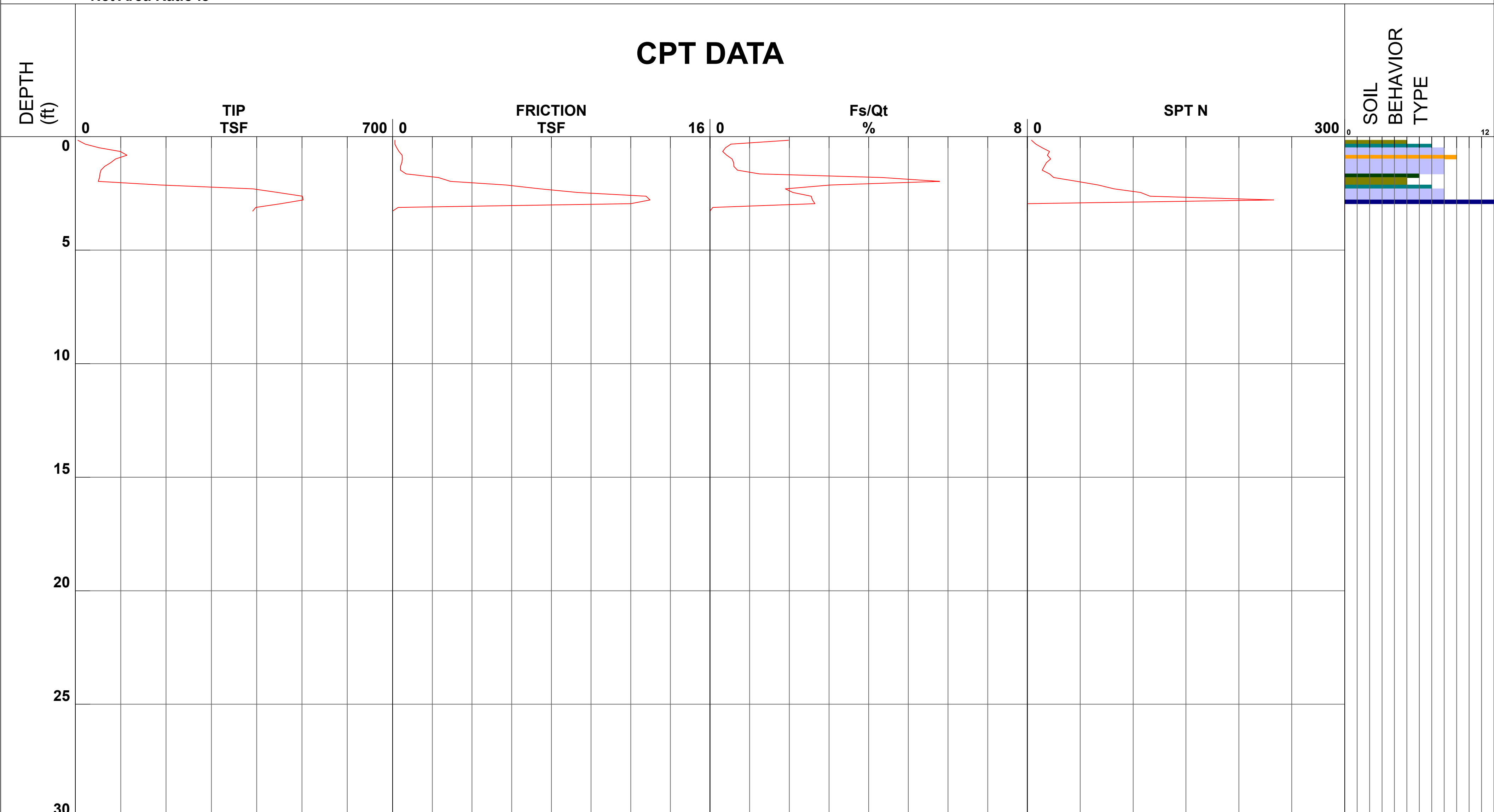
Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(302).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-02A	Date and Time	3/29/2016 10:23:16 AM	Maximum Depth	3.28 ft
EST GW Depth During Test		3.28 ft			

Net Area Ratio .8



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Cone Size 10cm squared

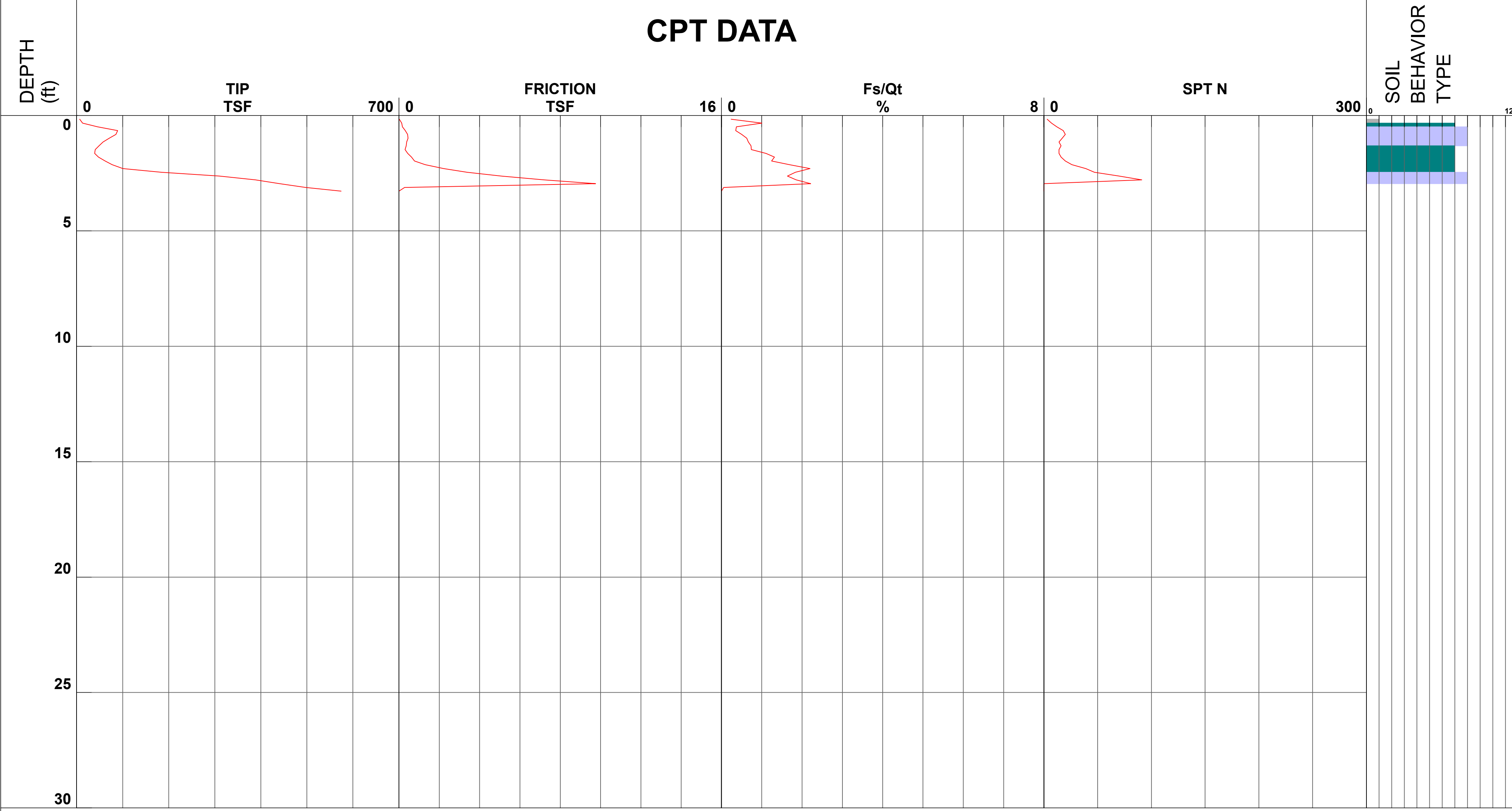
S*Soil behavior type and SPT based on data from UBC-1983

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(303).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-03	Date and Time	3/29/2016 10:38:10 AM	Maximum Depth	3.28 ft
EST GW Depth During Test		3.28 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

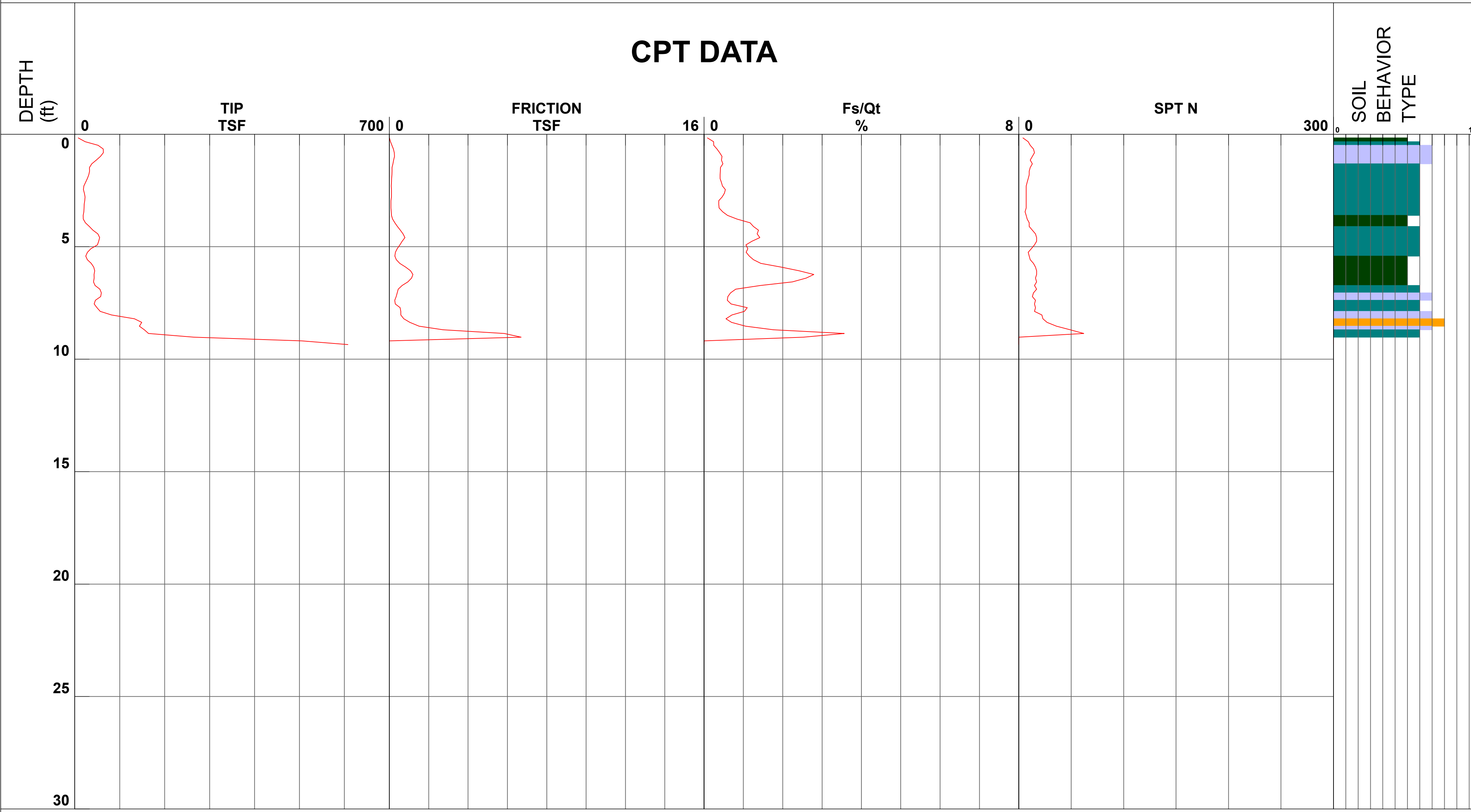
Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(304).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-04	Date and Time	3/29/2016 10:54:59 AM	Maximum Depth	9.35 ft
EST GW Depth During Test		9.35 ft			

Net Area Ratio .8



- 1 - sensitive fine grained
- 2 - organic material
- 3 - clay
- 4 - silty clay to clay
- 5 - clayey silt to silty clay
- 6 - sandy silt to clayey silt
- 7 - silty sand to sandy silt
- 8 - sand to silty sand
- 9 - sand
- 10 - gravelly sand to sand
- 11 - very stiff fine grained (*)
- 12 - sand to clayey sand (*)

Cone Size 10cm squared

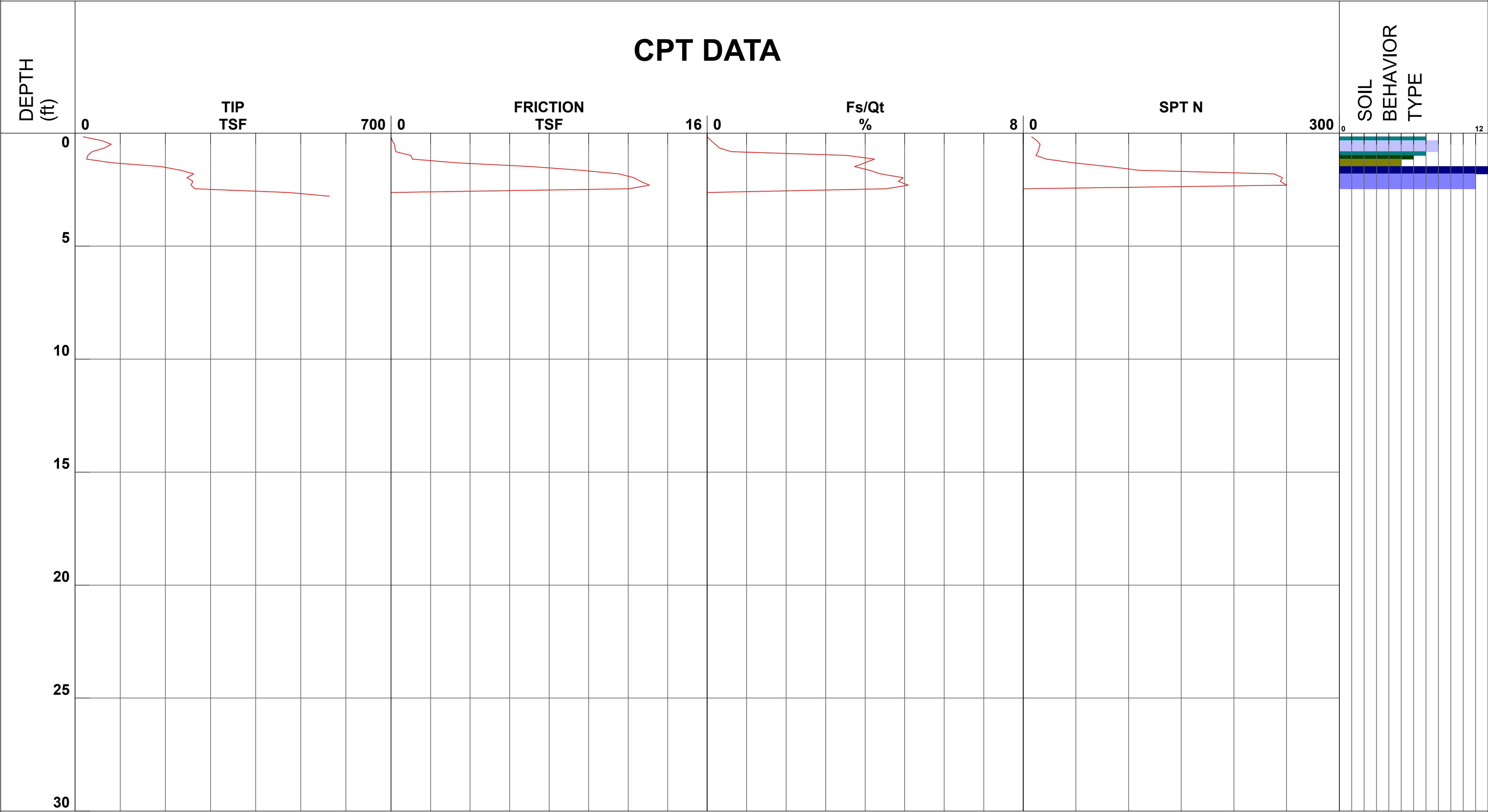
S*Soil behavior type and SPT based on data from UBC-1983

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(305).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-05	Date and Time	3/29/2016 11:10:58 AM	Maximum Depth	2.79 ft
EST GW Depth During Test		2.79 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Cone Size 10cm squared

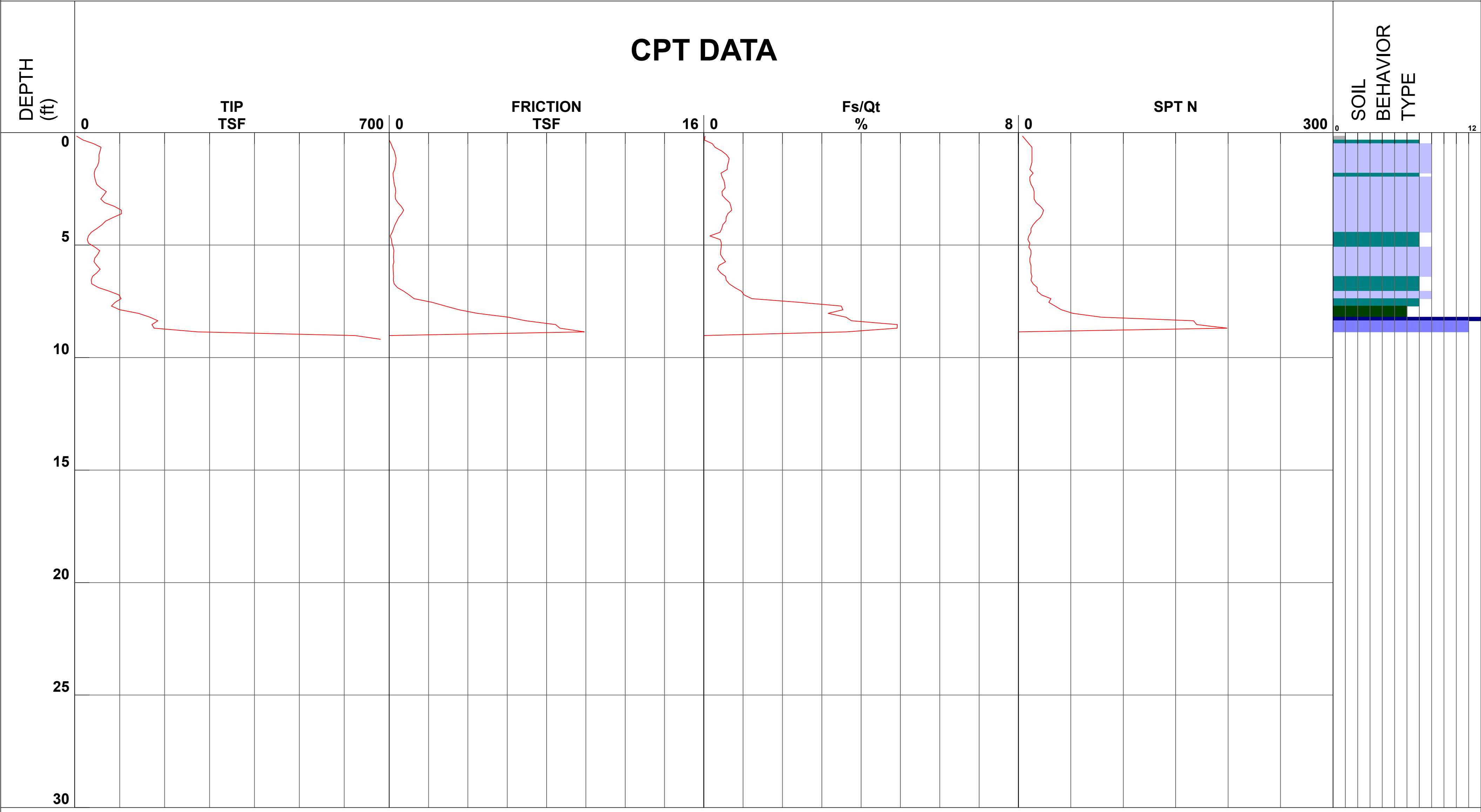
S*Soil behavior type and SPT based on data from UBC-1983

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(306).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-06	Date and Time	3/29/2016 11:25:18 AM	Maximum Depth	9.19 ft
EST GW Depth During Test		9.19 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained
2 - organic material
3 - clay
4 - silty clay to clay
5 - clayey silt to silty clay
6 - sandy silt to clayey silt
7 - silty sand to sandy silt
8 - sand to silty sand
9 - sand
10 - gravelly sand to sand
11 - very stiff fine grained (*)
12 - sand to clayey sand (*)

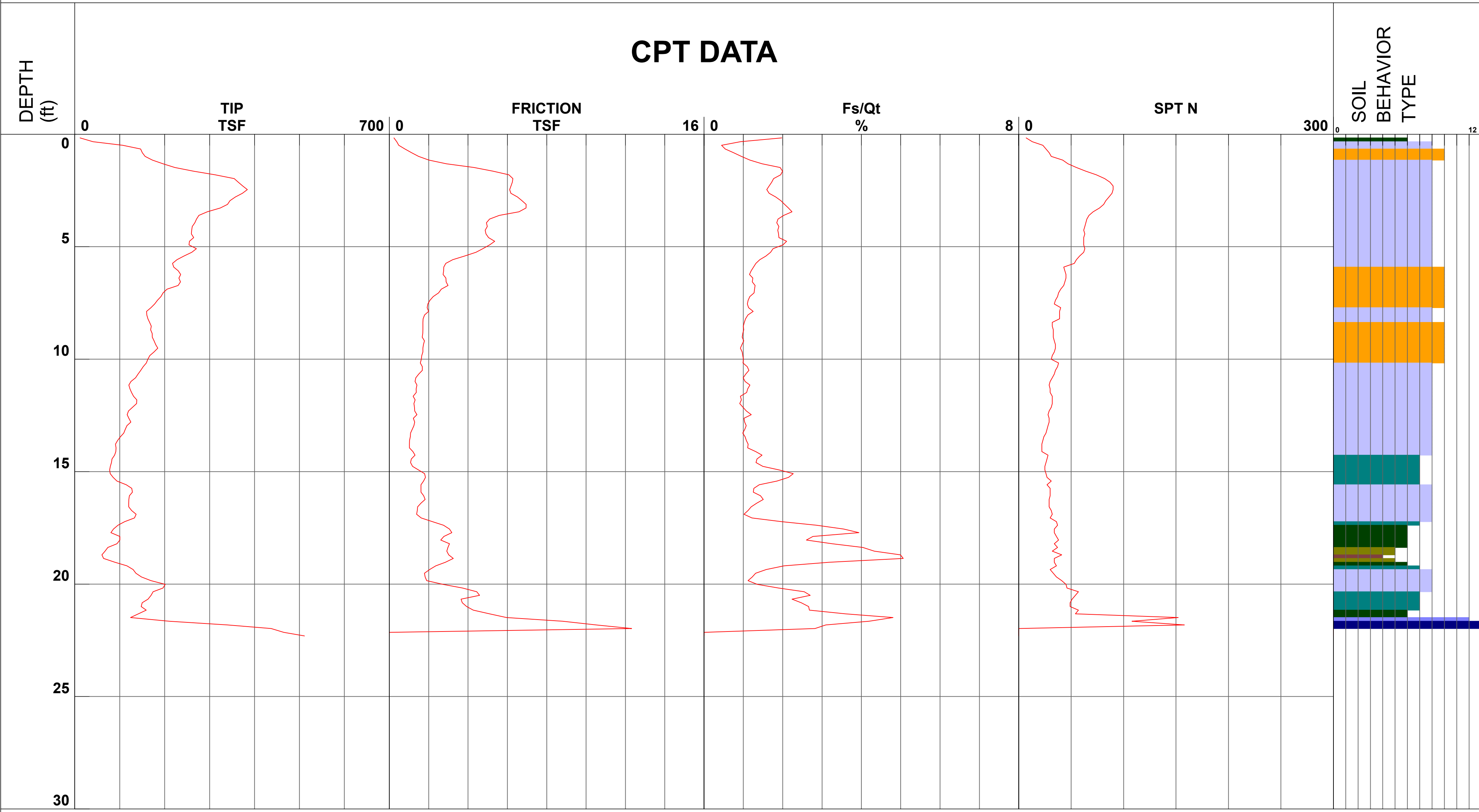
Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(307).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-07	Date and Time	3/29/2016 11:46:18 AM	Maximum Depth	22.31 ft
EST GW Depth During Test	22.31 ft				

Net Area Ratio .8



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

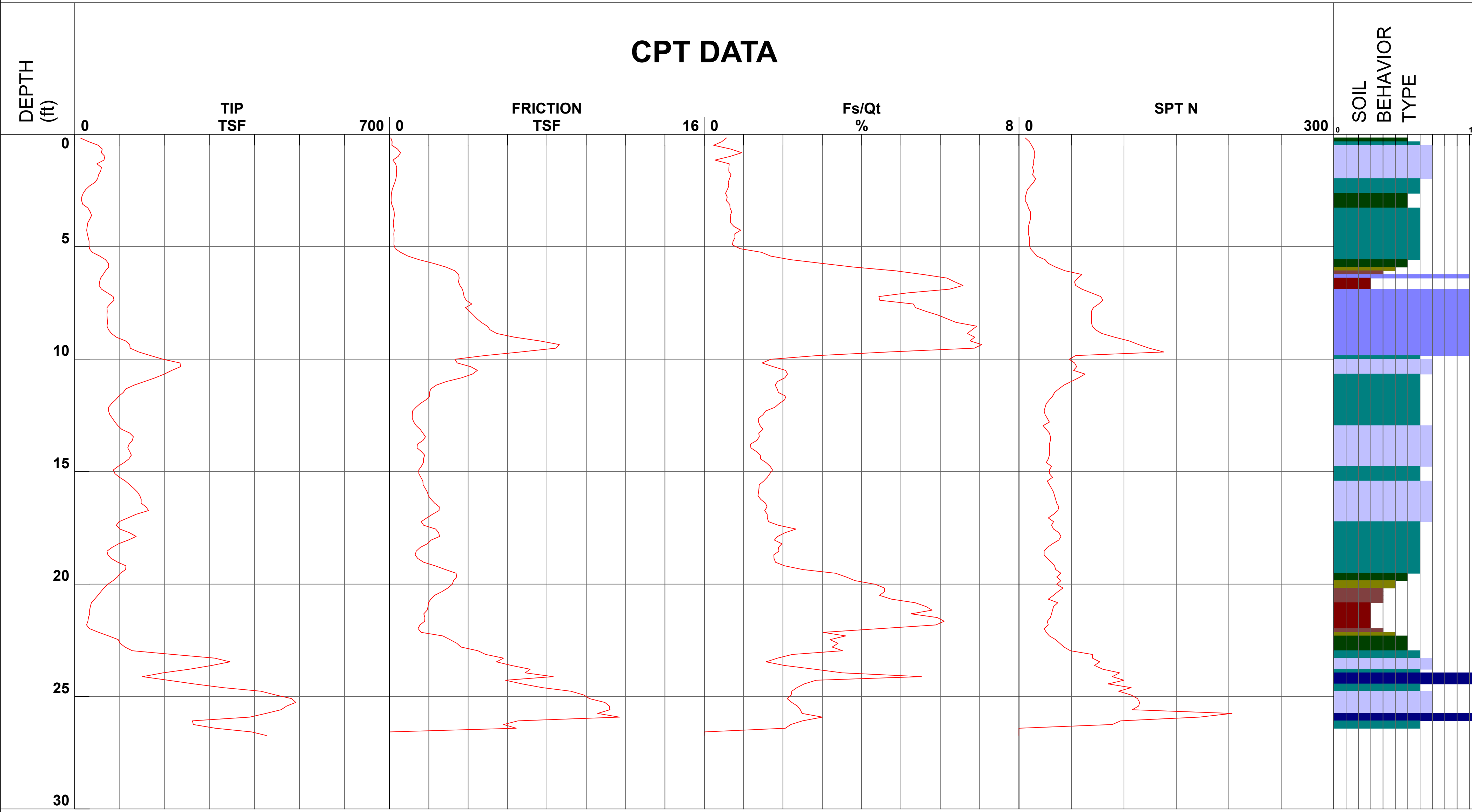
Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(308).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-08	Date and Time	3/29/2016 12:17:43 PM	Maximum Depth	26.74 ft
EST GW Depth During Test		26.74 ft			

Net Area Ratio .8



- 1 - sensitive fine grained
- 2 - organic material
- 3 - clay
- 4 - silty clay to clay
- 5 - clayey silt to silty clay
- 6 - sandy silt to clayey silt
- 7 - silty sand to sandy silt
- 8 - sand to silty sand
- 9 - sand
- 10 - gravelly sand to sand
- 11 - very stiff fine grained (*)
- 12 - sand to clayey sand (*)

Cone Size 10cm squared

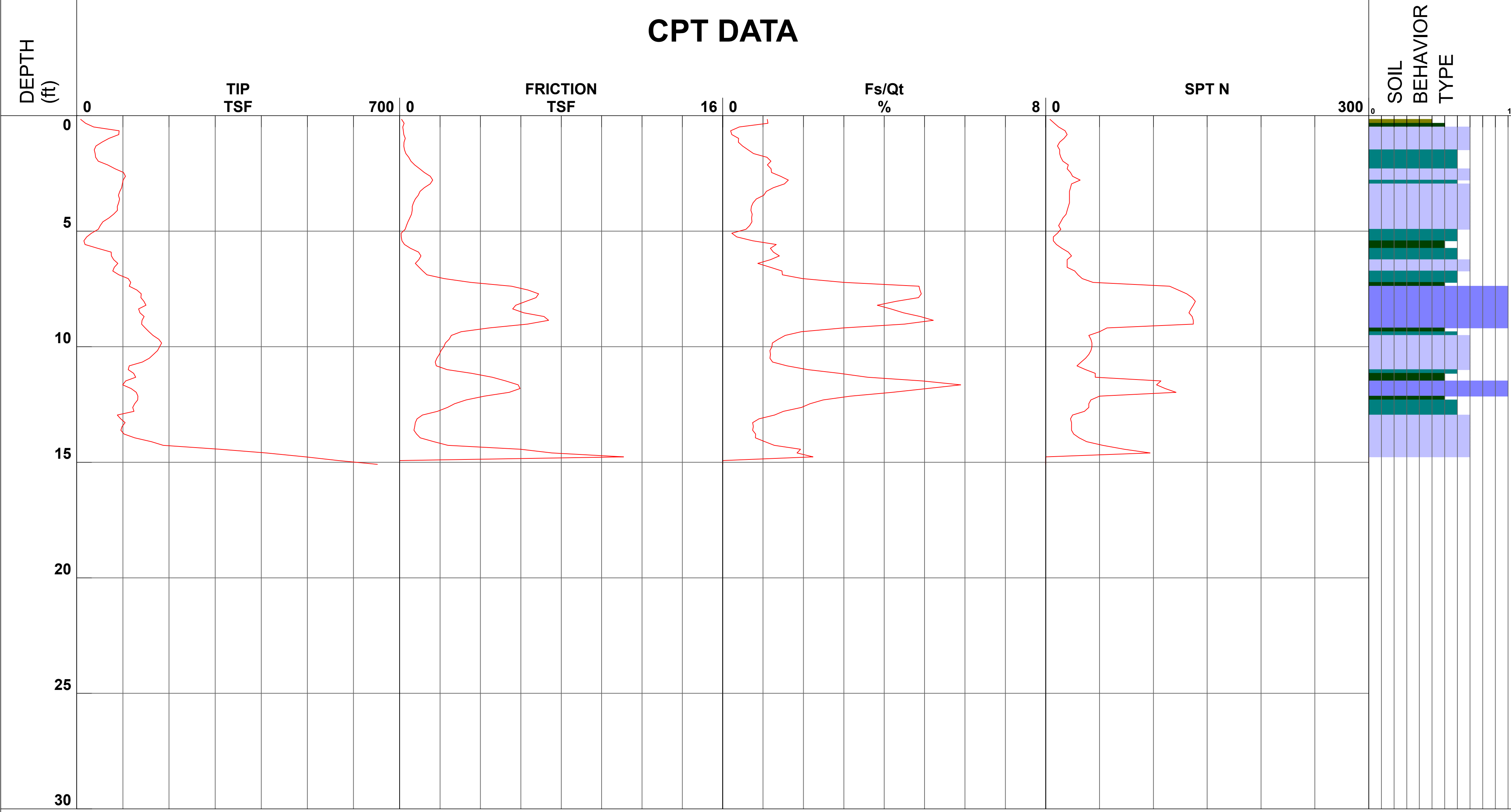
S*Soil behavior type and SPT based on data from UBC-1983

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(309).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-09	Date and Time	3/29/2016 12:49:30 PM	Maximum Depth	15.09 ft
EST GW Depth During Test		15.09 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

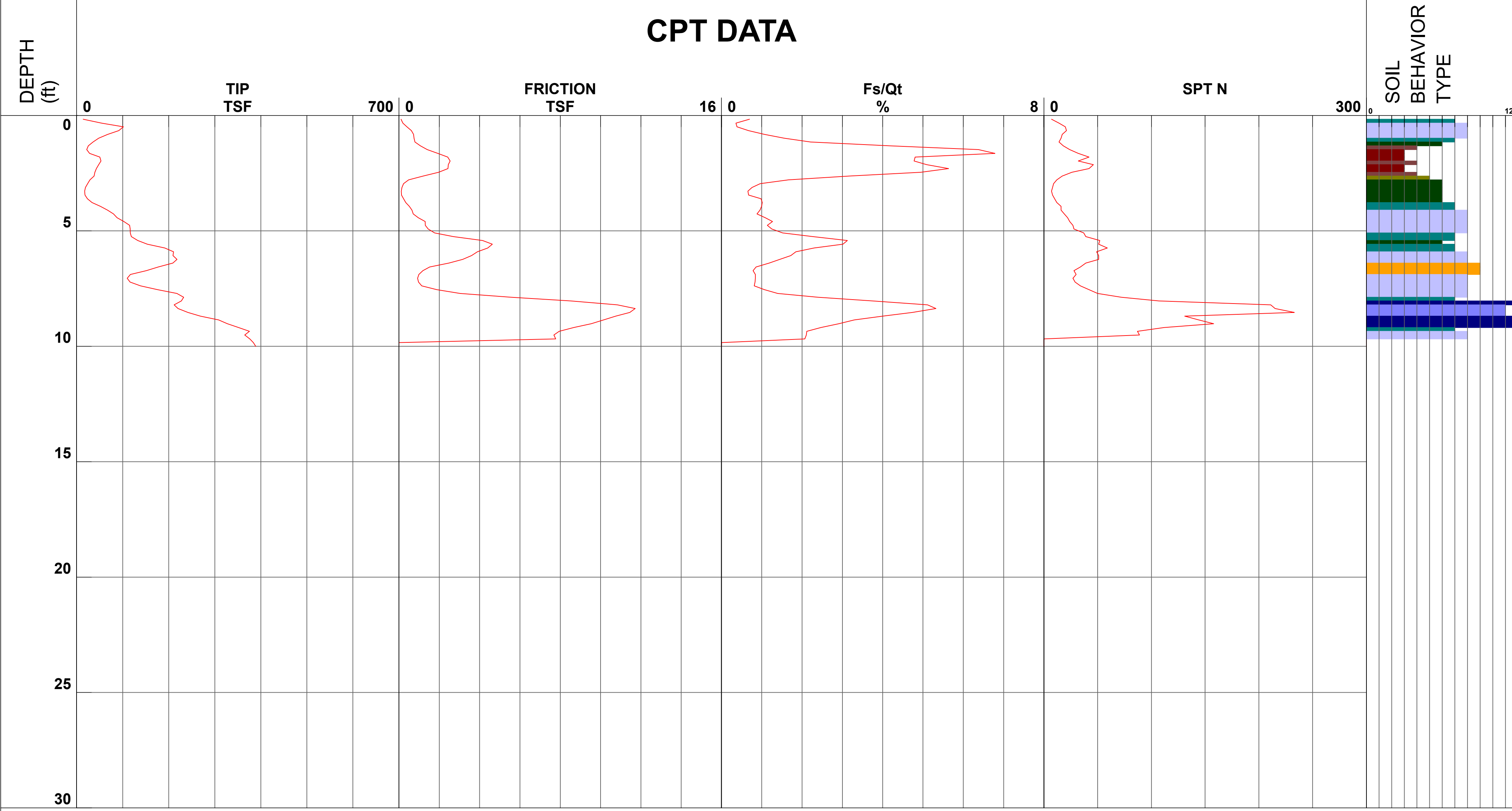
LGC Geotechnical Inc

Middle Earth Geo Testing Inc.

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(310).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-10	Date and Time	3/29/2016 1:10:41 PM	Maximum Depth	10.01 ft
EST GW Depth During Test		10.01 ft			

Net Area Ratio .8

CPT DATA



1 - sensitive fine grained	4 - silty clay to clay	7 - silty sand to sandy silt	10 - gravelly sand to sand
2 - organic material	5 - clayey silt to silty clay	8 - sand to silty sand	11 - very stiff fine grained (*)
3 - clay	6 - sandy silt to clayey silt	9 - sand	12 - sand to clayey sand (*)

Cone Size 10cm squared

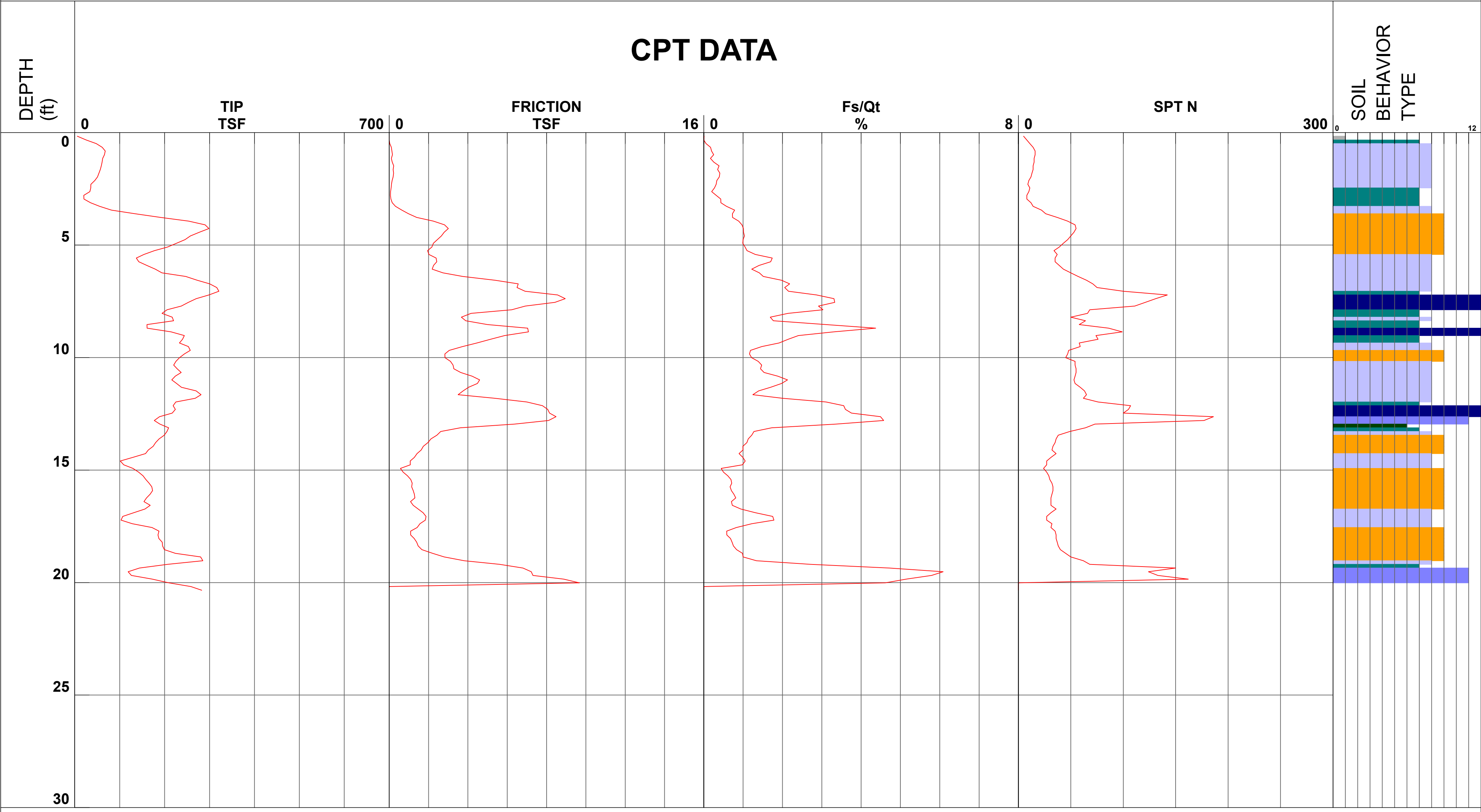
S*Soil behavior type and SPT based on data from UBC-1983

LGC Geotechnical Inc

Project	Richland-Stonebridge	Operator	DG-RC	Filename	SDF(311).cpt
Job Number	13092-01	Cone Number	DDG1366	GPS	
Hole Number	CPT-11	Date and Time	3/29/2016 1:52:16 PM	Maximum Depth	20.34 ft
EST GW Depth During Test		20.34 ft			

Net Area Ratio .8

CPT DATA



- 1 - sensitive fine grained
- 2 - organic material
- 3 - clay
- 4 - silty clay to clay
- 5 - clayey silt to silty clay
- 6 - sandy silt to clayey silt
- 7 - silty sand to sandy silt
- 8 - sand to silty sand
- 9 - sand
- 10 - gravelly sand to sand
- 11 - very stiff fine grained (*)
- 12 - sand to clayey sand (*)

Cone Size 10cm squared

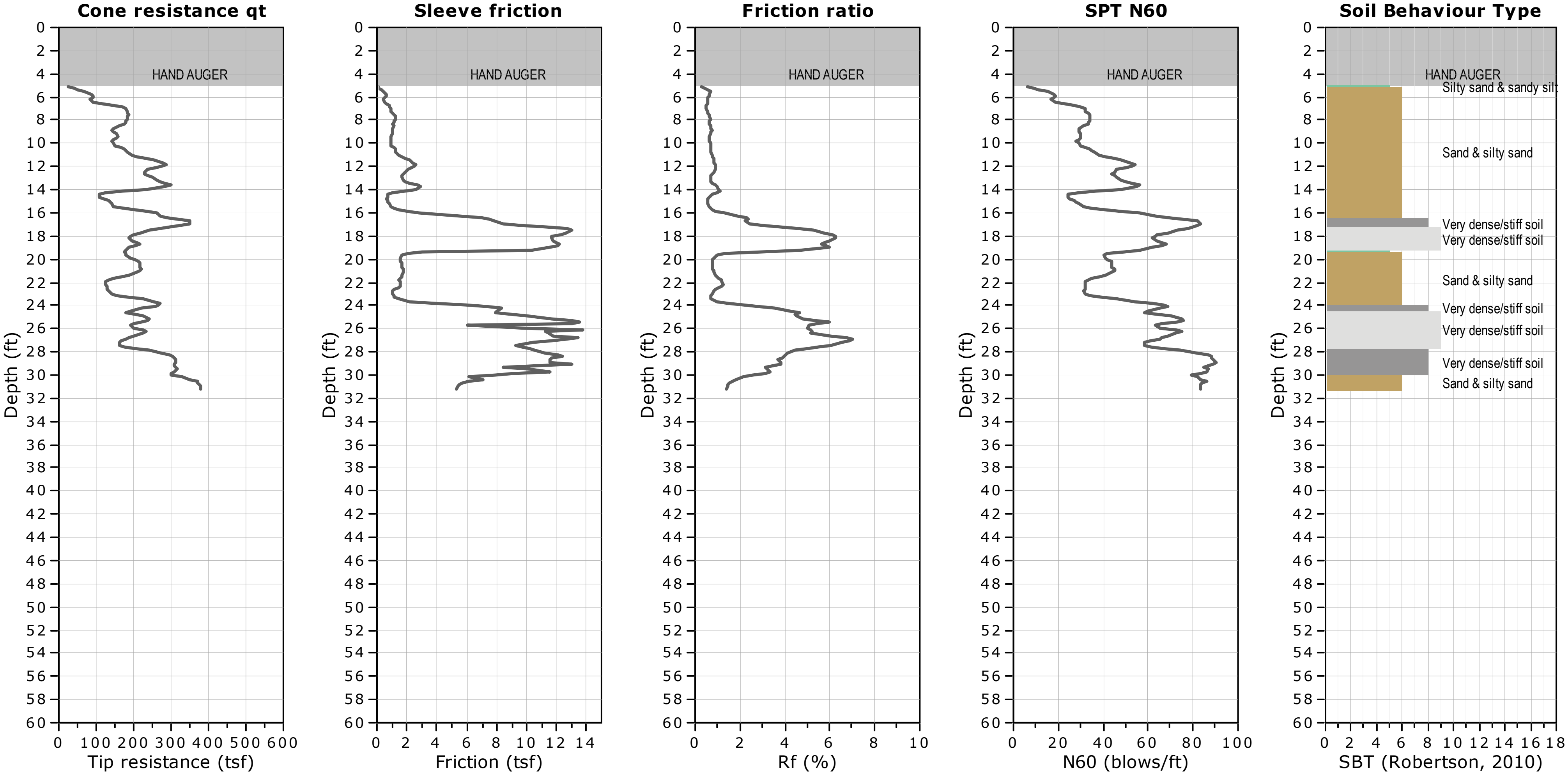
S*Soil behavior type and SPT based on data from UBC-1983

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-12

CLIENT: LGC GEOTECHNICAL INC.
SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON
Total depth: 31.17 ft, Date: 6/25/2019



SBTn legend

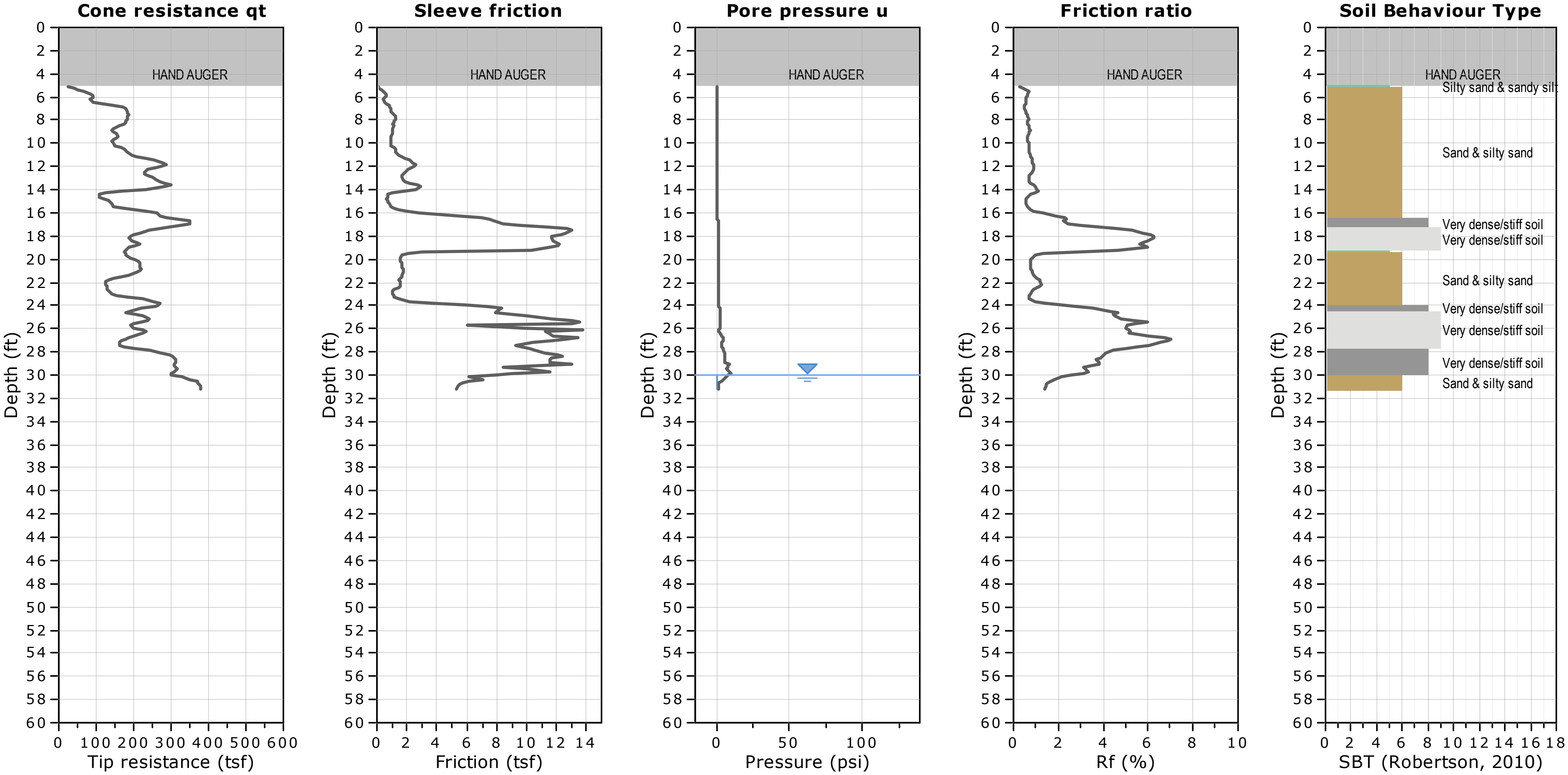
- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-12

CLIENT: LGC GEOTECHNICAL INC.
SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON
Total depth: 31.17 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

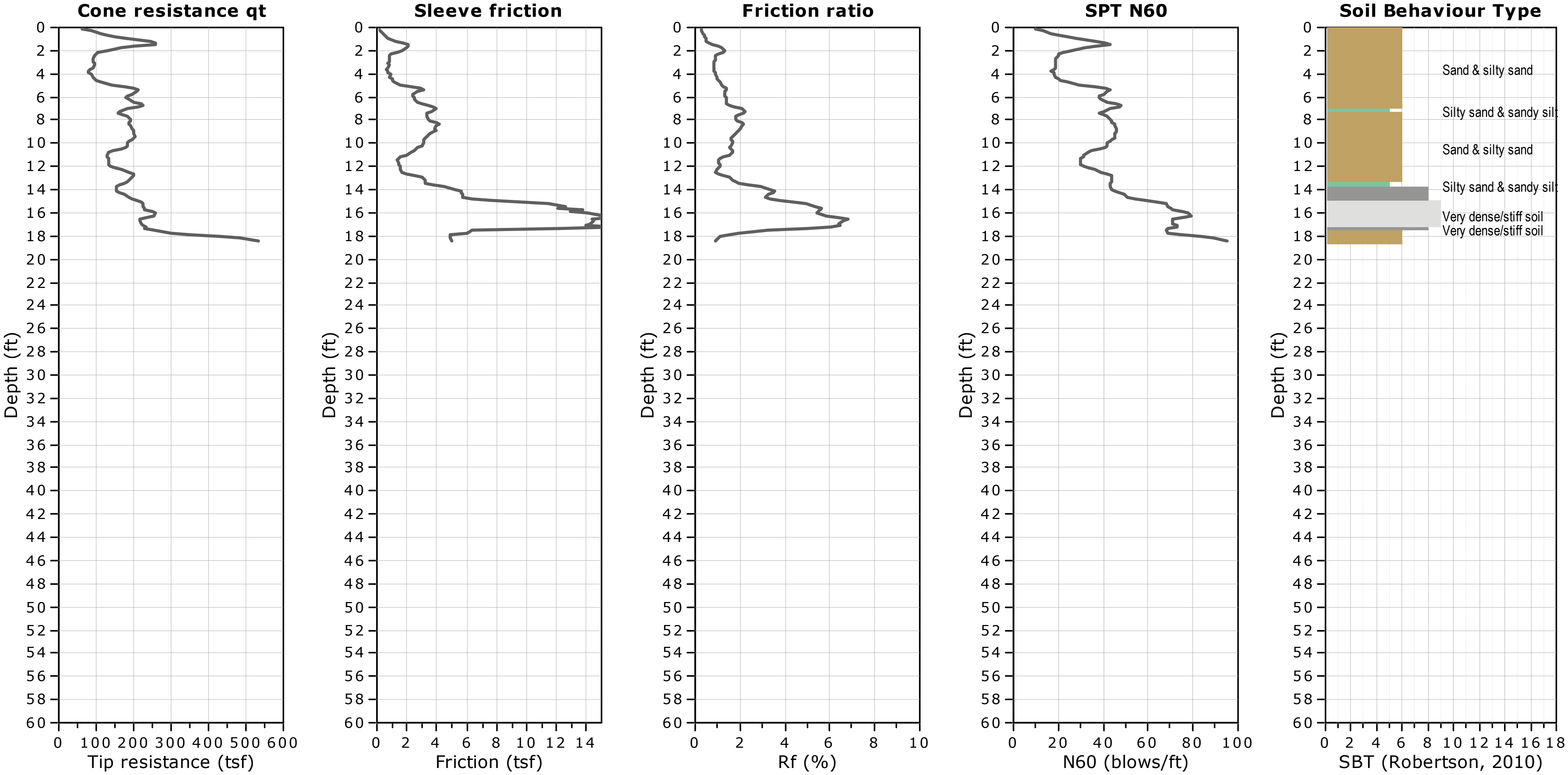
CPT: CPT-13

CLIENT: LGC GEOTECHNICAL INC.

FIELD REP: BRANDON

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Total depth: 18.37 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

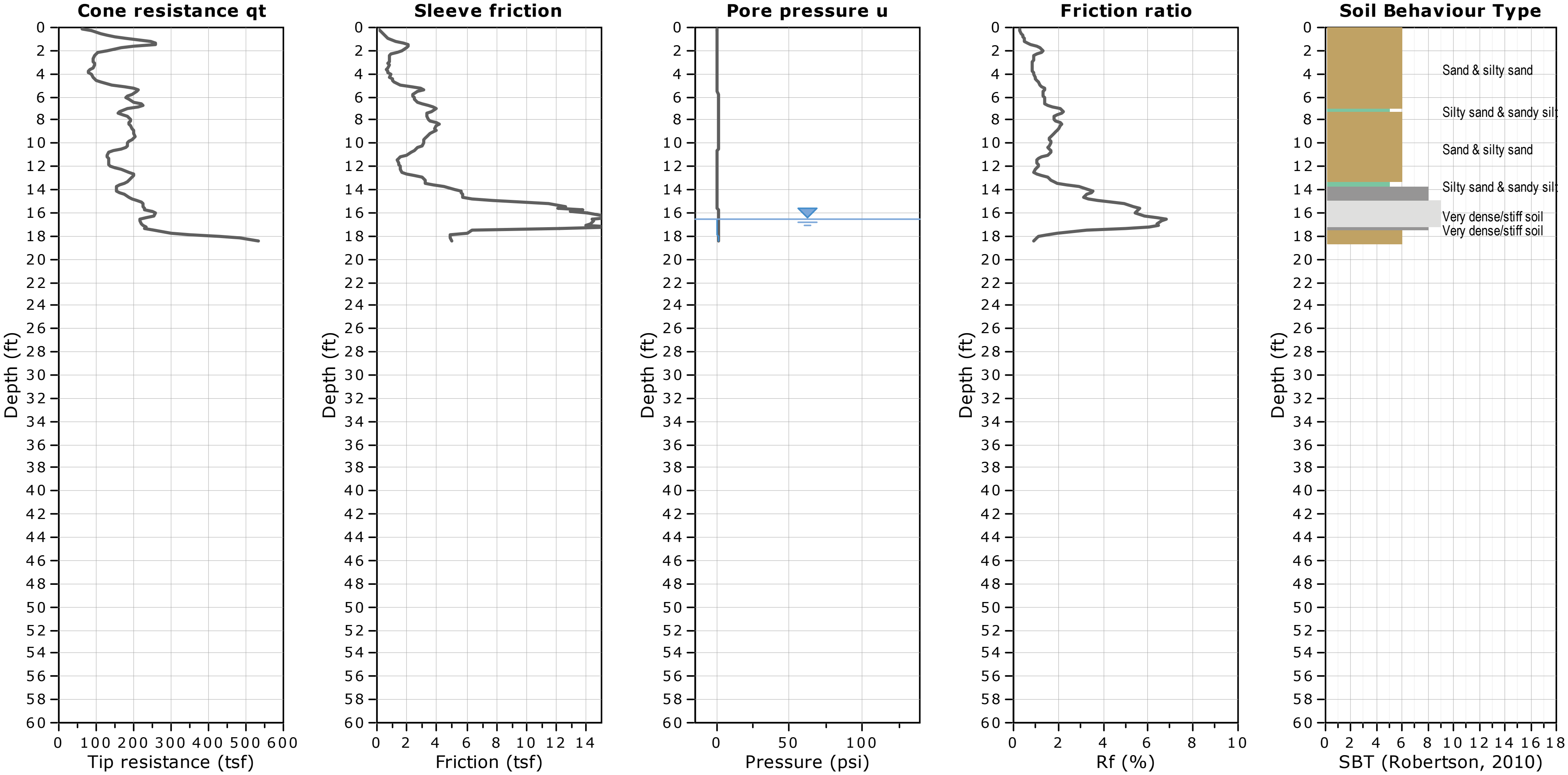
CPT: CPT-13

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON

Total depth: 18.37 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

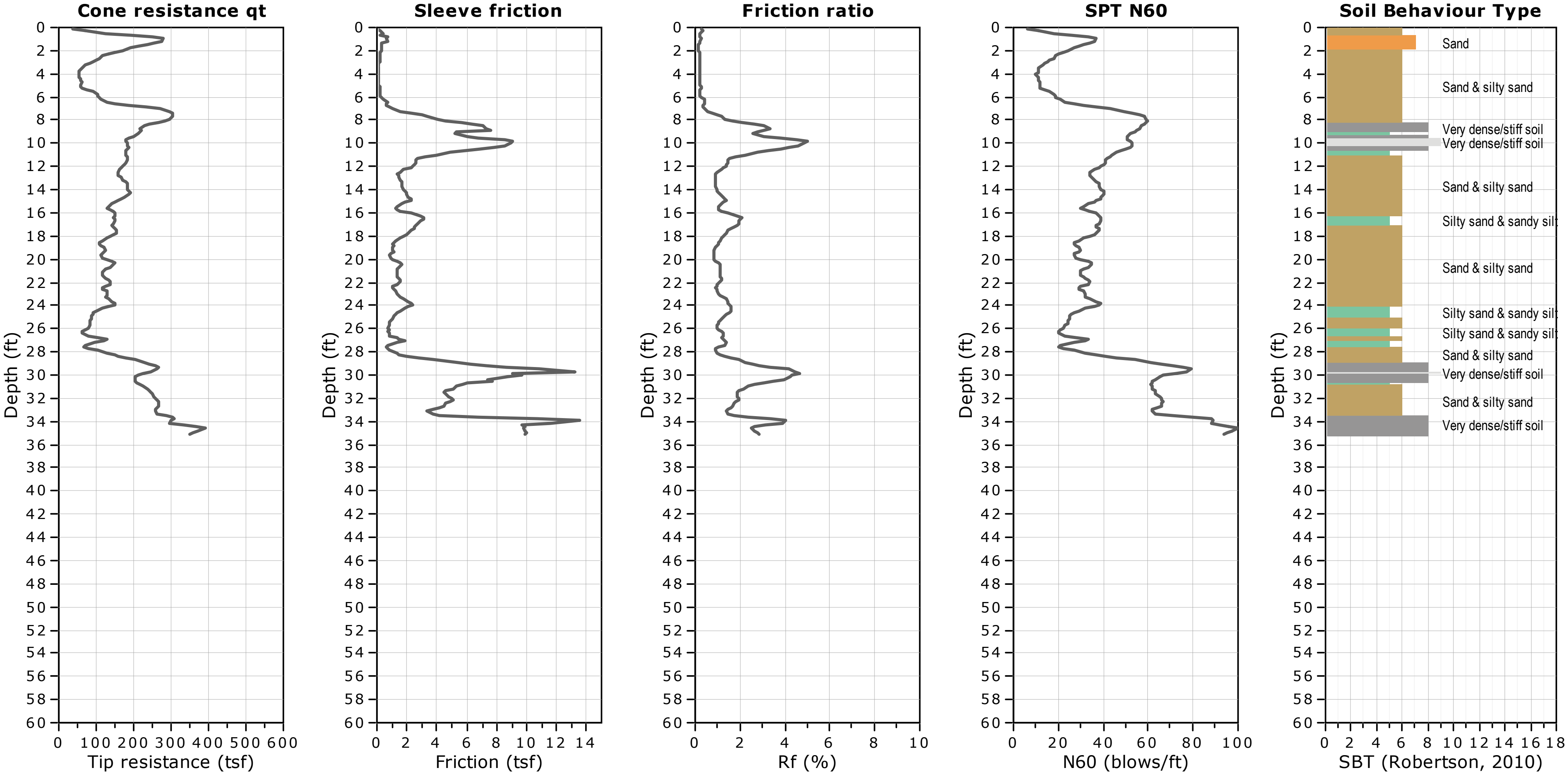
CPT: CPT-14

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON

Total depth: 35.10 ft, Date: 6/25/2019



SBTn legend

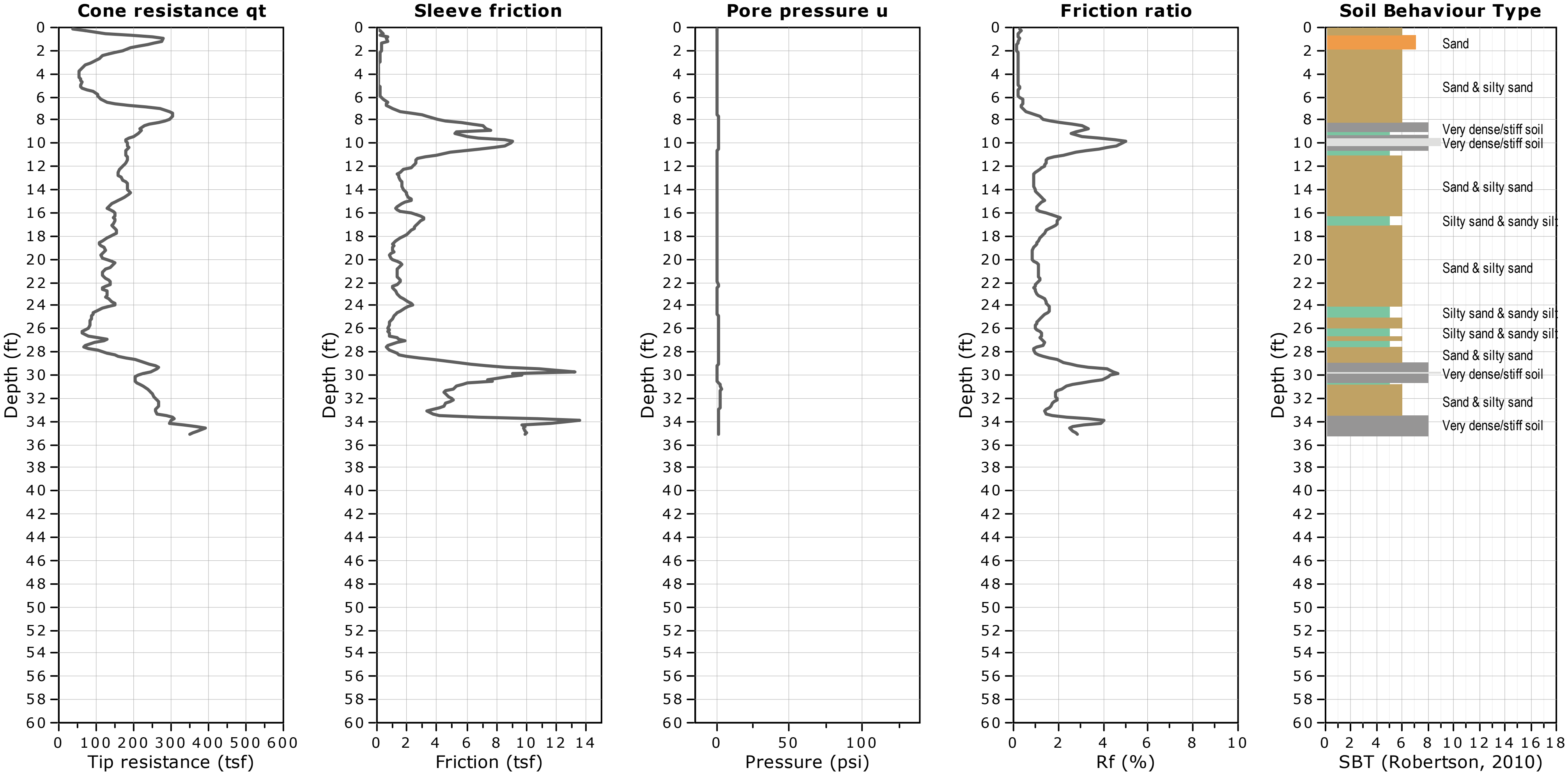
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-14

CLIENT: LGC GEOTECHNICAL INC.
SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON
Total depth: 35.10 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

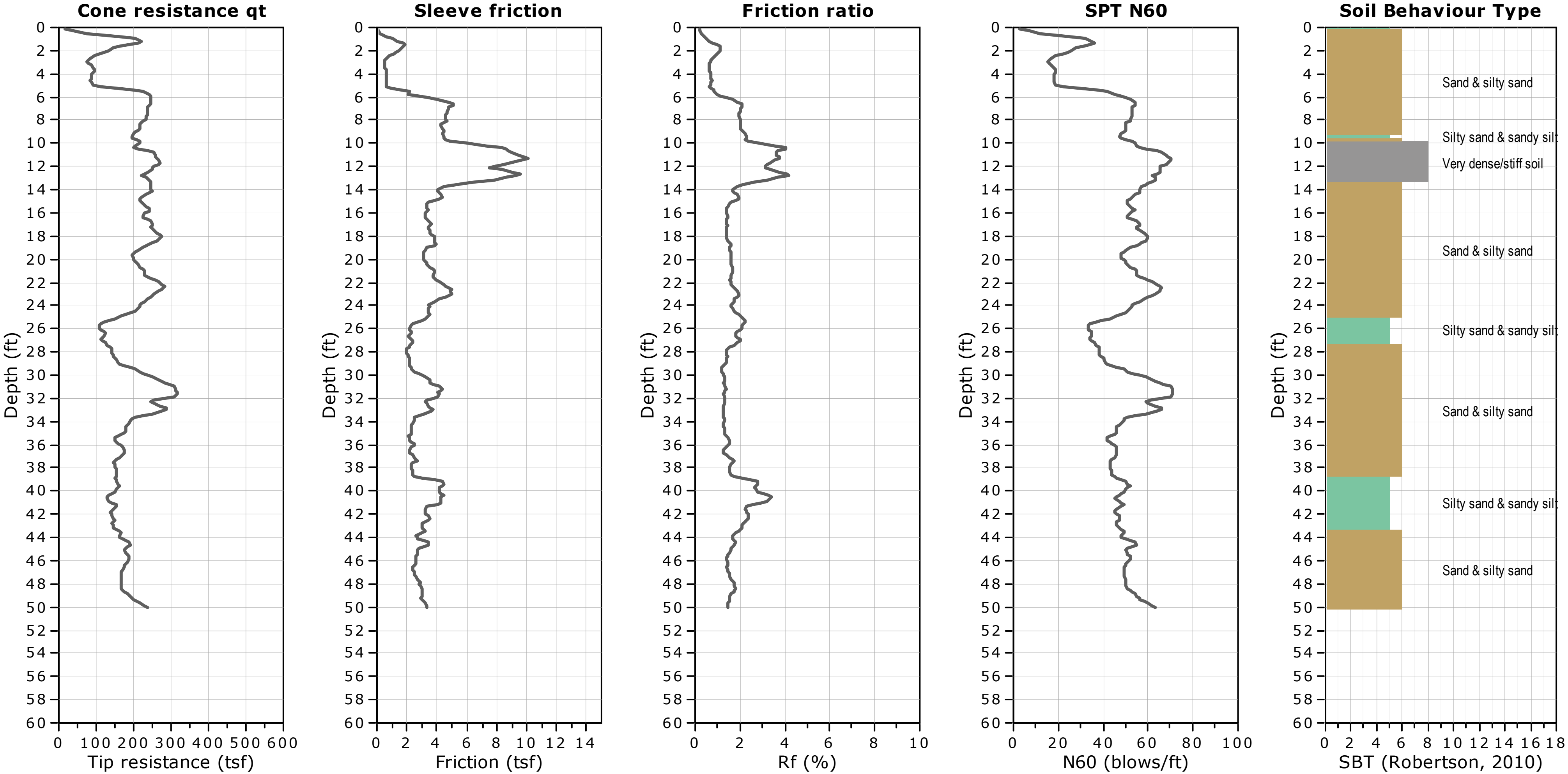
CPT: CPT-15

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON

Total depth: 50.03 ft, Date: 6/25/2019



SBTn legend

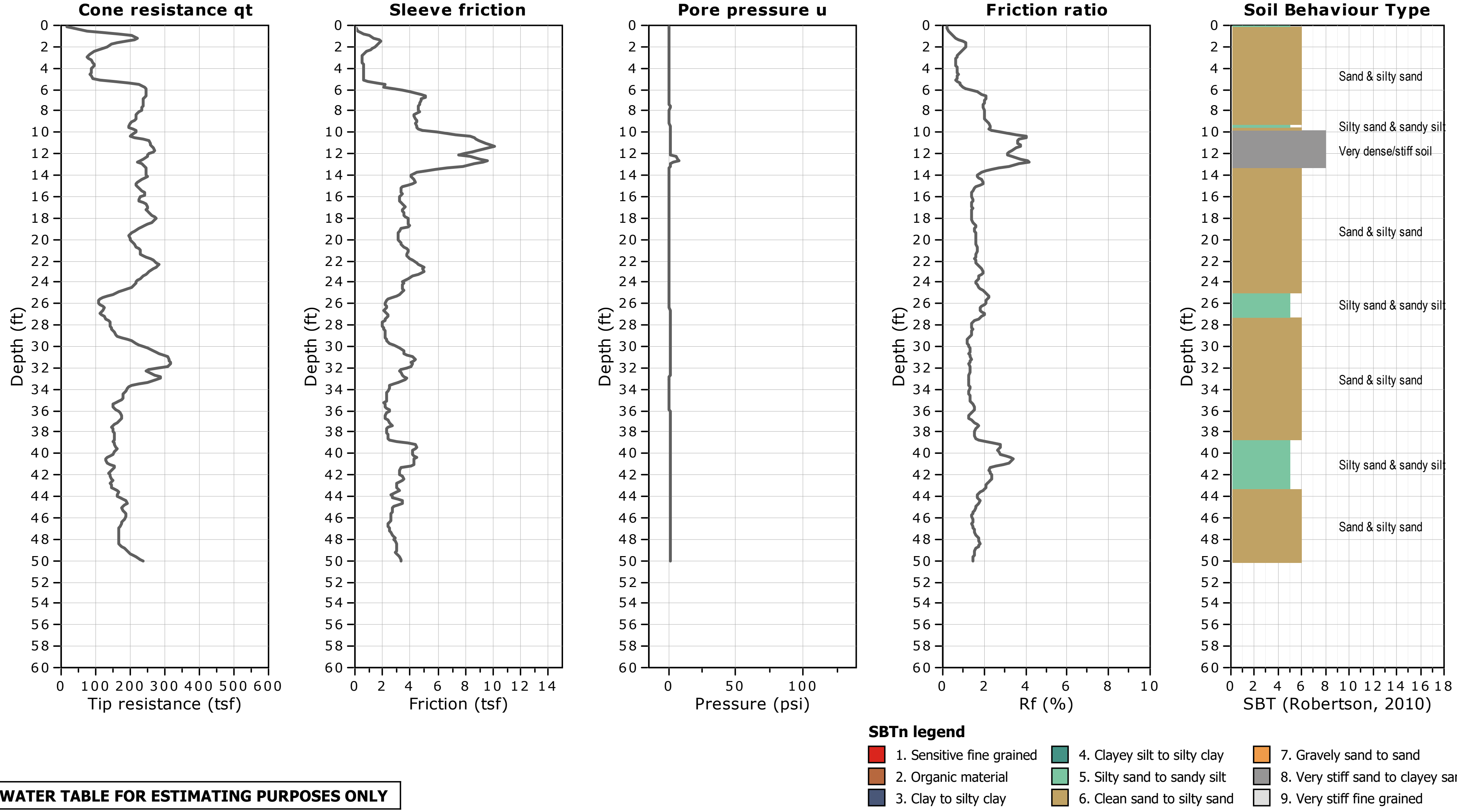
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-15

CLIENT: LGC GEOTECHNICAL INC.
SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON
Total depth: 50.03 ft, Date: 6/25/2019



WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

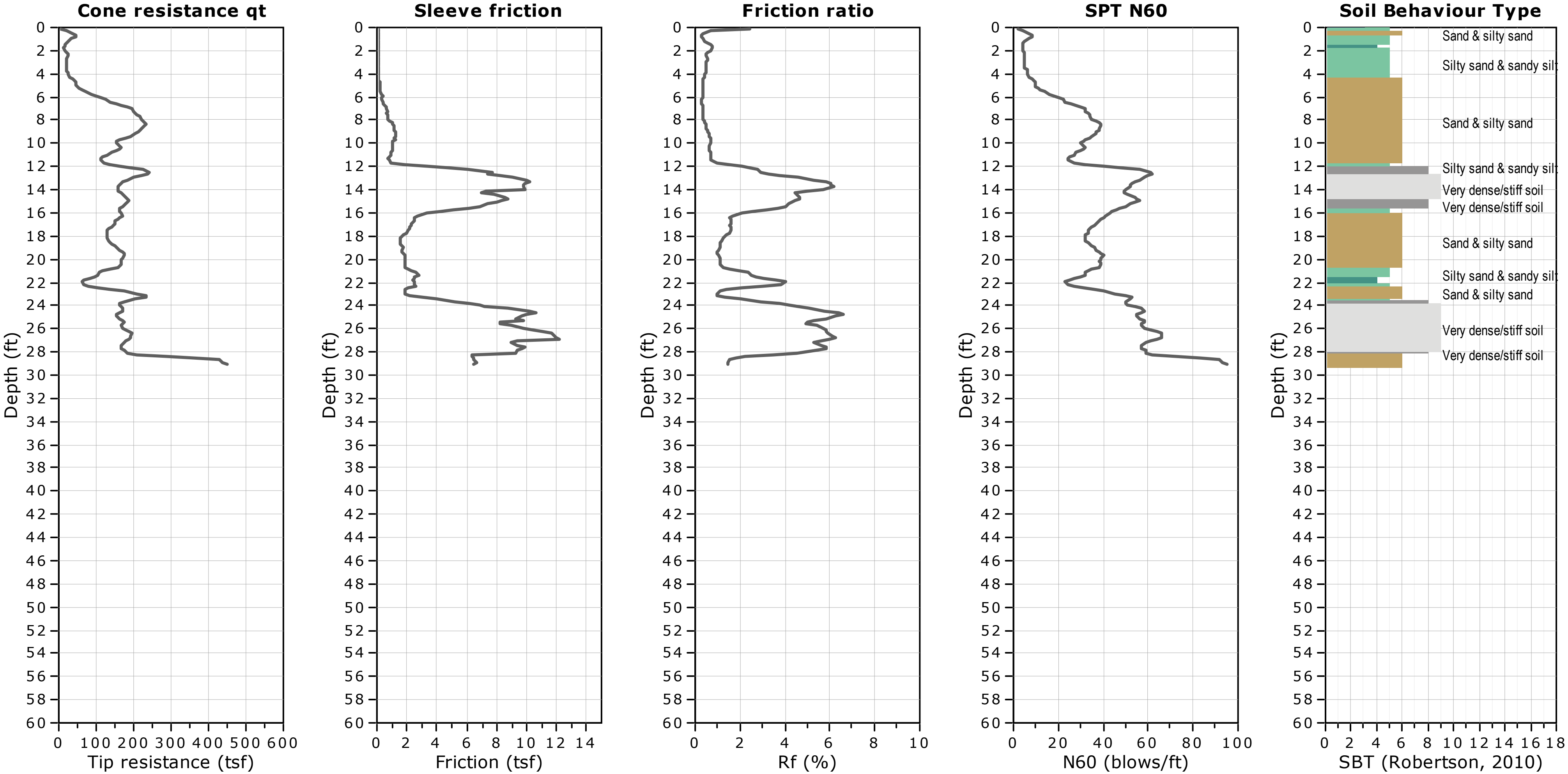
CPT: CPT-16

CLIENT: LGC GEOTECHNICAL INC.

FIELD REP: BRANDON

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Total depth: 29.04 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

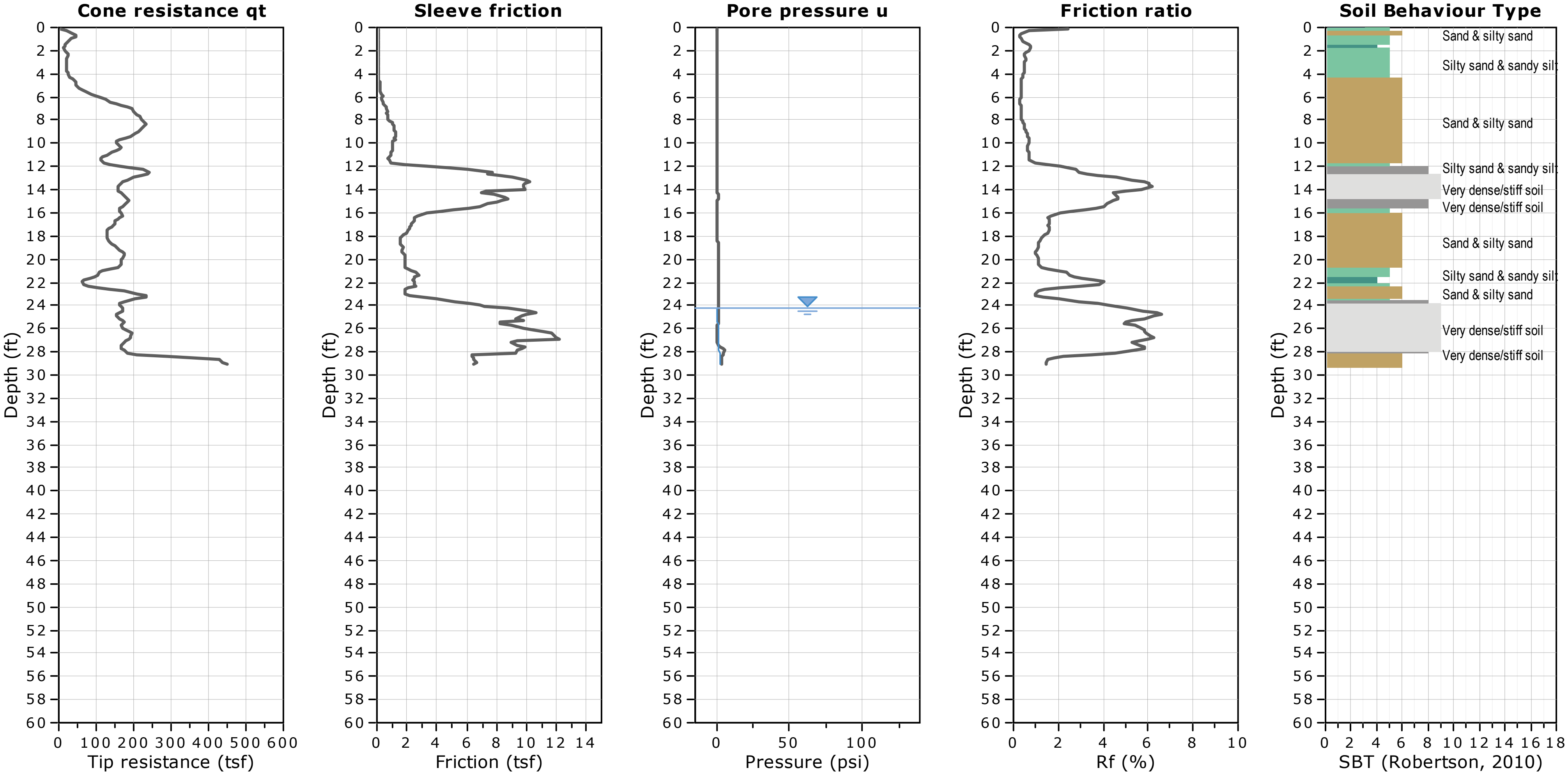
CPT: CPT-16

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON

Total depth: 29.04 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

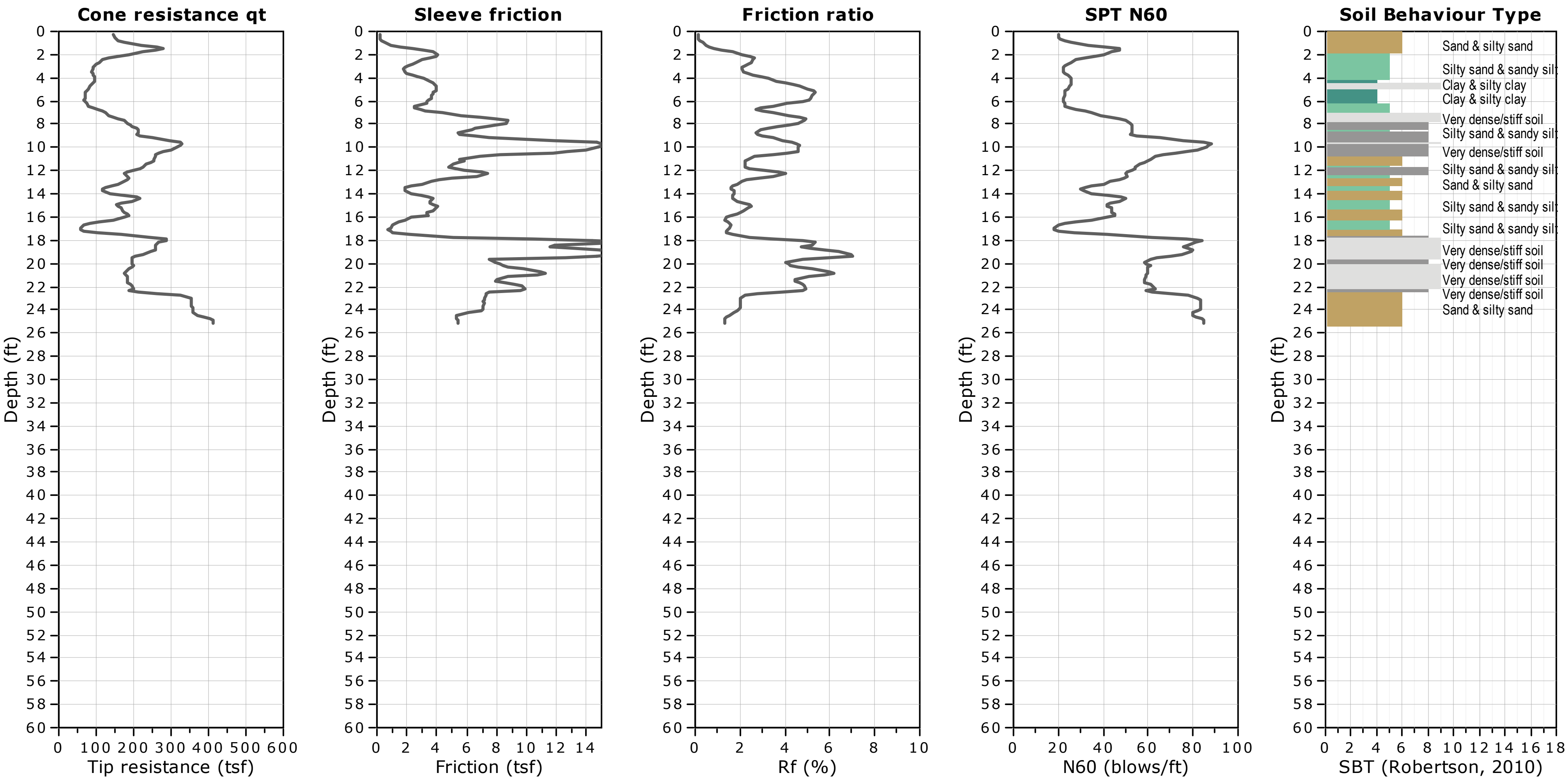
WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-17

CLIENT: LGC GEOTECHNICAL INC.
SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON
Total depth: 25.10 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

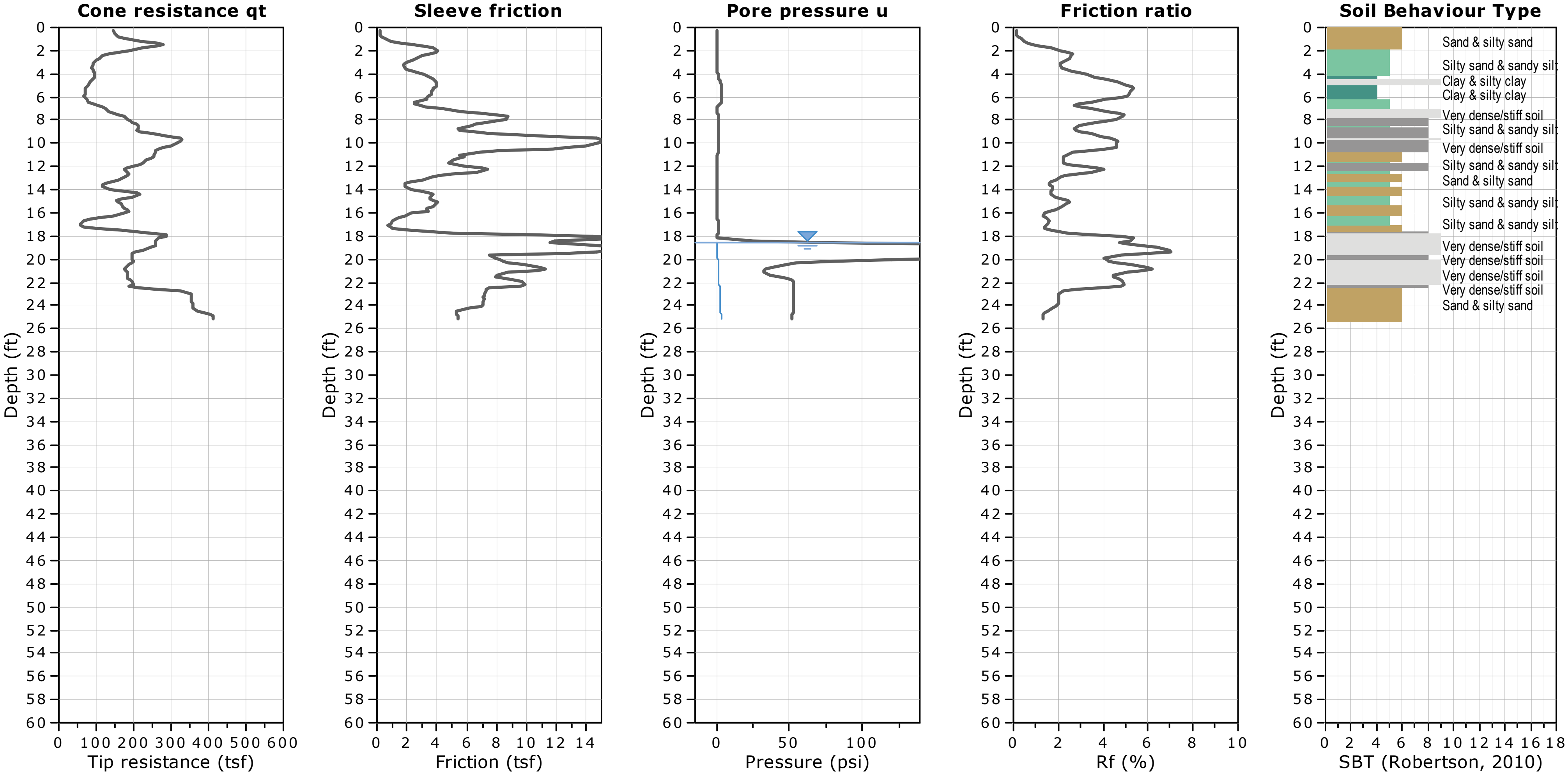
CPT: CPT-17

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON

Total depth: 25.10 ft, Date: 6/25/2019



SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

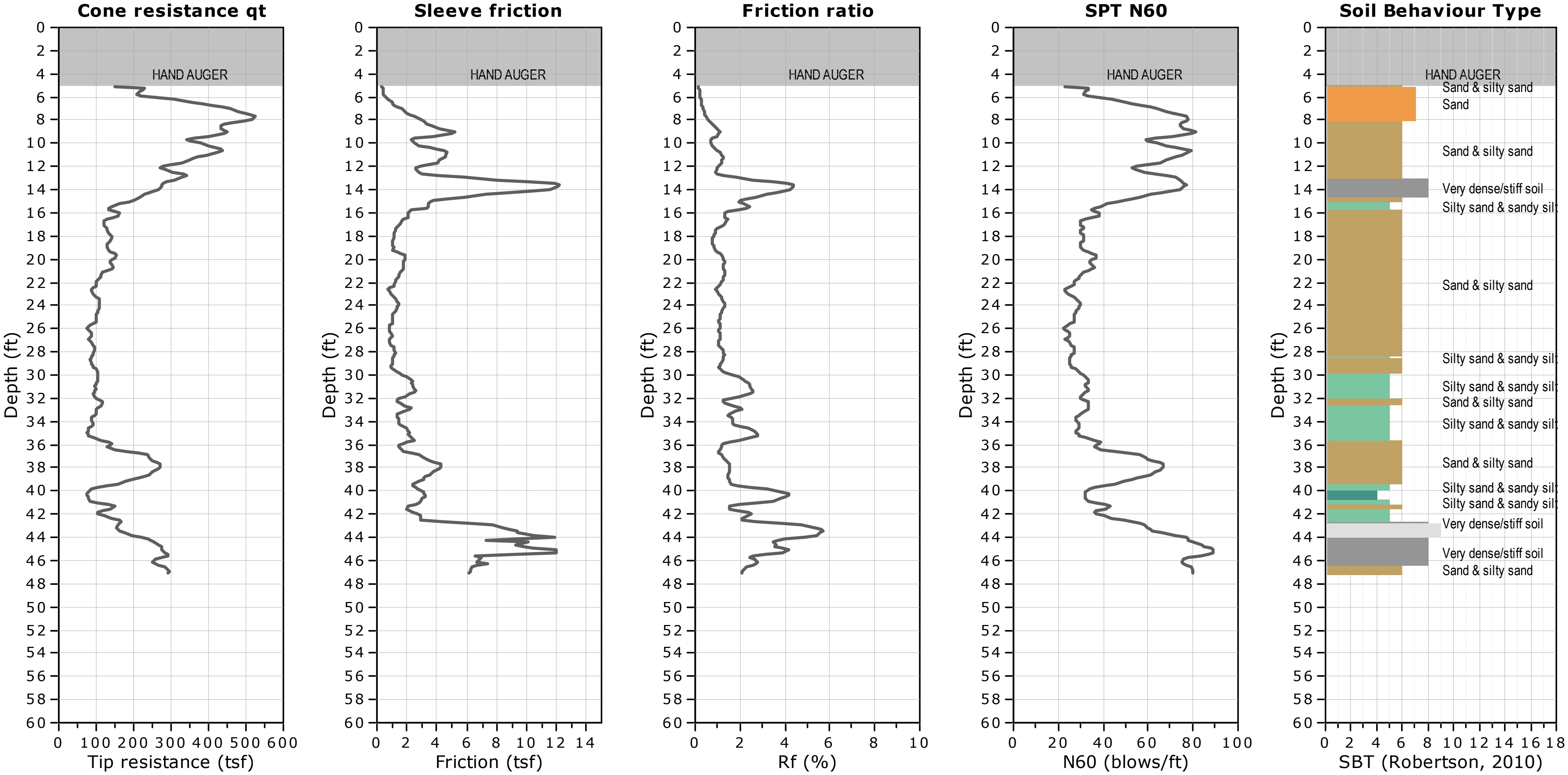
WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-18

CLIENT: LGC GEOTECHNICAL INC.
SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON
Total depth: 47.08 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

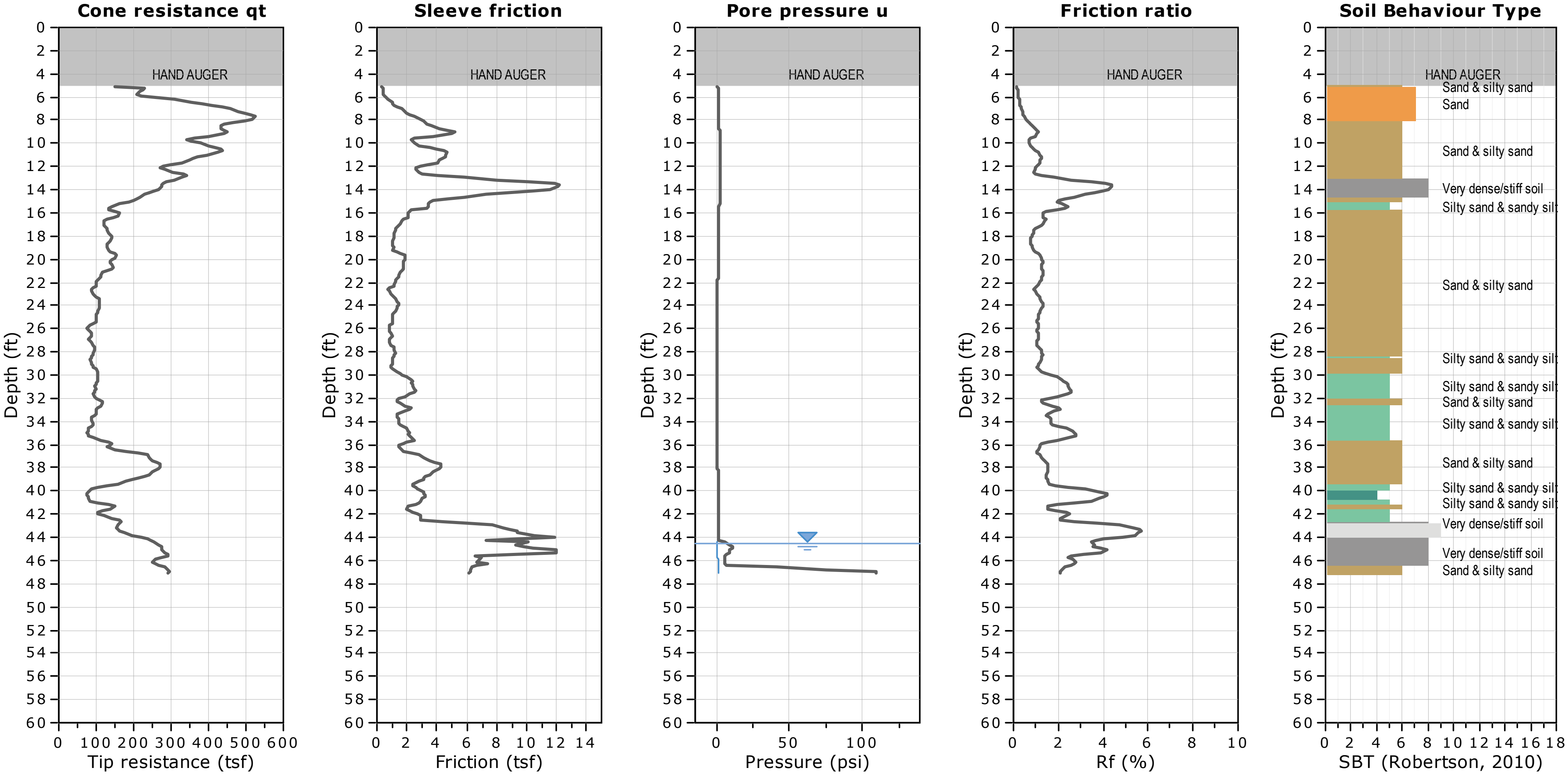
CPT: CPT-18

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON

Total depth: 47.08 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

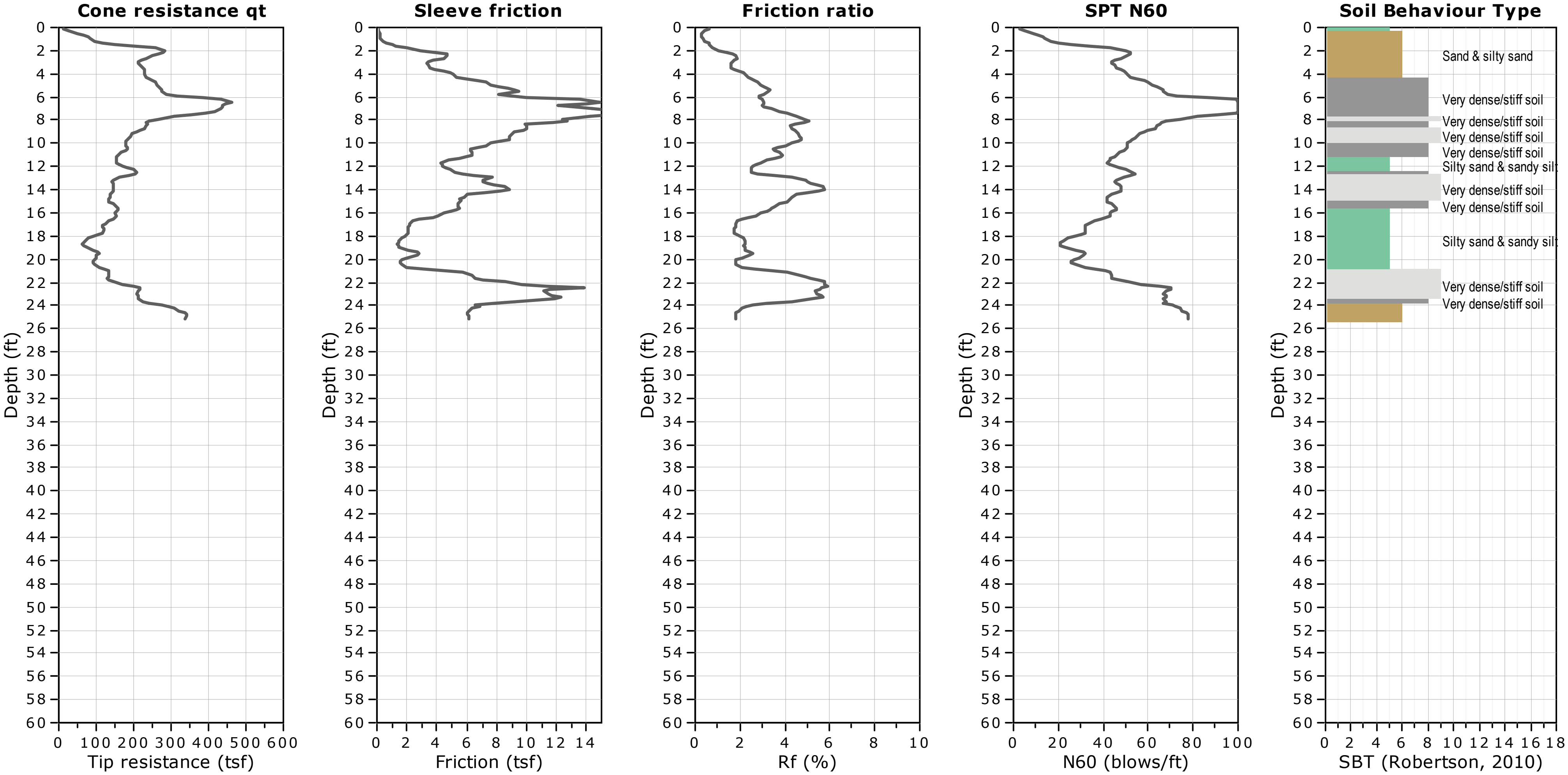
CPT: CPT-19

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON

Total depth: 25.10 ft, Date: 6/25/2019



SBTn legend

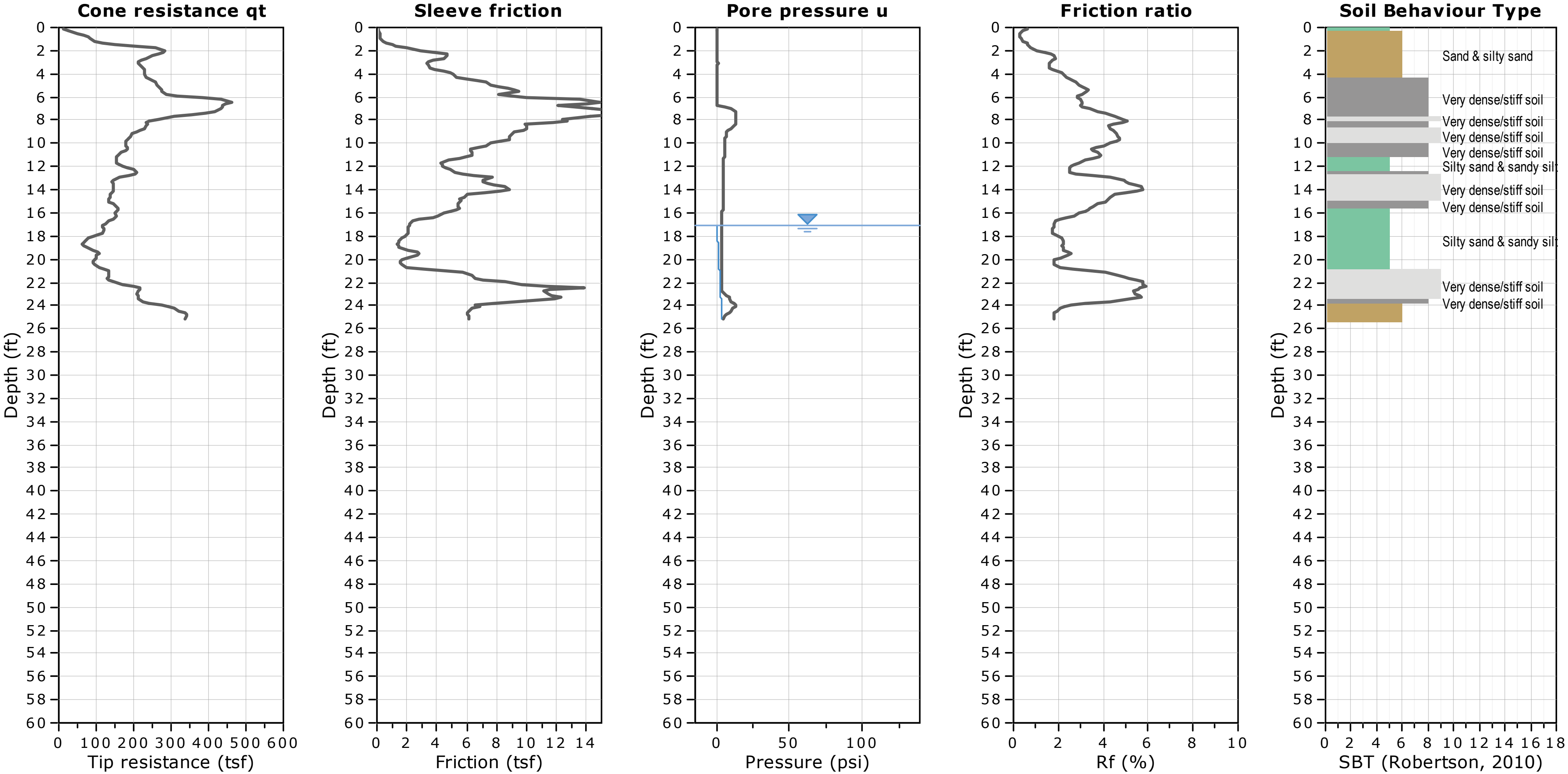
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-19

CLIENT: LGC GEOTECHNICAL INC.
SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON
Total depth: 25.10 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

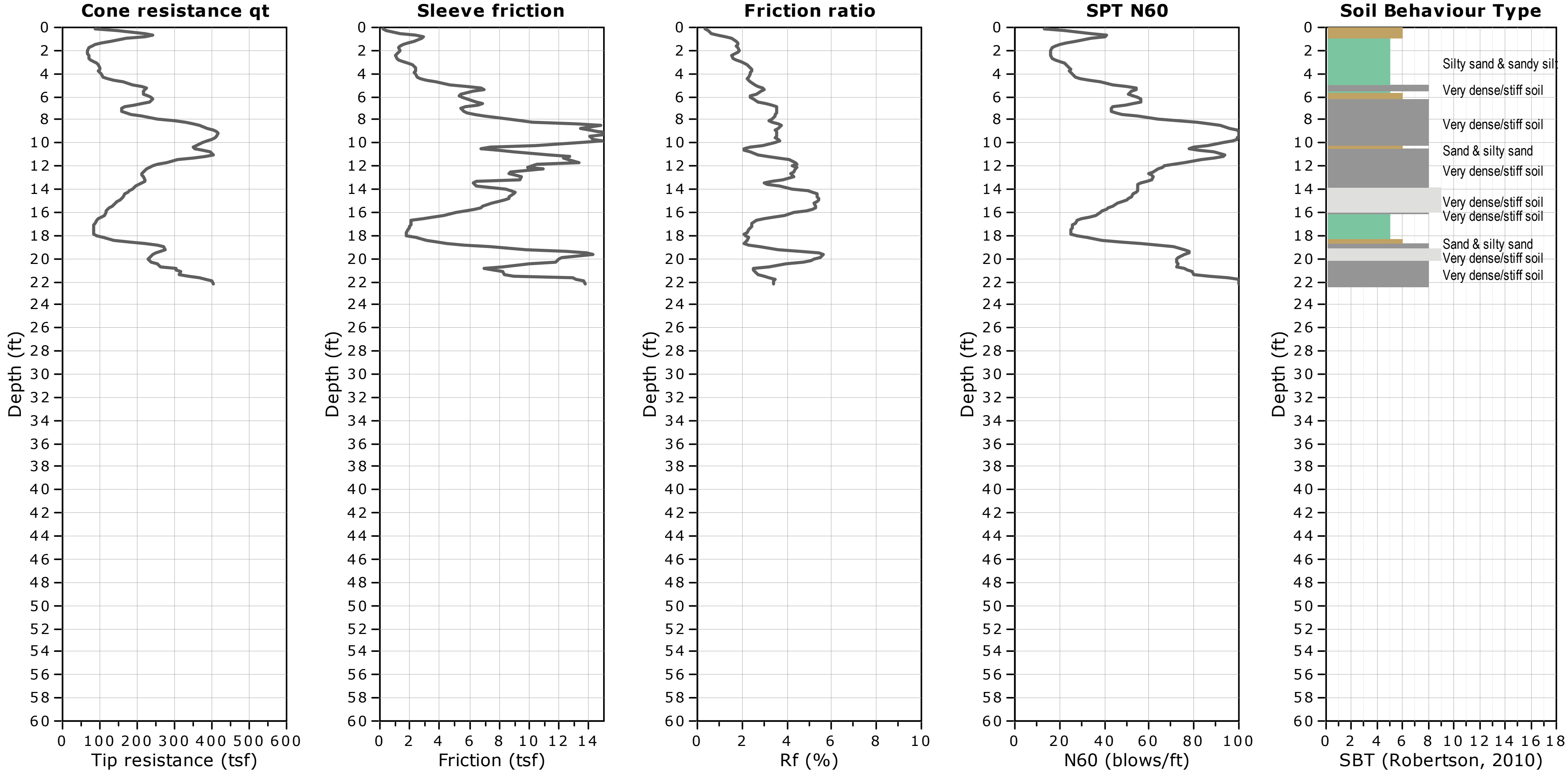
CPT: CPT-20

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON

Total depth: 22.15 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

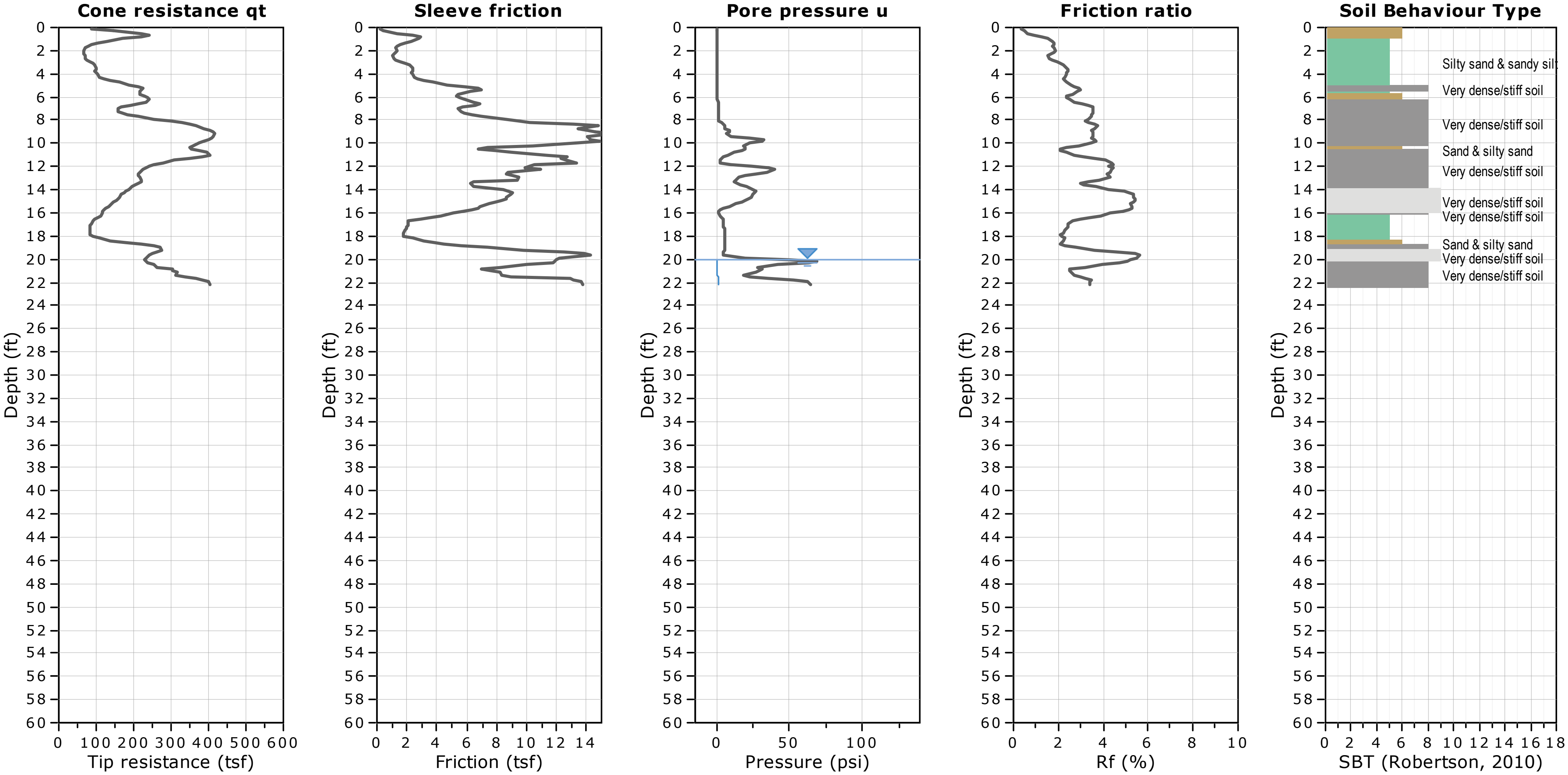
CPT: CPT-20

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON

Total depth: 22.15 ft, Date: 6/25/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

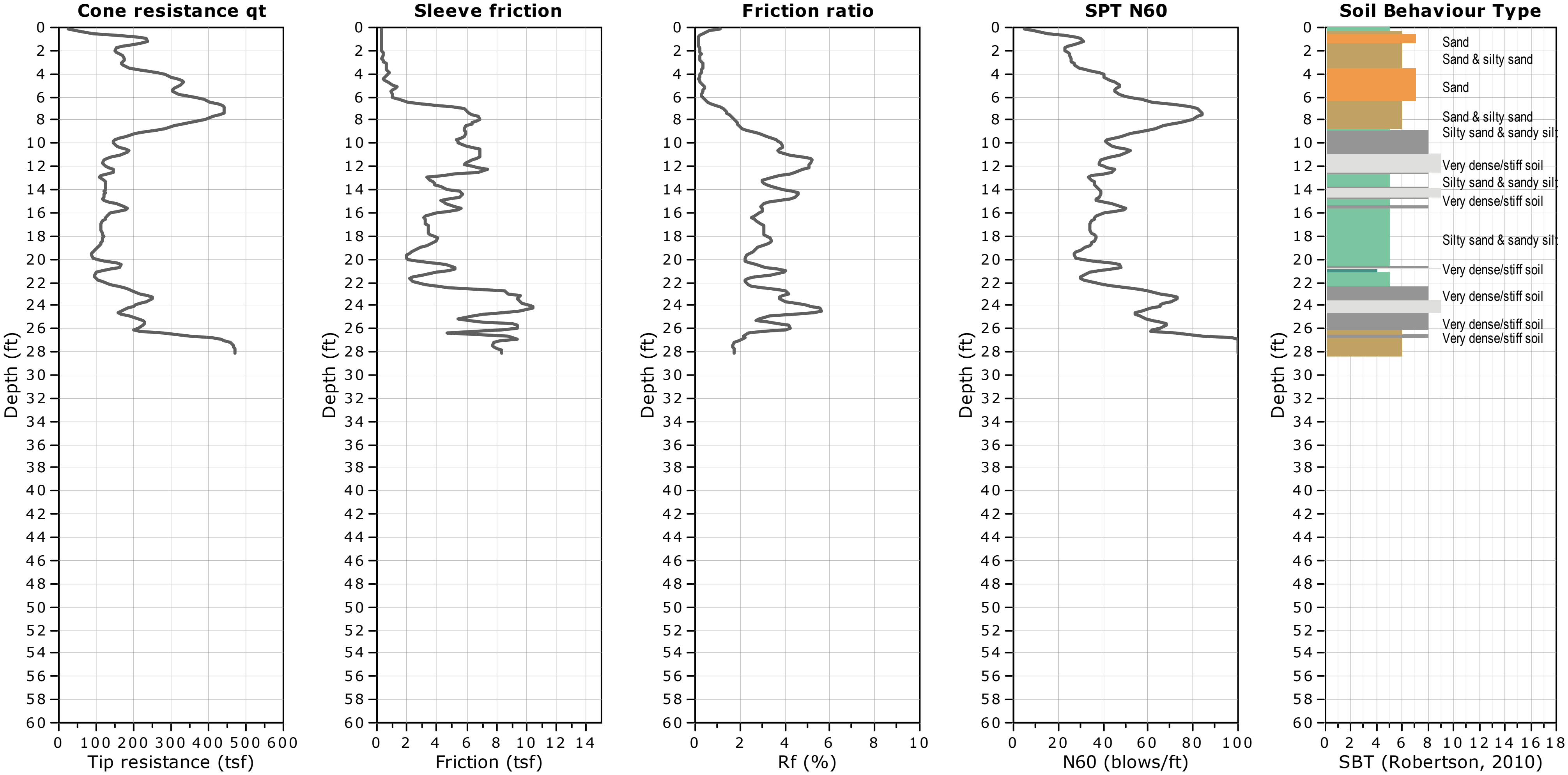
CPT: CPT-21

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON

Total depth: 28.05 ft, Date: 6/26/2019



SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

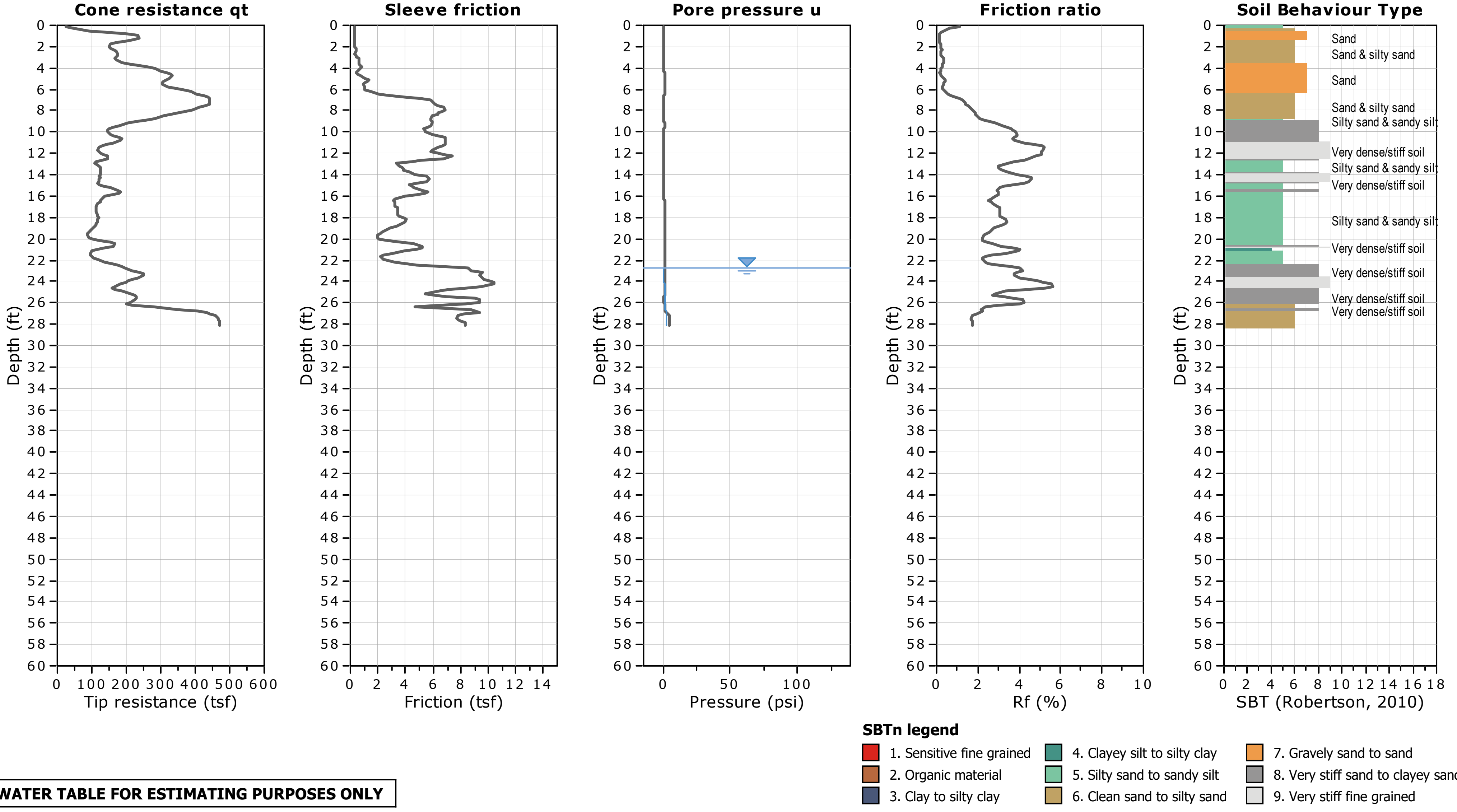
CPT: CPT-21

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON

Total depth: 28.05 ft, Date: 6/26/2019



WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

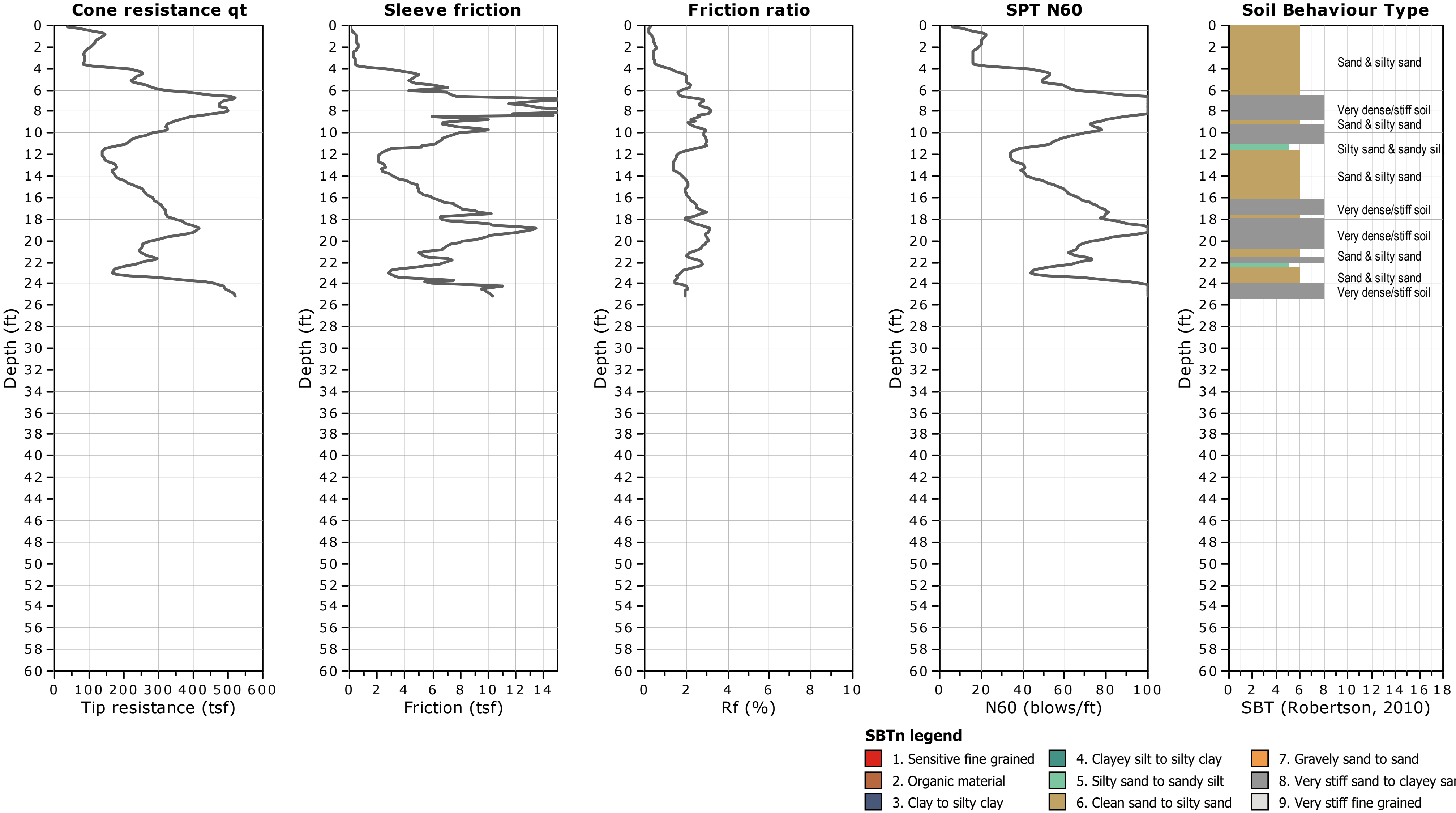
CPT: CPT-22

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON

Total depth: 25.10 ft, Date: 6/26/2019

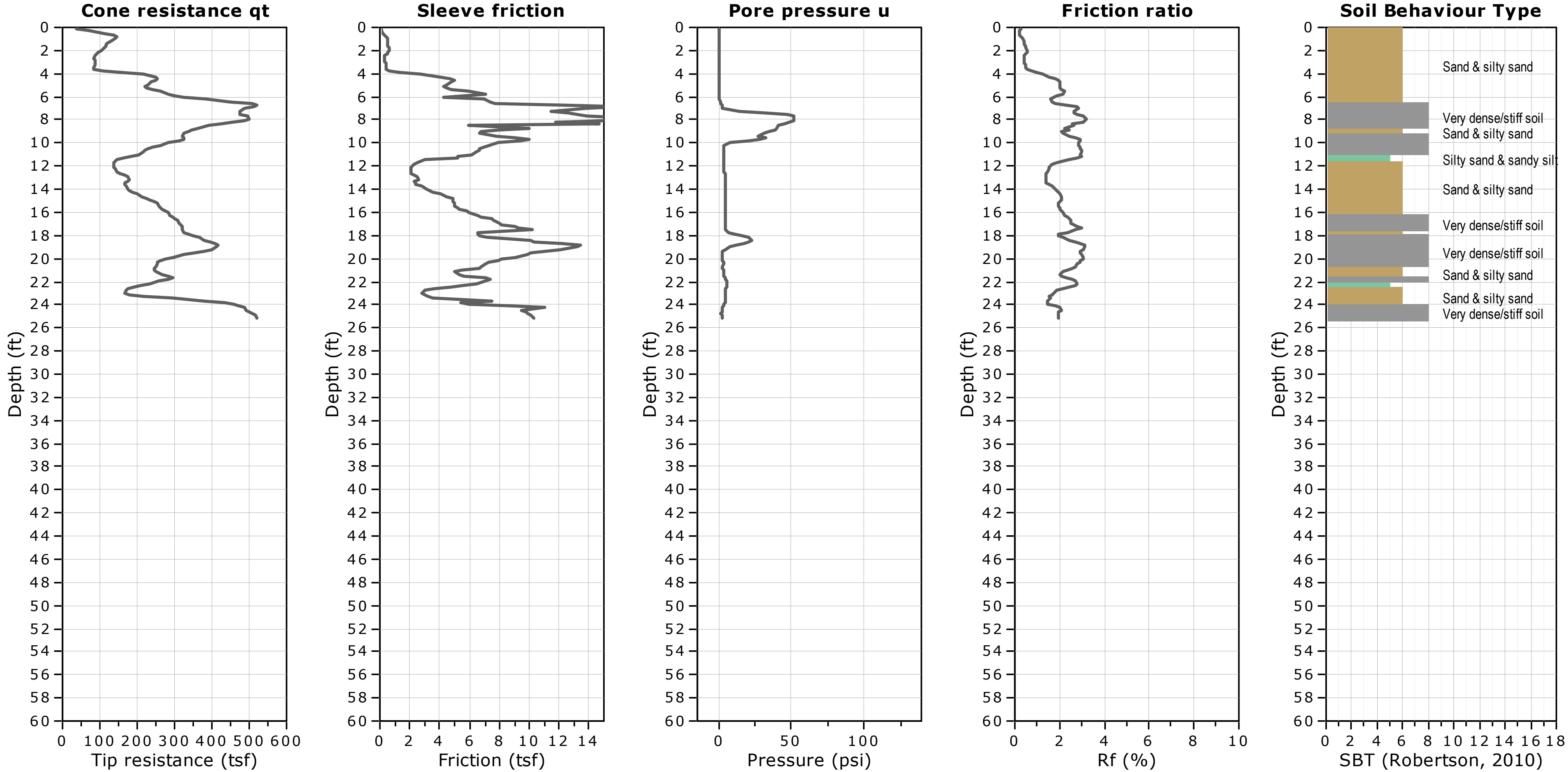


GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-22

CLIENT: LGC GEOTECHNICAL INC.
SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON
Total depth: 25.10 ft, Date: 6/26/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

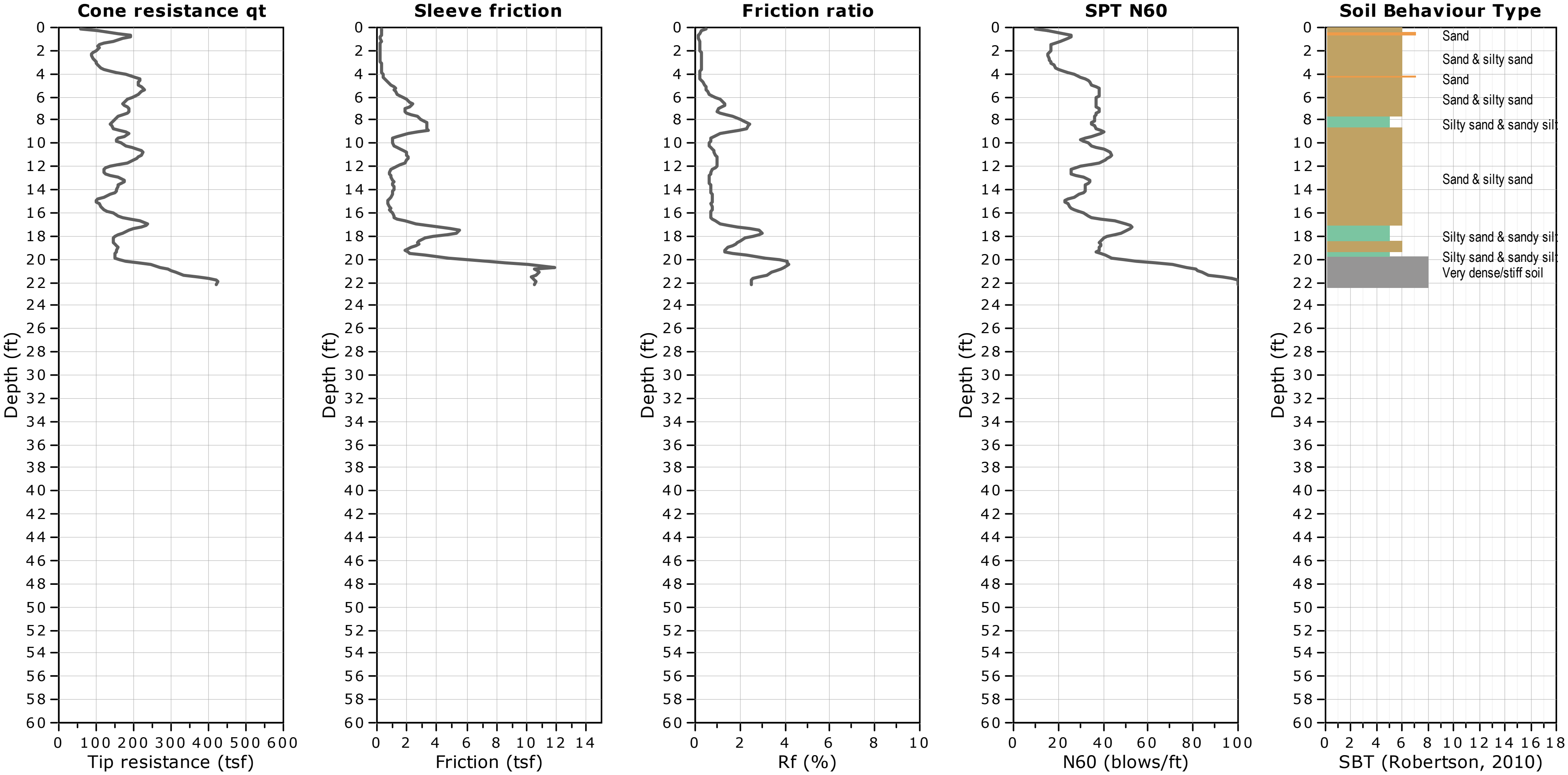
CPT: CPT-23

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON

Total depth: 22.15 ft, Date: 6/26/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

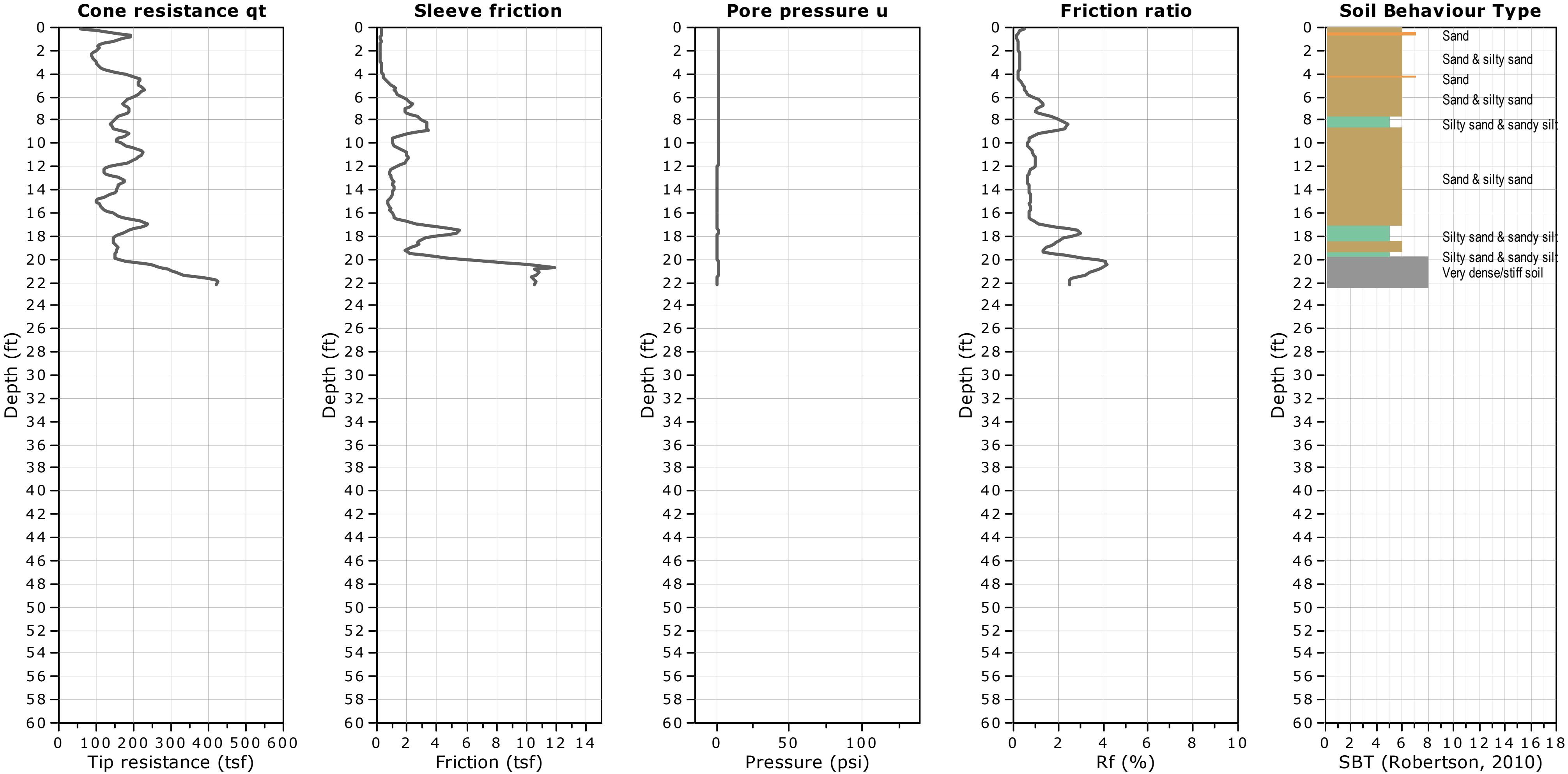
GREGG

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-23

CLIENT: LGC GEOTECHNICAL INC.
SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON
Total depth: 22.15 ft, Date: 6/26/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

GREGG DRILLING, INC.
www.greggdrilling.com

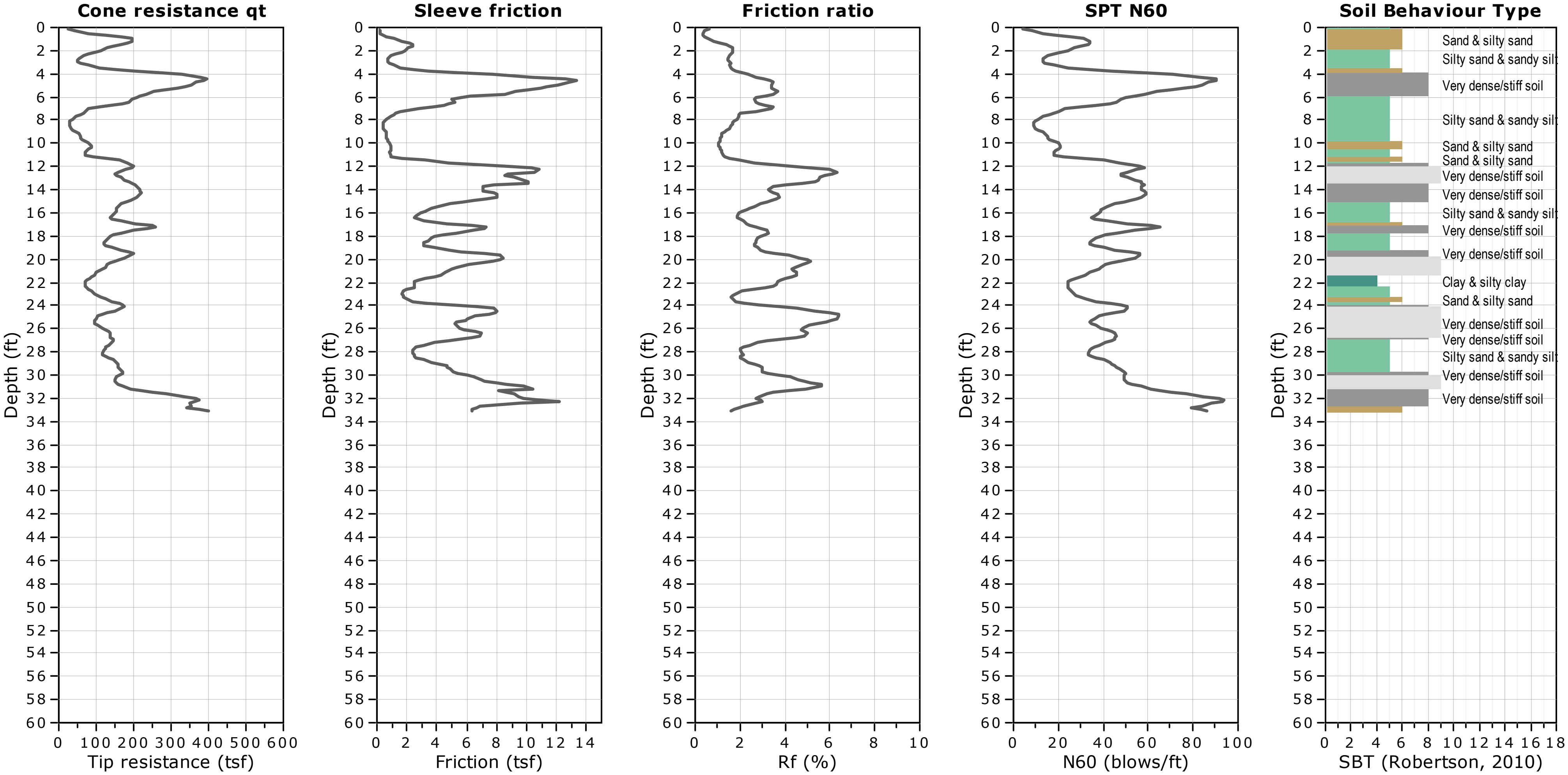
CPT: CPT-24

CLIENT: LGC GEOTECHNICAL INC.

SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

FIELD REP: BRANDON

Total depth: 33.14 ft, Date: 6/26/2019



SBTn legend

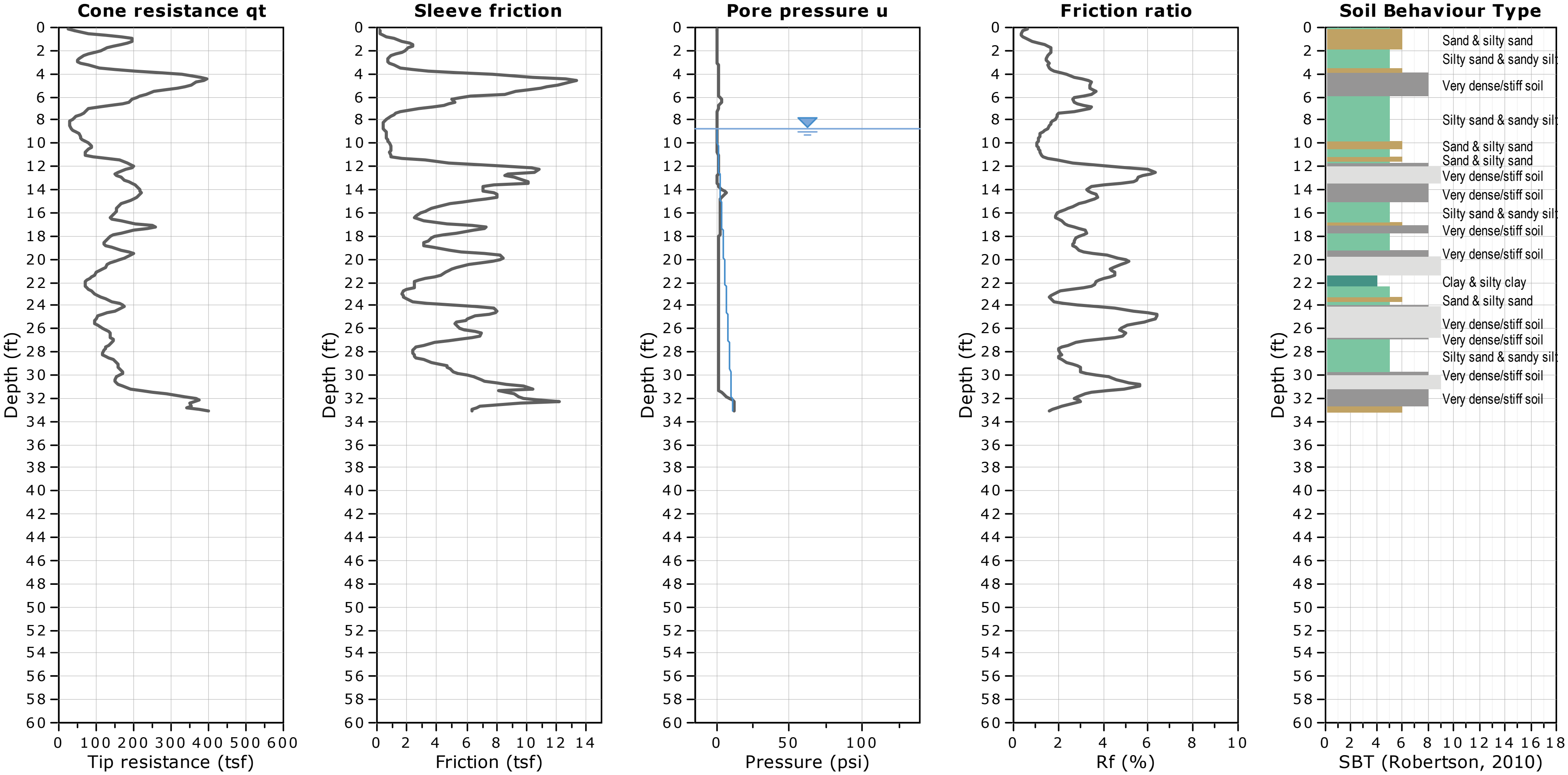
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

GREGG DRILLING, INC.
www.greggdrilling.com

CPT: CPT-24

CLIENT: LGC GEOTECHNICAL INC.
SITE: STONERIDGE - RAMONA EXPRESSWAY, PERRIS, CA

Field Rep: BRANDON
Total depth: 33.14 ft, Date: 6/26/2019



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

WATER TABLE FOR ESTIMATING PURPOSES ONLY

Appendix C
Laboratory Test Results

APPENDIX C

Laboratory Testing Procedures and Test Results

The laboratory testing program was formulated towards providing data relating to the relevant engineering properties of the soils with respect to residential construction. Samples considered representative of site conditions were tested in general accordance with American Society for Testing and Materials (ASTM) procedure and/or California Test Methods (CTM), where applicable. The following summary is a brief outline of the test type and a table summarizing the test results.

Moisture and Density Determination Tests: Moisture content (ASTM D2216) and dry density determinations (ASTM D2937) were performed on relatively undisturbed samples obtained from the test borings and/or trenches. The results of these tests are presented in the boring and/or trench logs. Where applicable, only moisture content was determined from undisturbed or disturbed samples.

Grain Size Distribution: Representative samples were dried, weighed, and soaked in water until individual soil particles were separated (per ASTM D421) and then washed on a No. 200 sieve. The portion retained on the No. 200 sieve was dried and then sieved on a U.S. Standard brass sieve set in accordance with ASTM D422 (CTM 202). Where an appreciable number of fines were encountered (greater than 20 percent passing the No. 200 sieve) a hydrometer analysis was done to determine the distribution of soil particles passing the No. 200 sieve.

Sample Location	Description	% Passing # 200 Sieve
HS-1 @ 2.5 ft	Brown Clayey Sand	22
HS-1 @ 7.5 ft	Brown Clayey Sand	33
HS-6 @ 2.5 ft	Brown Silty Sand	20
HS-6 @ 7.5 ft	Brown Silty Sand w/ Gravel, Decomposed Granite	21
HS-10 @ 7.5 ft	Dark Brown Silty Clayey Sand	24
TP-4 @ 0 to 2 ft	Reddish Brown Clayey Sand	38
HS-15 @ 10 ft	Light Olive Brown Sand with Silt	8
HS-18 @ 2 to 5 ft	Light Brown Sandy Silt	33
HS-20 @ 0 to 2.5 ft	Brown Silty Sand	18
HS-22 @ 7.5 ft	Light Olive Brown Sand with Silt	10
HS-24 @ 0 to 5 ft	Brown Sand	12
HS-24 @ 5 ft	Yellowish Brown Silty Clayey Sand	39

APPENDIX C (Cont'd)

Laboratory Testing Procedures and Test Results

Atterberg Limits: The liquid and plastic limits ("Atterberg Limits") were determined in accordance with ASTM Test Method D4318 for engineering classification of fine-grained material and presented in the table below. Plots are included in this appendix.

Sample Location	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	USCS Soil Classification
TP-4 @ 0 to 2 ft	28	14	14	CL
HS-15 @ 7.5 ft	NP	NP	NP	NP
HS-23 @ 10 ft	20	16	4	CL-ML

Maximum Density Tests: The maximum dry density and optimum moisture content of typical materials were determined in accordance with ASTM D1557. The results of these tests are presented in the table below:

Sample Location	Sample Description	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
HS-1 @ 0 to 3 ft	Yellowish Brown Silty Sand	135.0	7.5
HS-5 @ 0 to 4 ft	Dark Yellowish Brown Silty Clayey Sand	137.5	7.5
HS-9 & TP-4	Dark Yellowish Brown Silty Clayey Sand	134.5	8.5
TP-6 @ 2 to 3 ft	Dark Yellowish Brown Silty Clayey Sand	135.0	8.0
TP-9 @ 3 to 4 ft	Dark Yellowish Brown Silty, Clayey Sand	138.0	7.0
HS-18 @ 2 to 5 ft	Light Brown Sandy Silt	127.5	7.5
HS-20 @ 2 to 2.5 ft	Brown Silty Sand	135.0	7.0
HS-24 @ 0 to 5 ft	Brown Sand	128.5	7.5

Laboratory Testing Procedures and Test Results

Expansion Index: The expansion potential of selected samples was evaluated by the Expansion Index Test, Standard ASTM D4829. Specimens are molded under a given compactive energy to approximately the optimum moisture content and approximately 50 percent saturation or approximately 90 percent relative compaction. The prepared 1-inch-thick by 4-inch-diameter specimens are loaded to an equivalent 144 psf surcharge and are inundated with tap water until volumetric equilibrium is reached. The results of these tests are presented in the table below.

Sample Location	Expansion Index	Expansion Potential*
HS-4 @ 0 to 4 ft	33	Low
TP-1 @ 4 to 5 ft	0	Very Low
TP-4 @ 0 to 2 ft	21	Low
HS-18 @ 2 to 5 ft	6	Very Low
HS-20 @ 0 to 2.5 ft	1	Very Low
HS-24 @ 0 to 5 ft	0	Very Low

* ASTM D4829

Direct Shear: Direct shear tests were performed on selected driven samples, which were soaked for a minimum of 24 hours prior to testing. The samples were tested under various normal loads using a motor-driven, strain-controlled, direct-shear testing apparatus (ASTM D3080). The plot is provided in this Appendix.

Collapse/Swell Potential: Collapse tests were performed per ASTM D4546. Samples (2.4 inches in diameter and 1 inch in height) were placed in a consolidometer and loaded to their approximate in-situ effective stress. The curves are presented in this Appendix.

Consolidation: Consolidation tests were performed per ASTM D2435. Samples (2.4 inches in diameter and 1 inch in height) were placed in a consolidometer and increasing loads were applied. The samples were allowed to consolidate under "double drainage" and total deformation for each loading step was recorded. The percent consolidation for each load step was recorded as the ratio of the amount of vertical compression to the original sample height. The consolidation pressure curves are provided in this Appendix.

Laboratory Testing Procedures and Test Results

Chloride Content: Chloride content was tested in accordance with Caltrans Test Method (CTM) 422. The results are presented below.

Sample Location	Chloride Content, ppm
HS-1 @ 0 to 3 ft	81
HS-4 @ 0 to 4 ft	103
TP-1 @ 4 to 5 ft	51
HS-18 @ 2 to 5 ft	104
HS-20 @ 0 to 2.5 ft	41
HS-24 @ 0 to 5 ft	31

Minimum Resistivity and pH Tests: Minimum resistivity and pH tests were performed in general accordance with CTM 643 and standard geochemical methods. The electrical resistivity of a soil is a measure of its resistance to the flow of electrical current. As a result of a decrease in resistivity, the potential for corrosion increases. The results are presented in the table below.

Sample Location	pH	Minimum Resistivity (ohms-cm)
HS-1 @ 0 to 3 ft	5.78	2,960
HS-4 @ 0 to 4 ft	7.88	1,146
TP-1 @ 4 to 5 ft	7.90	3,300
HS-18 @ 2 to 5 ft	7.67	1,450
HS-20 @ 0 to 2.5 ft	7.74	5,290
HS-24 @ 0 to 5 ft	7.71	15,000

Laboratory Testing Procedures and Test Results

Soluble Sulfates: The soluble sulfate contents of selected samples were determined by standard geochemical methods (CTM 417). The soluble sulfate content is used to determine the appropriate cement type and maximum water-cement ratios. The test results are presented in the table below.

Sample Location	**Sulfate Content (ppm)**
HS-1 @ 0 to 3 ft	29
HS-4 @ 0 to 4 ft	34
TP-1 @ 4 to 5 ft	42
HS-18 @ 2 to 5 ft	196
HS-20 @ 0 to 2.5 ft	148
HS-24 @ 0 to 5 ft	168

*Based on ACI 318, Table 19.3.1.1 (ACI 318R-14).

R-Value: The resistance R-value was determined by the ASTM D2844 for base, subbase, and basement soils. The samples were prepared and exudation pressure and R-value were determined. The graphically determined R-values at exudation pressure of 300 psi are reported in this appendix. These results were used for pavement design purposes. The R-value plots are presented in this appendix.

Sample Location	**R-Value**
HS-3 @ 0 to 3 ft	67
HS-9 @ 0 to 4 ft	43

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Project Name: Richland – Stoneridge | Tested By: A. Santos | Date: 04/20/16

Project No.: 13092-01 | Data Input By: J. Ward | Date: 04/27/16

Boring No.: TP-4

Sample No.: B-1 | Depth (feet): 0-2

Soil Identification: Reddish brown clayey sand (SC)

% Gravel	N/A	Soil Type
% Sand	N/A	SC
% Fines	38	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	72.52	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	72.50	135.87
Wt.of Air-Dry Soil + Cont. (g)	1133.00	Wt. of Container No.___ (g)	1.00	57.25	75.31
Wt. of Container	108.80	Moisture Content (%)	0.00	0.13	
Dry Wt. of Soil (g)	1024.20	Wt. of Dry Soil (g)			60.56

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"		
1½"		
3/4"		
3/8"		
No. 4		
No. 10	75.08	92.7
Pan		

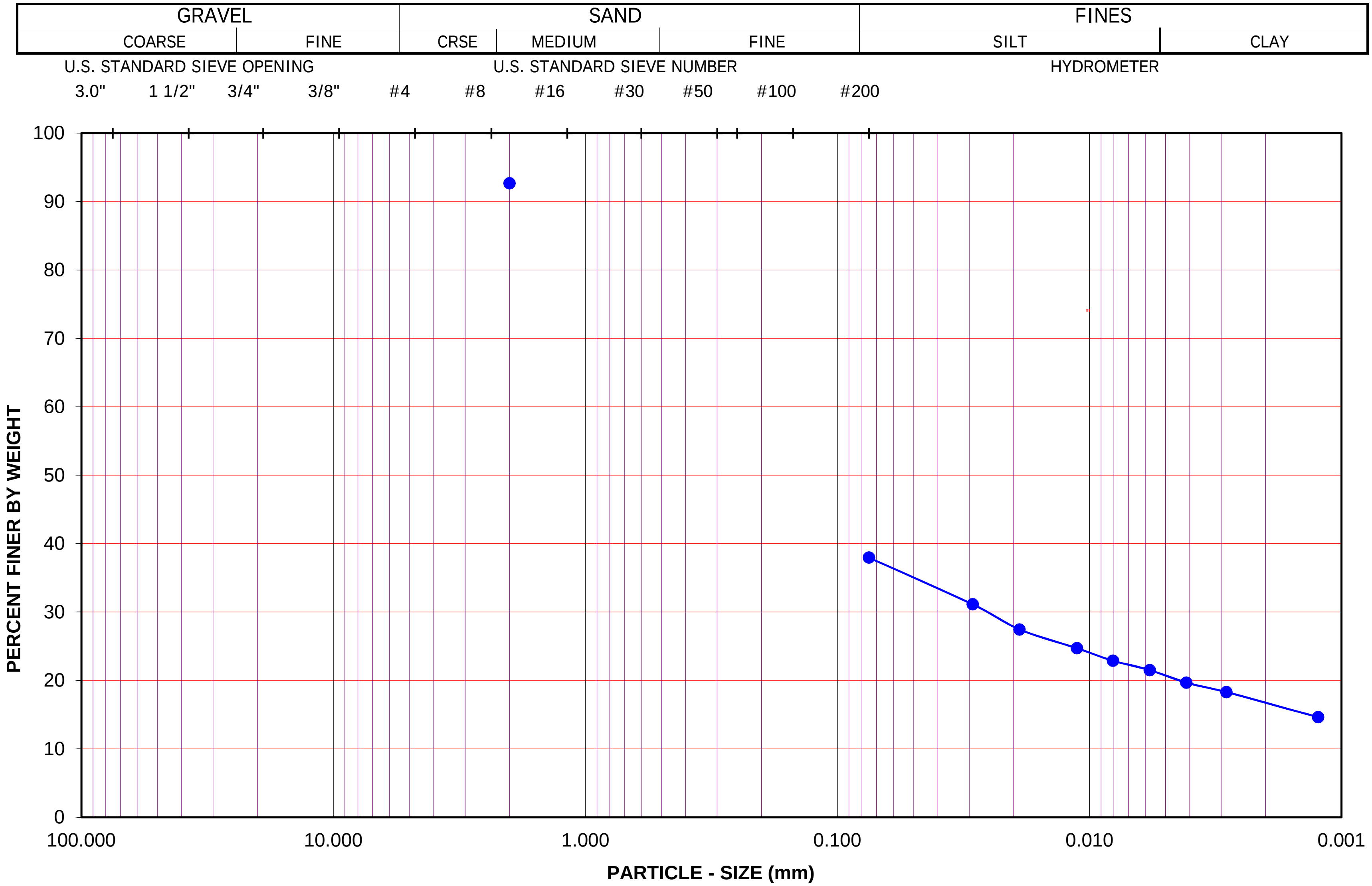
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	92.7
No. 16			
No. 30			
No. 50			
No. 100			
No. 200	59.24	41.0	38.0
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 100.50 Wt. of Dry Soil (g) 100.37

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
22-Apr-16	9:06	0		7.0			
	9:08	2	21.9	7.0	41.0	31.1	0.0291
	9:11	5	21.9	8.0	37.0	27.5	0.0190
	9:21	15	21.9	8.0	34.0	24.7	0.0112
	9:36	30	21.8	8.0	32.0	22.9	0.0081
	10:06	60	21.9	8.0	30.5	21.5	0.0058
	11:06	120	21.9	8.0	28.5	19.7	0.0041
	13:16	250	22.4	8.0	27.0	18.3	0.0029
23-Apr-16	9:06	1440	21.0	8.0	23.0	14.7	0.0012



Project Name: Richland – Stoneridge

Project No.: 13092-01

Boring No.: TP-4 Sample No.: B-1

Depth (feet): 0-2 Soil Type : SC

Soil Identification: Reddish brown clayey sand (SC)

GR:SA:FI : (%) **N/A : N/A : 38**

PARTICLE - SIZE DISTRIBUTION ASTM D 422

04/27/16

ATTERBERG LIMITS

ASTM D 4318

Project Name:	Richland – Stoneridge	Tested By:	A. Santos	Date:	04/25/16
Project No. :	13092-01	Input By:	J. Ward	Date:	04/27/16
Boring No.:	TP-4	Checked By:	J. Ward		
Sample No.:	B-1	Depth (ft.)	0-2		
Soil Identification:	Reddish brown clayey sand (SC)				

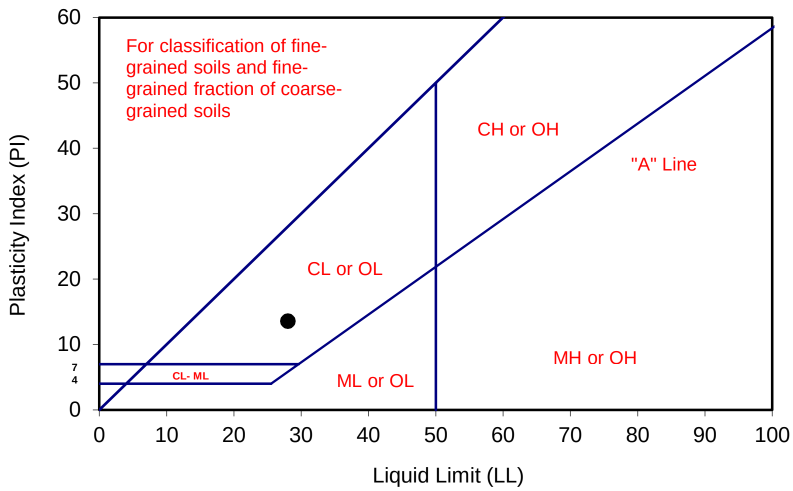
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			33	25	17	
Wet Wt. of Soil + Cont. (g)	9.90	10.59	22.37	26.70	22.82	
Dry Wt. of Soil + Cont. (g)	8.80	9.39	17.86	21.13	17.98	
Wt. of Container (g)	1.06	1.18	1.12	1.10	1.11	
Moisture Content (%) [Wn]	14.21	14.62	26.94	27.81	28.69	

Liquid Limit	**28**
Plastic Limit	**14**
Plasticity Index	**14**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 5.84

One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



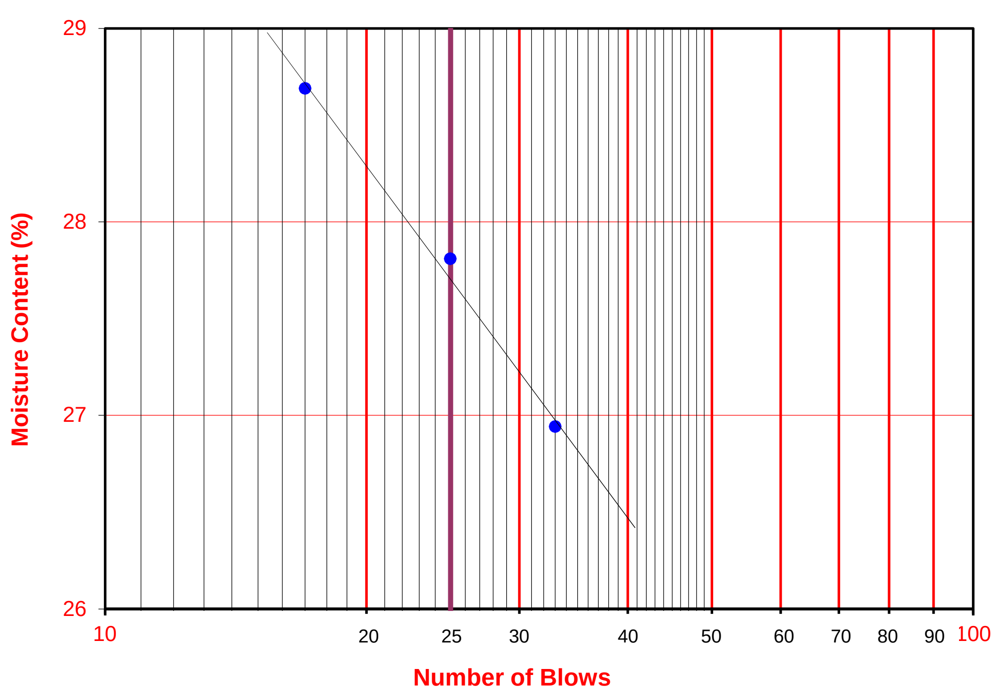
PROCEDURES USED

[ ] Wet Preparation
Multipoint - Wet

[X] Dry Preparation
Multipoint - Dry

[X] Procedure A
Multipoint Test

[ ] Procedure B
One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Stoneridge	Tested By:	A. Santos	Date:	07/23/19
Project No. :	13092-01	Input By:	G. Bathala	Date:	07/24/19
Boring No.:	HS-15	Checked By:	J. Ward		
Sample No.:	R-3	Depth (ft.)	7.5		
Soil Identification:	Olive brown silty sand (SM)				

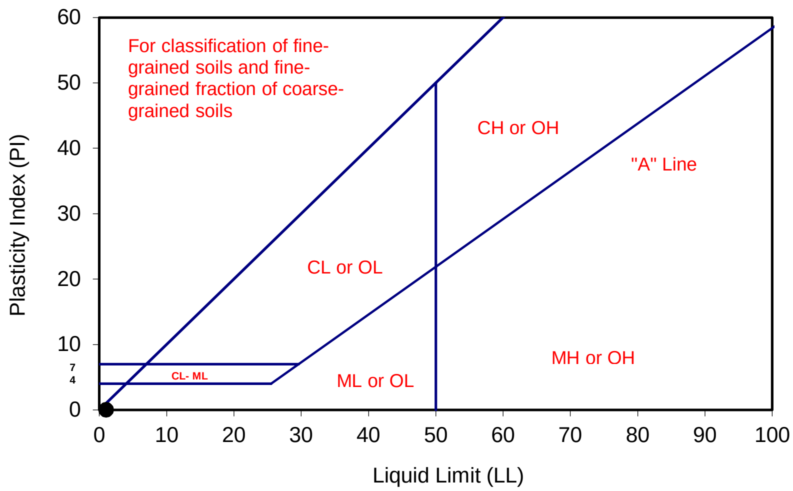
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			5			
Wet Wt. of Soil + Cont. (g)	**Cannot be rolled:**		18.85	**Cannot get more than 5 blows:**		
Dry Wt. of Soil + Cont. (g)	**NonPlastic**		15.58	**NonPlastic**		
Wt. of Container (g)			1.05			
Moisture Content (%) [Wn]			22.51			

Liquid Limit	**NP**
Plastic Limit	**NP**
Plasticity Index	**NP**
Classification	**NP**

PI at "A" - Line = 0.73(LL-20) =

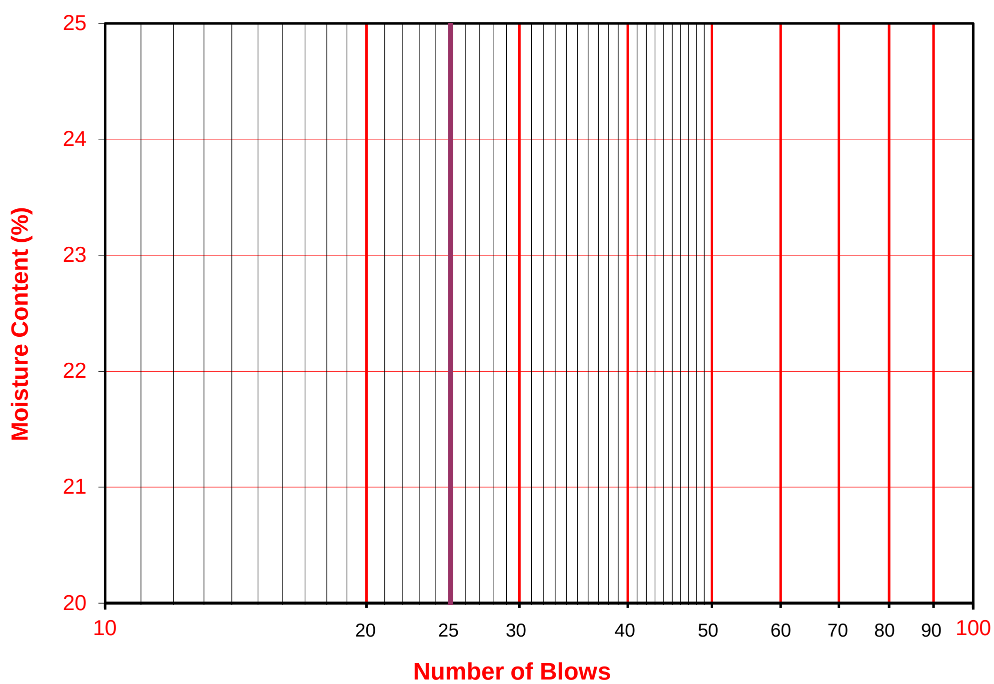
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation Multipoint - Wet
- [X] Dry Preparation Multipoint - Dry
- [X] Procedure A Multipoint Test
- [ ] Procedure B One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Stoneridge	Tested By:	R. Manning	Date:	07/18/19
Project No. :	13092-01	Input By:	G. Bathala	Date:	07/22/19
Boring No.:	HS-23	Checked By:	J. Ward		
Sample No.:	R-4	Depth (ft.)	10.0		
Soil Identification:	Olive brown silty, clayey sand (SC-SM)				

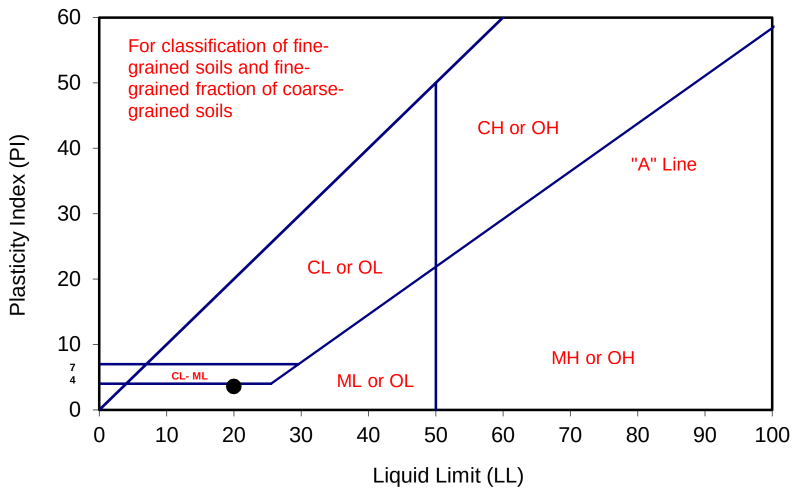
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	23	16	
Wet Wt. of Soil + Cont. (g)	19.41	19.47	26.87	26.31	24.80	
Dry Wt. of Soil + Cont. (g)	18.24	18.29	24.75	24.15	22.80	
Wt. of Container (g)	11.11	11.11	13.55	13.39	13.41	
Moisture Content (%) [Wn]	16.41	16.43	18.93	20.07	21.30	

Liquid Limit	**20**
Plastic Limit	**16**
Plasticity Index	**4**
Classification	**CL-ML**

PI at "A" - Line = 0.73(LL-20) | 0

One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



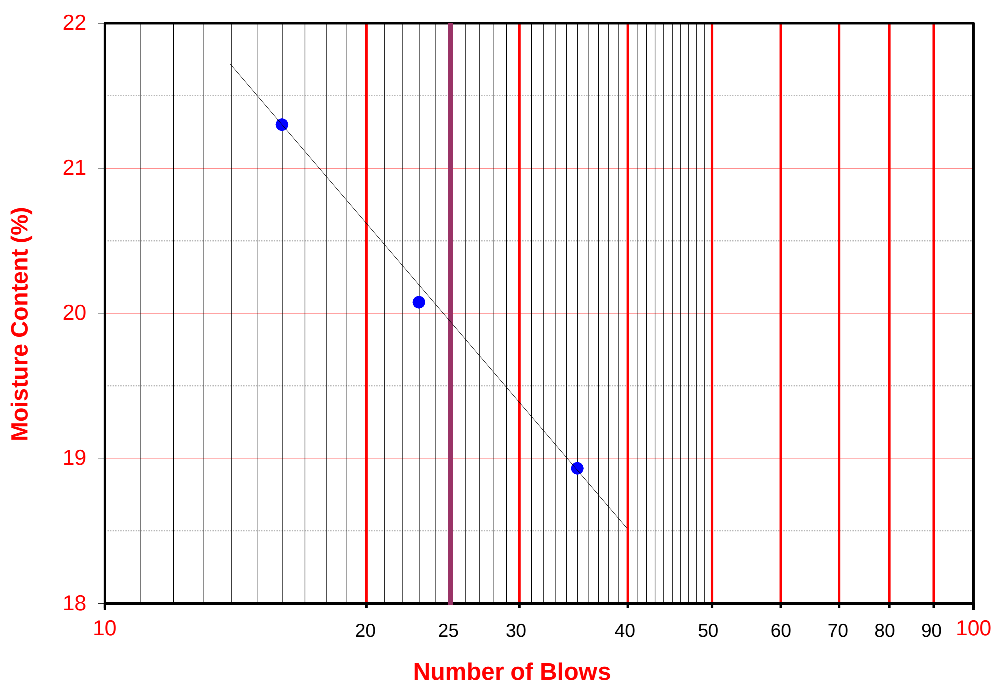
PROCEDURES USED

☐ Wet Preparation
Multipoint - Wet

☒ Dry Preparation
Multipoint - Dry

☒ Procedure A
Multipoint Test

☐ Procedure B
One-point Test

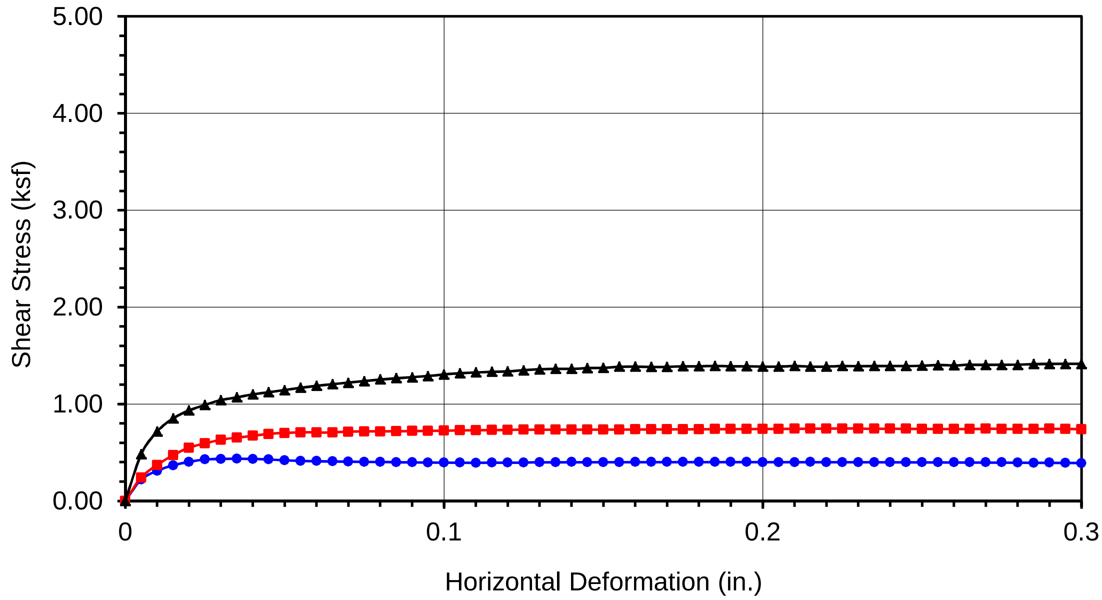


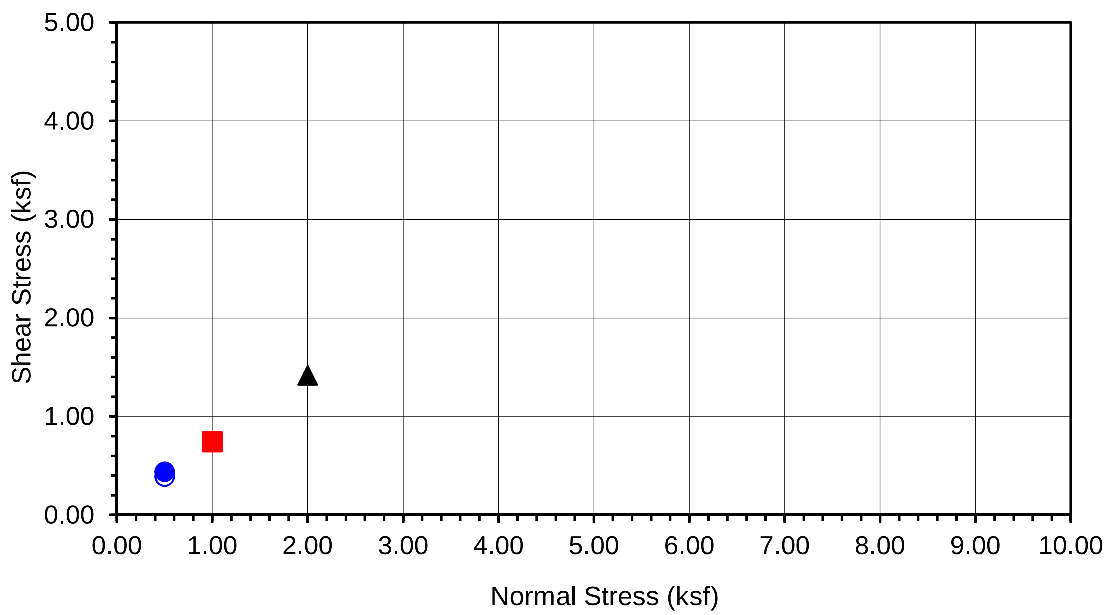
DIRECT SHEAR TEST

Consolidated Drained - ASTM D 3080

Project Name:	Richland – Stoneridge	Tested By:	G. Bathala	Date:	04/20/16
Project No.:	13092-01	Checked By:	J. Ward	Date:	04/27/16
Boring No.:	HS-2	Sample Type:	Ring		
Sample No.:	R-1	Depth (ft.):	2.5		
Soil Identification:	Brown clayey sand (SC)				

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	196.20	198.05	202.46
Weight of Ring(gm):	45.31	45.16	45.73
Before Shearing			
Weight of Wet Sample+Cont.(gm):	202.91	202.91	202.91
Weight of Dry Sample+Cont.(gm):	193.08	193.08	193.08
Weight of Container(gm):	64.62	64.62	64.62
Vertical Rdg.(in): Initial	0.0000	0.2461	0.2583
Vertical Rdg.(in): Final	-0.0052	0.2531	0.2721
After Shearing			
Weight of Wet Sample+Cont.(gm):	221.23	233.99	218.56
Weight of Dry Sample+Cont.(gm):	202.23	216.08	200.81
Weight of Container(gm):	66.16	76.26	57.73
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**HS-2**
Sample No.	**R-1**
Depth (ft)	**2.5**

Sample Type:

Ring

Soil Identification:

Brown clayey sand (SC)

Normal Stress (kip/ft²)	0.500	1.000	2.000
Peak Shear Stress (kip/ft²)	● 0.437	■ 0.748	▲ 1.415
Shear Stress @ End of Test (ksf)	○ 0.390	□ 0.739	△ 1.415
Deformation Rate (in./min.)	0.0050	0.0050	0.0050
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	7.65	7.65	7.65
Dry Density (pcf)	116.6	118.1	121.1
Saturation (%)	46.3	48.4	52.7
Soil Height Before Shearing (in.)	0.9948	0.9930	0.9862
Final Moisture Content (%)	14.0	12.8	12.4

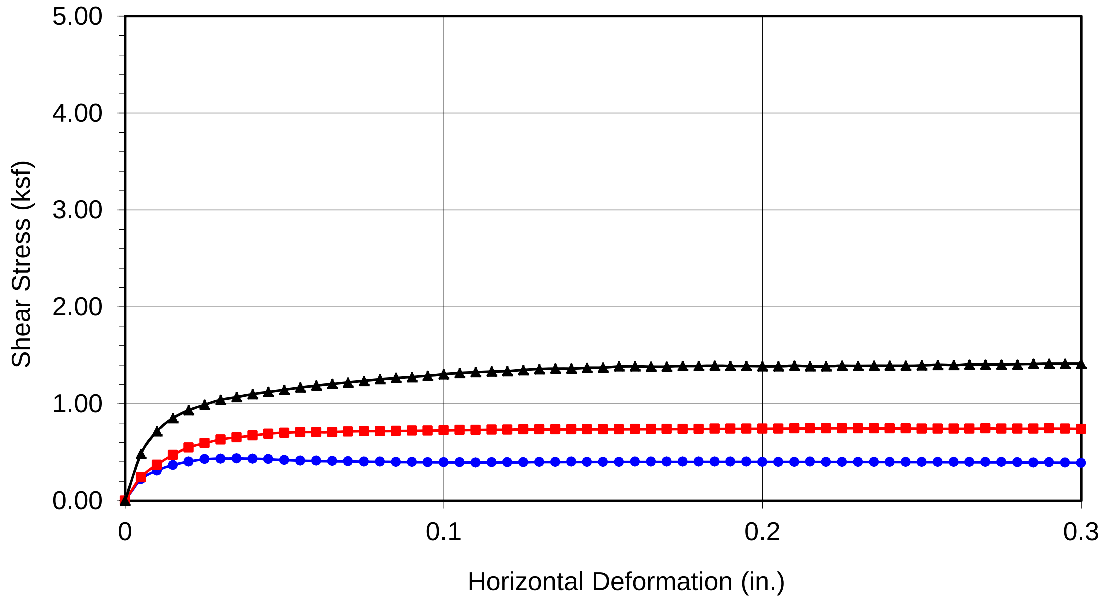
DIRECT SHEAR TEST RESULTS

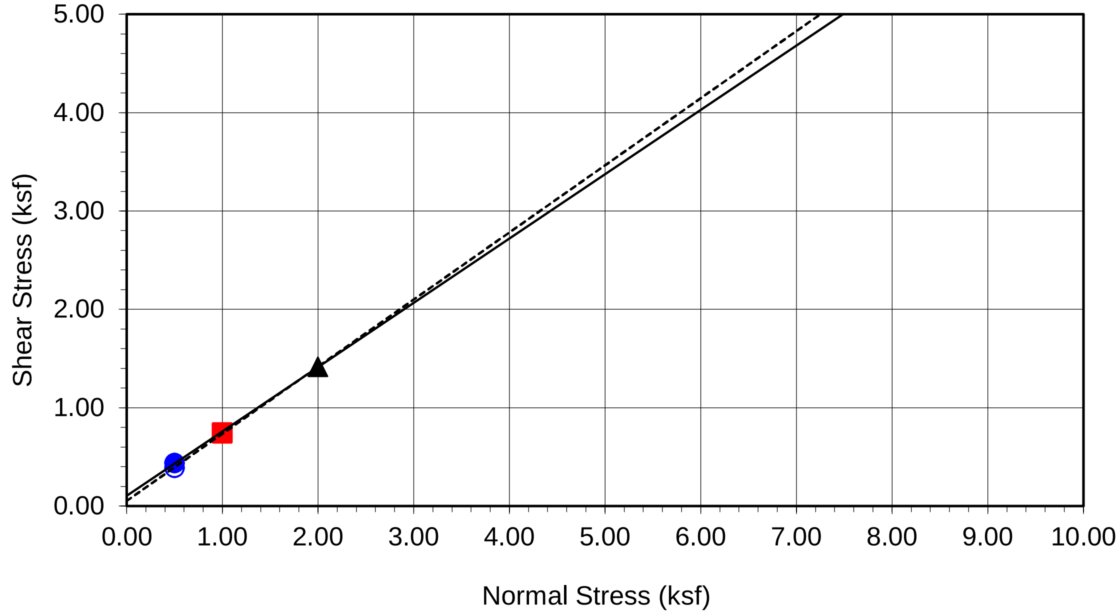
Consolidated Drained - ASTM D 3080

Project No.: 13092-01

Richland – Stoneridge

04-16





Boring No.	**HS-2**
Sample No.	**R-1**
Depth (ft)	**2.5**
Sample Type:	Ring
Soil Identification: Brown clayey sand (SC)	

Strength Parameters

	C (psf)	ϕ (°)
Peak	104	33
Ultimate	52	34

Normal Stress (kip/ft²)	0.500	1.000	2.000
Peak Shear Stress (kip/ft²)	● 0.437	■ 0.748	▲ 1.415
Shear Stress @ End of Test (ksf)	○ 0.390	□ 0.739	△ 1.415
Deformation Rate (in./min.)	0.0050	0.0050	0.0050
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	7.65	7.65	7.65
Dry Density (pcf)	116.6	118.1	121.1
Saturation (%)	46.3	48.4	52.7
Soil Height Before Shearing (in.)	0.9948	0.9930	0.9862
Final Moisture Content (%)	14.0	12.8	12.4

DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 13092-01

Richland – Stoneridge

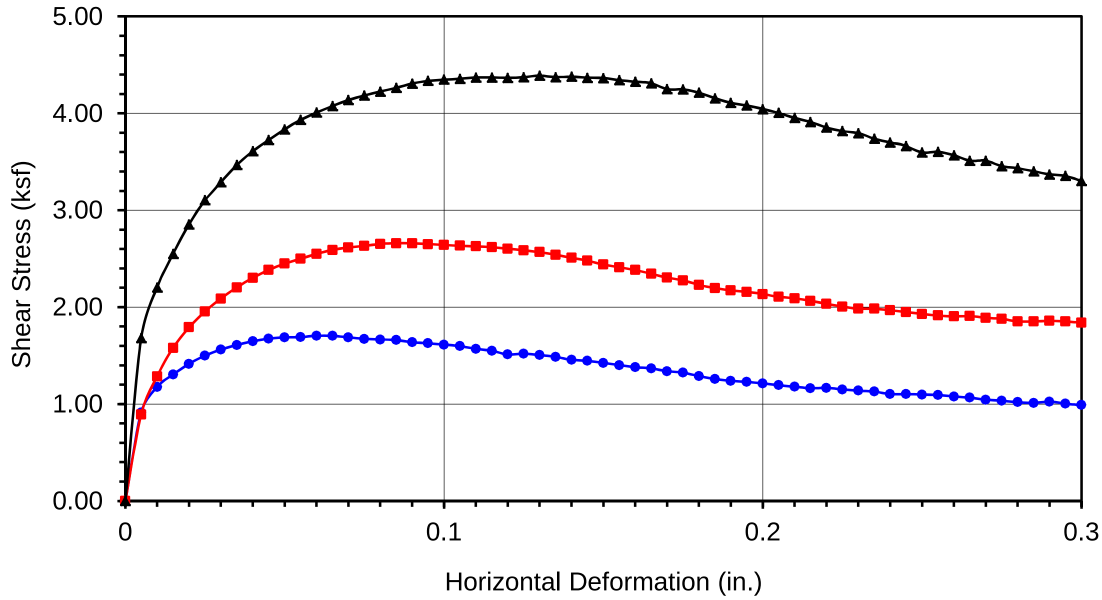
04-16

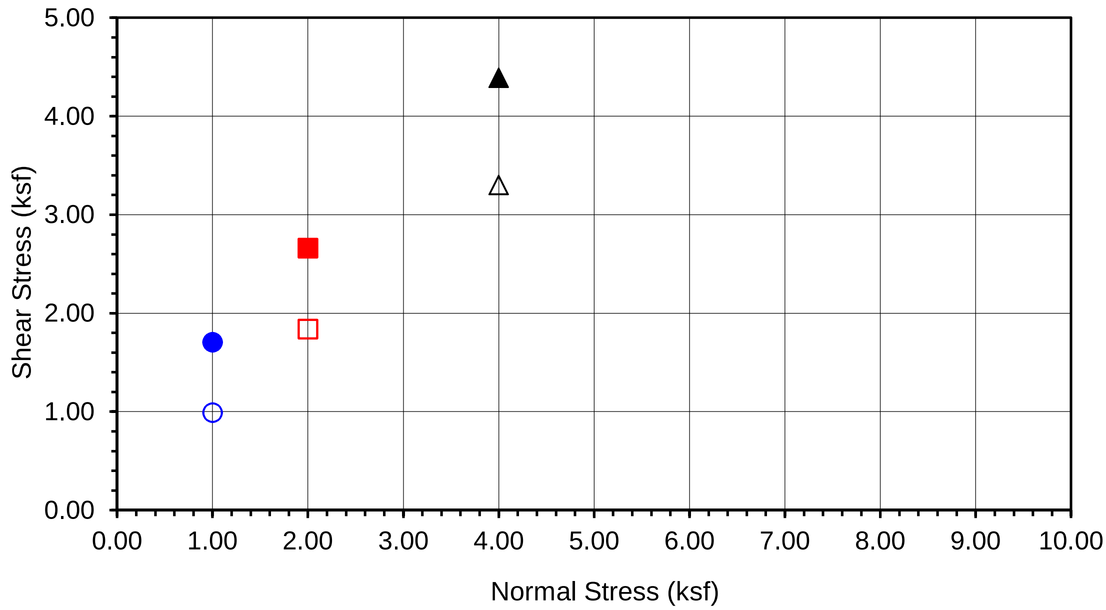
DIRECT SHEAR TEST

Consolidated Drained - ASTM D 3080

Project Name: Richland – Stoneridge
Tested By: G. Bathala
Date: 04/20/16
Project No.: 13092-01
Checked By: J. Ward
Date: 04/27/16
Boring No.: HS-6
Sample Type: Ring
Sample No.: R-2
Depth (ft.): 5.0
Soil Identification: Olive gray clayey sand (SC)

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	209.75	212.49	212.51
Weight of Ring(gm):	45.08	45.69	45.31
Before Shearing			
Weight of Wet Sample+Cont.(gm):	232.84	232.84	232.84
Weight of Dry Sample+Cont.(gm):	220.68	220.68	220.68
Weight of Container(gm):	71.79	71.79	71.79
Vertical Rdg.(in): Initial	0.2353	0.2783	0.0000
Vertical Rdg.(in): Final	0.2265	0.2752	-0.0056
After Shearing			
Weight of Wet Sample+Cont.(gm):	208.36	239.44	227.46
Weight of Dry Sample+Cont.(gm):	182.92	217.77	206.20
Weight of Container(gm):	39.05	65.67	57.44
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**HS-6**
Sample No.	**R-2**
Depth (ft)	**5**
Sample Type: Ring	
Soil Identification: Olive gray clayey sand (SC)	

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.704	■ 2.660	▲ 4.389
Shear Stress @ End of Test (ksf)	○ 0.990	□ 1.839	△ 3.301
Deformation Rate (in./min.)	0.0050	0.0050	0.0050
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	8.17	8.17	8.17
Dry Density (pcf)	126.6	128.2	128.6
Saturation (%)	66.5	70.1	70.9
Soil Height Before Shearing (in.)	1.0088	1.0031	0.9944
Final Moisture Content (%)	17.7	14.2	14.3

DIRECT SHEAR TEST RESULTS

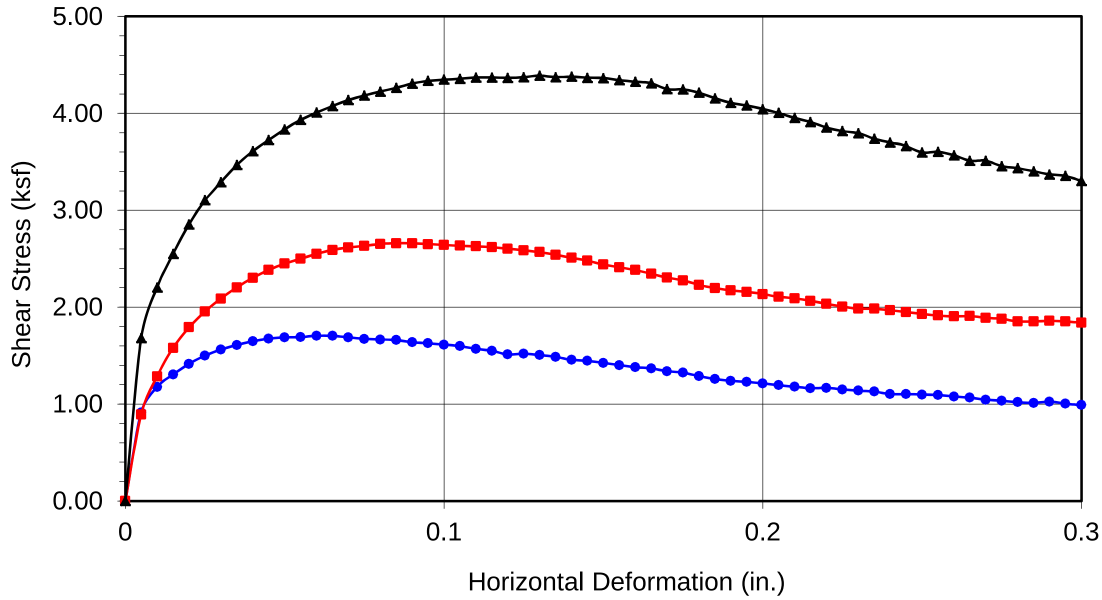
Consolidated Drained - ASTM D 3080

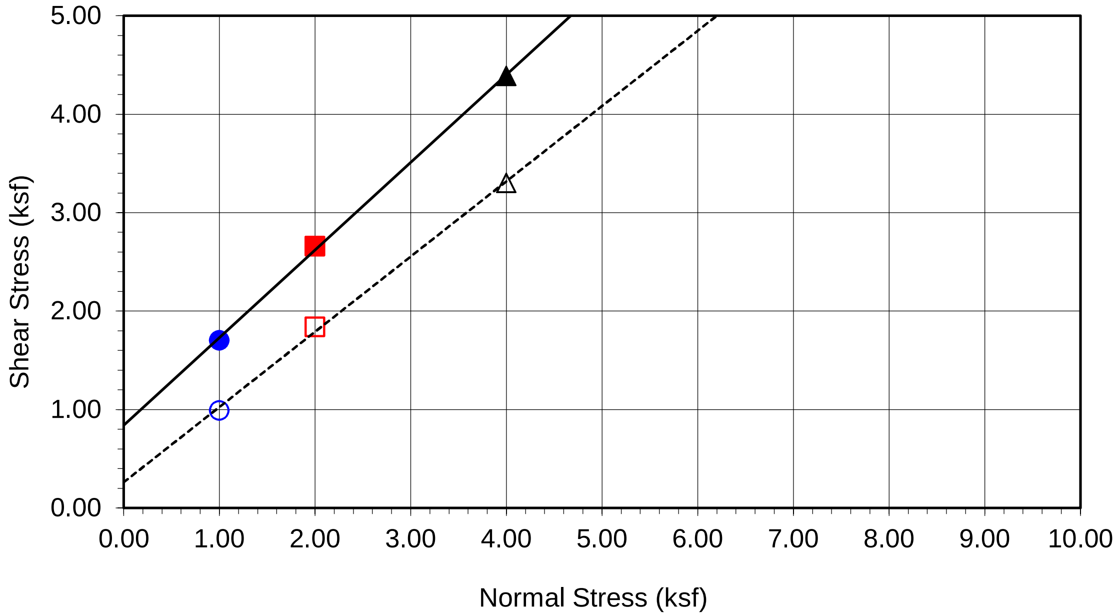
Project No.: 13092-01

Richland – Stoneridge

04-16

DS HS-6, R-2 @ 5





Boring No.	**HS-6**
Sample No.	**R-2**
Depth (ft)	**5**
Sample Type:	Ring
Soil Identification: Olive gray clayey sand (SC)	

Strength Parameters

	C (psf)	ϕ (°)
Peak	840	42
Ultimate	259	37

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.704	■ 2.660	▲ 4.389
Shear Stress @ End of Test (ksf)	○ 0.990	□ 1.839	△ 3.301
Deformation Rate (in./min.)	0.0050	0.0050	0.0050
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	8.17	8.17	8.17
Dry Density (pcf)	126.6	128.2	128.6
Saturation (%)	66.5	70.1	70.9
Soil Height Before Shearing (in.)	1.0088	1.0031	0.9944
Final Moisture Content (%)	17.7	14.2	14.3

DIRECT SHEAR TEST RESULTS

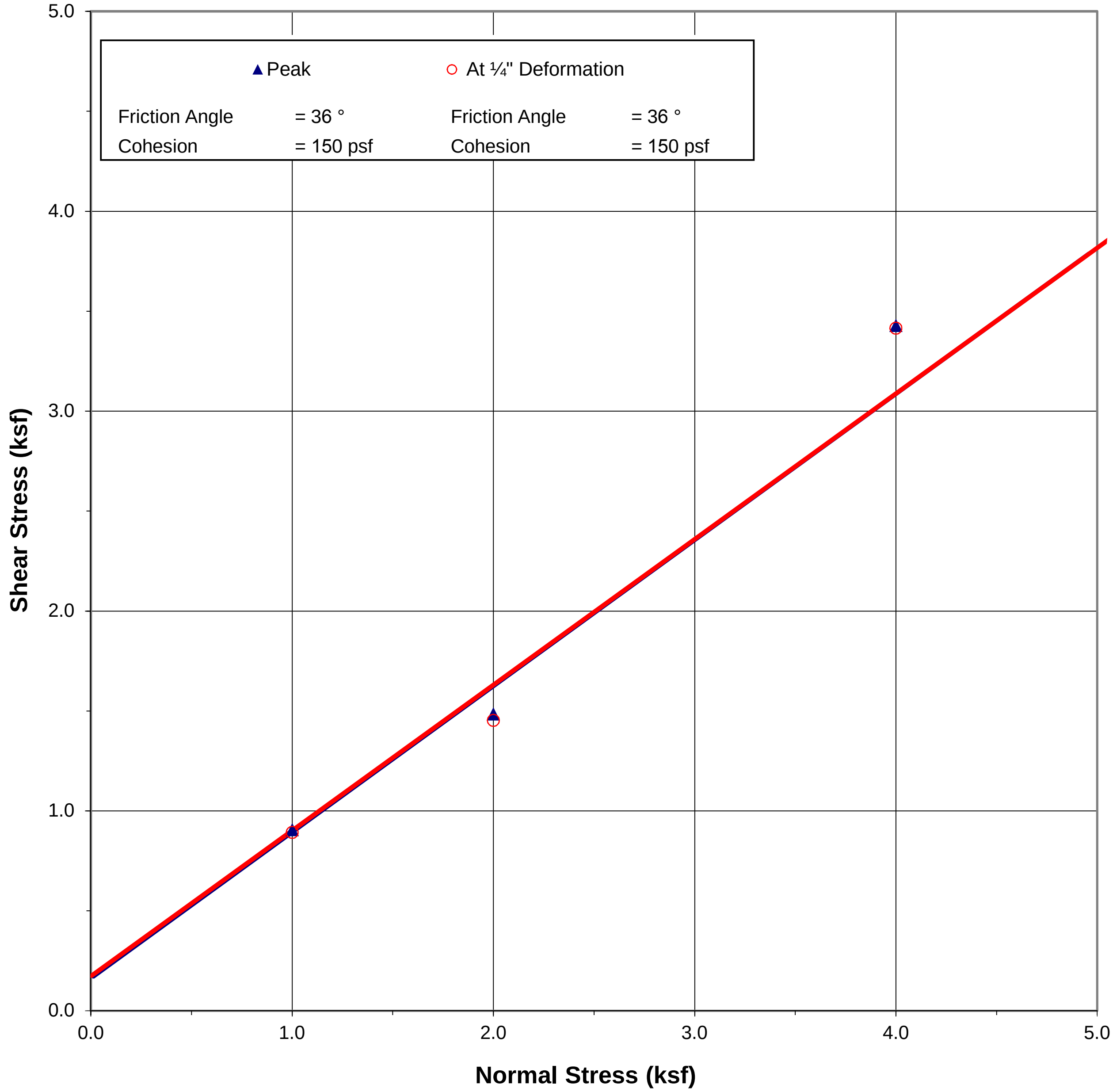
Consolidated Drained - ASTM D 3080

Project No.: 13092-01

Richland – Stoneridge

04-16

DS HS-6, R-2 @ 5



Location:	Sample No.:	Depth (ft)	Sample Type	Shear Rate (inch/min)	Dry Density (pcf)	Initial Moisture Content (%)	Final Moisture Content (%)
HS-20	**B-1**	**2.5'**	**Remolded**	**0.004**	**135.0**	**7.0**	**16.4**

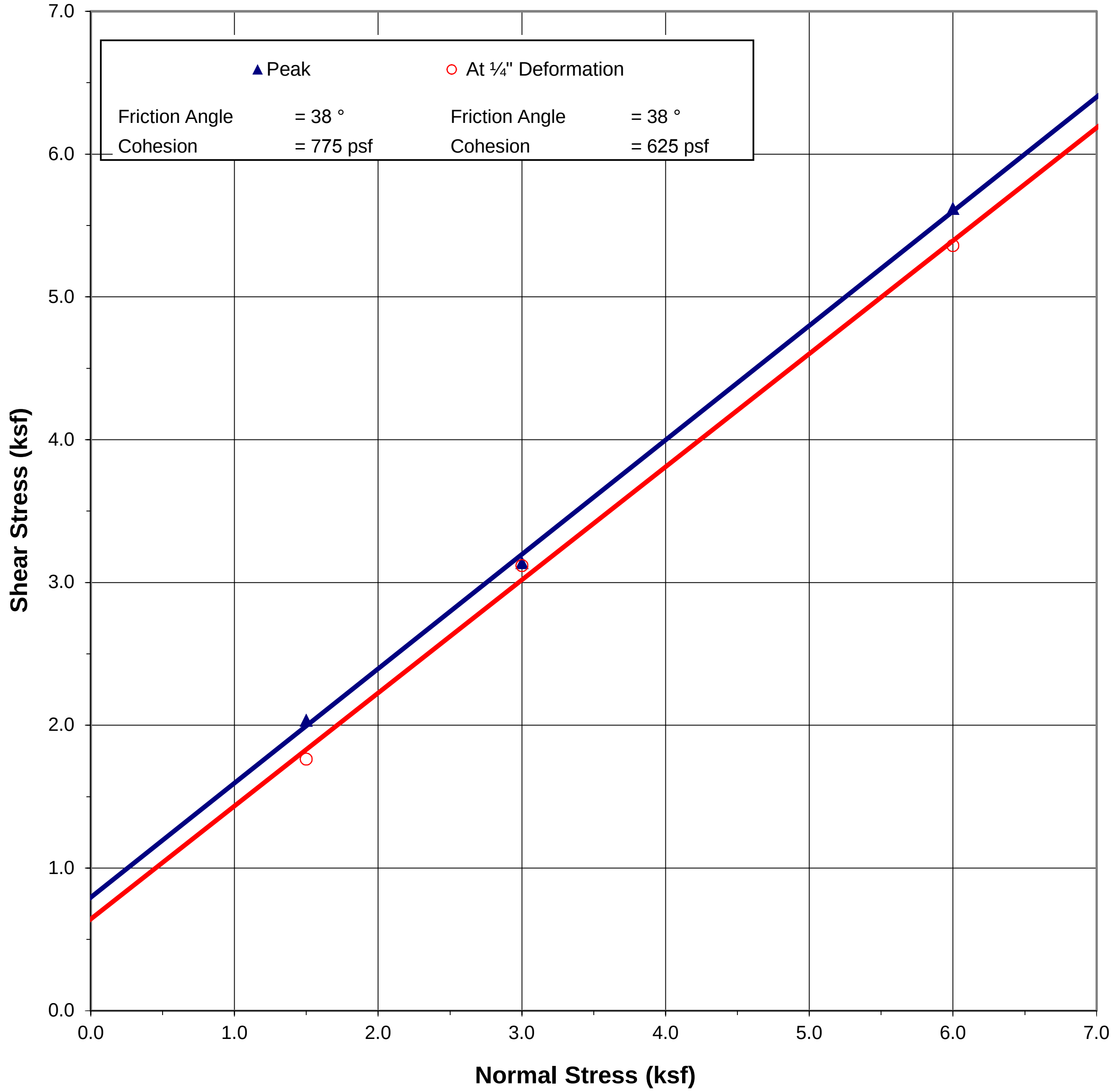
Sample Description: SM

LGC Geotechnical, Inc.

DIRECT SHEAR PLOT

Project Number: 13092-01
Date: Jun-19

Stoneridge



Location:	Sample No.:	Depth (ft)	Sample Type	Shear Rate (inch/min)	Dry Density (pcf)	Initial Moisture Content (%)	Final Moisture Content (%)
HS-24	**R-4**	**10'**	**Ring**	**0.004**	**132.4**	**7.6**	**14.4**

Sample Description: DG

LGC Geotechnical, Inc.

DIRECT SHEAR PLOT

Project Number: 13092-01
Date: Jun-19

Stoneridge

ONE-DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS

ASTM D 4546

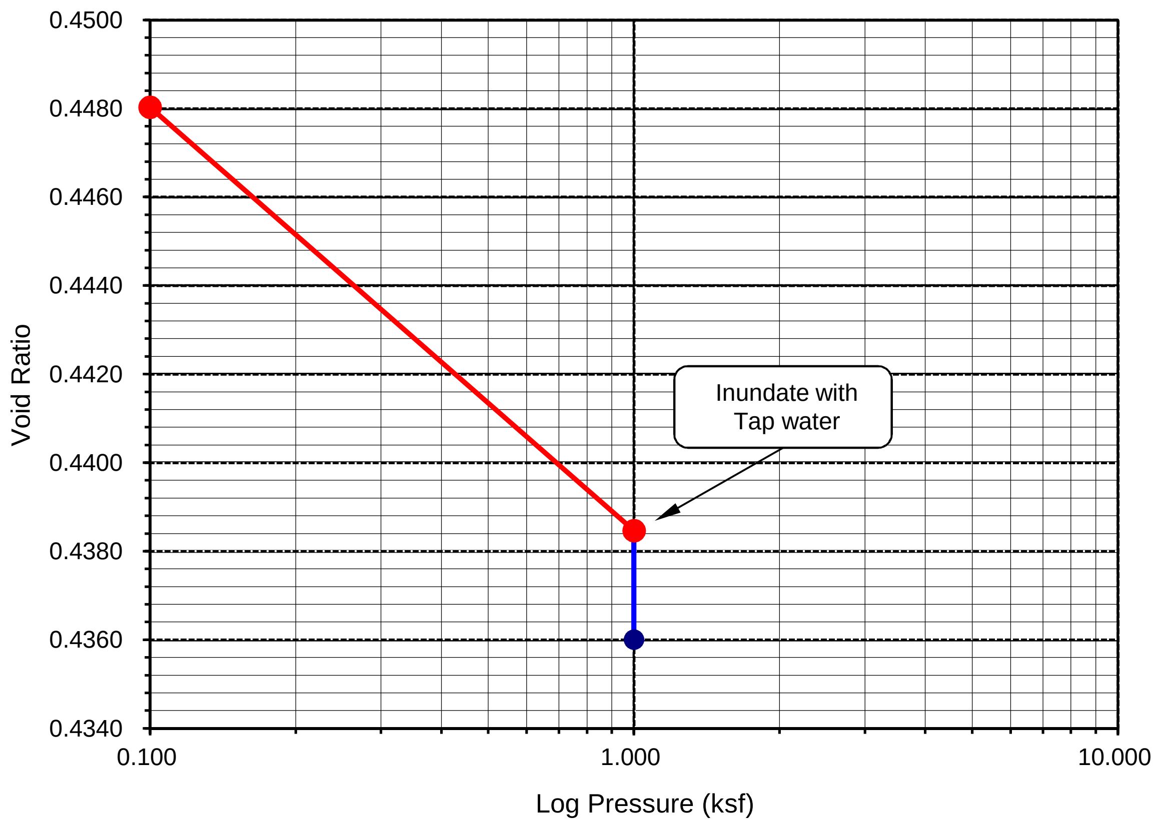
Project Name:	Richland – Stoneridge	Tested By:	G. Bathala	Date:	04/20/16
Project No.:	13092-01	Checked By:	J. Ward	Date:	04/27/16
Boring No.:	HS-10	Sample Type:	Ring		
Sample No.:	R-3	Depth (ft.)	7.5		
Sample Description:	Dark brown silty, clayey sand (SC-SM)				

Initial Dry Density (pcf):	116.4	Final Dry Density (pcf):	117.4
Initial Moisture (%):	7.49	Final Moisture (%) :	13.9
Initial Length (in.):	1.0000	Initial Void Ratio:	0.4485
Initial Dial Reading:	0.2653	Specific Gravity(assumed):	2.70
Diameter(in):	2.415	Initial Saturation (%)	45.1

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.100	0.2650	0.9997	0.00	-0.03	0.4480	-0.03
1.000	0.2567	0.9914	0.17	-0.86	0.4385	-0.69
H2O	0.2550	0.9897	0.17	-1.03	0.4360	-0.86

Percent Swell (+) / Settlement (-) After Inundation = -0.17

Void Ratio - Log Pressure Curve



ONE-DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS

ASTM D 4546

Project Name:	Stoneridge	Tested By:	G. Bathala	Date:	07/18/19
Project No.:	13092-01	Checked By:	J. Ward	Date:	07/24/19
Boring No.:	HS-15	Sample Type:	Ring		
Sample No.:	R-4	Depth (ft.)	10.0		

Sample Description: Light olive brown well-graded sand with silt (SW-SM)

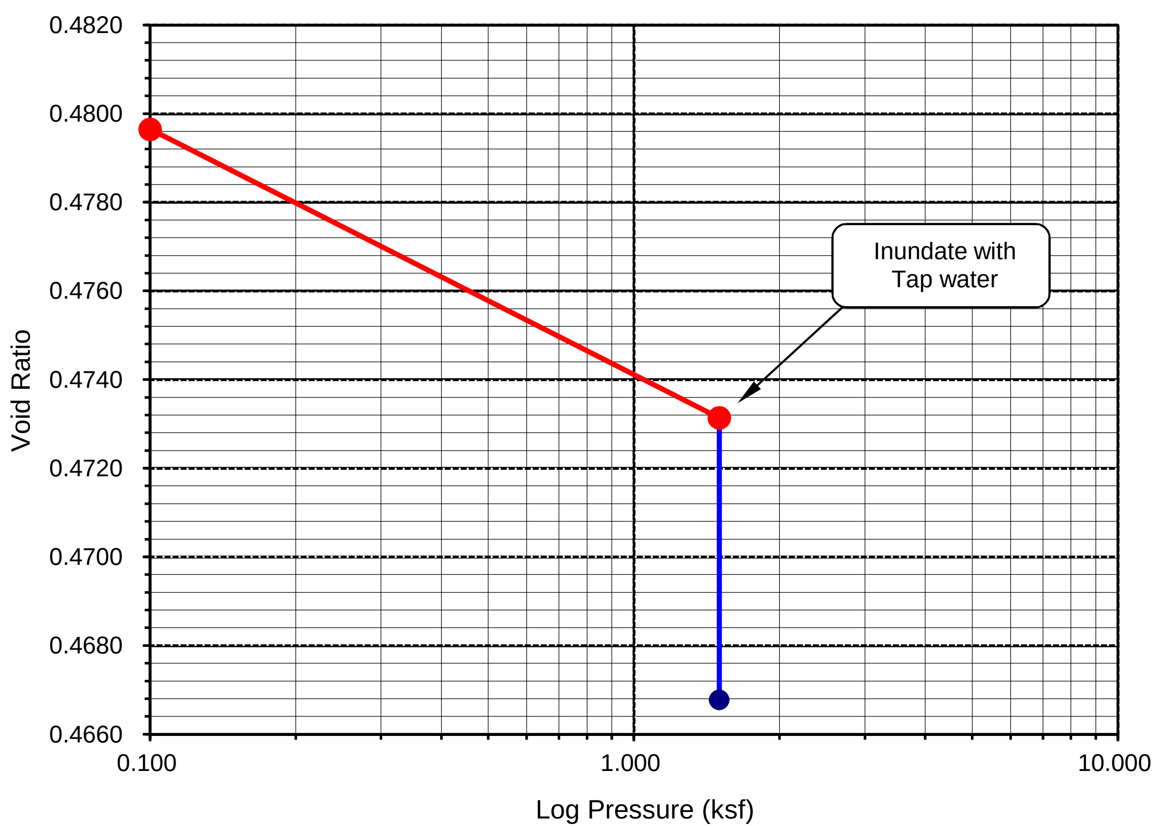
Initial Dry Density (pcf):	113.9
Initial Moisture (%):	1.91
Initial Length (in.):	1.0000
Initial Dial Reading:	0.2809
Diameter(in):	2.415

Final Dry Density (pcf):	114.9
Final Moisture (%) :	14.2
Initial Void Ratio:	0.4796
Specific Gravity(assumed):	2.70
Initial Saturation (%)	10.7

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.100	0.2809	1.0000	0.00	0.00	0.4796	0.00
1.500	0.2739	0.9930	0.26	-0.70	0.4731	-0.44
H2O	0.2696	0.9887	0.26	-1.13	0.4668	-0.87

Percent Swell (+) / Settlement (-) After Inundation = -0.43

Void Ratio - Log Pressure Curve



ONE-DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS
ASTM D 4546

Project Name:	Stoneridge	Tested By:	G. Bathala	Date:	07/19/19
Project No.:	13092-01	Checked By:	J. Ward	Date:	07/24/19
Boring No.:	HS-22	Sample Type:	Ring		
Sample No.:	R-3	Depth (ft.)	7.5		

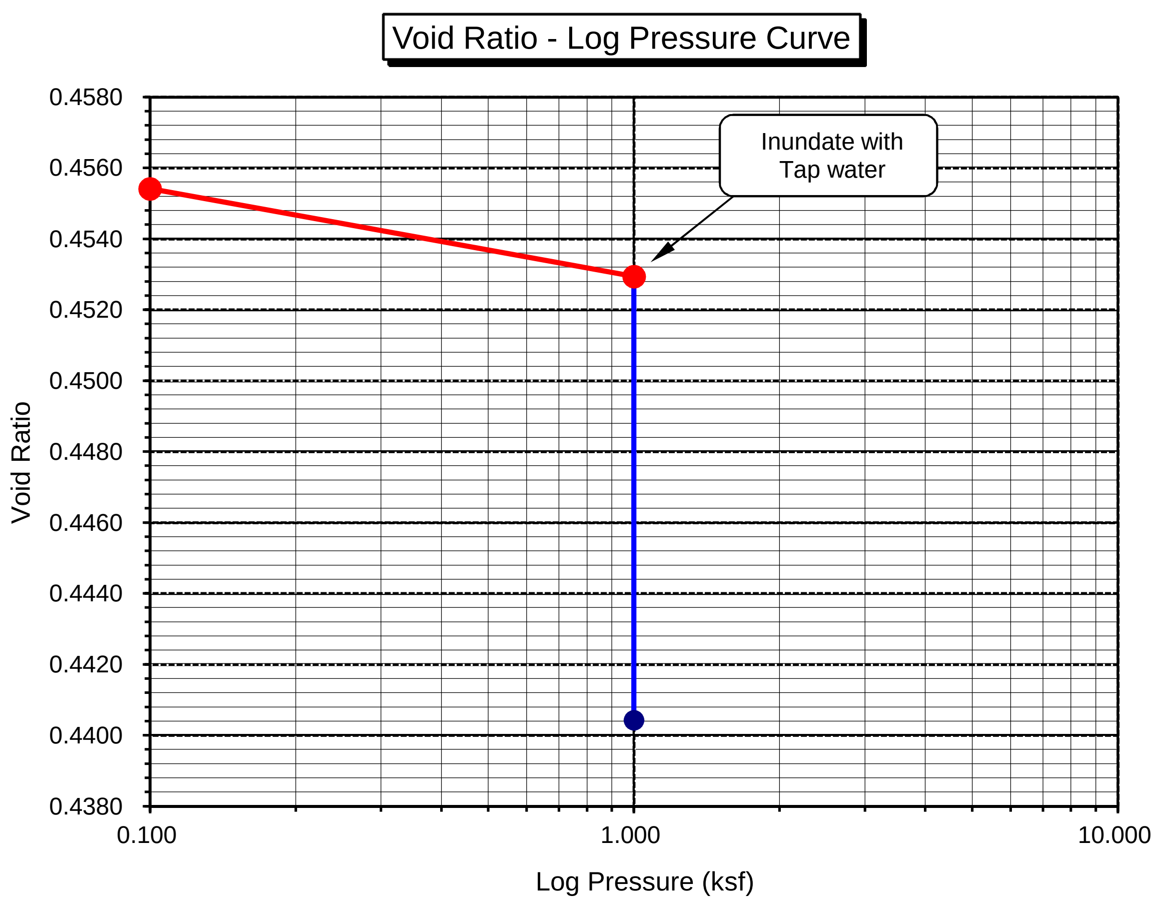
Sample Description: Light olive brown well-graded sand with silt (SW-SM)

Initial Dry Density (pcf):	115.8
Initial Moisture (%):	1.10
Initial Length (in.):	1.0000
Initial Dial Reading:	0.2798
Diameter(in):	2.415

Final Dry Density (pcf):	117.0
Final Moisture (%) :	13.7
Initial Void Ratio:	0.4554
Specific Gravity(assumed):	2.70
Initial Saturation (%)	6.5

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.100	0.2798	1.0000	0.00	0.00	0.4554	0.00
1.000	0.2761	0.9963	0.20	-0.37	0.4529	-0.17
H_2O	0.2675	0.9877	0.20	-1.23	0.4404	-1.03

Percent Swell (+) / Settlement (-) After Inundation = -0.86



ONE-DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS
ASTM D 4546

Project Name:	Stoneridge	Tested By:	G. Bathala	Date:	07/19/19
Project No.:	13092-01	Checked By:	J. Ward	Date:	07/24/19
Boring No.:	HS-24	Sample Type:	Ring		
Sample No.:	R-2	Depth (ft.)	5.0		

Sample Description: Yellowish brown silty, clayey sand (SC-SM)

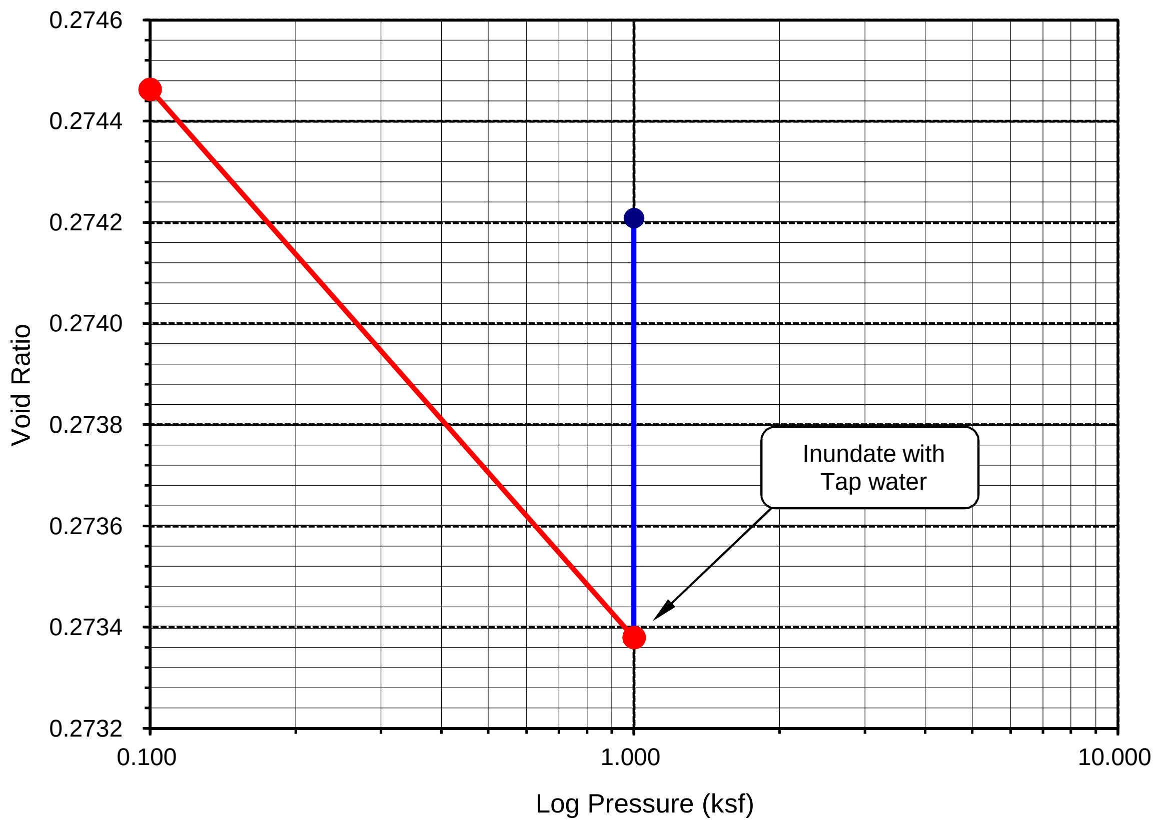
Initial Dry Density (pcf):	132.2
Initial Moisture (%):	8.11
Initial Length (in.):	1.0000
Initial Dial Reading:	0.3215
Diameter(in):	2.415

Final Dry Density (pcf):	132.3
Final Moisture (%) :	11.1
Initial Void Ratio:	0.2748
Specific Gravity(assumed):	2.70
Initial Saturation (%)	79.6

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.100	0.32120	0.9997	0.00	-0.03	0.2745	-0.03
1.000	0.31765	0.9962	0.27	-0.39	0.2734	-0.12
H2O	0.31830	0.9968	0.27	-0.32	0.2742	-0.05

Percent Swell (+) / Settlement (-) After Inundation = 0.07

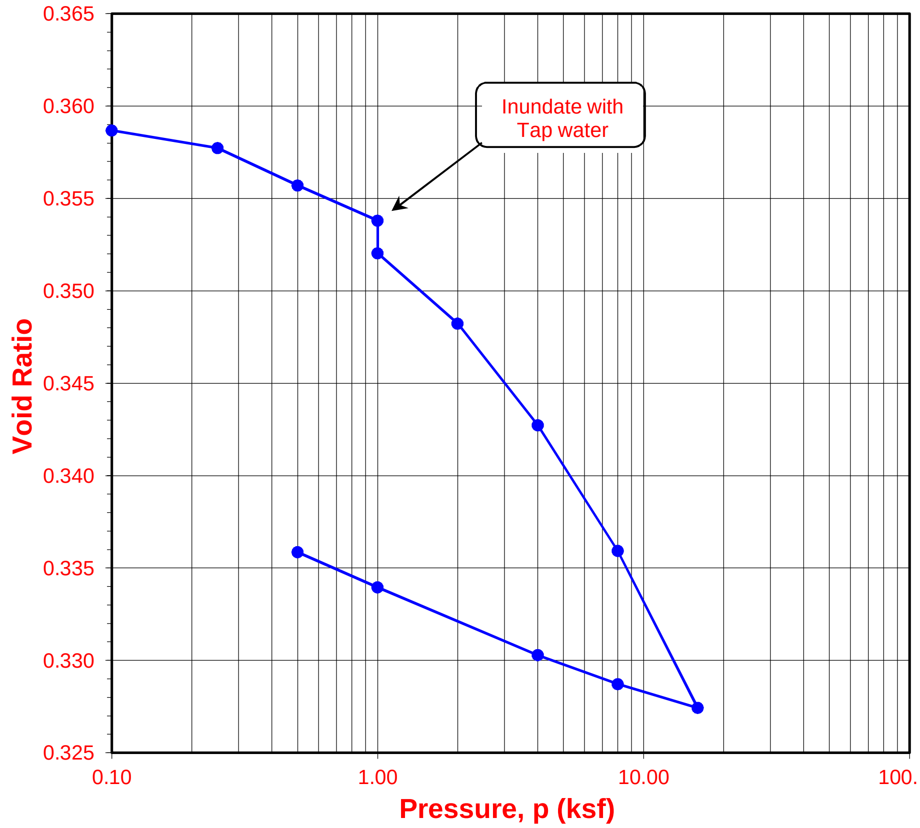
Void Ratio - Log Pressure Curve



ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project Name:	Stoneridge	Tested By:	G. Bathala
Date:	07/15/19		
Project No.:	13092-01	Checked By:	J. Ward
Date:	07/24/19		
Boring No.:	HS-15	Depth (ft.):	7.5
Sample No.:	R-3	Sample Type:	Ring
Soil Identification:	Olive brown silty sand (SM)		

Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	199.67
Weight of Ring (g)	45.65
Height after consol. (in.)	0.9829
Before Test	
Wt.Wet Sample+Cont. (g)	335.83
Wt.of Dry Sample+Cont. (g)	326.41
Weight of Container (g)	39.23
Initial Moisture Content (%)	3.3
Initial Dry Density (pcf)	124.0
Initial Saturation (%)	25
Initial Vertical Reading (in.)	0.3017
After Test	
Wt.of Wet Sample+Cont. (g)	280.67
Wt. of Dry Sample+Cont. (g)	263.36
Weight of Container (g)	69.53
Final Moisture Content (%)	11.68
Final Dry Density (pcf)	125.4
Final Saturation (%)	92
Final Vertical Reading (in.)	0.2818
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

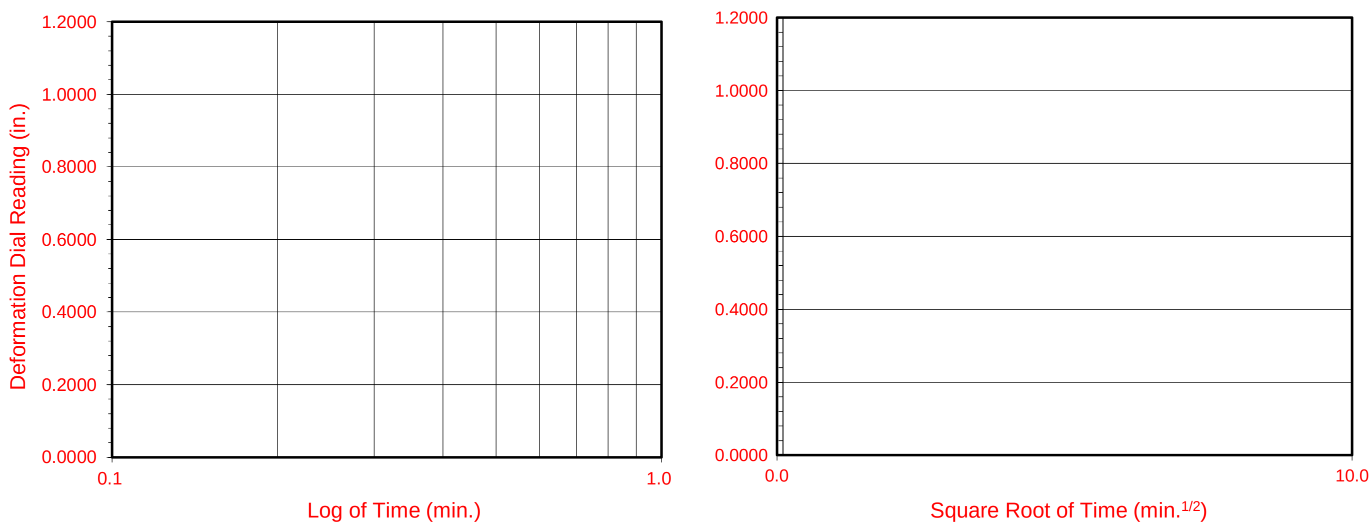


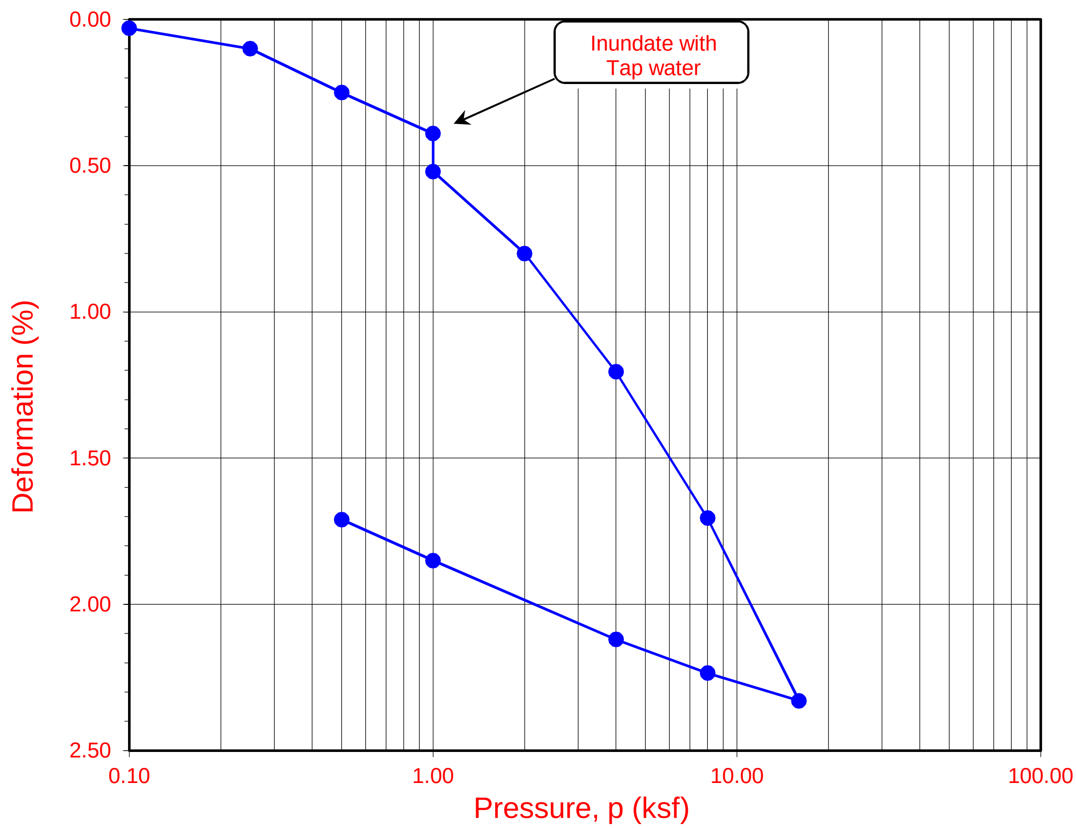
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3014	0.9997	0.00	0.03	0.359	0.03
0.25	0.3002	0.9985	0.05	0.15	0.358	0.10
0.50	0.2982	0.9965	0.10	0.35	0.356	0.25
1.00	0.2960	0.9943	0.18	0.57	0.354	0.39
1.00	0.2947	0.9930	0.18	0.70	0.352	0.52
2.00	0.2910	0.9893	0.27	1.07	0.348	0.80
4.00	0.2857	0.9840	0.40	1.61	0.343	1.21
8.00	0.2791	0.9774	0.56	2.27	0.336	1.71
16.00	0.2707	0.9690	0.77	3.10	0.327	2.33
8.00	0.2729	0.9712	0.65	2.89	0.329	2.24
4.00	0.2751	0.9734	0.54	2.66	0.330	2.12
1.00	0.2796	0.9779	0.36	2.21	0.334	1.85
0.50	0.2818	0.9801	0.28	1.99	0.336	1.71

Time Readings

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

Time Readings





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
HS-15	**R-3**	**7.5**	**3.3**	**11.7**	**124.0**	**125.4**	**0.359**	**0.336**	**25**	**92**

Soil Identification: Olive brown silty sand (SM)

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 13092-01

Stoneridge

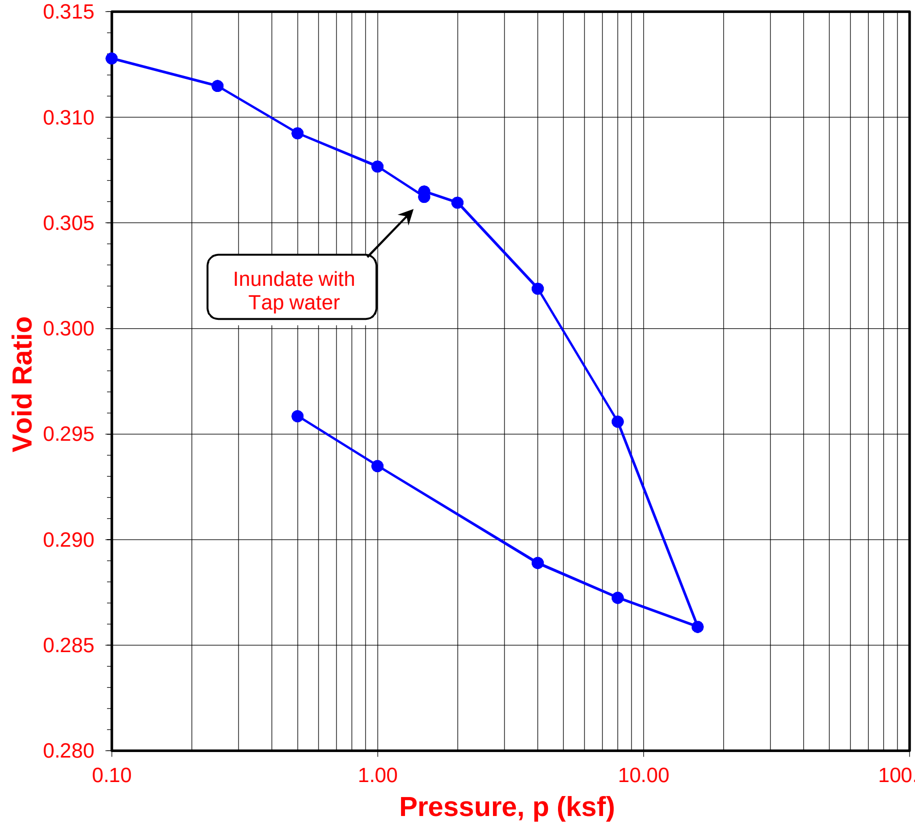
07-19

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Project Name:	Stoneridge	Tested By: G. Bathala	Date:	07/15/19
Project No.:	13092-01	Checked By: J. Ward	Date:	07/24/19
Boring No.:	HS-23	Depth (ft.): 10.0		
Sample No.:	R-4	Sample Type:	Ring	
Soil Identification:	Olive brown silty, clayey sand (SC-SM)			

Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	215.12
Weight of Ring (g)	42.58
Height after consol. (in.)	0.9868
Before Test	
Wt.Wet Sample+Cont. (g)	390.82
Wt.of Dry Sample+Cont. (g)	361.89
Weight of Container (g)	39.21
Initial Moisture Content (%)	9.0
Initial Dry Density (pcf)	131.7
Initial Saturation (%)	79
Initial Vertical Reading (in.)	0.3051
After Test	
Wt.of Wet Sample+Cont. (g)	278.57
Wt. of Dry Sample+Cont. (g)	261.60
Weight of Container (g)	60.64
Final Moisture Content (%)	10.71
Final Dry Density (pcf)	133.5
Final Saturation (%)	100
Final Vertical Reading (in.)	0.2904
Specific Gravity (assumed)	2.77
Water Density (pcf)	62.43

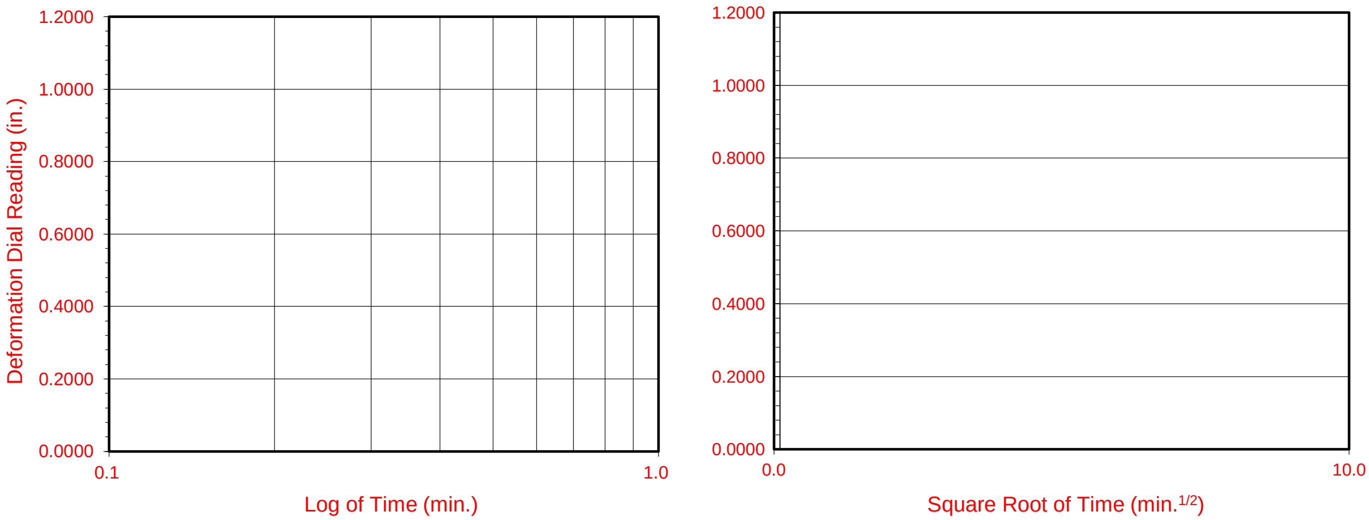


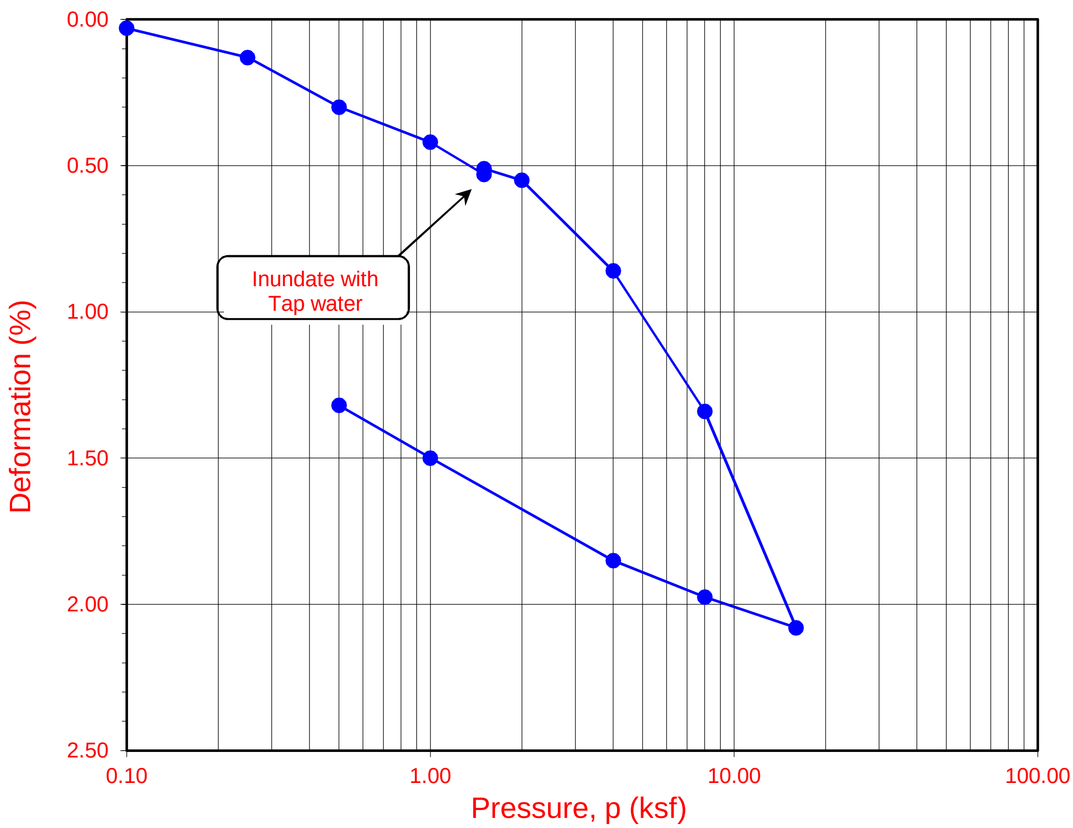
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3048	0.9997	0.00	0.03	0.313	0.03
0.25	0.3036	0.9985	0.02	0.15	0.311	0.13
0.50	0.3017	0.9966	0.04	0.34	0.309	0.30
1.00	0.3002	0.9951	0.07	0.49	0.308	0.42
1.50	0.2989	0.9938	0.09	0.62	0.306	0.53
1.50	0.2991	0.9940	0.09	0.60	0.306	0.51
2.00	0.2985	0.9934	0.11	0.66	0.306	0.55
4.00	0.2947	0.9896	0.18	1.04	0.302	0.86
8.00	0.2889	0.9838	0.28	1.62	0.296	1.34
16.00	0.2802	0.9751	0.41	2.49	0.286	2.08
8.00	0.2818	0.9767	0.36	2.34	0.287	1.98
4.00	0.2836	0.9785	0.30	2.15	0.289	1.85
1.00	0.2882	0.9831	0.19	1.69	0.293	1.50
0.50	0.2904	0.9853	0.15	1.47	0.296	1.32

Time Readings

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

Time Readings





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
HS-23	**R-4**	**10.0**	**9.0**	**10.7**	**131.7**	**133.5**	**0.313**	**0.296**	**79**	**100**

Soil Identification: Olive brown silty, clayey sand (SC-SM)

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 13092-01

Stoneridge

07-19

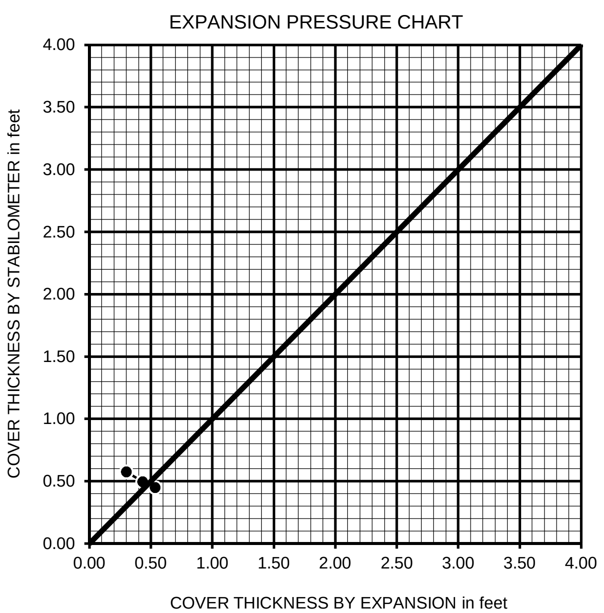
R-VALUE TEST RESULTS

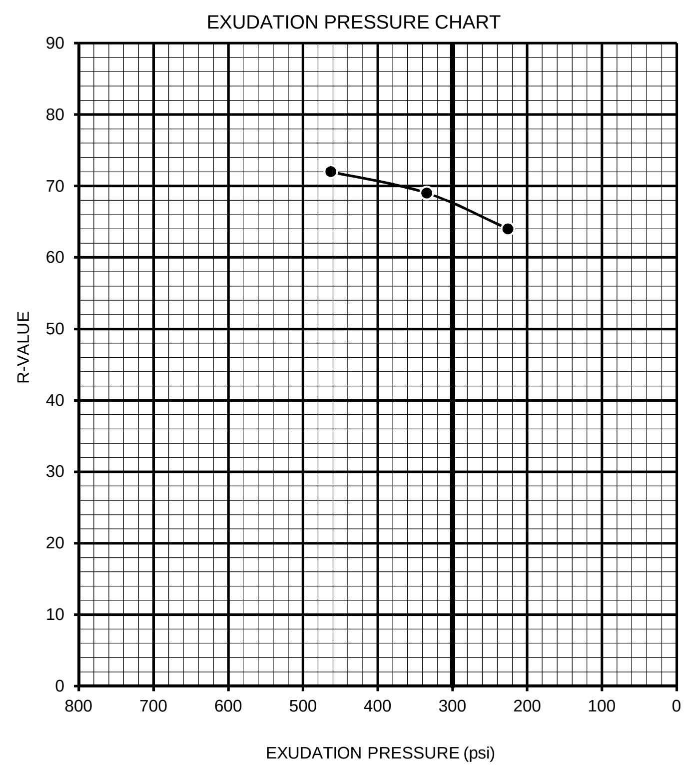
DOT CA Test 301

PROJECT NAME:	Richland – Stoneridge	PROJECT NUMBER:	13092-01
BORING NUMBER:	HS-3	DEPTH (FT.):	0-3
SAMPLE NUMBER:	B-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Brown silty sand (SM)	DATE COMPLETED:	4/21/2016

TEST SPECIMEN	a	b	c
MOISTURE AT COMPACTION %	9.2	9.7	10.2
HEIGHT OF SAMPLE, Inches	2.46	2.48	2.53
DRY DENSITY, pcf	129.5	131.8	130.1
COMPACTOR PRESSURE, psi	350	240	175
EXUDATION PRESSURE, psi	463	334	225
EXPANSION, Inches x 10exp-4	16	13	9
STABILITY Ph 2,000 lbs (160 psi)	30	32	36
TURNS DISPLACEMENT	4.19	4.50	4.88
R-VALUE UNCORRECTED	72	69	64
R-VALUE CORRECTED	72	69	64

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	0.45	0.50	0.58
EXPANSION PRESSURE THICKNESS, ft.	0.53	0.43	0.30





R-VALUE BY EXPANSION:	70
R-VALUE BY EXUDATION:	67
EQUILIBRIUM R-VALUE:	67

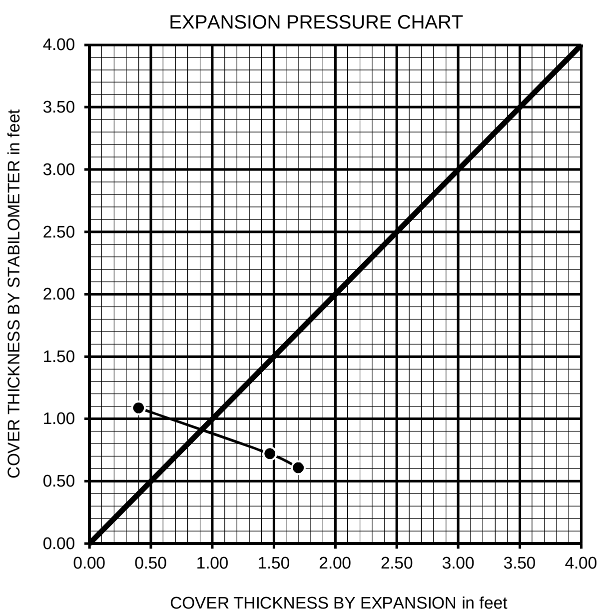
R-VALUE TEST RESULTS

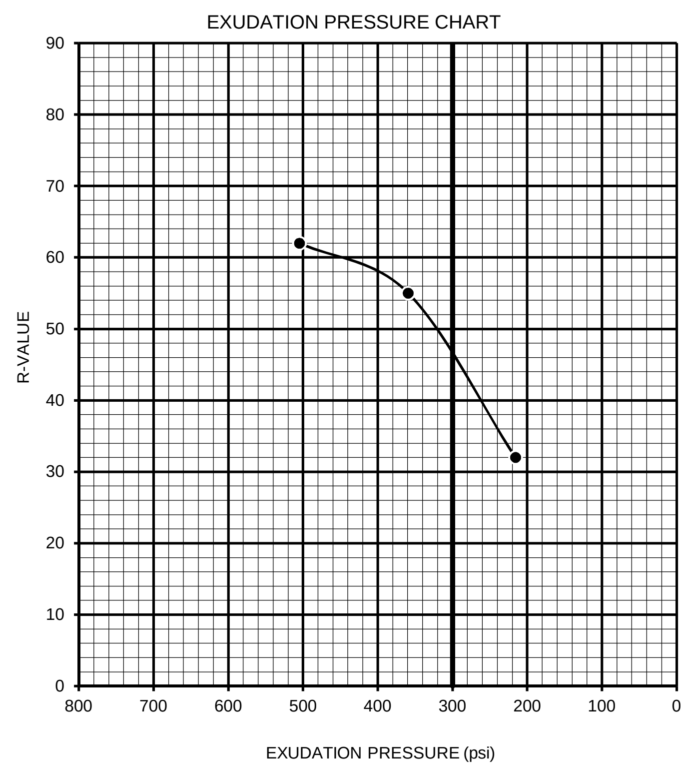
DOT CA Test 301

PROJECT NAME:	Richland – Stoneridge	PROJECT NUMBER:	13092-01
BORING NUMBER:	HS-9	DEPTH (FT.):	0-4
SAMPLE NUMBER:	B-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Brown silty, clayey sand (SC-SM)	DATE COMPLETED:	4/21/2016

TEST SPECIMEN	a	b	c
MOISTURE AT COMPACTION %	10.2	10.7	11.6
HEIGHT OF SAMPLE, Inches	2.43	2.42	2.46
DRY DENSITY, pcf	133.3	131.2	129.4
COMPACTOR PRESSURE, psi	250	200	125
EXUDATION PRESSURE, psi	504	359	216
EXPANSION, Inches x 10exp-4	51	44	12
STABILITY Ph 2,000 lbs (160 psi)	40	50	88
TURNS DISPLACEMENT	4.20	4.09	4.37
R-VALUE UNCORRECTED	64	57	32
R-VALUE CORRECTED	62	55	32

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	0.61	0.72	1.09
EXPANSION PRESSURE THICKNESS, ft.	1.70	1.47	0.40





R-VALUE BY EXPANSION:	43
R-VALUE BY EXUDATION:	46
EQUILIBRIUM R-VALUE:	43

Appendix D
Seismic Refraction Survey Report

TERRA GEOSCIENCES

SEISMIC REFRACTION SURVEY

RICHLAND STONERIDGE PROJECT

SOUTHEAST OF RAMONA EXPRESSWAY AND RIDER STREET

PERRIS AREA, RIVERSIDE COUNTY, CALIFORNIA

Project No. 193235-1

July 1, 2019

Prepared for:

LGC Geotechnical, Inc.
131 Calle Iglesia, Suite 200
San Clemente, CA 92672

LGC Geotechnical, Inc.
131 Calle Iglesia, Suite 200
San Clemente, CA 92672

July 1, 2019
Project No. 193235-1

Attention: Mr. Kevin Dyekman, Project Geologist

Regarding: Seismic Refraction Survey
Richland Stoneridge Project
Southeast of Ramona Expressway and Rider Street
Perris Area, Riverside County, California
LGC Project No. 13092-01

EXECUTIVE SUMMARY

As requested, this firm has performed a geophysical survey using the seismic refraction method for the above-referenced site. The purpose of this investigation was to assess the general seismic velocity characteristics of the underlying earth materials and to evaluate whether high velocity bedrock materials (non-rippable) may be present. Additionally, the structure and seismic velocity distribution of the subsurface earth materials was also assessed. This report will describe in further detail the procedures used and the results of our findings, along with presentation of representative seismic models for the survey traverse.

For this study, five survey traverses were performed across the subject property, as selected by your office. The traverses were located in the field by use of Google™ Earth imagery (2019) and GPS coordinates. The approximate locations of these traverses are shown on the Seismic Line Location Map, Plate 1, of which the base map is a captured Google™ Earth image (2019).

This opportunity to be of service is sincerely appreciated. If you should have questions regarding this report or do not understand the limitations of this study or the data and results that are presented, please do not hesitate to contact our office.

Respectfully submitted,
TERRA GEOSCIENCES

Donn C. Schwartzkopf
Principal Geophysicist
PGP 1002

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INTRODUCTION

The subject study area is located southeast of Ramona Expressway and Rider Street, in the Perris area of Riverside County, California. Topographically, the subject study area is situated along the northwestern flank of some low-lying unnamed hills just south of the Bernasconi Hills, which is covered with dense shrub brush and annual weeds and grasses, with scattered numerous large boulder outcrops.

Geomorphically, the subject study area is located within the northwestern portion of the Perris Block, which is an eroded mass of Cretaceous and older crystalline rock forming generally flat-lying erosion surfaces now present at various elevations. More specifically, the subject property is located within the western transition zone of the southern Peninsular Ranges batholith, along the northwestern portion of the Cretaceous age Lakeview Mountains Valley pluton. Locally, as shown on Figure 1 below, surficial mapping by Morton (2003) indicates the subject study area to be underlain by Cretaceous age granitic rocks generally described as being a gray, medium- to coarse-grained, massive to foliated, biotite hornblende tonalite (map symbol Klmt). For reference, the approximate locations of the seismic traverses are indicated as the red lines in Figure 1 below.

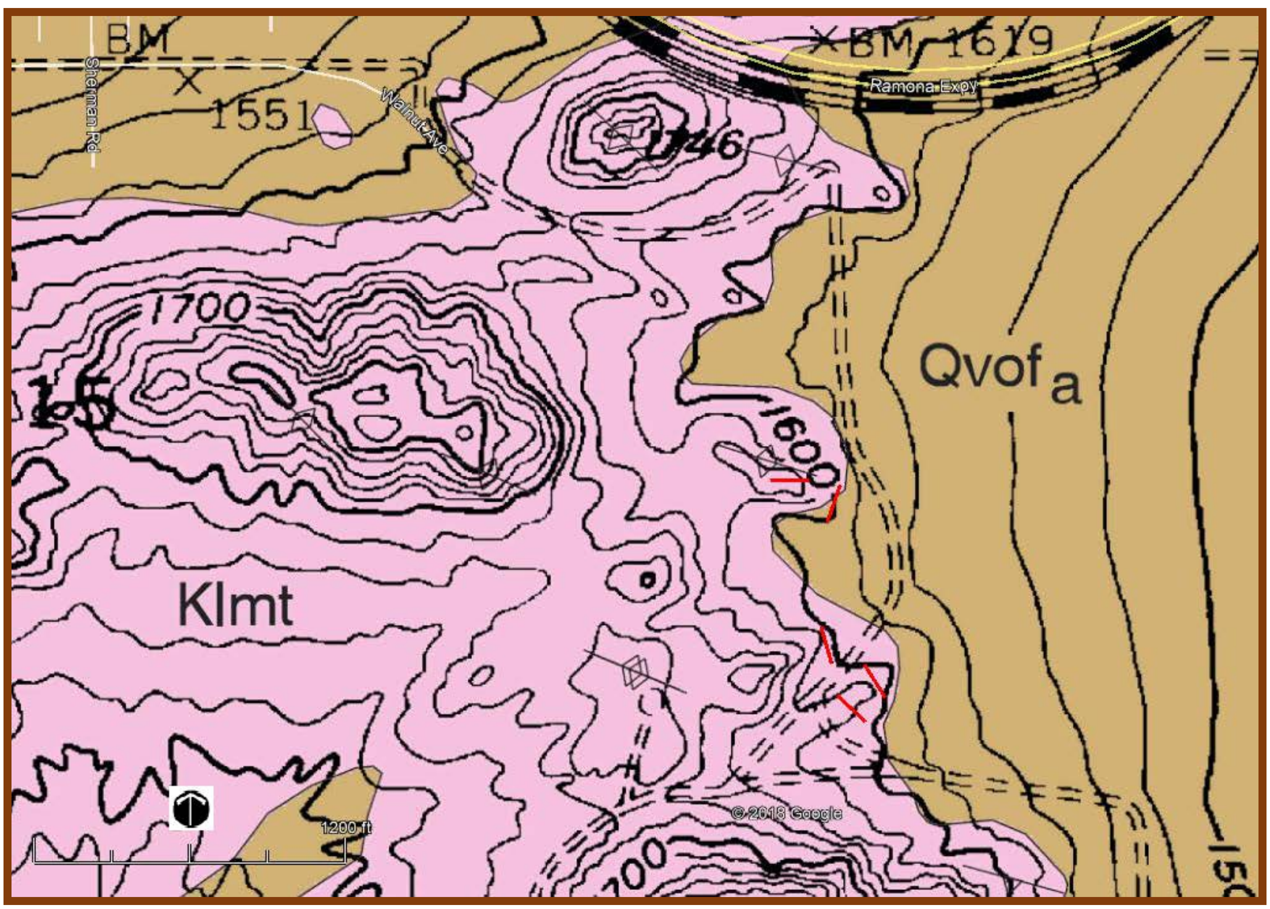


FIGURE 1- Geologic Map (Morton, 2003), Seismic traverses shown as red lines.

SEISMIC REFRACTION SURVEY

Methodology

The seismic refraction method consists of measuring (at known points along the surface of the ground) the travel times of compressional waves generated by an impulsive energy source and can be used to estimate the layering, structure, and seismic acoustic velocities of subsurface horizons. Seismic waves travel down and through the soils and rocks, and when the wave encounters a contact between two earth materials having different velocities, some of the wave's energy travels along the contact at the velocity of the lower layer. The fundamental assumption is that each successively deeper layer has a velocity greater than the layer immediately above it. As the wave travels along the contact, some of the wave's energy is refracted toward the surface where it is detected by a series of motion-sensitive transducers (geophones). The arrival time of the seismic wave at the geophone locations can be related to the relative seismic velocities of the subsurface layers in feet per second (fps), which can then be used to aid in interpreting both the depth and type of materials encountered.

Field Procedures

Five seismic refraction survey lines (Seismic Lines S-1 through S-5) have been performed along representative areas across the subject study area as selected by you. The traverses were located in the field by use of Google™ Earth imagery (2019) and GPS coordinates and have been delineated on the Seismic Line Location Map, as presented on Plate 1. The survey traverses were each 150 feet in length, which consisted of a total of twenty-four 14-Hertz geophones, spaced at regular six-foot intervals, in order to detect both the direct and refracted waves. A 16-pound sledge-hammer was used as the energy source to produce the seismic waves. Multiple hammer impacts were utilized at each shot point in order to increase the signal to noise ratio, which enhanced the primary seismic "P"-waves.

The seismic wave arrivals were digitally recorded in SEG-2 format on a Geometrics StrataVisor™ NZXP model signal enhancement refraction seismograph. Seven shot points were utilized along each spread using forward, reverse, and several intermediate locations in order to obtain high resolution survey data for velocity analysis and depth modeling purposes. The data was acquired using a sampling rate of 0.0625 milliseconds having a record length of 0.064 seconds. No acquisition filters were used during data collection.

During acquisition, the seismograph displays the seismic wave arrivals on the computer screen which were used to analyze the arrival time of the primary seismic "P"-waves at each geophone station, in the form of a wiggle trace for quality control purposes in the field. If spurious "noise" was observed, the shot location was resampled during relatively quieter periods. Each geophone and seismic shot location were surveyed using a hand level and ruler for topographic correction, with "0" being the lowest point along each survey line.

Data Processing

The recorded seismic data was subsequently transferred to our office computer for processing and analyzing purposes, using the computer programs **SIPwin** (**S**eismic Refraction **I**nterpretation **P**rogram for **Win**dows) developed by Rimrock Geophysics, Inc. (2004); **Refractor** (Geogiga, 2001-2018); and **Rayfract™** (Intelligent Resources, Inc., 1996-2019). All of the computer programs perform their individual analyses using exactly the same input data, which includes the first-arrival times of the "P"-waves and the survey line geometry.

- **SIPwin** is a ray-trace modeling program that evaluates the subsurface using layer assignments based on time-distance curves and is better suited for layered media, using the "Seismic Refraction Modeling by Computer" method (Scott, 1973). The first step in the modeling procedure is to compute layer velocities by least-squares techniques. Then the program uses the delay-time method to estimate depths to the top of layer-2. A forward modeling routine traces rays from the shot points to each geophone that received a first-arrival ray refracted along the top of layer-2. The travel time of each such ray is compared with the travel time recorded in the field by the seismic system. The program then adjusts the layer-2 depths so as to minimize discrepancies between the computed ray-trace travel times and the first arrival times picked from the seismic waveform record. The process of ray tracing and model adjustment is repeated a total of six times to improve the accuracy of depths to the top of layer-2. This first-arrival picks were then used to generate the Layer Velocity Models using the **SIPwin** computer program, which presents the subsurface velocities as individual layers and are presented within Appendix A for reference. In addition, the associated Time-Distance Plot for each survey line, which shows the individual data picks of the first "P-wave" arrival times, also appears in Appendix A.

- **Refractor** is seismic refraction software that also evaluates the subsurface using layer assignments utilizing interactive and interchangeable analytical methods that include the Delay-Time method, the ABC method, and the Generalized Reciprocal Method (GRM). These methods are used for defining irregular non-planar refractors and are briefly described below. The <u>Delay-Time</u> method will measure the delay time depth to a refractor beneath each geophone rather than at shot points. Delay-time is the time spent by a wave to travel up or down through the layer (slant path) compared to the time the wave would spend if traveling along the projection of the slant path on the refractor. The <u>ABC</u> (intercept time) method makes use of critically refracted rays converging on a common surface position. This method involves using three surface to surface travel times between three geophones and the velocity of the first layer in an equation to calculate depth under the central geophone and is applied to all other geophones on the survey line. The <u>GRM</u> method is a technique for delineating undulating refractors at any depth from in-line seismic refraction data consisting of forward and reverse travel-times and is capable of resolving dips of up to 20% and does not over-smooth or average the subsurface refracting layers. In addition, the technique provides an approach for recognizing and compensating for hidden layer conditions.

- **Rayfract™** is seismic refraction tomography software that models subsurface refraction, transmission, and diffraction of acoustic waves which generally indicates the relative structure and velocity distribution of the subsurface using first break energy propagation modeling. An initial 1D gradient model is created using the DeltatV method (Gebrande and Miller, 1985) which gives a good initial fit between modeled and picked first breaks. The DeltatV method is a turning-ray inversion method which delivers continuous depth vs. velocity profiles for all profile stations. These profiles consist of horizontal inline offset, depth, and velocity triples. The method handles real-life geological conditions such as velocity gradients, linear increasing of velocity with depth, velocity inversions, pinched-out layers and outcrops, and faults and local velocity anomalies. This initial model is then refined automatically with a true 2D WET (Wavepath Eikonal Traveltime) tomographic inversion (Schuster and Quintus-Bosz, 1993).

  WET tomography models multiple signal propagation paths contributing to one first break, whereas conventional ray tracing tomography is limited to the modeling of just one ray per first break. This computer program performs the analysis by using the same first-arrival P-wave times and survey line geometry that were generated during the layer velocity model analyses. The associated Refraction Tomographic Models which display the subsurface earth material velocity structure, is represented by the velocity contours (isolines displayed in feet/second), supplemented with the color-coded velocity shading for visual reference, and are presented within Appendix B.

The combined use of these computer programs provided a more thorough and comprehensive analysis of the subsurface structure and velocity characteristics. Each computer program has a specific purpose based on the objective of the analysis being performed. **SIPwin** and **Refractor** were primarily used for detecting generalized subsurface velocity layers providing "weighted average velocities." The processed seismic data of these two programs were compared and averaged to provide a final composite layer velocity model which provided a more thorough representation of the subsurface. **Rayfract™** provided tomographic velocity and structural imaging that is very conducive to detecting strong lateral velocity characteristics such as imaging corestones, dikes, and other subsurface structural characteristics.

SUMMARY OF GEOPHYSICAL INTERPRETATION

To begin our discussion, it is important to consider that the seismic velocities obtained within bedrock materials are influenced by the nature and character of the localized major structural discontinuities (foliation, fracturing, relic bedding, etc.), creating anisotropic conditions. Anisotropy (direction-dependent properties of materials) can be caused by "micro-cracks," jointing, foliation, layered or inter-bedded rocks with unequal layer stiffness, small-scale lithologic changes, etc. (Barton, 2007). Velocity anisotropy complicates interpretation and it should be noted that the seismic velocities obtained during this survey may have been influenced by the nature and character of any localized structural discontinuities within the bedrock underlying the subject site.

Generally, it is expected that higher (truer) velocities will be obtained when the seismic waves propagate along direction (strike) of the dominant structure, with a damping effect when the seismic waves travel in a perpendicular direction. Such variable directions can result in velocity differentials of between 2% to 40% depending upon the degree of the structural fabric (i.e., weakly-moderately-strongly foliated, respectively). Therefore, the seismic velocities obtained during our field study and as discussed below, should be considered minimum velocities at this time.

The first computer method described below used for data analysis is the traditional layer method (**SIPwin** and **Refractor**). Using this method, it should be understood that the data obtained represents an average of seismic velocities within any given layer. For example, high seismic velocity boulders, dikes, or other local lithologic inconsistencies, may be isolated within a low velocity matrix, thus yielding an average medium velocity for that layer. Therefore, in any given layer, a range of velocities could be anticipated, which can also result in a wide range of excavation characteristics. In general, the site where locally surveyed, was noted to be characterized by three major subsurface layers (Layers V1, V2, and V3) with respect to seismic velocities.

The following velocity layer summaries have been prepared using the **SIPwin** and **Refractor** analysis, with the representative Layer Velocity Model presented within Appendix A along with the respective Time-Distance Plot.

- **Velocity Layer V1**:

  This uppermost velocity layer (V1) is most likely comprised of colluvium, topsoil, wind-blown sands, and/or completely-weathered and fractured bedrock materials. This layer has an average weighted velocity of 1,336 to 1,659 fps, which is typical for these types of unconsolidated surficial earth materials.

- **Velocity Layer V2**:

  The second layer (V2) yielded a seismic velocity range of 3,330 to 4,763 fps, which is typical for highly-weathered granitic bedrock materials. This velocity range may indicate the presence of homogeneous weathered bedrock with a relatively wide spaced joint/fracture system and/or the possibility of buried relatively-fresher boulders within a very highly-weathered bedrock matrix.

- **Velocity Layer V3**:

  The third layer (V3) indicates the presence of slightly-weathered bedrock, having a seismic velocity range of 8,279 to 11,260 fps. These higher velocities signify the decreasing effect of weathering as a function of depth and could indicate a slightly-weathered bedrock matrix that has a wide-spaced fracture system, or possibly the presence of abundant widely-scattered buried fresh large crystalline boulders in a moderately-weathered matrix, which based on the abundant large surface rock outcrops exposed across the site, appears likely.

The following table summarizes the results of the survey lines with respect to the "weighted average" seismic velocities for each layer, as indicated on the Layer Velocity Models, presented within Appendix A.

TABLE 1- VELOCITY SUMMARY OF SEISMIC SURVEY LINES

Seismic Line	V1 Layer (fps)	V2 Layer (fps)	V3 Layer (fps)
S-1	**1,371**	**3,657**	**11,260**
S-2	**1,389**	**3,330**	**8,279**
S-3	**1,336**	**4,058**	**-----**
S-4	**1,373**	**3,498**	**10,169**
S-5	**1,659**	**4,763**	**10,717**

Using **Rayfract™**, tomographic models were also prepared for comparative purposes to better illustrate the general structure and velocity distribution of the subsurface, using velocity contour isolines, as presented within Appendix B. Although no discrete velocity layers or boundaries are created, these models generally resemble the corresponding overall average layer velocities as presented within Appendix A.

In general, the seismic velocity of the bedrock gradually increases with depth, with occasional lateral velocity differentials suggesting the local presence of buried corestones and/or dike structures. These corestones are expected as numerous bedrock outcrops are scattered across the hillside in the study area. The colors representing the velocity gradients have been standardized on all of the models for comparative purposes.

GENERALIZED RIPPABILITY CHARACTERISTICS OF BEDROCK

A summary of the generalized rippability characteristics of bedrock based on a compilation of rippability performance charts prepared by Caterpillar, Inc. (2018; see Figure 2, Page 8), Caltrans (Stephens, 1978), and Santi (2006), has been provided to aid in evaluating potential excavation difficulties with respect to the seismic velocities obtained along the local areas surveyed. These seismic velocity ranges and rippability potentials have been tabulated below for reference.

TABLE 2- CATERPILLAR RIPPABILITY CHART (D9 Ripper)

Granitic Rock Velocity	Rippability
< 6,800	Rippable
6,800 – 8,000	Moderately Rippable
> 8,000	Non-Rippable

Additionally, we have provided the Caltrans Rippability Chart as presented below within Table 2 for comparison. These values are from published Caltrans studies (Stephens, 1978) that are based on their experience and which appear to be more conservative than Caterpillar's rippability chart. It should be noted that the type of bedrock was not indicated.

TABLE 3- STANDARD CALTRANS RIPPABILITY CHART

Velocity (feet/sec ±)	Rippability
< 3,500	Easily Ripped
3,500 – 5,000	Moderately Difficult
5,000 – 6,600	Difficult Ripping / Light Blasting
> 6,600	Blasting Required

Table 3 is partially modified from the "Engineering Behavior from Weathering Grade" as presented by Santi (2006), which also provides velocity ranges with respect to rippability potentials, along with other rock engineering properties that may be pertinent.

TABLE 4- SUMMARY OF ROCK ENGINEERING PROPERTIES

ENGINEERING PROPERTY:	Slightly Weathered	Moderately Weathered	Highly Weathered	Completely Weathered
Excavatability	Blasting necessary	Blasting to rippable	Generally rippable	Rippable
Slope Stability	½ :1 to 1:1 (H:V)	1:1 (H:V)	1:1 to 1.5:1 (H:V)	1.5:1 to 2:1 (H:V)
Schmidt Hammer Value	51 – 56	37 – 48	12 – 21	5 – 20
Seismic Velocity (fps)	8,200 – 13,125	5,000 – 10,000	3,300 – 6,600	1,650 – 3,300

The Caterpillar D9R Ripper Performance Chart (Caterpillar, 2018) has been provided on Figure 2 below for reference.

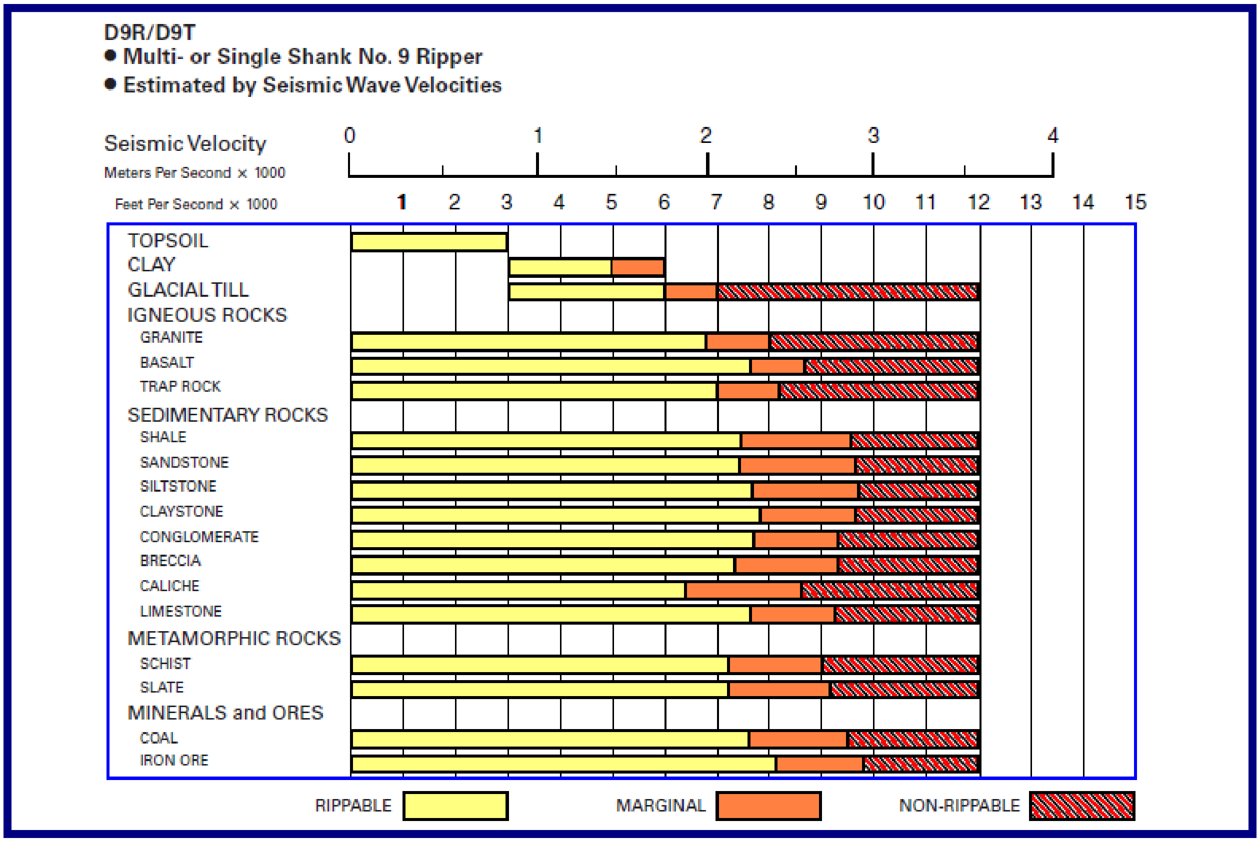


FIGURE 2- Caterpillar D9R Ripper Performance Chart (2018).

For purposes of the discussion in this report with respect to the expected bedrock rippability characteristics, we are assuming that a D9R/D9T dozer will be used as a minimum, such as discussed further below and as shown in Figure 2 above. Smaller excavating equipment will most likely result in slower production rates and possible refusal within relatively lower velocity bedrock materials. It should be noted that the decision for blasting of bedrock materials for facilitating the excavation process is sometimes made based upon economic production reasons and not solely on the rippability (velocity/hardness) characteristics of the bedrock.

A summary of the generalized rippability characteristics of granitic bedrock (such as present within the subject study area) has been provided below to aid in evaluating potential excavation difficulties with respect to the seismic velocities obtained along the local areas that were surveyed. The velocity ranges described below are general averages of Tables 2 and 3 presented in this report (see Page 7) and assume typical, good-working, heavy excavation equipment, such as D9R dozer using a single shank, as described by Caterpillar, Inc. (2000 and 2018).

However, different excavating equipment (i.e., trenching equipment) may not correlate well with these velocity ranges as the rippability performance charts are tailored for conventional bulldozer equipment and cannot be directly correlated. Trenching operations which utilize large excavator-type equipment within granitic bedrock materials, typically encounter very difficult to non-productable conditions where seismic velocities are generally greater than 4,000± fps, and less for smaller backhoe-type equipment.

These average seismic velocity ranges are summarized below:

- **Rippable Condition (0 - 4,000 ft/sec)**:

  This velocity range indicates rippable materials which may consist of alluvial-type deposits and decomposed granitic bedrock, with random hardrock floaters. These materials typically break down into silty sands (depending on parent lithologic materials), whereas floaters will require special disposal. Some areas containing numerous hardrock floaters may present utility trench problems. Large floaters exposed at or near finished grade may present problems for footing or infrastructure trenching.

  Marginally Rippable Condition (4,000 - 7,000 ft/sec):

  This range of seismic velocities indicates materials which may consist of moderately weathered bedrock and/or large areas of fresh bedrock materials separated by weathered fractured zones. These bedrock materials are generally rippable with difficulty by a Caterpillar D9R or equivalent. Excavations may produce material that will partially break down into a coarse, silty to clean sand, with a high percentage of very coarse sand to pebble-sized material depending on the parent bedrock lithology. Less fractured or weathered materials will probably require blasting to facilitate removal.

- **Non-Rippable Condition (7,000 ft/sec or greater)**:

  This velocity range includes non-rippable material consisting primarily of moderately fractured bedrock at lower velocities and only slightly fractured or unfractured rock at higher velocities. Materials in this velocity range may be marginally rippable, depending upon the degree of fracturing and the skill and experience of the operator. Tooth penetration is often the key to ripping success, regardless of seismic velocity. If the fractures and joints do not allow tooth penetration, the material may not be ripped effectively; however, pre-blasting or "popping" may induce sufficient fracturing to permit tooth entry. In their natural state, materials with these velocities are generally not desirable for building pad grade, due to difficulty in footing and utility trench excavation. Blasting will most likely produce oversized material, requiring special disposal.

GEOLOGIC & EARTHWORK CONSIDERATIONS

To evaluate whether a particular bedrock material can be ripped or excavated, this geophysical survey should be used in conjunction with the geologic and/or geotechnical report and/or information gathered for the subject project which may describe the physical properties of the bedrock. The physical characteristics of bedrock materials that favor ripping generally include the presence of fractures, faults, and other structural discontinuities, weathering effects, brittleness or crystalline structure, stratification or lamination, large grain size, moisture permeated clay, and low compressive strength. If the bedrock is foliated and/or fractured at depth, this structure could aid in excavation production.

Unfavorable bedrock conditions can include such characteristics as massive and homogeneous formations, non-crystalline structure, absence of planes of weakness, fine-grained materials, and formations of clay origin where moisture makes the material plastic. Use of these physical bedrock conditions along with the subsurface velocity characteristics as presented within this report should aid in properly evaluating the type of equipment that will be necessary and the production levels that can be anticipated for this project. A summary of excavation considerations is included within Appendix C in order to provide you and your grading contractor with a better understanding of the complexities of excavation in bedrock materials, so that proper planning and excavation techniques can be employed.

SUMMARY OF FINDINGS AND CONCLUSIONS

The raw field data was considered to be of good quality with minor amounts of ambient “noise” that was introduced during our survey, originating from vehicular traffic along Domenigoni Parkway to the north and wind sources. Analysis of the data and picking of the primary “P”-wave arrivals was therefore performed with little difficulty, with only minor interpolation of some data points being necessary.

Based on the results of our comparative seismic analyses of the computer programs **SIPwin**, **Refractor**, and **Rayfract™**, the seismic refraction survey line models appear to generally coincide with one another, with some minor variances due to the methods that these programs process, integrate, and display the input data. The anticipated excavation potentials of the velocity layers encountered locally during our survey are as follows:

- **Velocity Layer V1**:

  No excavating difficulties are expected to be encountered within the uppermost, low-velocity V1 layer (average weighted velocity of 1,336 to 1,659 fps) and should excavate with conventional ripping. This surficial velocity layer is expected to be comprised of colluvium, topsoil, wind-blown sands, and/or completely-weathered and fractured bedrock materials.

- **<u>Velocity Layer V2</u>**:

  The second V2 layer (average weighted velocity of 3,330 to 4,763 fps) is believed to consist of highly-weathered granitic bedrock. Using the rock classifications as presented within Tables 2 through 4 and Figure 2, seismic wave velocities of less than 6,800± fps are generally noted to be within the threshold for conventional ripping. Isolated floaters (i.e., boulders, corestones, etc.) may be locally present within this layer, based on nearby surficial bedrock outcrops, and could produce somewhat difficult conditions locally. Placement of infrastructure within this velocity layer using excavator equipment may require some breaking and/or light blasting to obtain desired grade.

- **<u>Velocity Layer V3</u>**:

  The third V3 layer is believed to consist of slightly-weathered bedrock. Hard excavation difficulties within this velocity layer (average weighted velocity range of 8,279 to 11,260 fps) should be anticipated if encountered during grading. This layer may consist of relatively homogeneous bedrock with wide-spaced fracturing, or may contain higher velocity scattered corestones, dikes, and other lithologic variables, within a relatively lower velocity bedrock matrix. Significant blasting should be anticipated throughout this layer to achieve desired grade, including any infrastructure. Caterpillar (2018; see Figure 2) indicates this velocity range to be "non-rippable" using a D9R dozer or equivalent. Larger equipment may facilitate excavation potentials within this higher velocity layer. The absence of the V3 layer within Seismic Line S-3 indicates that the depth to this contact boundary is greater than 35± feet locally, based on the length of the seismic traverse performed.

The ray sampling coverage of the subsurface seismic waves that were acquired during the processing of the refraction tomographic models using **Rayfract™**, appeared to be of good quality. Based on the tomographic modeling and typical excavation characteristics observed within bedrock materials of the southern California region, anticipation of gradual increasing hardness with depth should be anticipated during grading. Some lateral velocity variations should be expected to be encountered across the site generally due to the presence of buried corestones, dikes, and/or lithologic variabilities.

CLOSURE

The field geophysical survey was performed on June 25, 2019 by the undersigned using "state of the art" geophysical equipment and techniques along the selected traverse location. The seismic data was further evaluated using recently developed computerized tomographic inversion techniques to provide a more thorough analysis and understanding of the subsurface velocity and structural conditions. It should be noted that our data presented within this report was obtained along five specific locations therefore other areas in the local may contain different velocity layers and depths not encountered during our field survey. Additional survey traverses may be necessary to further evaluate the excavation characteristics across other portions of the site where cut grading will be proposed, if warranted. Estimates of layer velocity boundaries as presented in this report are generally considered to be within 10± percent of the total depth of the contact.

It is important to understand that the fundamental limitation for seismic refraction surveys is known as nonuniqueness, wherein a specific seismic refraction data set does not provide sufficient information to determine a single “true” earth model. Therefore, the interpretation of any seismic data set uses “best-fit” approximations along with the geologic models that appear to be most reasonable for the local area being surveyed. Client should also understand that when using the theoretical geophysical principles and techniques discussed in this report, sources of error are possible in both the data obtained, and in the interpretation, and that the results of this survey may not represent actual subsurface conditions. These are all factors beyond **Terra Geosciences** control and no guarantees as to the results of this survey can be made. We make no warranty, either expressed or implied.

In summary, the results of this seismic refraction survey are to be considered as an aid to assessing the rippability and excavation potentials of the bedrock locally. This information should be carefully reviewed by the grading contractor and representative “test” excavations with the proposed type of excavation equipment for the proposed construction should be considered, so that they may be correlated with the data presented within this report.

SEISMIC LINE LOCATION MAP

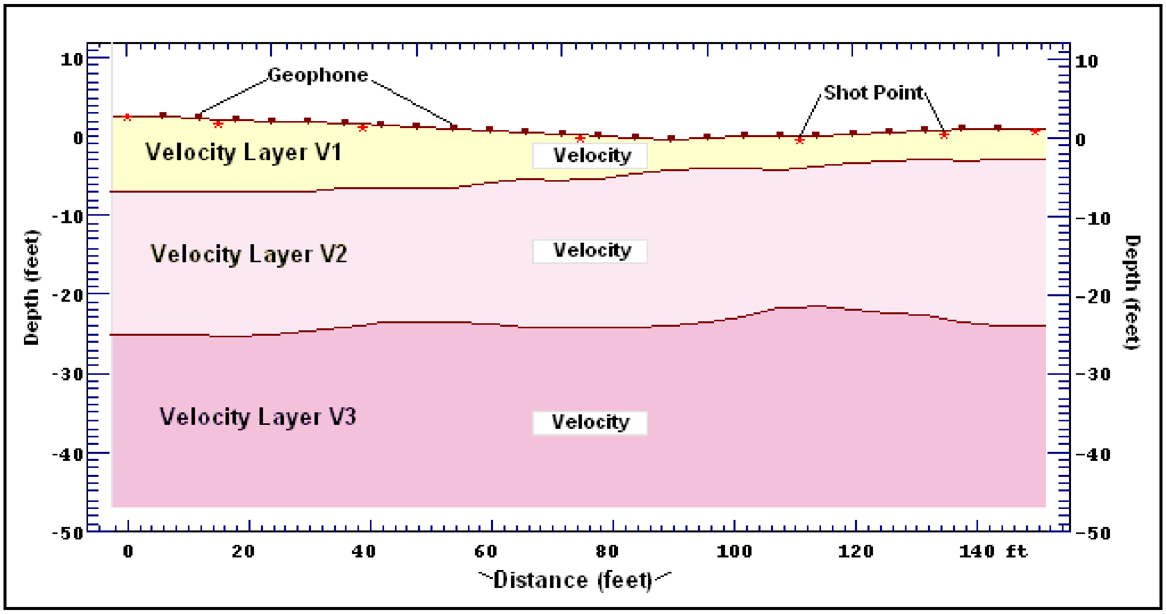
Base Map: Google™ Earth imagery (2019); Seismic traverses shown as yellow lines.

APPENDIX A

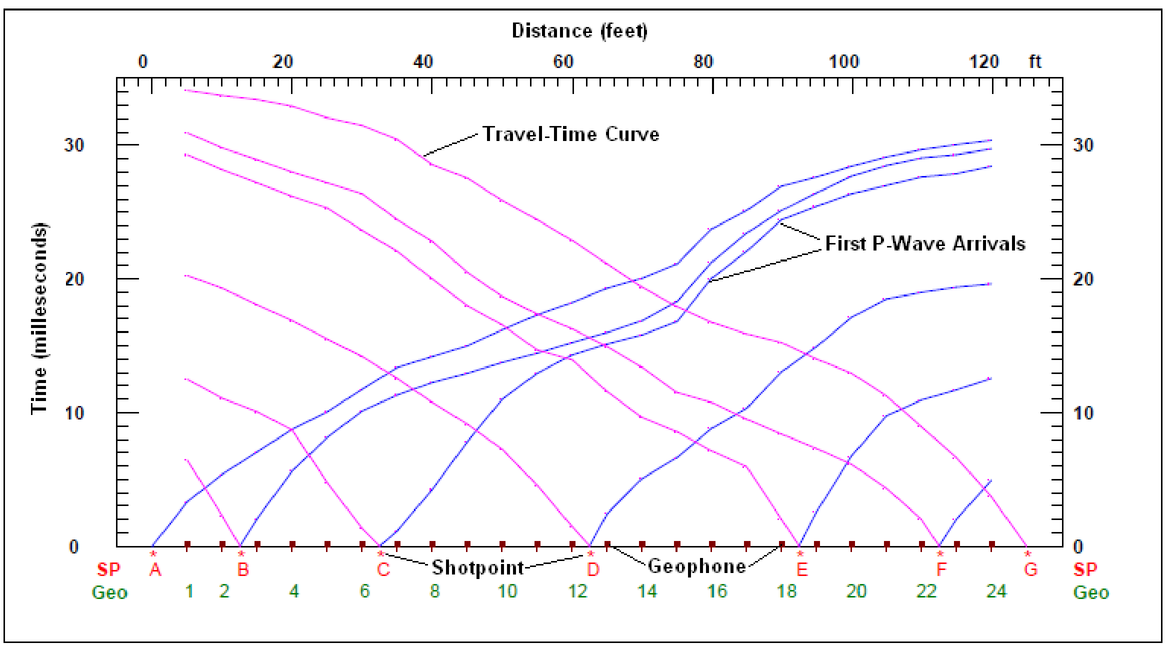
LAYER VELOCITY MODELS

LAYER VELOCITY MODEL LEGEND

LAYER VELOCITY MODEL



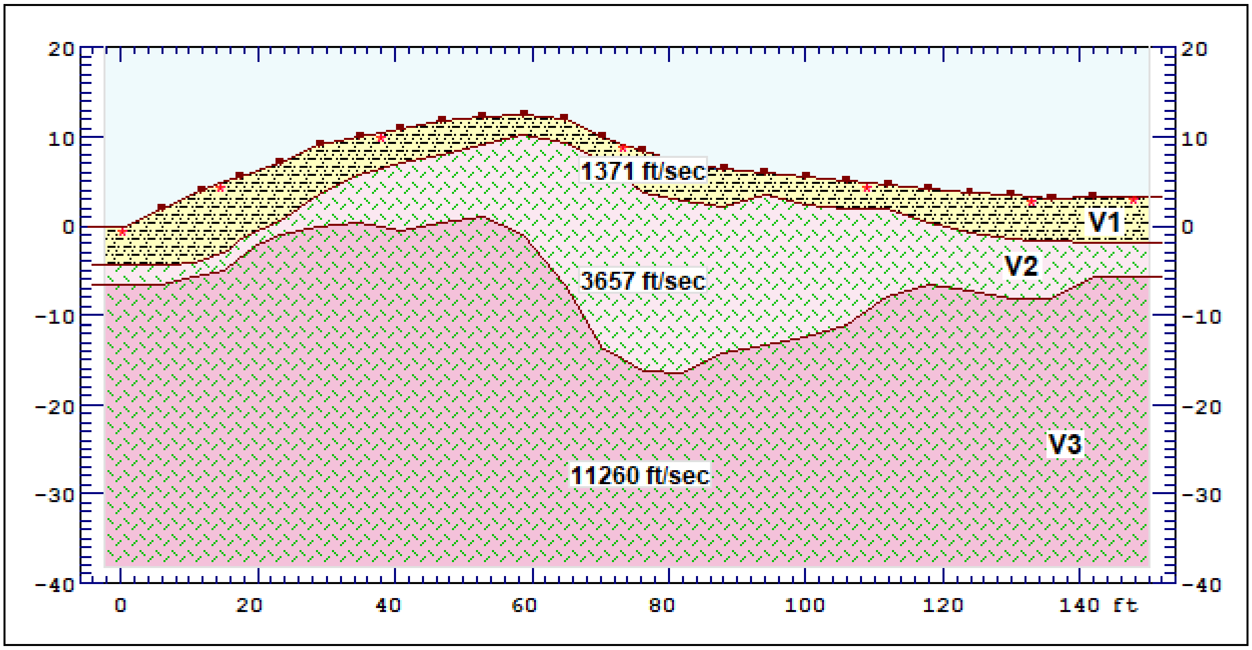
TIME-DISTANCE PLOT



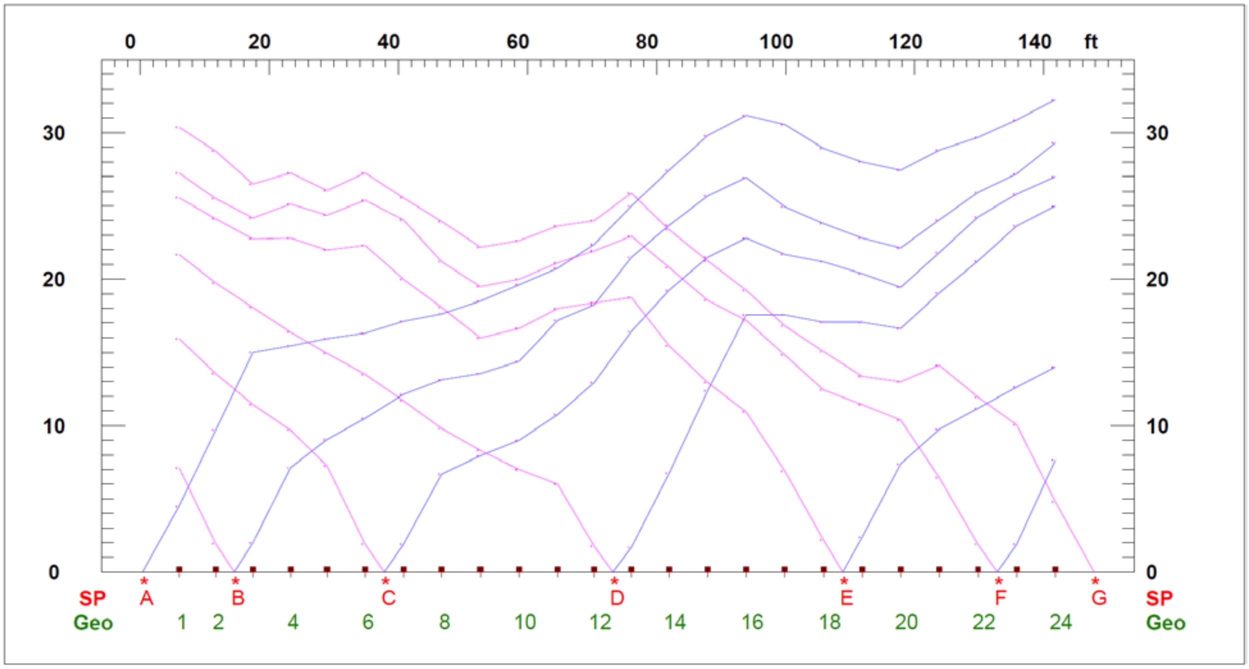
SEISMIC LINE S-1

North 19° East >

LAYER VELOCITY MODEL



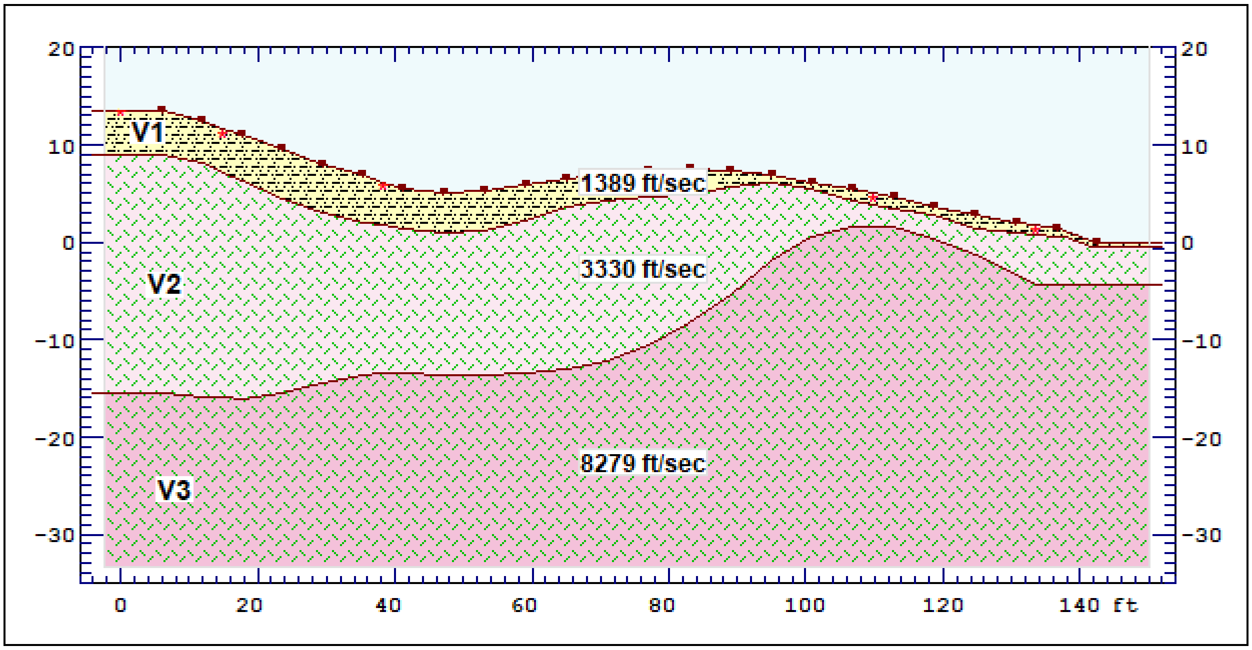
TIME-DISTANCE PLOT



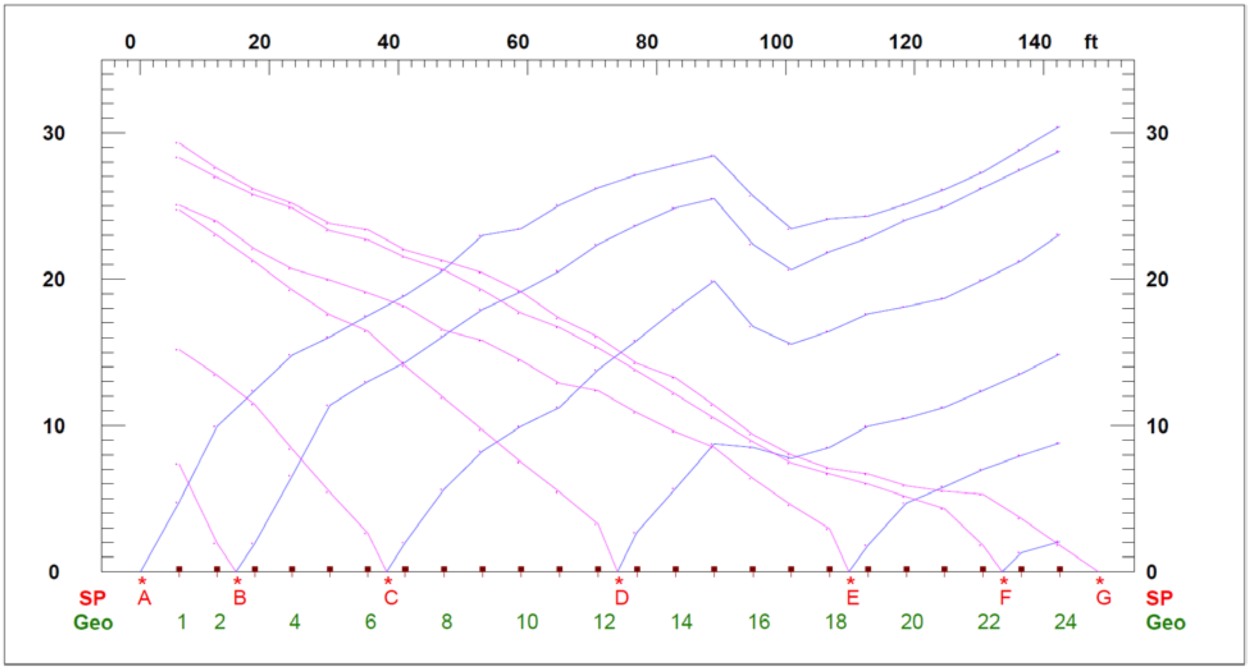
SEISMIC LINE S-2

< West - East >

LAYER VELOCITY MODEL



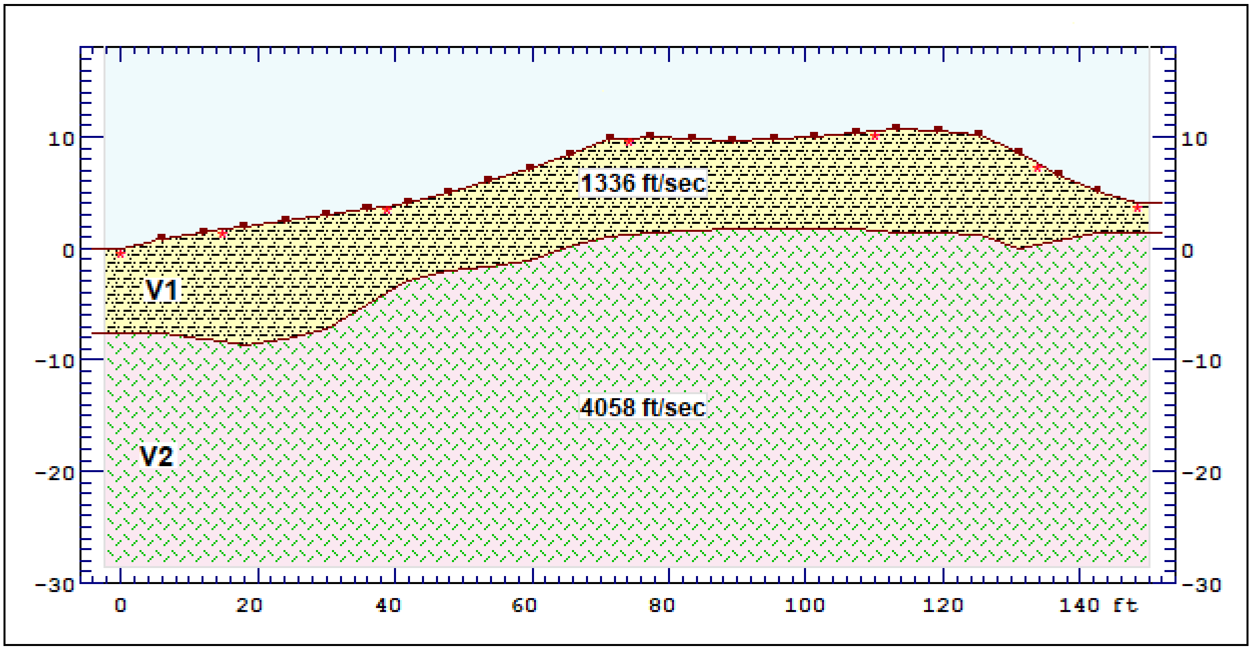
TIME-DISTANCE PLOT



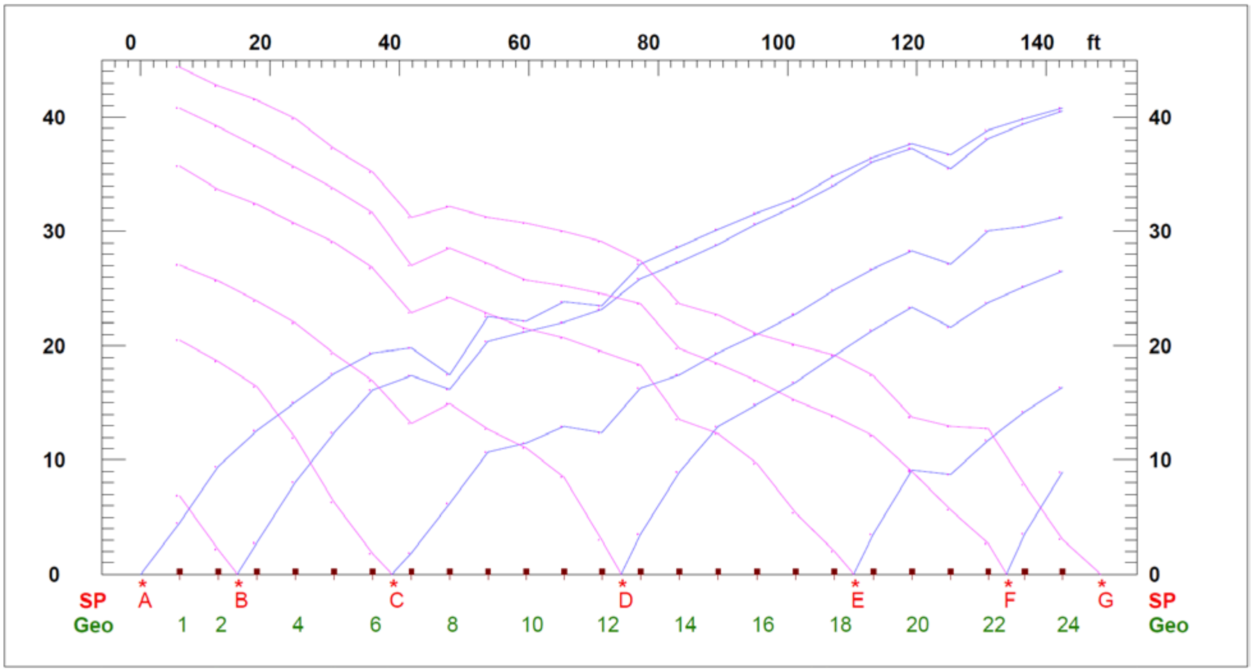
SEISMIC LINE S-3

North 16° West >

LAYER VELOCITY MODEL



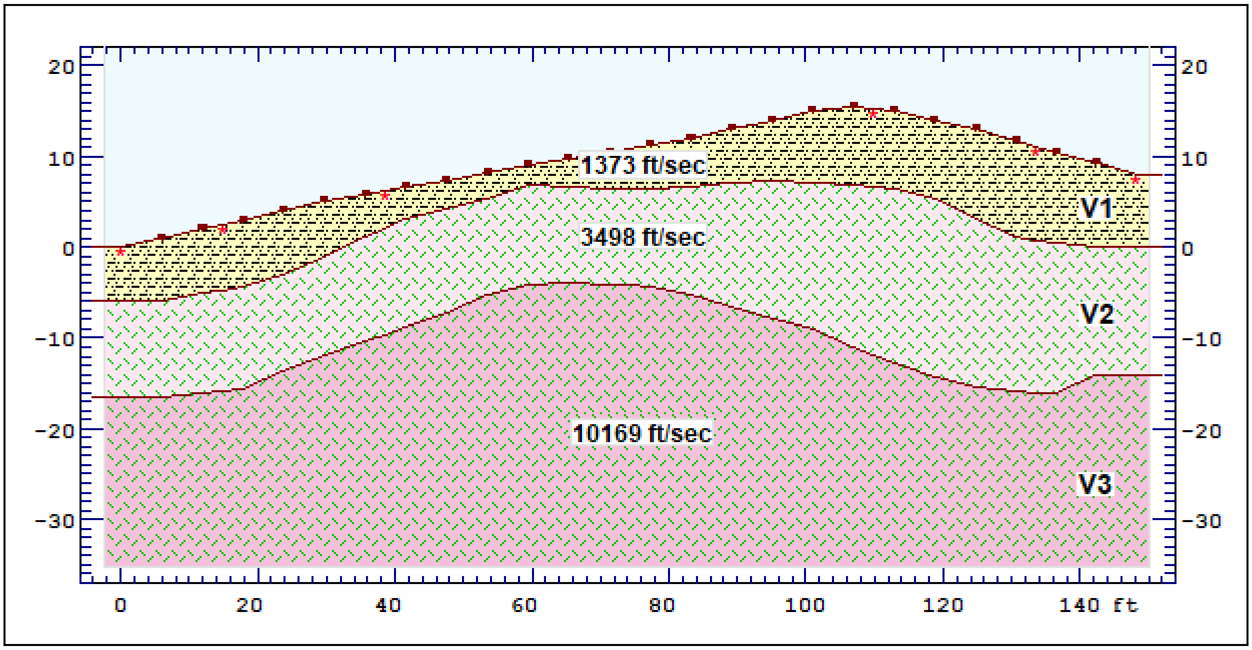
TIME-DISTANCE PLOT



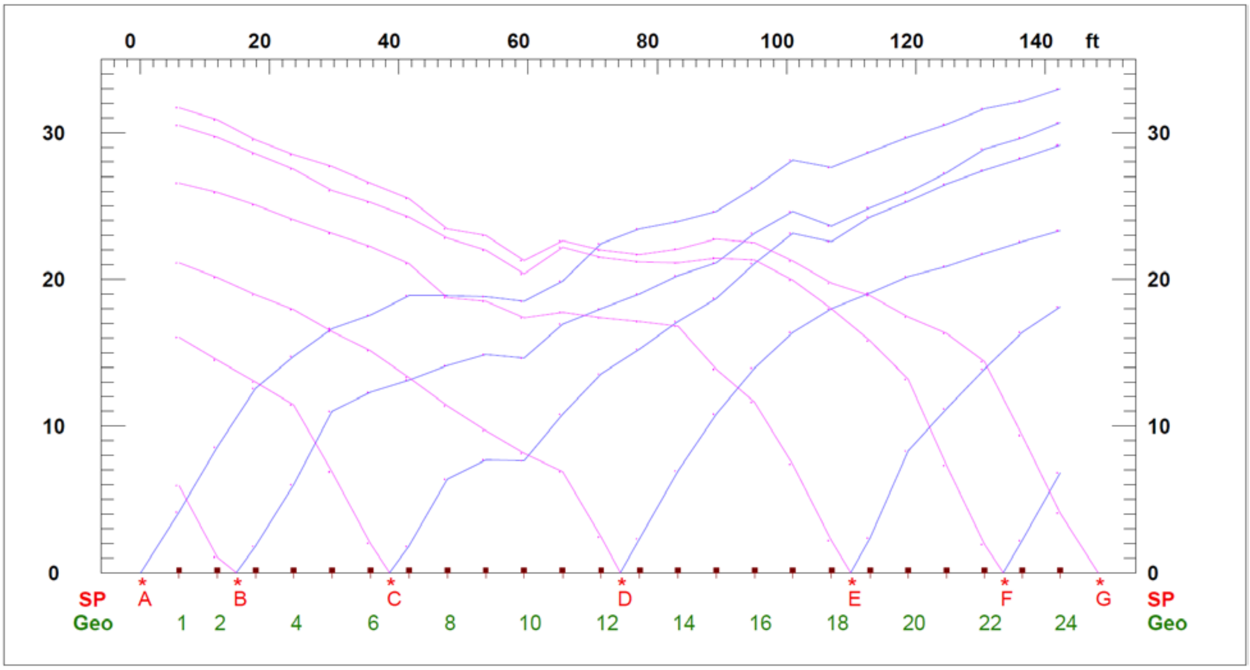
SEISMIC LINE S-4

North 33° West >

LAYER VELOCITY MODEL



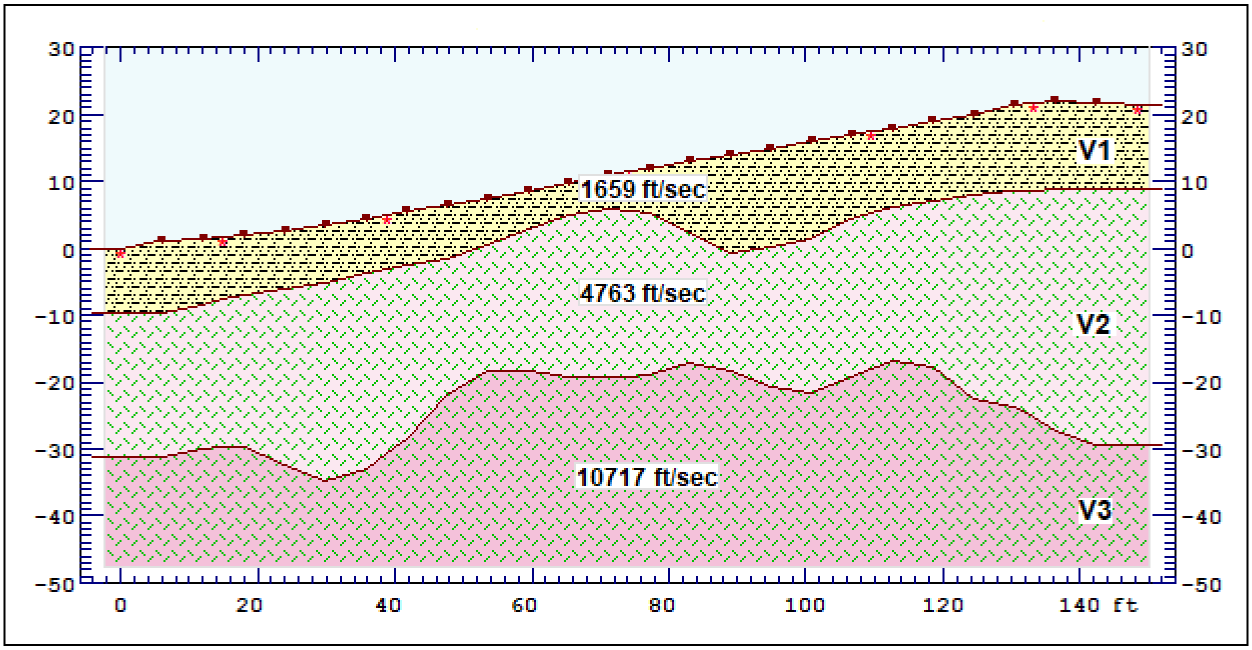
TIME-DISTANCE PLOT



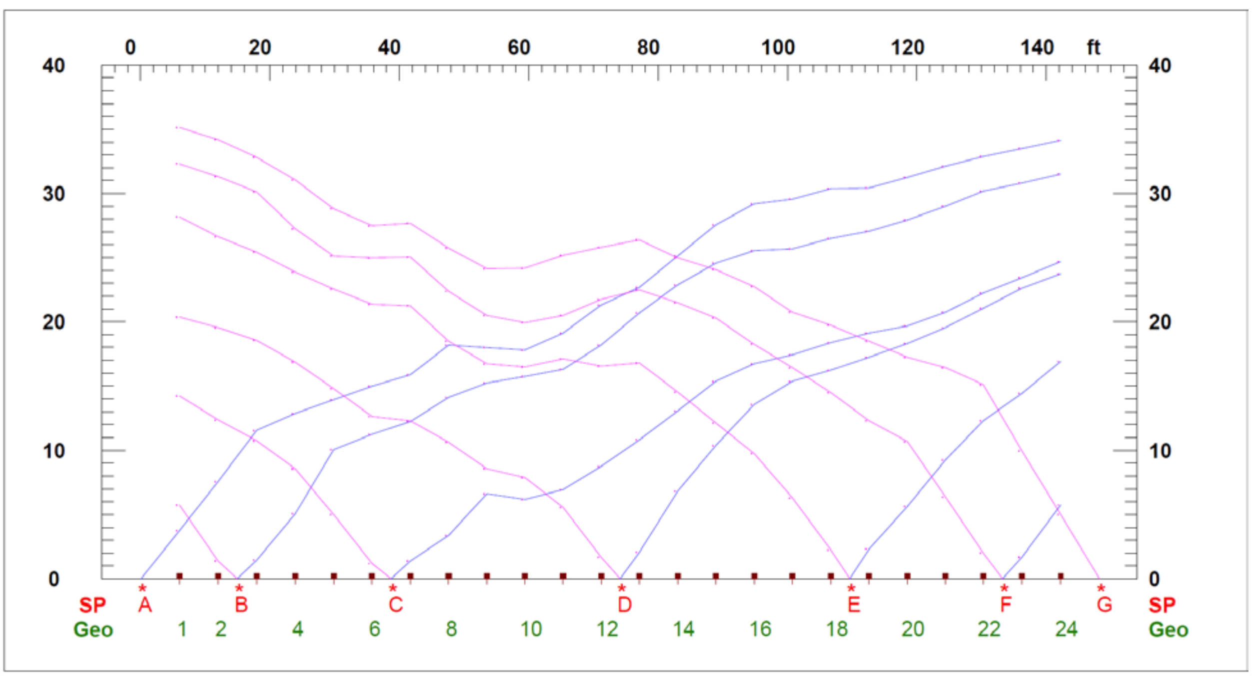
SEISMIC LINE S-5

North 47° West >

LAYER VELOCITY MODEL



TIME-DISTANCE PLOT



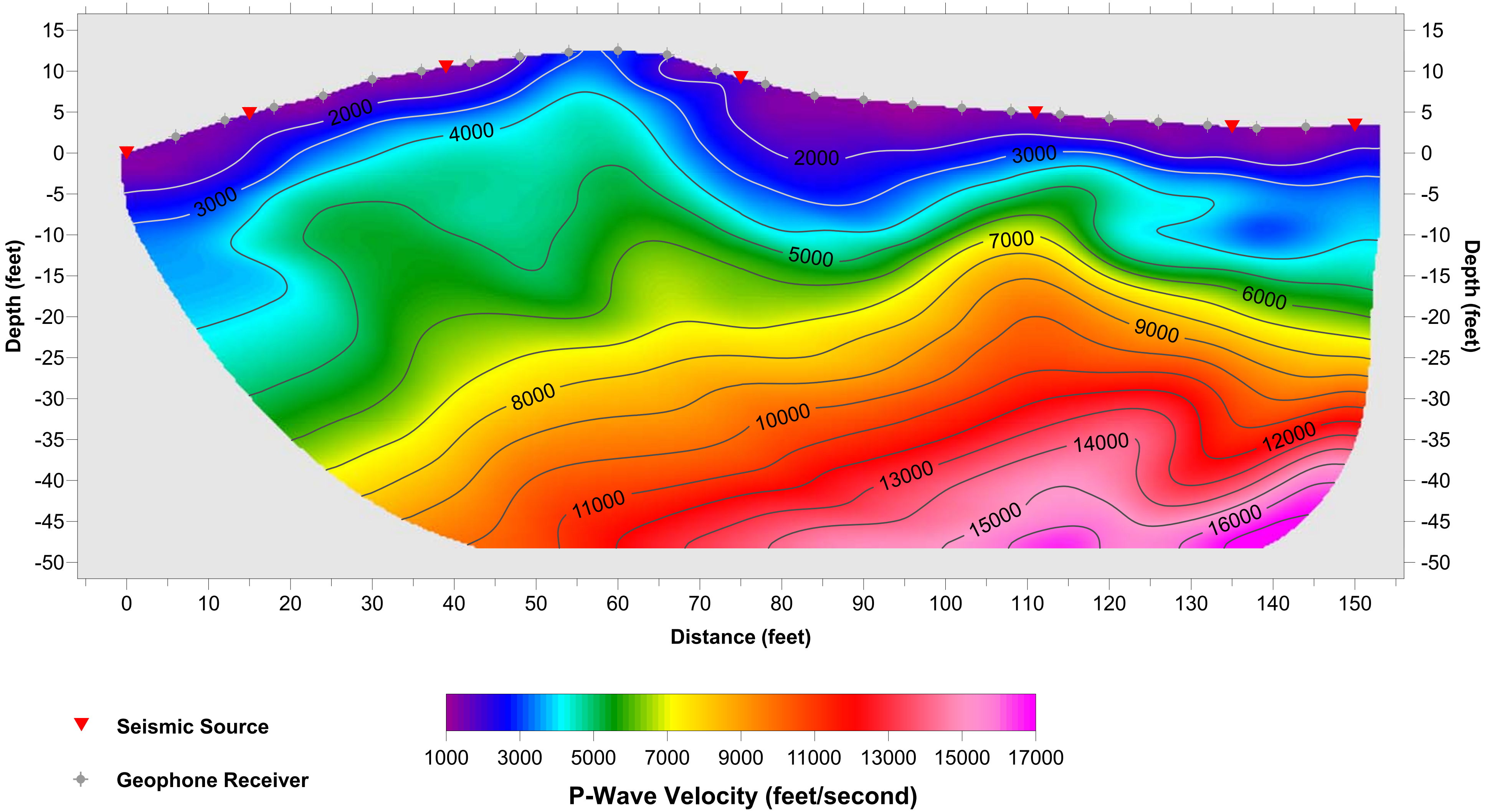
APPENDIX B

REFRACTION TOMOGRAPHIC MODELS

SEISMIC LINE S-1

North 19° East →

REFRACTION TOMOGRAPHIC MODEL

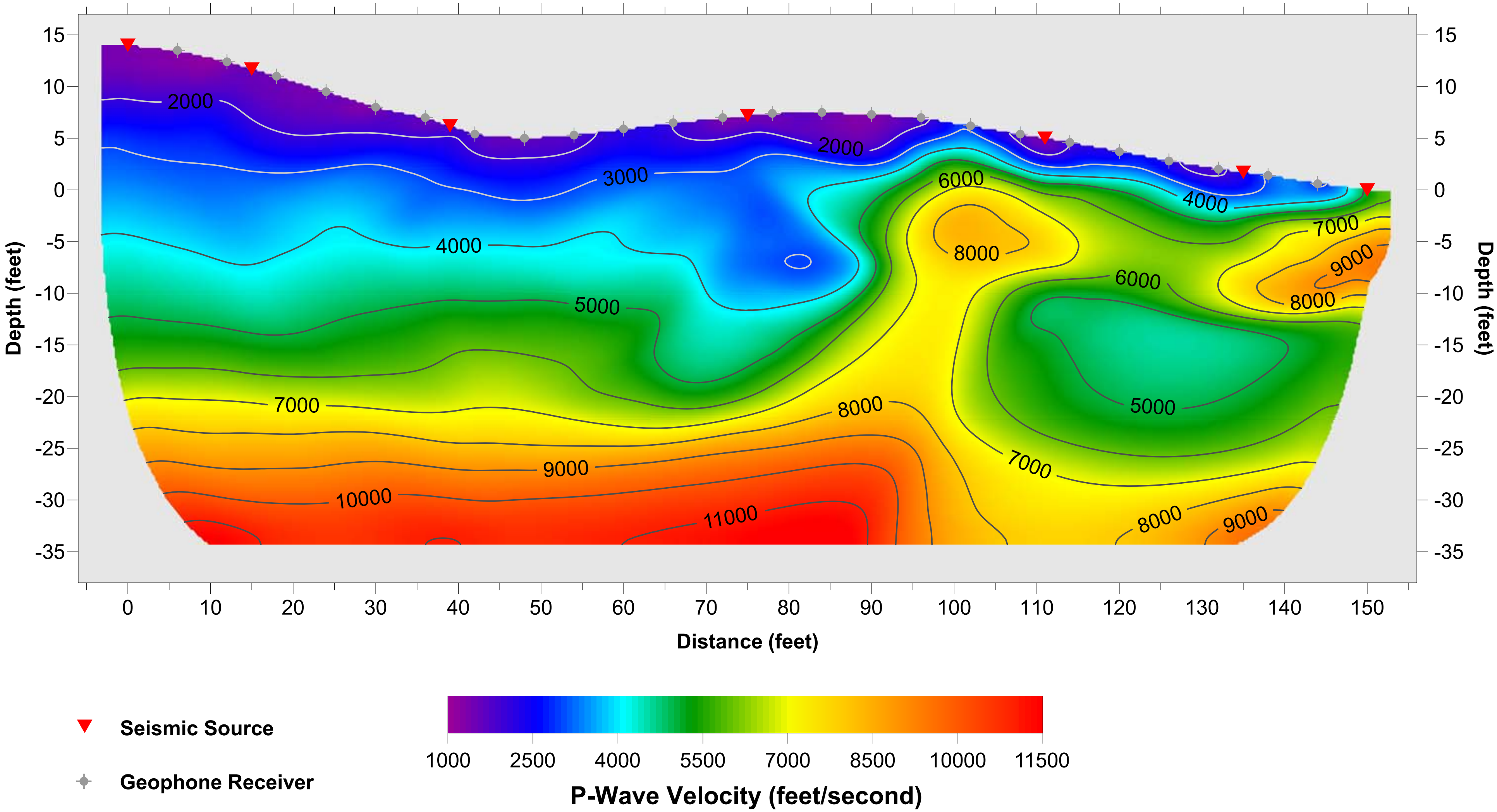


SCALE: 1:1 (Horizontal = Vertical)

SEISMIC LINE S-2

< West - East >

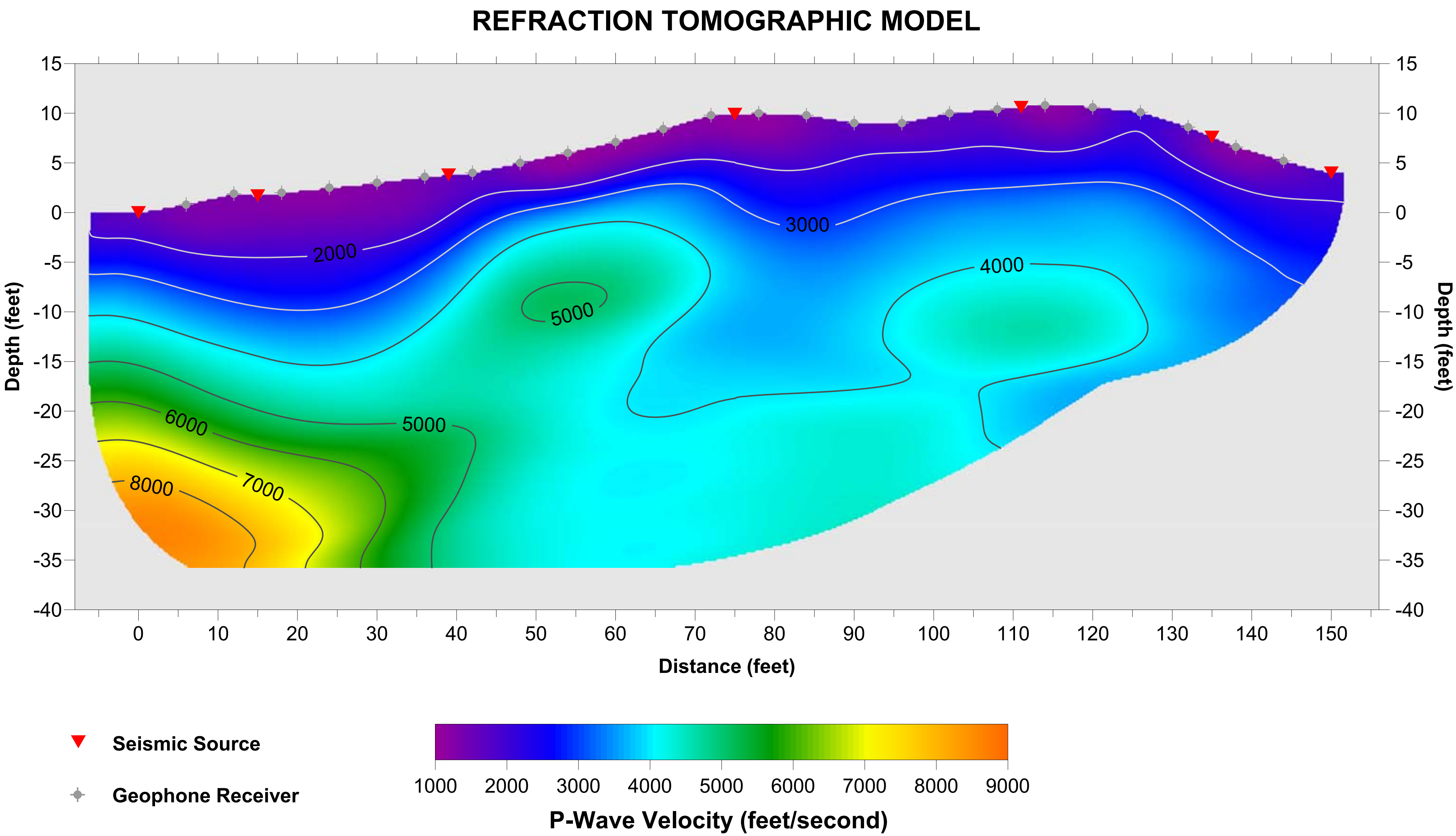
REFRACTION TOMOGRAPHIC MODEL



SCALE: Vertical Exaggeration 1.25X

SEISMIC LINE S-3

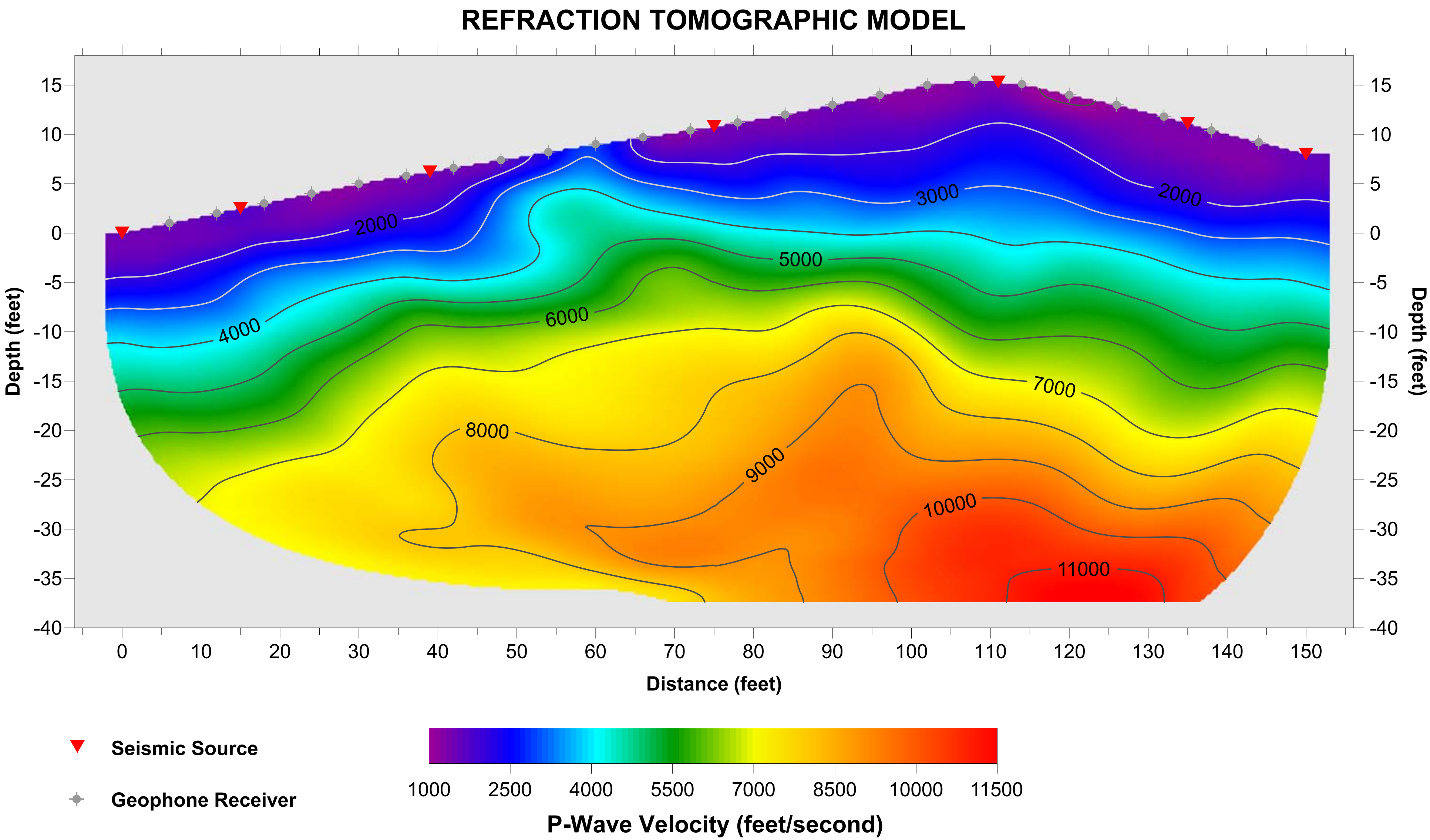
North 16° West →



SCALE: Vertical Exaggeration 1.25X

SEISMIC LINE S-4

North 33° West →

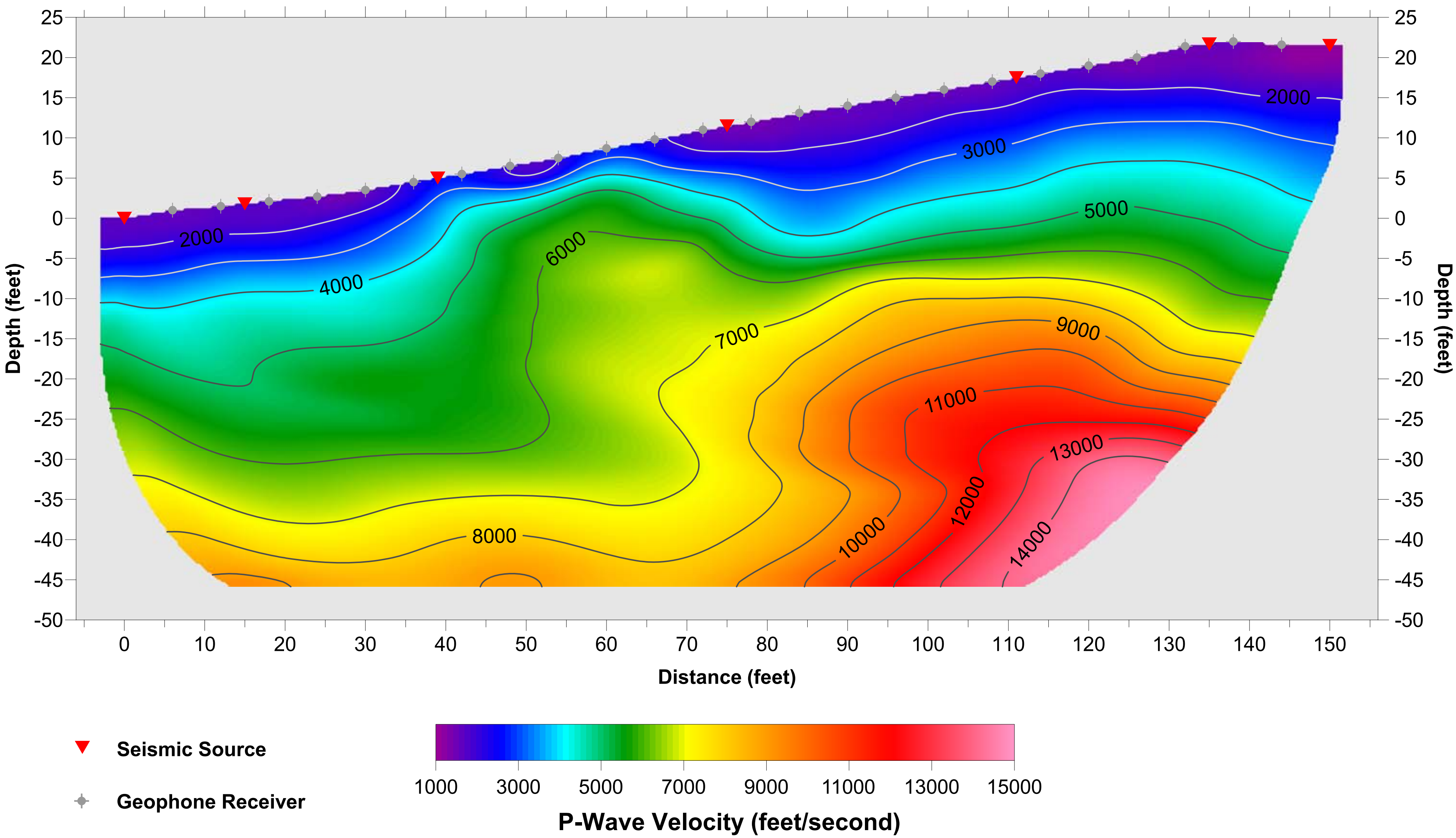


SCALE: Vertical Exaggeration 1.25X

SEISMIC LINE S-5

North 47° West →

REFRACTION TOMOGRAPHIC MODEL



SCALE: 1:1 (Horizontal = Vertical)

APPENDIX C

EXCAVATION CONSIDERATIONS

EXCAVATION CONSIDERATIONS

These excavation considerations have been included to provide the client with a brief overall summary of the general complexity of hard bedrock excavation. It is considered the client's responsibility to ensure that the grading contractor they select is both properly licensed and qualified, with experience in hard-bedrock ripping processes. To evaluate whether a particular bedrock material can be ripped, this geophysical survey should be used in conjunction with the geologic or geotechnical report prepared for the project which describes the physical properties of the bedrock. The physical characteristics of bedrock materials that favor ripping generally include the presence of fractures, faults and other structural discontinuities, weathering effects, brittleness or crystalline structure, stratification of lamination, large grain size, moisture permeated clay, and low compressive strength. Unfavorable conditions can include such characteristics as massive and homogeneous formations, non-crystalline structure, absence of planes of weakness, fine-grained materials, and formations of clay origin where moisture makes the material plastic.

When assessing the potential rippability of the underlying bedrock of a given site, the above geologic characteristics along with the estimated seismic velocities can then be used to evaluate what type of equipment may be appropriate for the proposed grading. When selecting the proper ripping equipment there are three primary factors to consider, which are:

- ***Down Pressure available at the tip, which determines the ripper penetration that can be attained and maintained,***

- ***Tractor flywheel horsepower, which determines whether the tractor can advance the tip, and,***

- ***Tractor gross-weight, which determines whether the tractor will have sufficient traction to use the horsepower.***

In addition to selecting the appropriate tractor, selection of the proper ripper design is also important. There are basically three designs, being radial, parallelogram, and adjustable parallelogram, of which the contractor should be aware of when selecting the appropriate design to be used for the project. The penetration depth will depend upon the down-pressure and penetration angle, as well as the length of the shank tips (short, intermediate, and long).

Also, important in the excavation process is the ripping technique used as well as the skill of the individual tractor operator. These techniques include the use of one or more ripping teeth, up- and down-hill ripping, and the direction of ripping with respect to the geologic structure of the bedrock locally. The use of two tractors (one to push the first tractor-ripper) can extend the range of materials that can be ripped. The second tractor can also be used to supply additional down-pressure on the ripper. Consideration of light blasting can also facilitate the ripper penetration and reduce the cost of moving highly consolidated rock formations.

All of the combined factors above should be considered by both the client and the grading contractor, to ensure that the proper selection of equipment and ripping techniques are used for the proposed grading.

APPENDIX D

REFERENCES

REFERENCES

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Appendix E
Infiltration Test Results

Infiltration Test Data Sheet

LGC Geotechnical, Inc
131 Calle Iglesia Suite 200, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: Stoneridge
Project Number: 13092-01
Date: 6/25/2019
Boring Number: I-1

Test hole dimensions (if circular)	
Boring Depth (feet)*:	10
Boring Diameter (inches):	8
Pipe Diameter (inches):	3

*measured at time of test

Test pit dimensions (if rectangular)	
Pit Depth (feet):	
Pit Length (feet):	
Pit Breadth (feet):	

Minimum test Head (D_o):

(What the sounder tape should read) Boring Depth - (5 x Boring Radius) 8.4 ft

(Shallow) The value on the sounder tape should be close to this value during testing for **DEEP** testing fill to 4 feet below top of hole

*Pre-Test (Sandy Soil Criteria)**

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Greater Than or Equal to 0.5 feet (yes/no)
1	7:59	8:24	25.0	7.26	7.26	0.00	No
2	8:24	8:49	25.0	7.26	7.31	0.05	No

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight, and then obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25 inches

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Calculated Infiltration Rate(in/hr)
1	8:49	9:19	30.0	7.31	7.40	0.09	0.13
2	9:19	9:49	30.0	7.24	7.31	0.07	0.10
3	9:49	10:19	30.0	7.31	7.39	0.08	0.11
4	10:19	10:49	30.0	7.19	7.23	0.04	0.05
5	10:49	11:19	30.0	7.23	7.30	0.07	0.10
6	11:19	11:49	30.0	7.30	7.37	0.07	0.10
7	11:49	12:19	30.0	7.20	7.26	0.06	0.08
8	12:19	12:49	30.0	7.26	7.31	0.05	0.07
9	12:49	13:19	30.0	7.31	7.38	0.07	0.10
10	13:19	13:49	30.0	7.25	7.32	0.07	0.10
11	13:49	14:19	30.0	7.10	7.15	0.05	0.07
12	14:19	14:49	30.0	7.15	7.22	0.07	0.09

Calculated Infiltration Rate (No factors of safety)	**0.1**
Factor of Safety	**2.0**
Calculated Infiltration Rate (With Factor of Safety)	**0.0**

Sketch:

Notes:

Based on Guidelines from: Riverside County (9/1/2011)
Spreadsheet Revised on: 10/26/2016

LGC Geotechnical, Inc.

Infiltration Test Data Sheet

LGC Geotechnical, Inc

131 Calle Iglesia Suite 200, San Clemente, CA 92672 tel. (949) 369-6141

Project Name: Stoneridge
Project Number: 13092-01
Date: 6/25/2019
Boring Number: I-2

Test hole dimensions (if circular)	
Boring Depth (feet)*:	5
Boring Diameter (inches):	8
Pipe Diameter (inches):	3

*measured at time of test

Test pit dimensions (if rectangular)	
Pit Depth (feet):	
Pit Length (feet):	
Pit Breadth (feet):	

Minimum test Head (D_o):

(What the sounder tape should read) Boring Depth - (5 x Boring Radius) 3.4 ft

(Shallow) The value on the sounder tape should be close to this value during testing for **DEEP** testing fill to 4 feet below top of hole

*Pre-Test (Sandy Soil Criteria)**

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval (min)	Initial Depth to Water (feet)	Final Depth to Water (feet)	Total Change in Water Level (feet)	Greater Than or Equal to 0.5 feet (yes/no)
1	8:46	9:11	25.0	3.09	3.35	0.26	No
2	9:11	9:36	25.0	3.16	3.35	0.19	No

*If two consecutive measurements show that six inches of water seeps away in less than 25 minutes, the test shall be run for an additional hour with measurements taken every 10 minutes. Otherwise, pre-soak (fill) overnight, and then obtain at least twelve measurements per hole over at least six hours (approximately 30 minute intervals) with a precision of at least 0.25 inches

Main Test Data

Trial No.	Start Time (24:HR)	Stop Time (24:HR)	Time Interval, Δt (min)	Initial Depth to Water, D_o (feet)	Final Depth to Water, D_f (feet)	Change in Water Level, ΔD (feet)	Calculated Infiltration Rate(in/hr)
1	9:36	10:06	30.0	3.17	3.39	0.22	0.47
2	10:06	10:36	30.0	3.00	3.27	0.27	0.53
3	10:36	11:06	30.0	3.01	3.28	0.27	0.53
4	11:06	11:36	30.0	3.03	3.29	0.26	0.52
5	11:36	12:06	30.0	3.03	3.29	0.26	0.52
6	12:06	12:36	30.0	3.07	3.32	0.25	0.51
7	12:36	13:06	30.0	3.12	3.35	0.23	0.48
8	13:06	13:36	30.0	3.14	3.37	0.23	0.48
9	13:36	14:06	30.0	3.06	3.30	0.24	0.48
10	14:06	14:36	30.0	2.92	3.21	0.29	0.55
11	14:36	15:06	30.0	2.99	3.24	0.25	0.49
12	15:06	15:36	30.0	3.06	3.30	0.24	0.48

Calculated Infiltration Rate (No factors of safety)	**0.5**
Factor of Safety	**2.0**
Calculated Infiltration Rate (With Factor of Safety)	**0.2**

Sketch:

Notes:

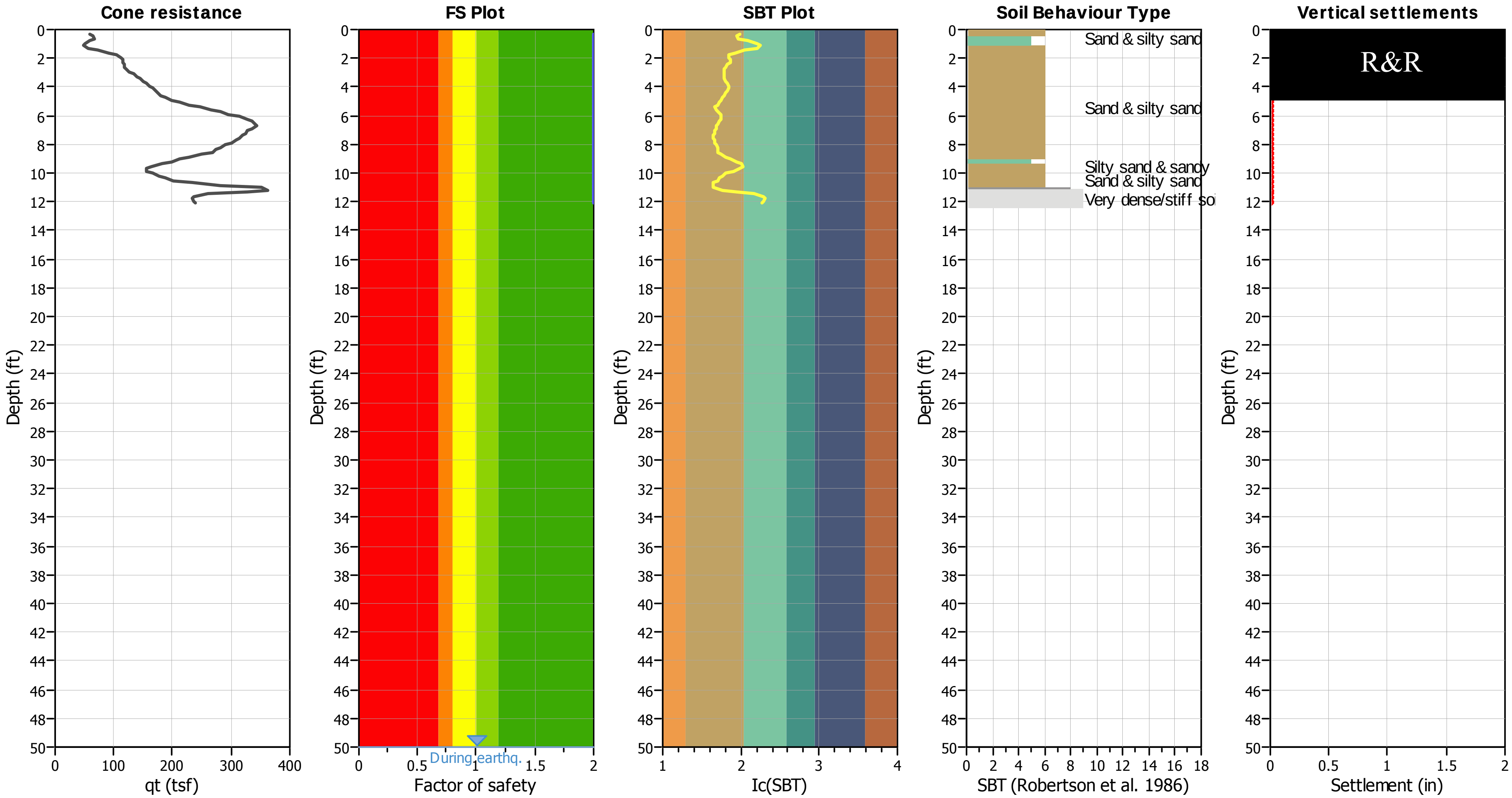
Based on Guidelines from: Riverside County (9/1/2011)
Spreadsheet Revised on: 10/26/2016

Appendix F
Liquefaction Analysis

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-01
Total depth: 12.14 ft



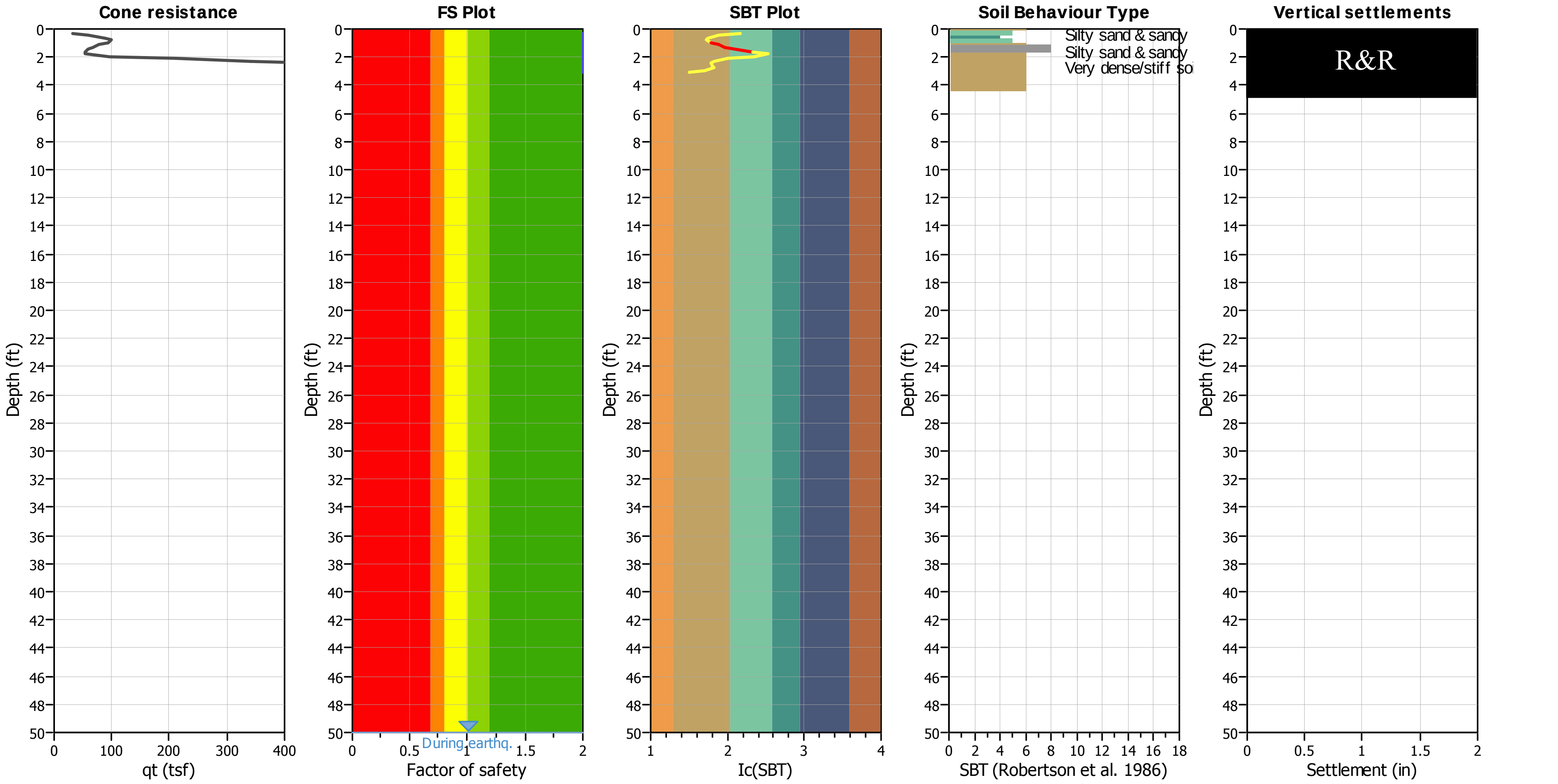
Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

CPeT-IT v.2.1.6.8 - CPTU data presentation & interpretation software - Report created on: 8/12/2019, 4:41:50 PM
Project file: Z:\2013\13092-01 Richland Communities - Stoneridge\Engineering\Liquefaction\Ciq_13092-01.clq

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-02
Total depth: 3.12 ft

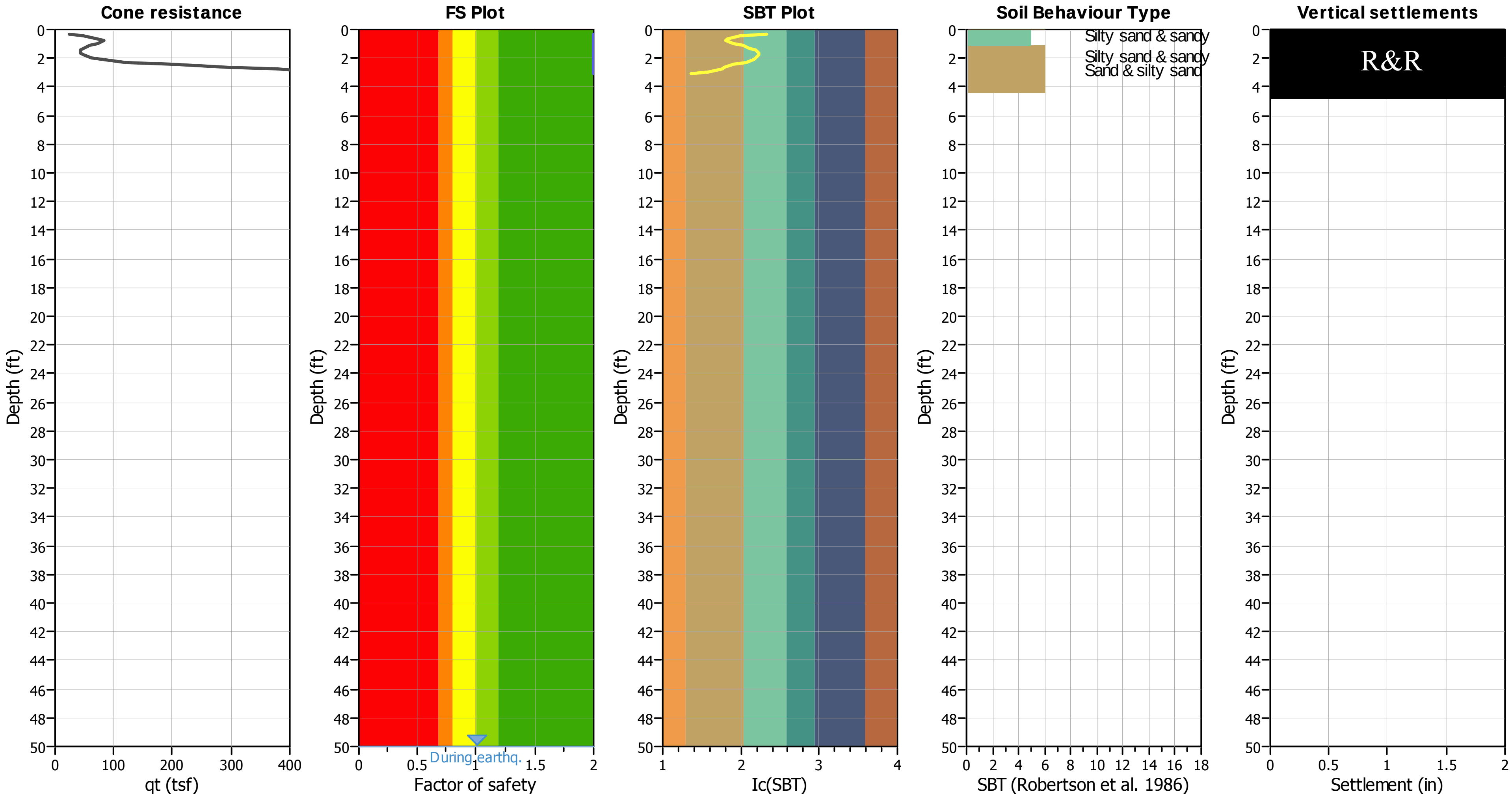


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-03
Total depth: 3.12 ft

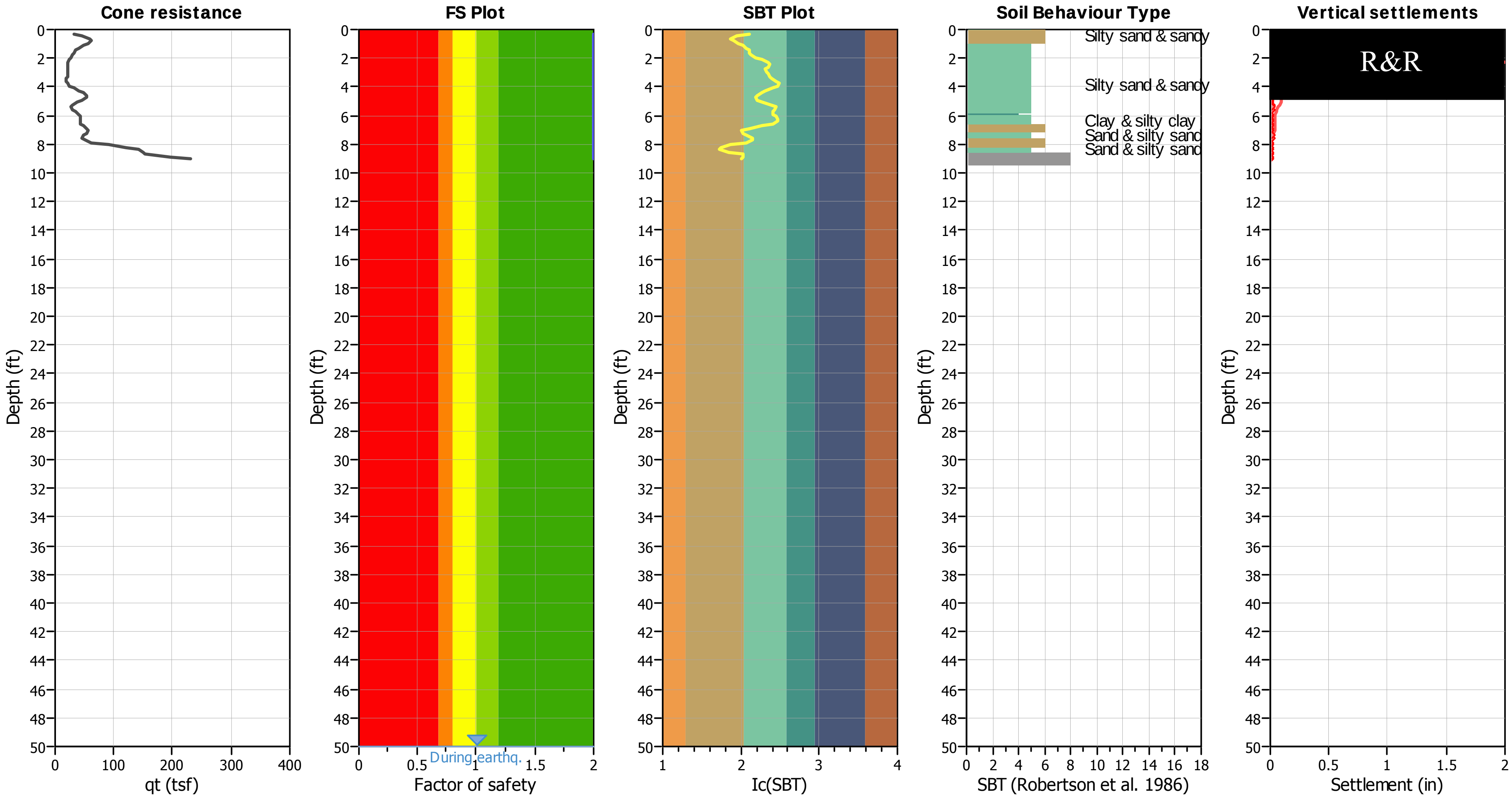


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-04
Total depth: 9.02 ft

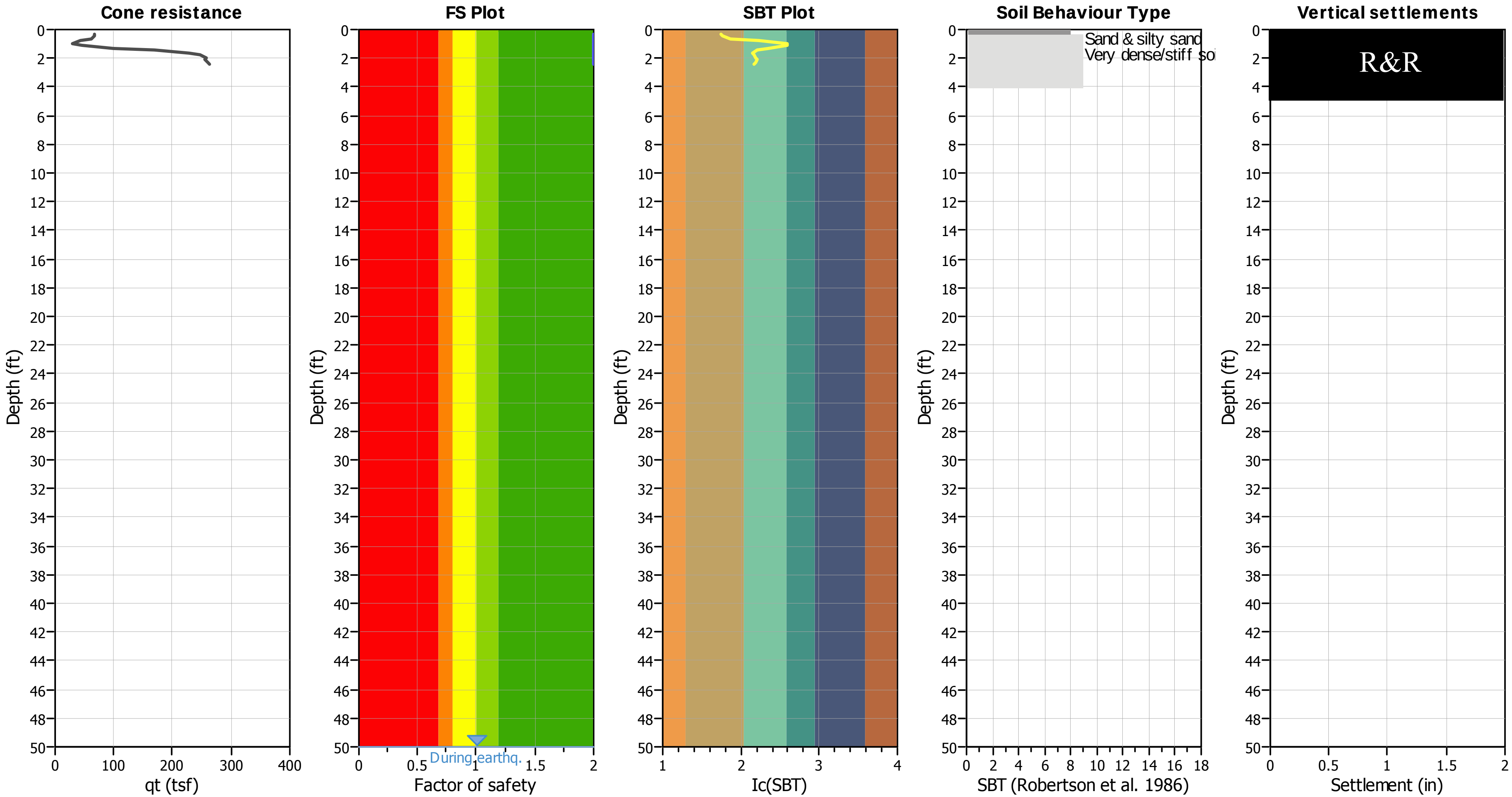


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-05
Total depth: 2.46 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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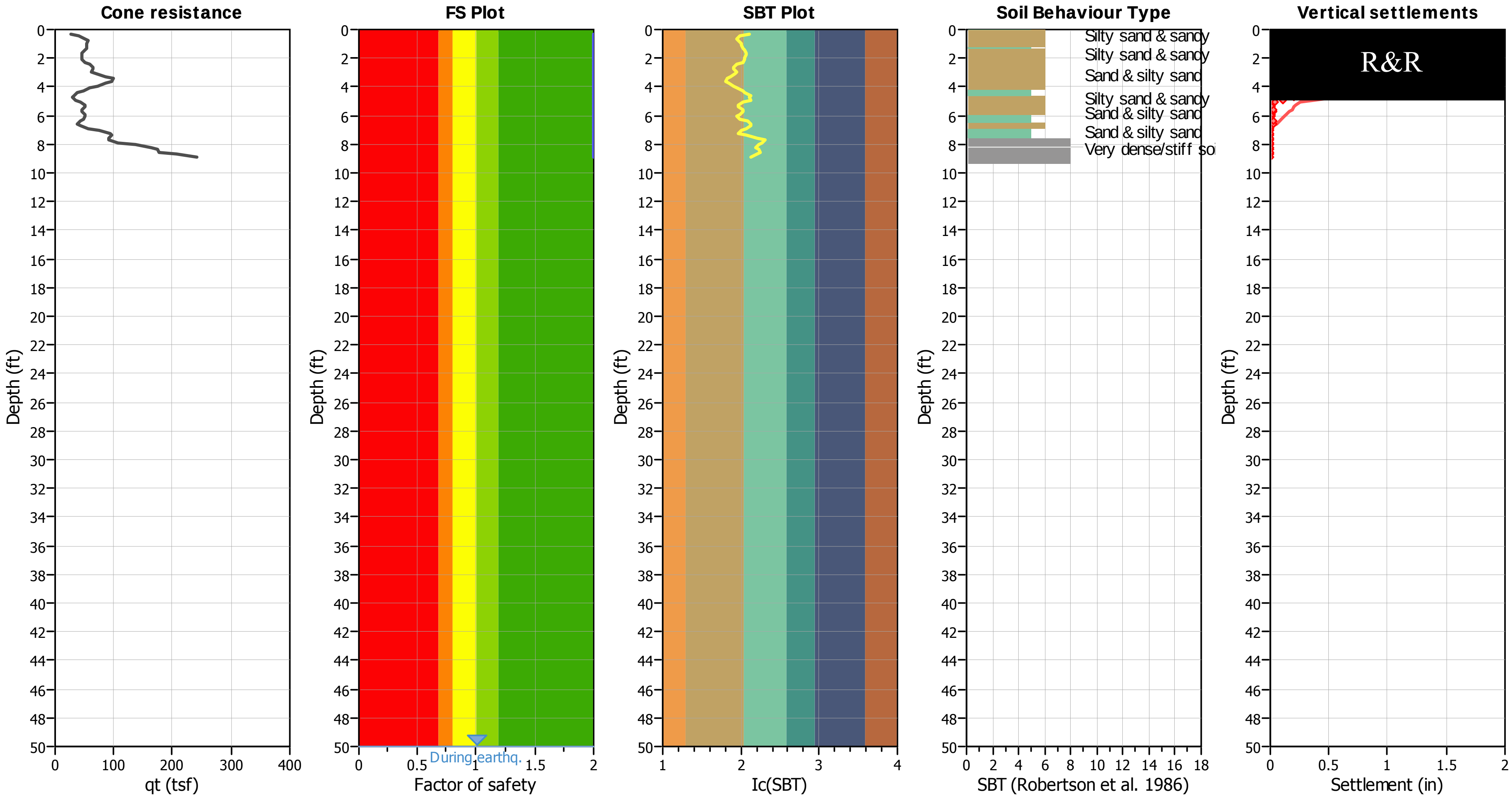
LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-06
Total depth: 8.86 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

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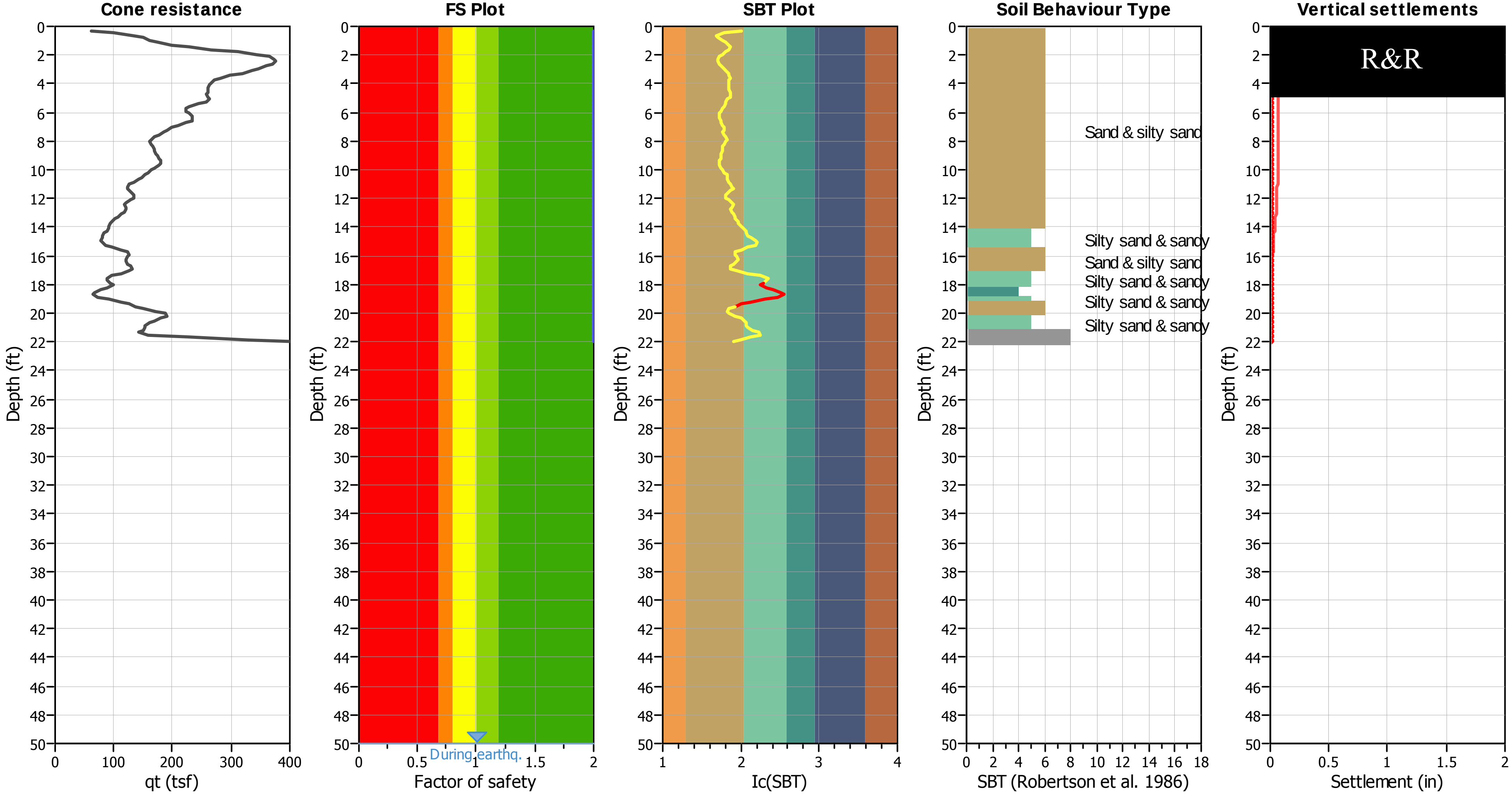
LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-07
Total depth: 21.98 ft

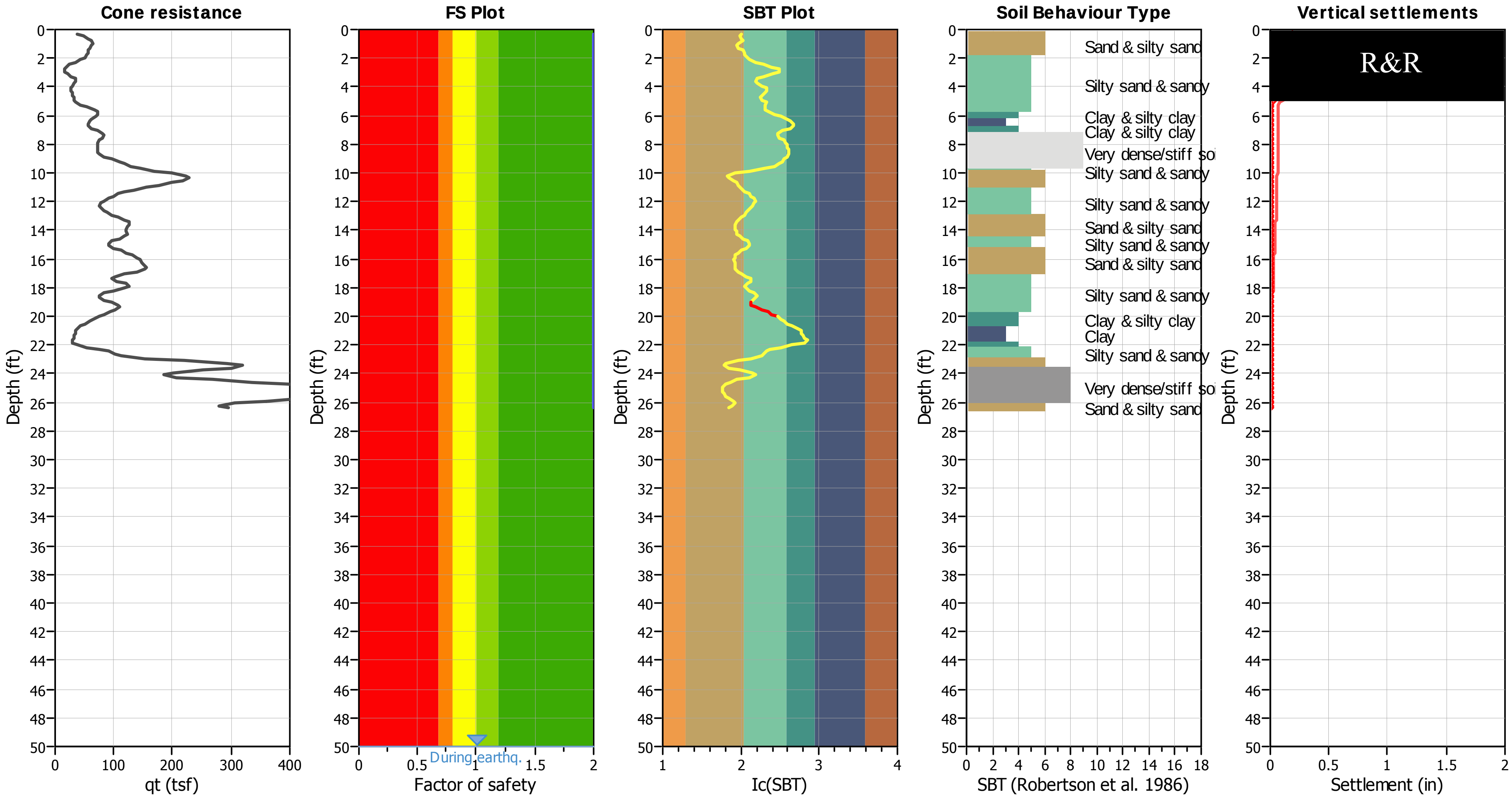


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-08
Total depth: 26.41 ft

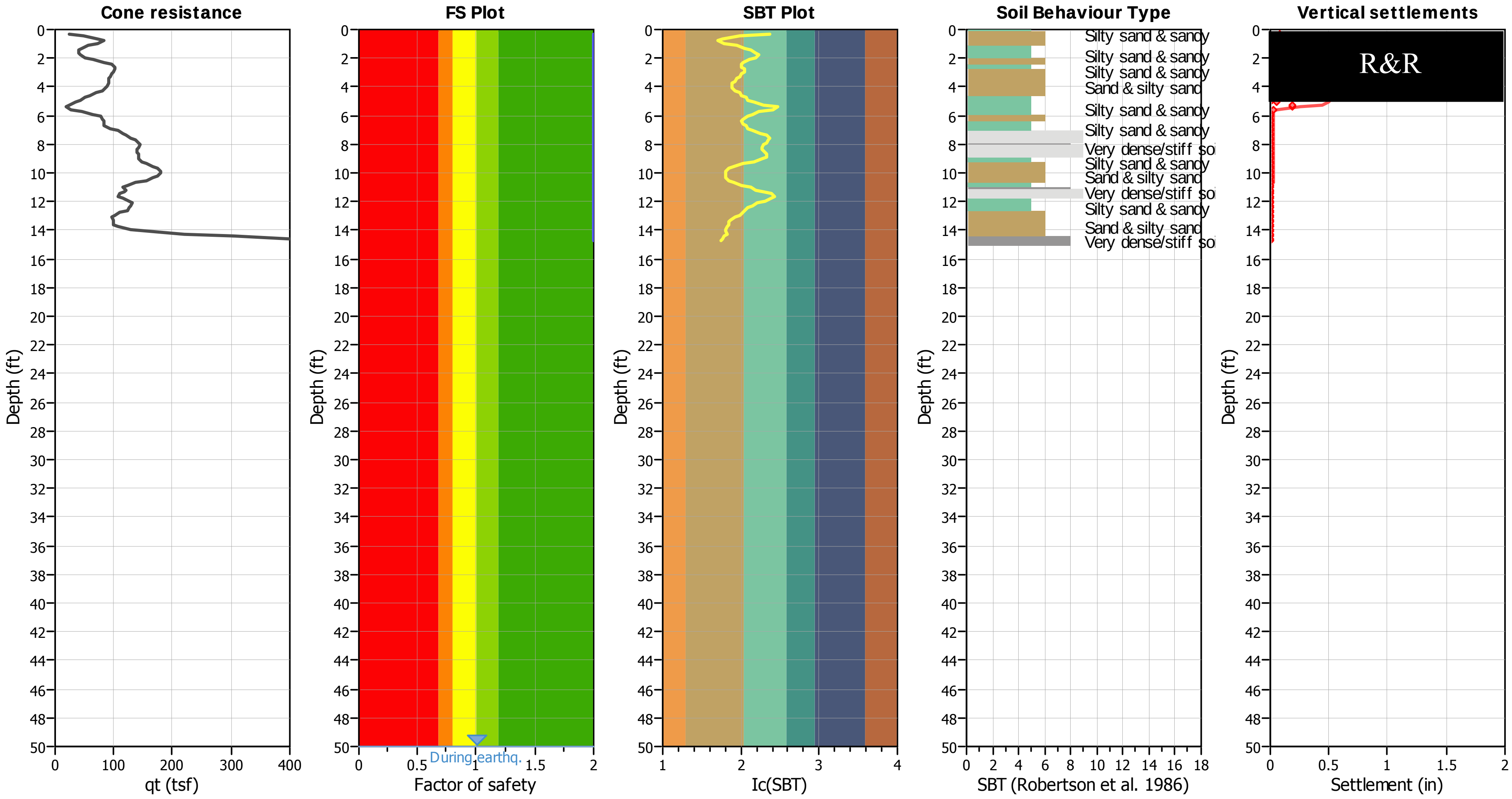


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-09
Total depth: 14.76 ft

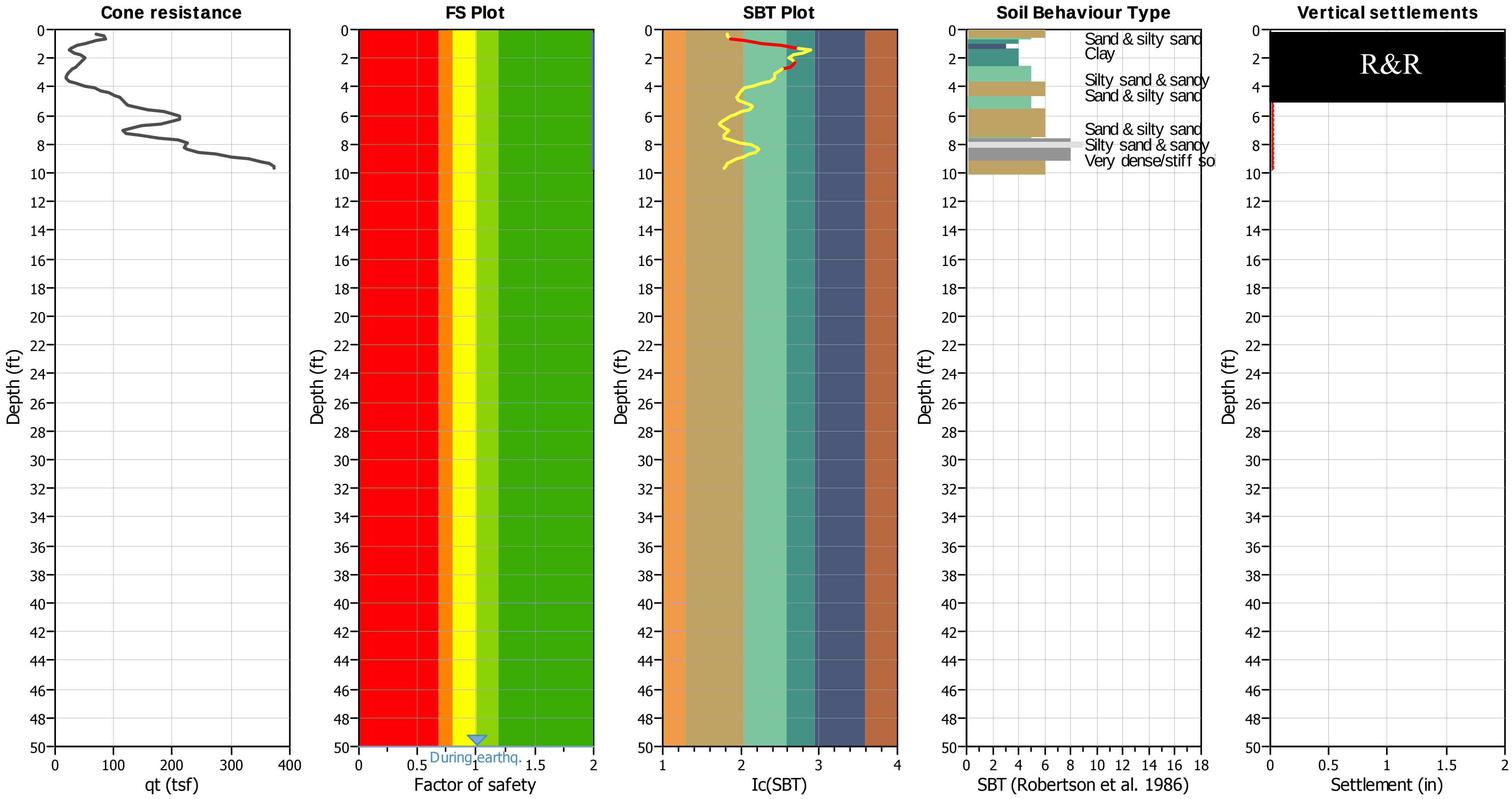


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-10
Total depth: 9.68 ft

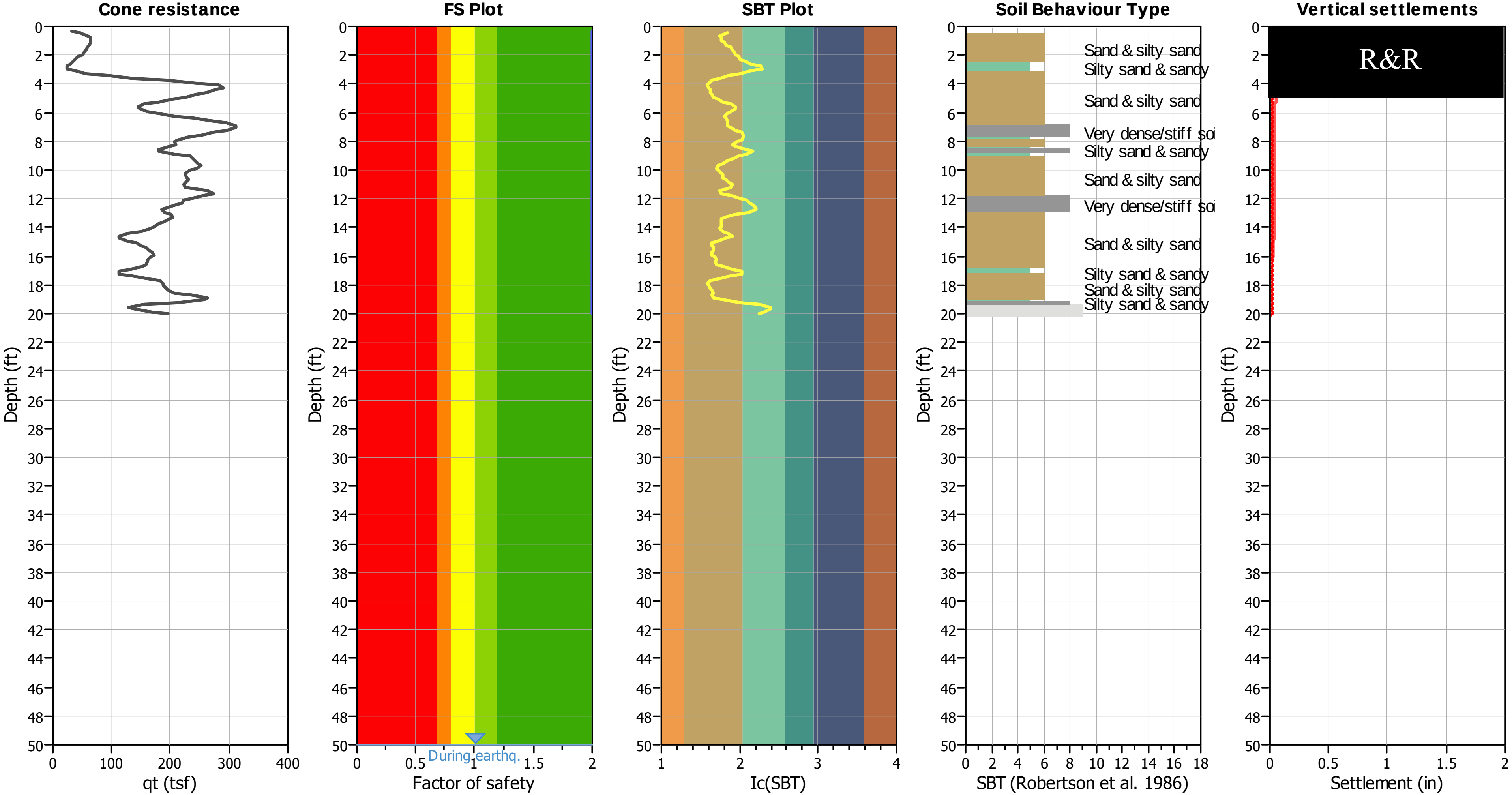


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-11
Total depth: 20.01 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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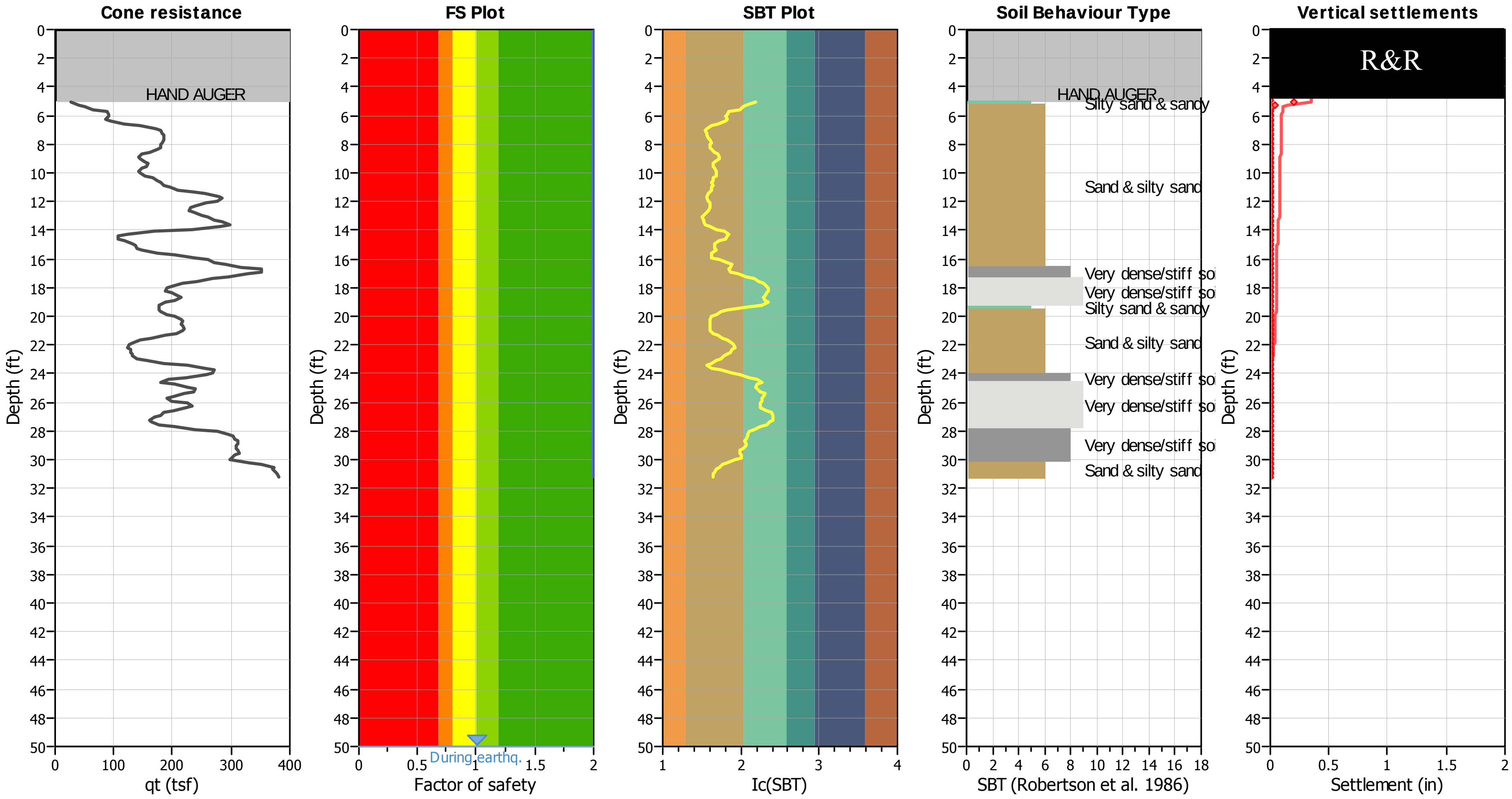
LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-12
Total depth: 31.17 ft



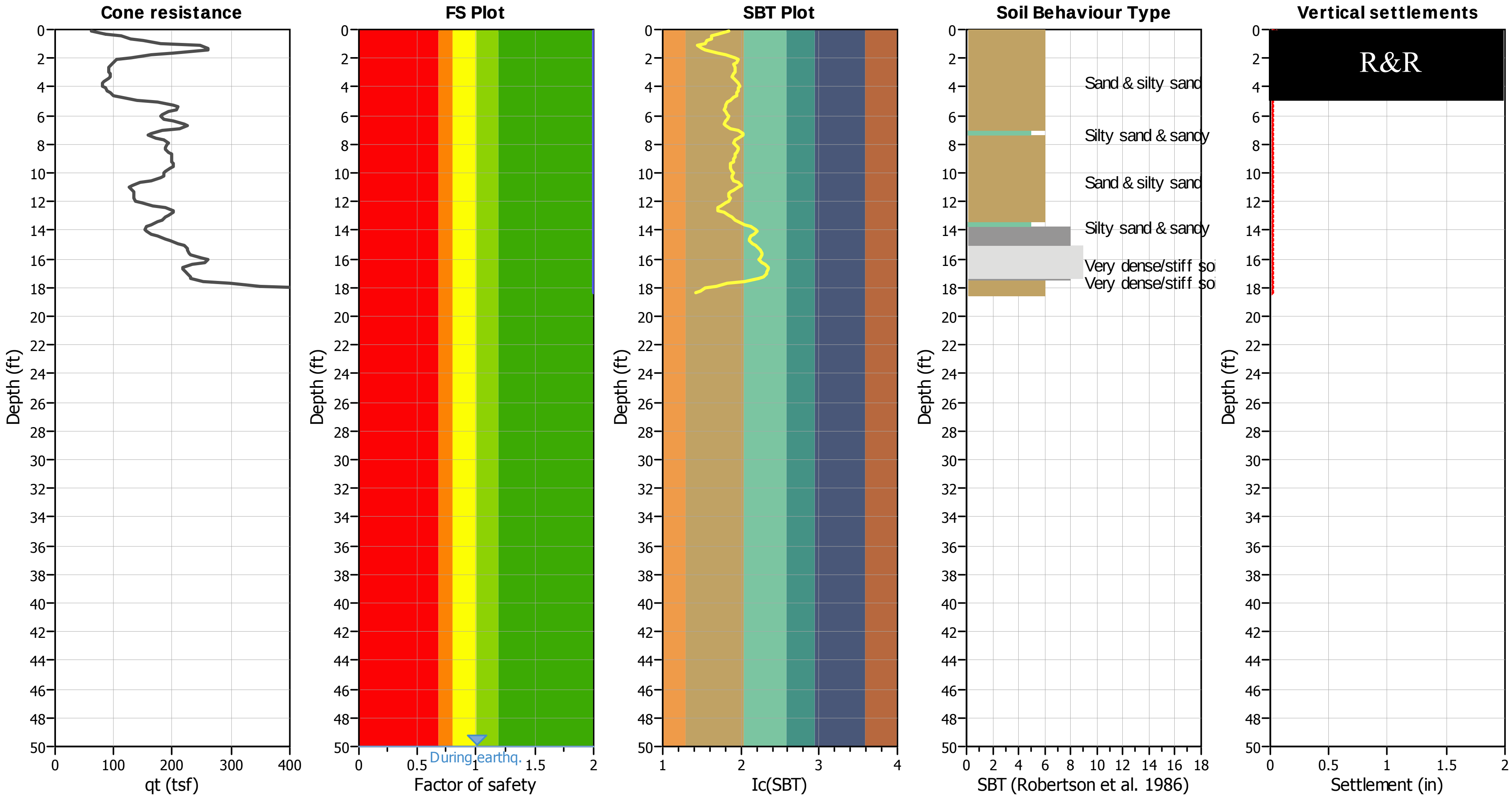
Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

CPeT-IT v.2.1.6.8 - CPTU data presentation & interpretation software - Report created on: 8/12/2019, 4:42:08 PM
Project file: Z:\2013\13092-01 Richland Communities - Stoneridge\Engineering\Liquefaction\Ciq_13092-01.clq

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-13
Total depth: 18.37 ft



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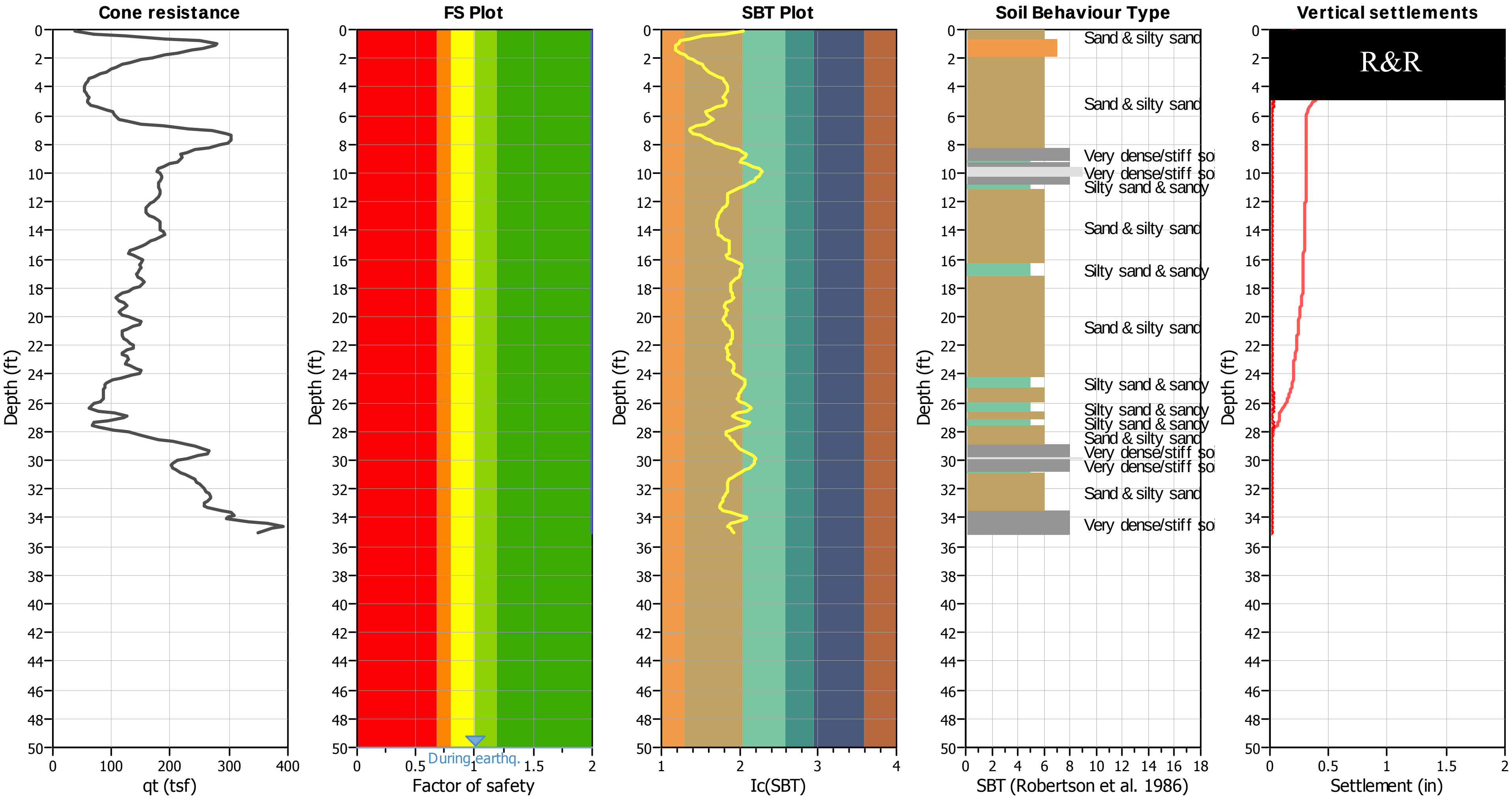
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-14
Total depth: 35.10 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

CPeT-IT v.2.1.6.8 - CPTU data presentation & interpretation software - Report created on: 8/12/2019, 4:42:12 PM
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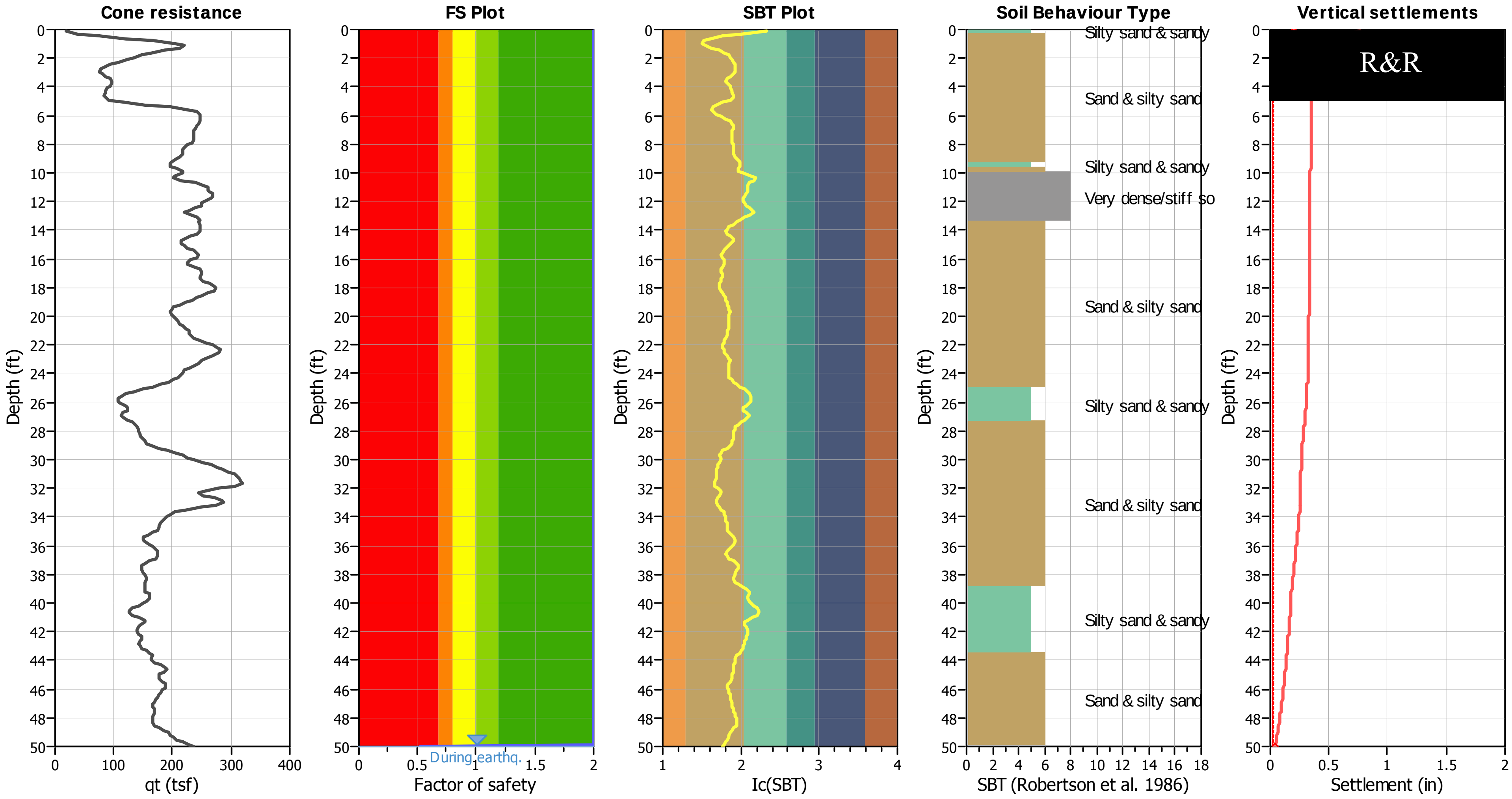
LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-15
Total depth: 50.03 ft



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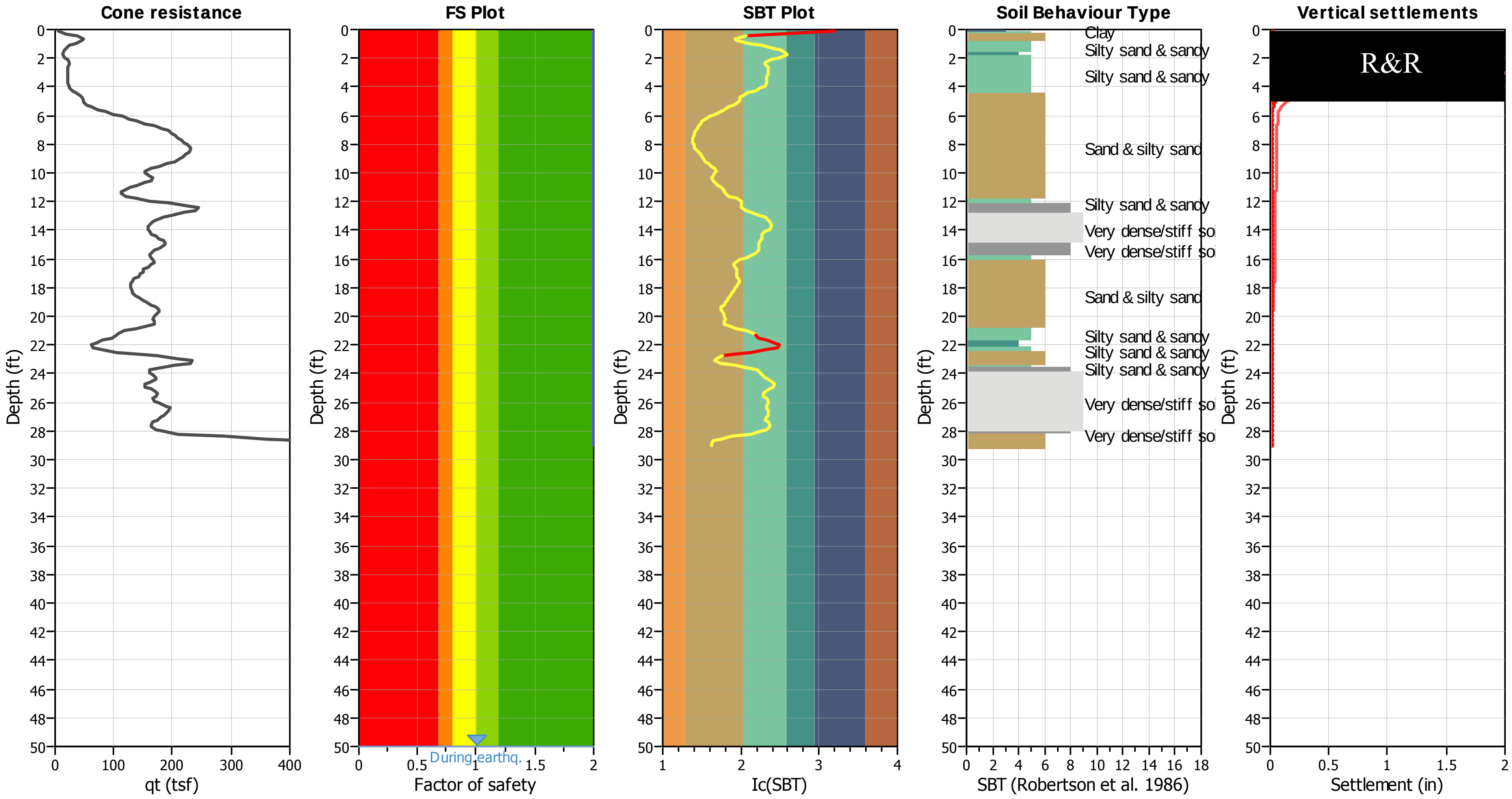
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-16
Total depth: 29.04 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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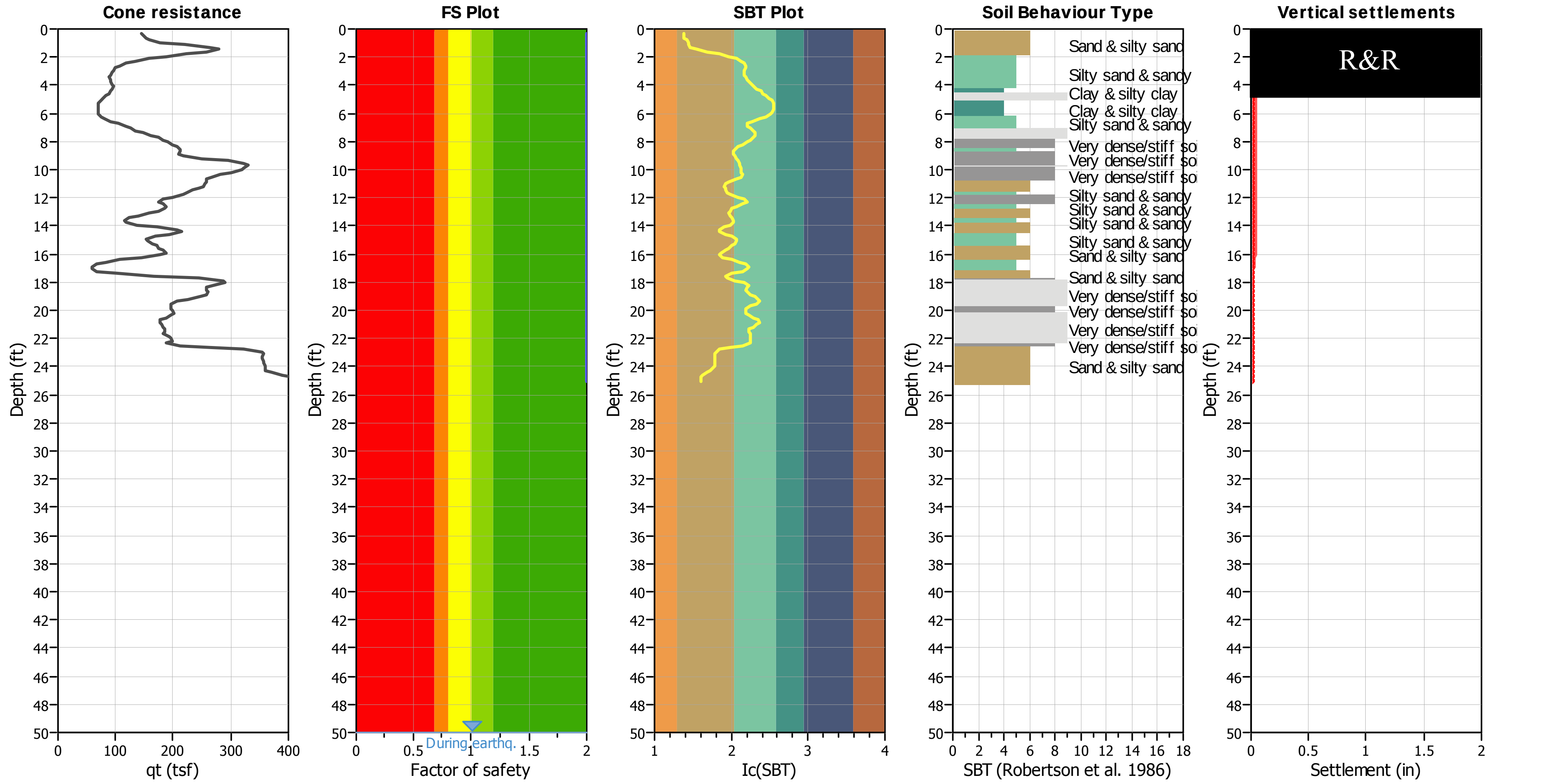
LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-17
Total depth: 25.10 ft

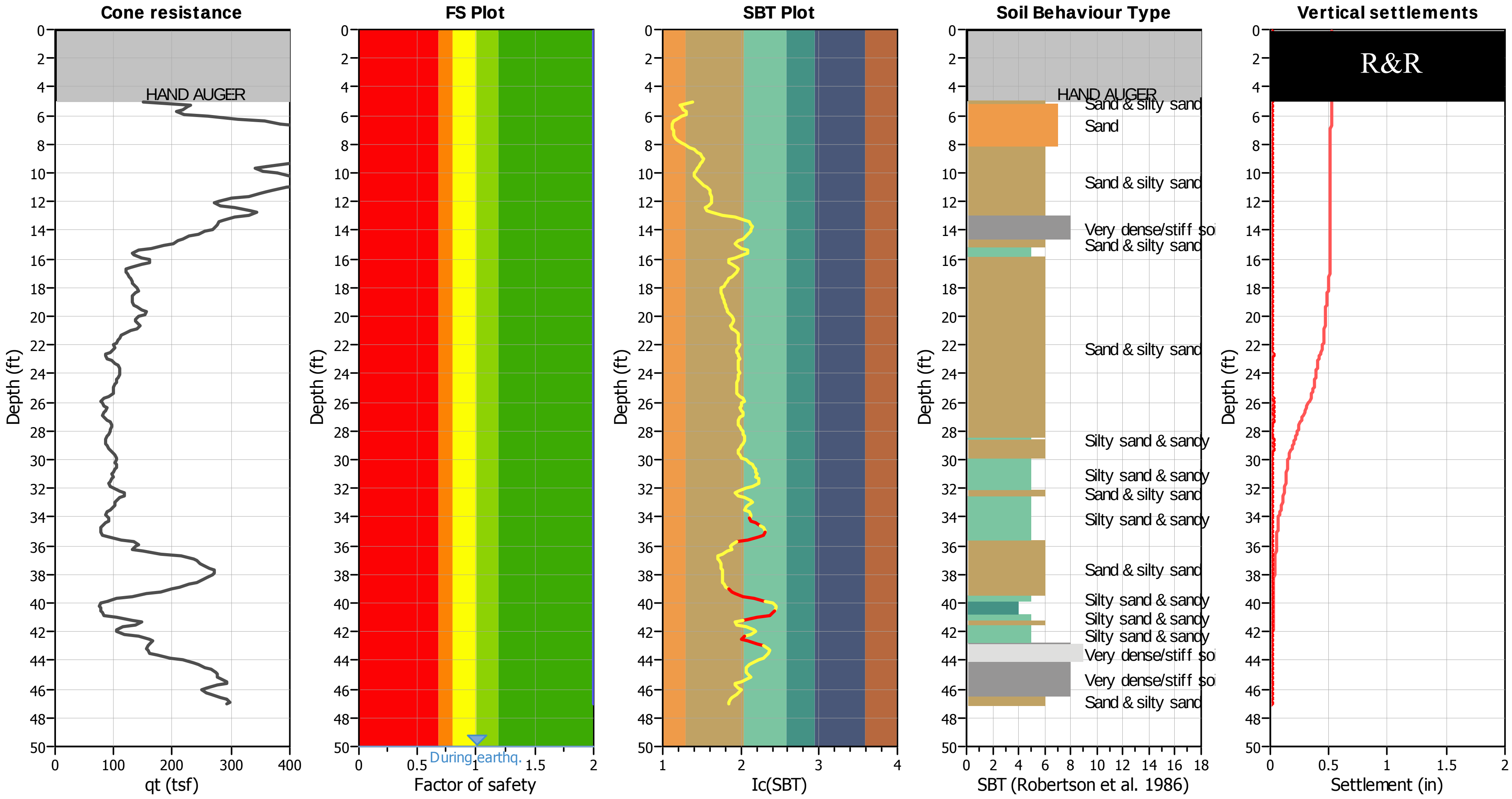


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-18
Total depth: 47.08 ft

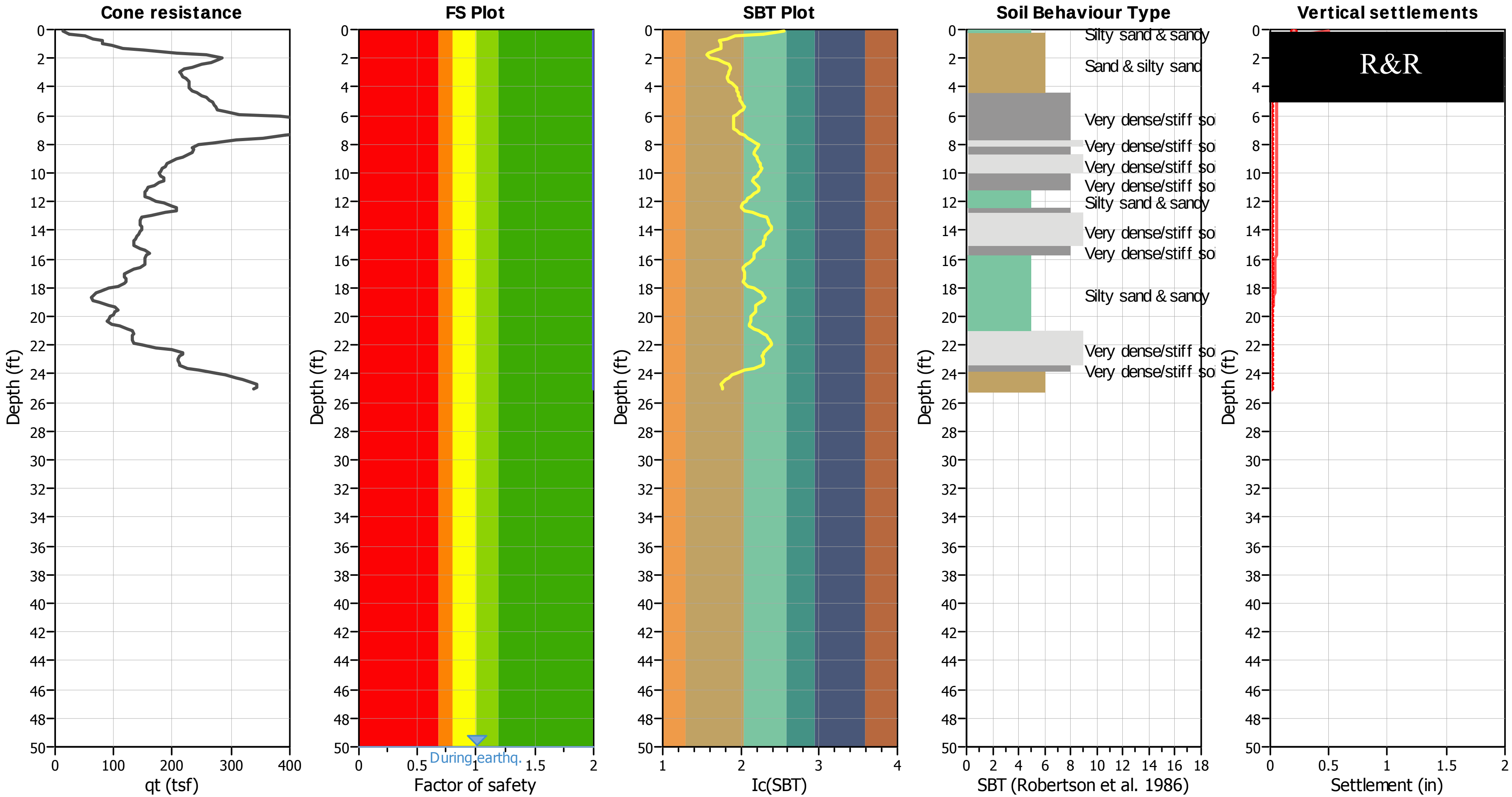


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-19
Total depth: 25.10 ft

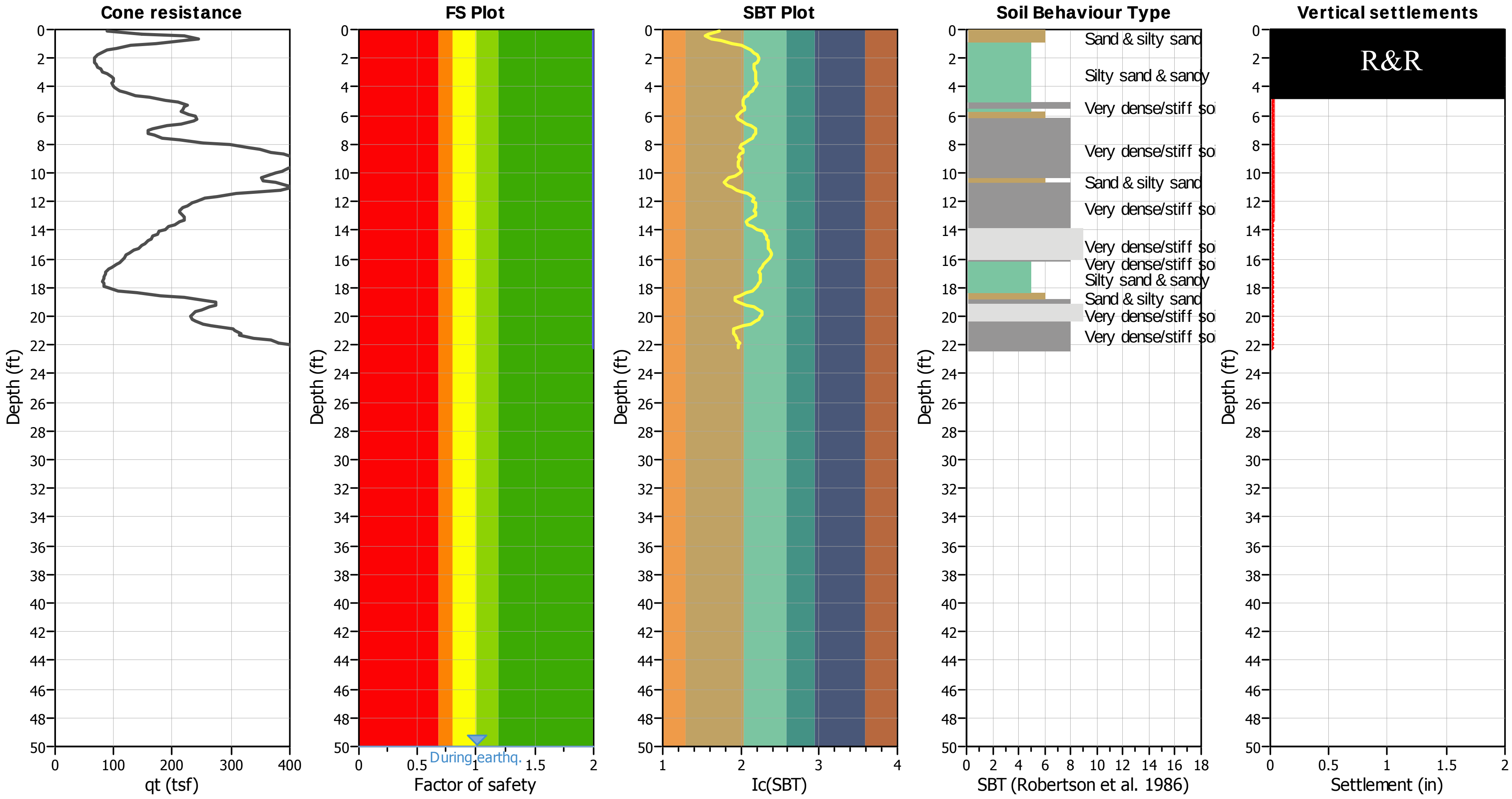


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-20
Total depth: 22.15 ft

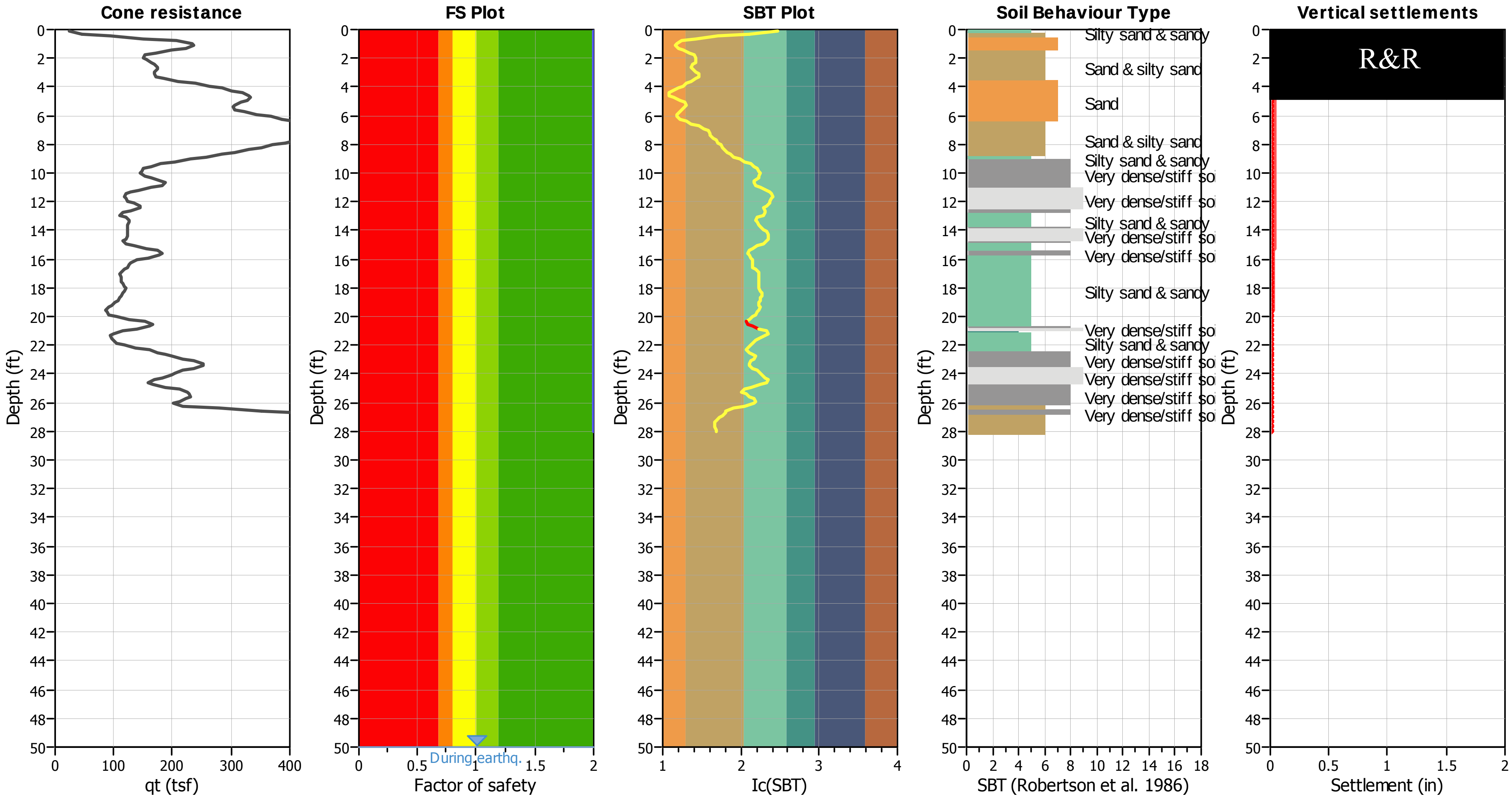


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-21
Total depth: 28.05 ft

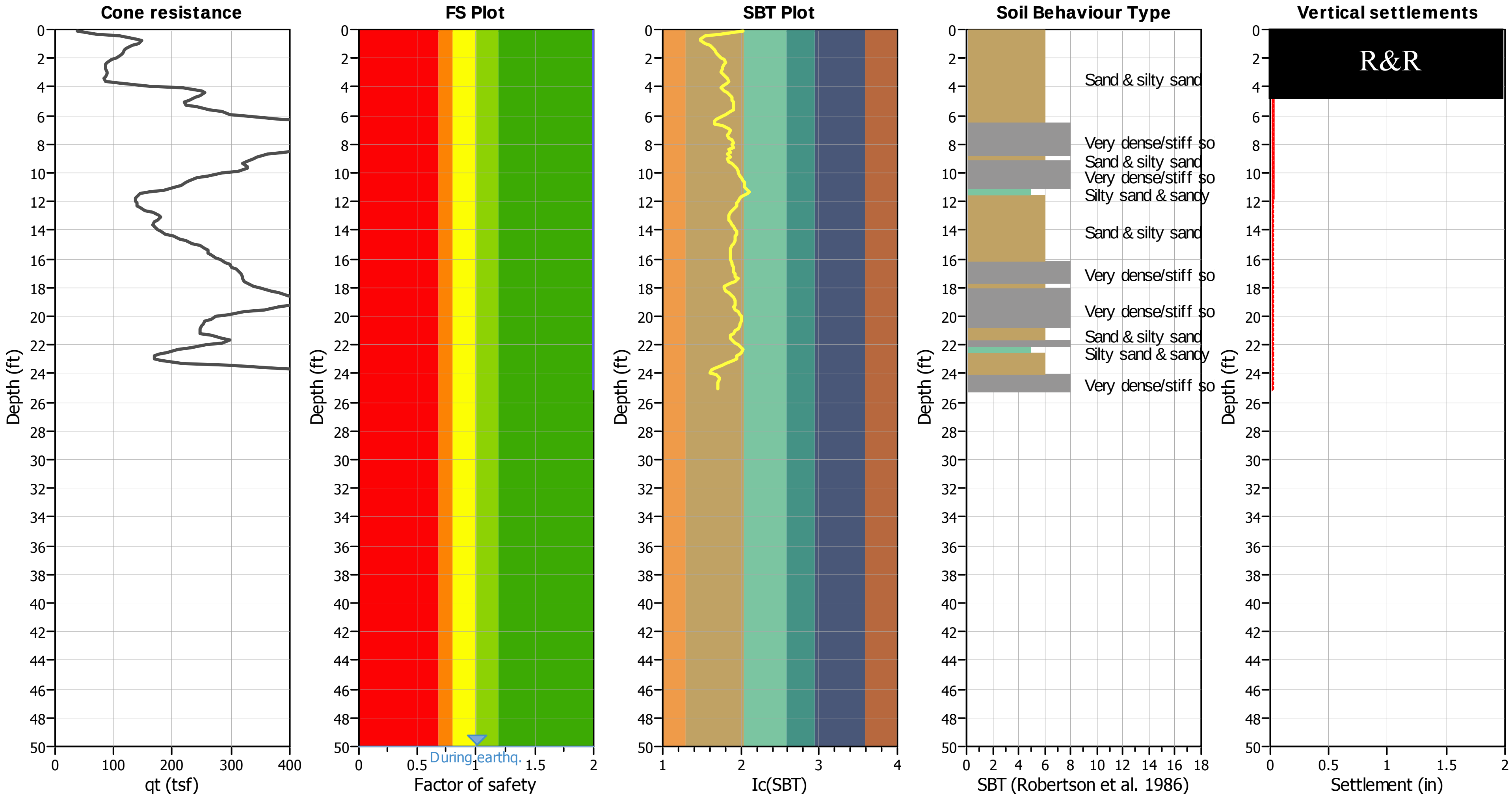


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-22
Total depth: 25.10 ft

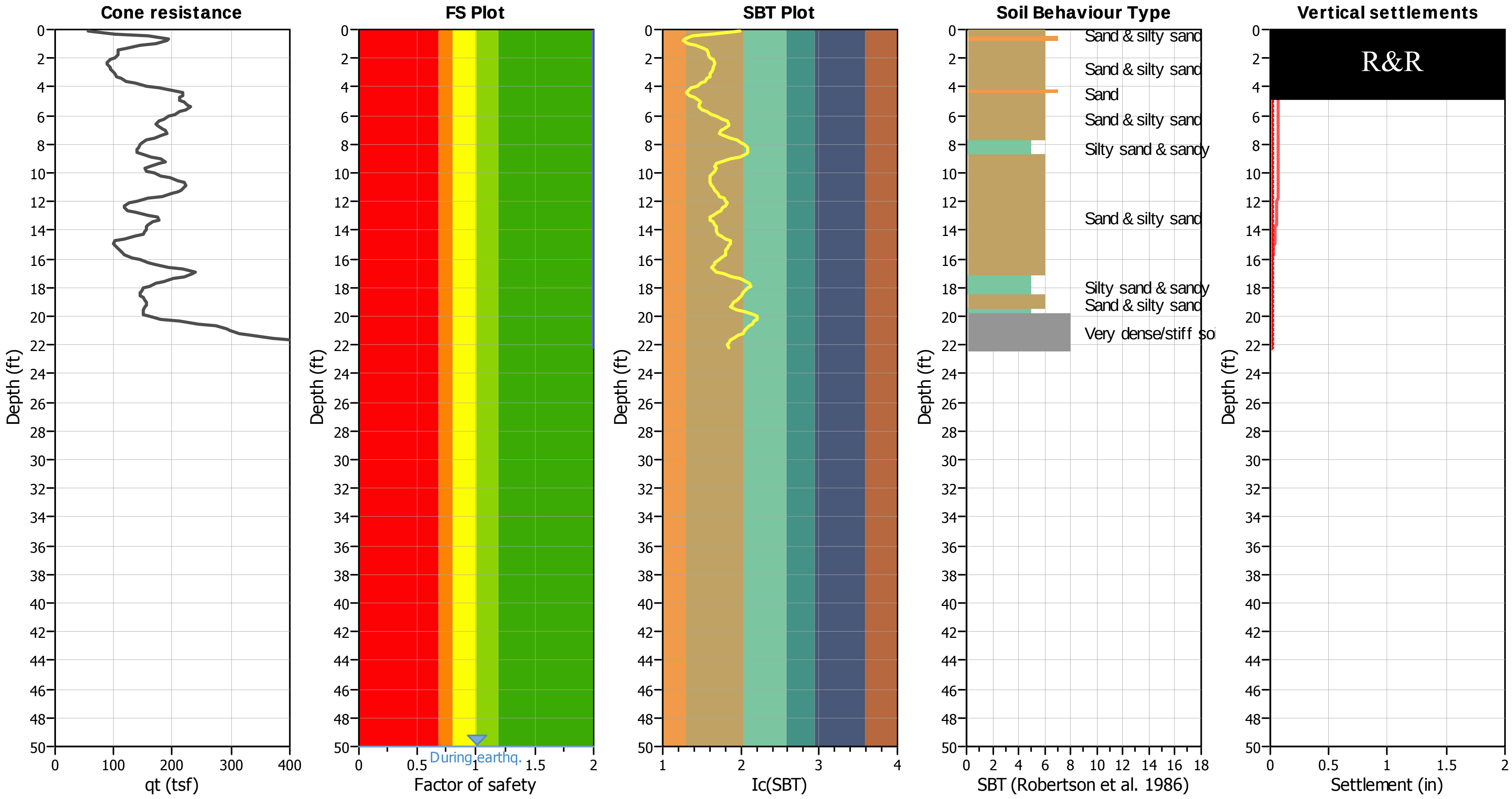


Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

LGC Geotechnical, Inc.
Geotechnical Engineers

Project: Stoneridge
Location: Riverside County

CPT: CPT-23
Total depth: 22.15 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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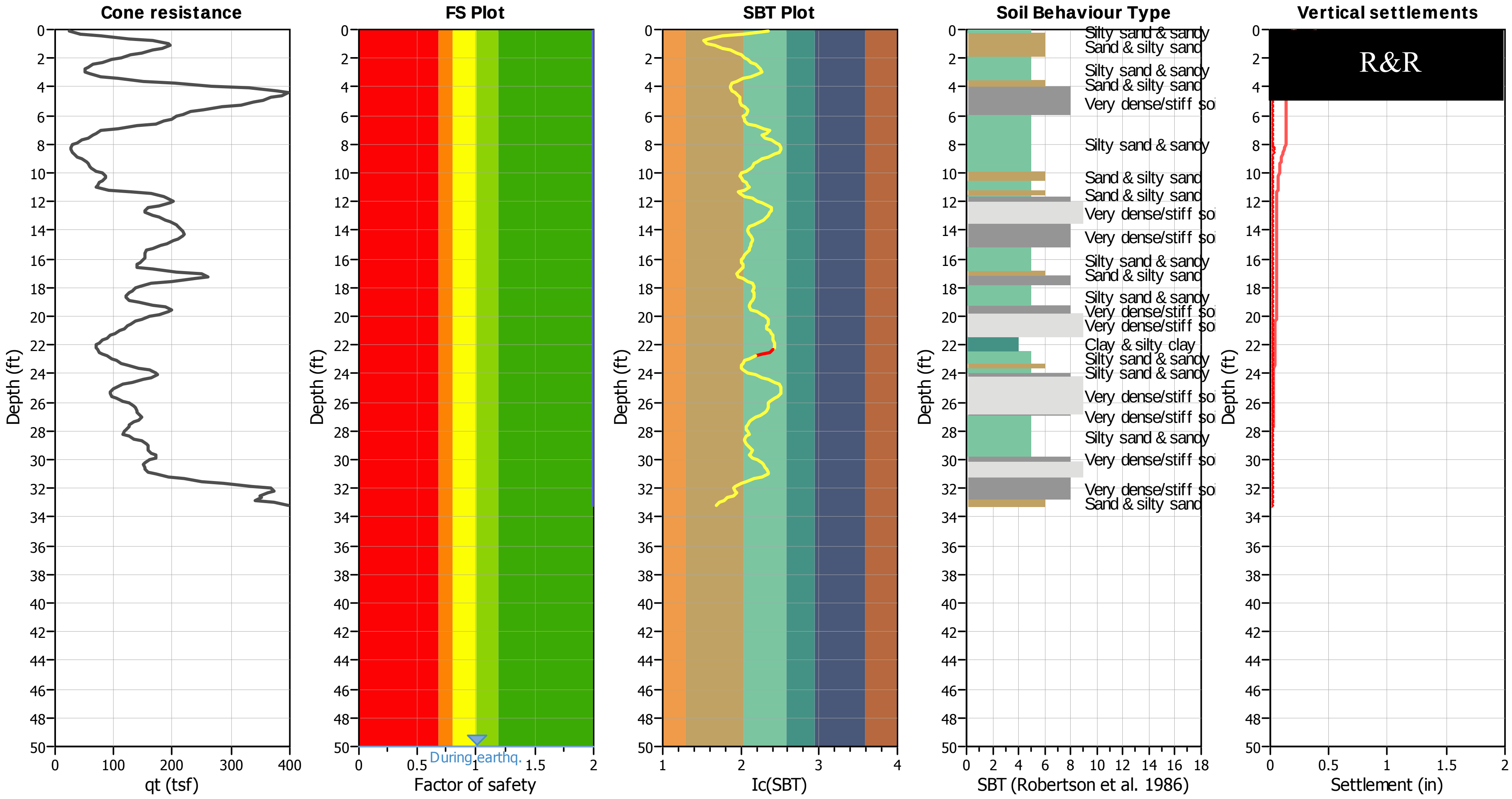
LGC Geotechnical, Inc.
Geotechnical Engineers

Project: **Stoneridge**
Location: **Riverside County**

CPT: CPT-24
Total depth: 33.14 ft



Analysis method:	NCEER (1998)	G.W.T. (in-situ):	50.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	50.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Appendix G
General Earthwork Specifications for Rough Grading

General Earthwork and Grading Specifications for Rough Grading

1.0 General

1.1 Intent

These General Earthwork and Grading Specifications are for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the specific recommendations in the geotechnical report shall supersede these more general Specifications. Observations of the earthwork by the project Geotechnical Consultant during the course of grading may result in new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

1.2 The Geotechnical Consultant of Record

Prior to commencement of work, the owner shall employ a qualified Geotechnical Consultant of Record (Geotechnical Consultant). The Geotechnical Consultant shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading.

Prior to commencement of grading, the Geotechnical Consultant shall review the "work plan" prepared by the Earthwork Contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observation, mapping, and compaction testing.

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to confirm that the attained level of compaction is being accomplished as specified. The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

1.3 The Earthwork Contractor

The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the project plans and specifications. The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of “equipment” of work and the estimated quantities of daily earthwork

contemplated for the site prior to commencement of grading. The Contractor shall inform the owner and the
Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate personnel will be available for observation and testing. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish the earthwork in accordance with the applicable grading codes and agency ordinances, these Specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of the Geotechnical Consultant, unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in these specifications, the Geotechnical Consultant shall reject the work and may recommend to the owner that construction be stopped until the conditions are rectified. It is the contractor's sole responsibility to provide proper fill compaction.

2.0 Preparation of Areas to be Filled

2.1 Clearing and Grubbing

Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies, and the Geotechnical Consultant.

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area.

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed. The contractor is responsible for all hazardous waste relating to his work. The Geotechnical Consultant does not have expertise in this area. If hazardous waste is a concern, then the Client should acquire the services of a qualified environmental assessor.

2.2 Processing

Existing ground that has been declared satisfactory for support of fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Existing ground that is not satisfactory shall be over-excavated as specified in the following section. Scarification shall continue until soils are broken down and free of oversize material and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

2.3 Over-excavation

In addition to removals and over-excavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be over-excavated to competent ground as evaluated by the Geotechnical Consultant during grading.

2.4 Benching

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), the ground shall be stepped or benched. Please see the Standard Details for a graphic illustration. The lowest bench or key shall be a minimum of 15 feet wide and at least 2 feet deep, into competent material as evaluated by the Geotechnical Consultant. Other benches shall be excavated a minimum height of 4 feet into competent material or as otherwise recommended by the Geotechnical Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise over-excavated to provide a flat subgrade for the fill.

2.5 Evaluation/Acceptance of Fill Areas

All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

3.0 Fill Material

3.1 General

Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.

3.2 Oversize

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 8 inches, shall not be buried or placed in fill unless location, materials, and placement methods are specifically accepted by the Geotechnical Consultant. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction.

3.3 Import

If importing of fill material is required for grading, proposed import material shall meet the requirements of the geotechnical consultant. The potential import source shall be given to the Geotechnical Consultant at least 48 hours (2 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

4.0 Fill Placement and Compaction

4.1 Fill Layers

Approved fill material shall be placed in areas prepared to receive fill (per Section 3.0) in near-horizontal layers not exceeding 8 inches in loose thickness. The Geotechnical Consultant may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

4.2 Fill Moisture Conditioning

Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557).

4.3 Compaction of Fill

After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density (ASTM Test Method D1557). Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

4.4 Compaction of Fill Slopes

In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by backrolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of maximum density per ASTM Test Method D1557.

4.5 Compaction Testing

Field tests for moisture content and relative compaction of the fill soils shall be performed by the Geotechnical Consultant. Location and frequency of tests shall be at the Consultant's discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

4.6 ***Frequency of Compaction Testing***

Tests shall be taken at intervals not exceeding 2 feet in vertical rise and/or 1,000 cubic yards of compacted fill soils embankment. In addition, as a guideline, at least one test shall be taken on slope faces for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope. The Contractor shall assure that fill construction is such that the testing schedule can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork construction if these minimum standards are not met.

4.7 ***Compaction Test Locations***

The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of each test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than
5 feet apart from potential test locations shall be provided.

5.0 ***Subdrain Installation***

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the grading plan, and the Standard Details. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. All subdrains shall be surveyed by a land surveyor/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys.

6.0 ***Excavation***

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by the Geotechnical Consultant during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by the Geotechnical Consultant prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by the Geotechnical Consultant.

7.0 ***Trench Backfills***

7.1 The Contractor shall follow all OHSA and Cal/OSHA requirements for safety of trench excavations.

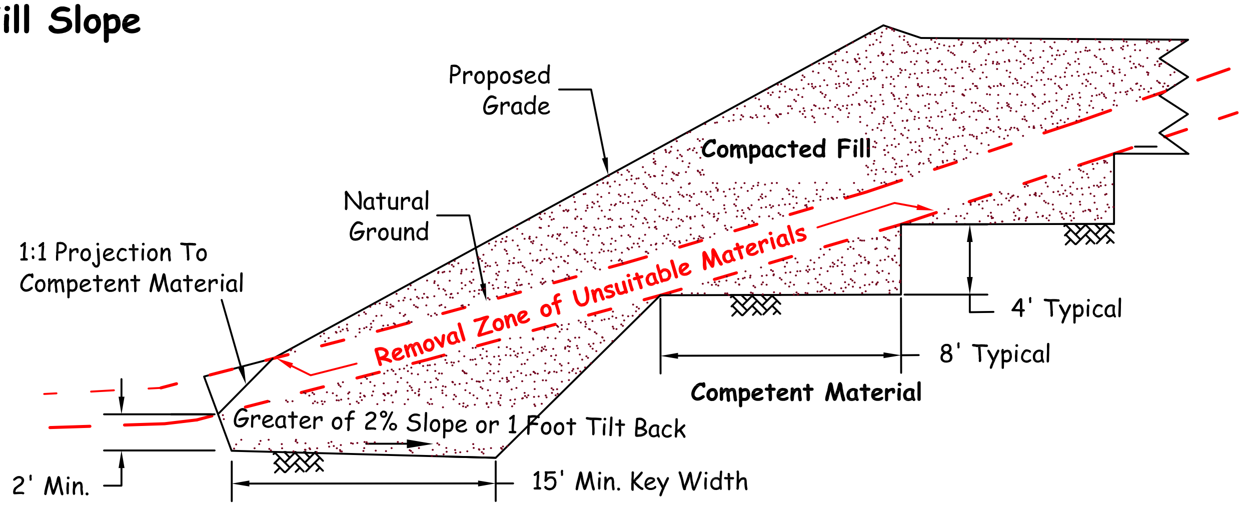
7.2 All bedding and backfill of utility trenches shall be done in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over the top of the conduit and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of maximum from 1 foot above the top of the conduit to the surface.

7.3 The jetting of the bedding around the conduits shall be observed by the Geotechnical Consultant.

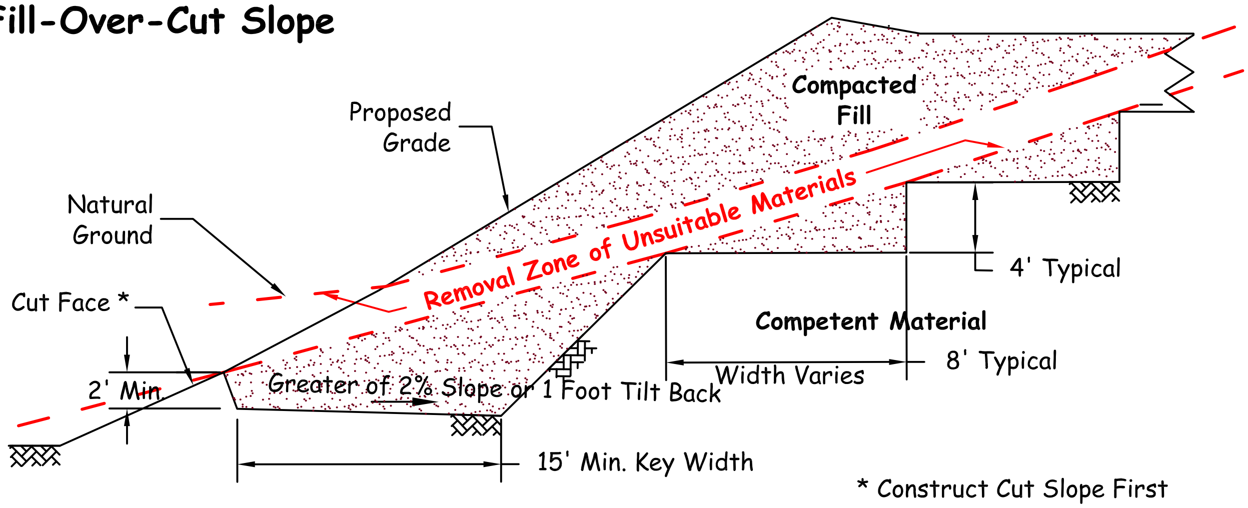
7.4 The Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.

7.5 Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method.

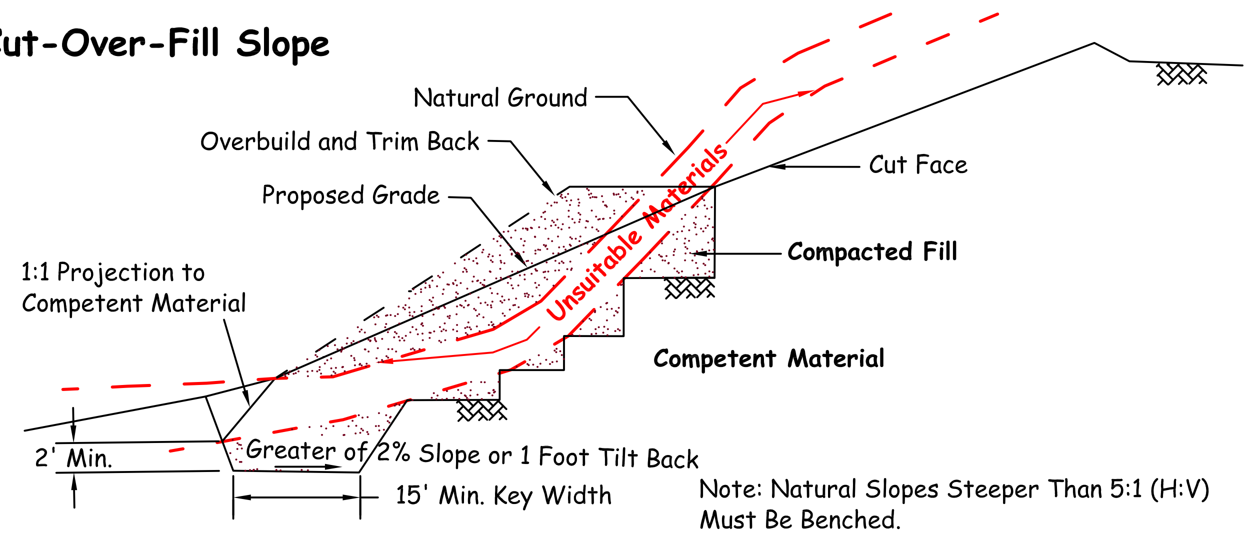
Fill Slope



Fill-Over-Cut Slope

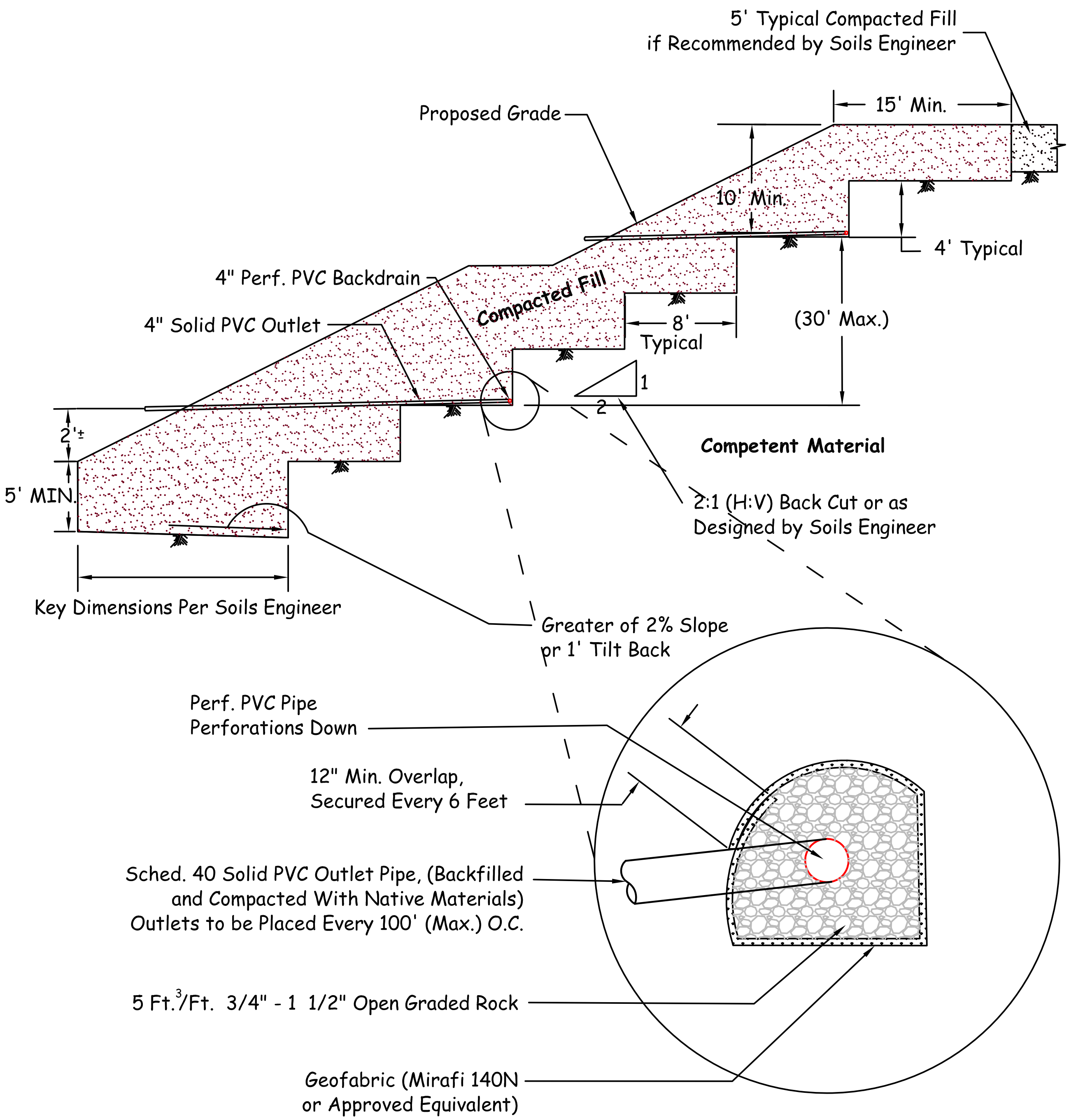


Cut-Over-Fill Slope



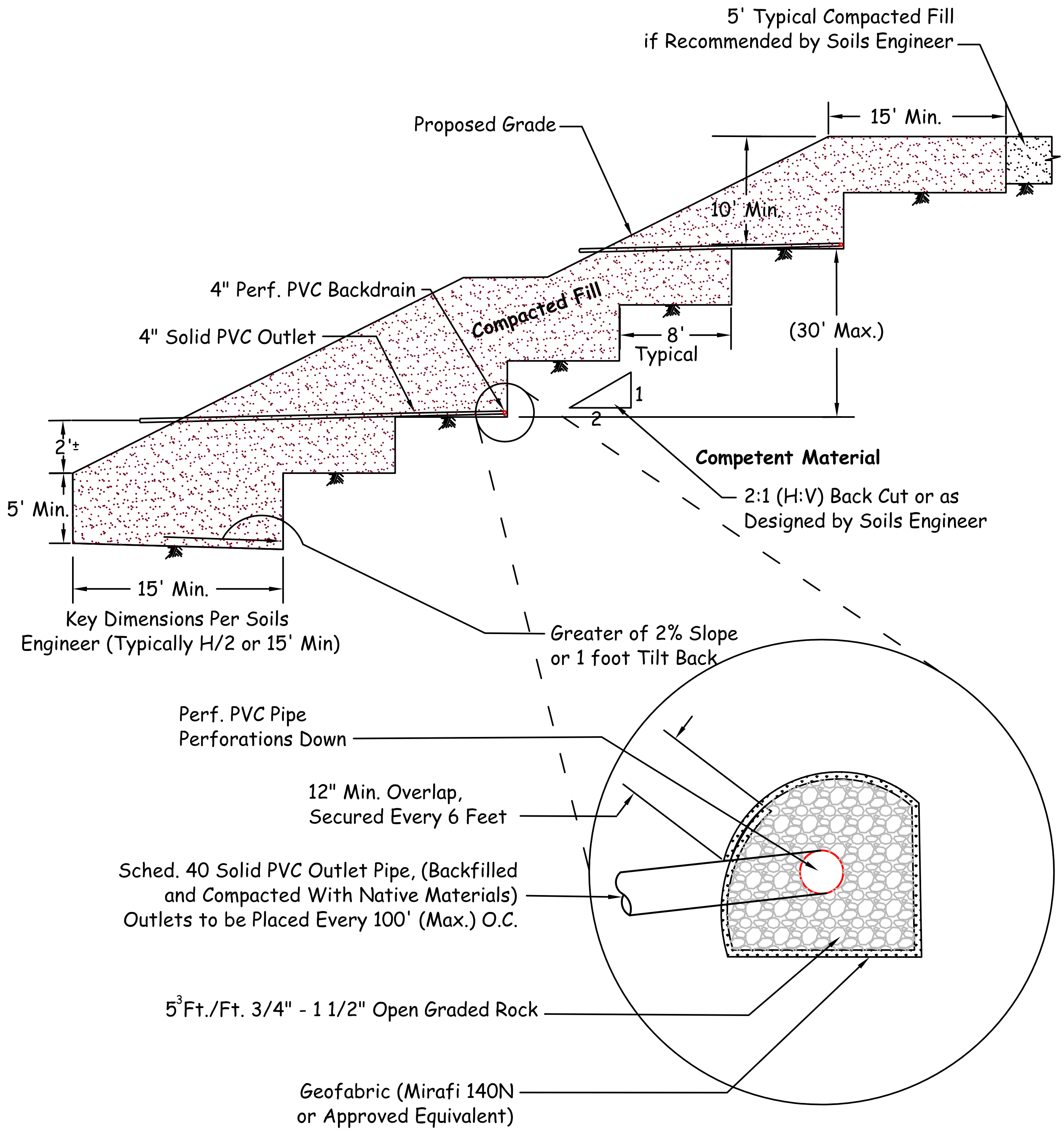
LGC Geotechnical, Inc.

KEYING AND BENCHING



LGC Geotechnical, Inc.

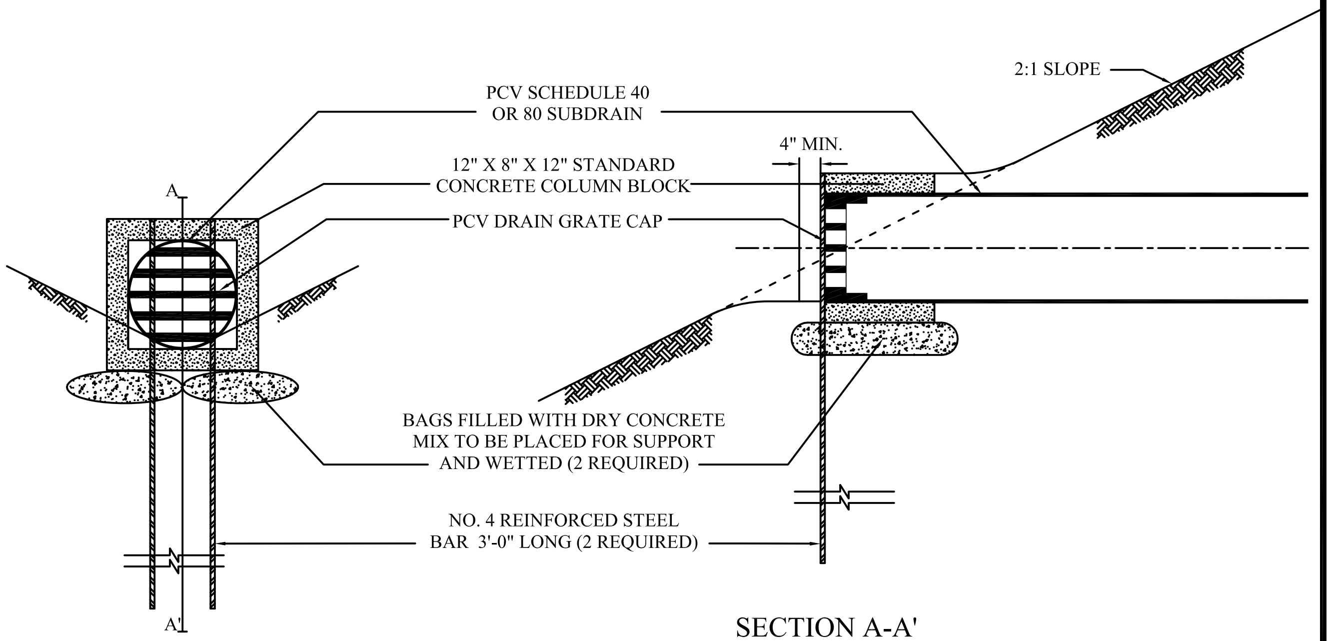
TYPICAL BUTTRESS DETAIL



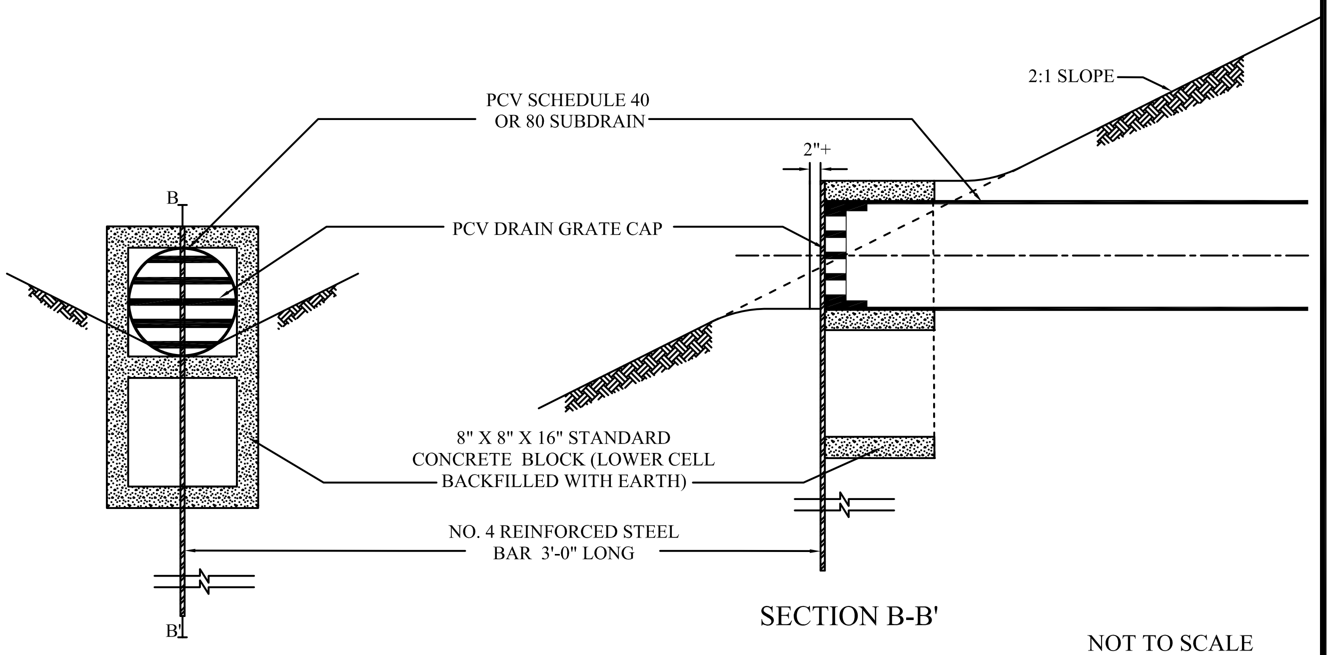
LGC Geotechnical, Inc.

TYPICAL STABILIZATION FILL DETAIL

SUBDRAIN OUTLET MARKER -6" & 8" PIPE



SUBDRAIN OUTLET MARKER -4" PIPE



NOT TO SCALE

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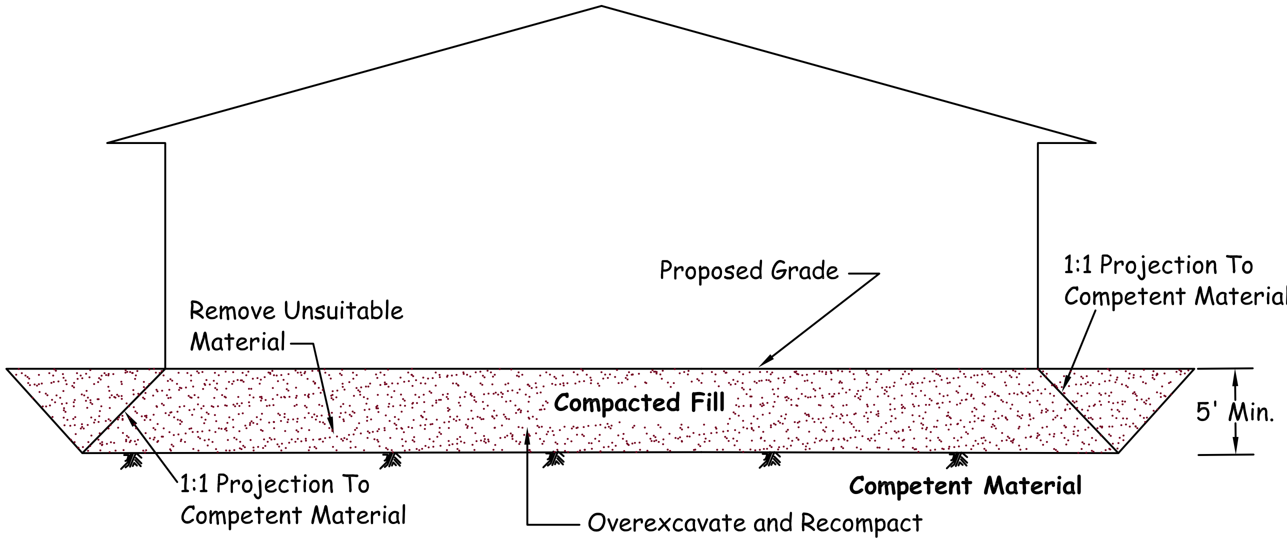
SUBDRAIN OUTLET MARKER DETAIL

Cut Lot

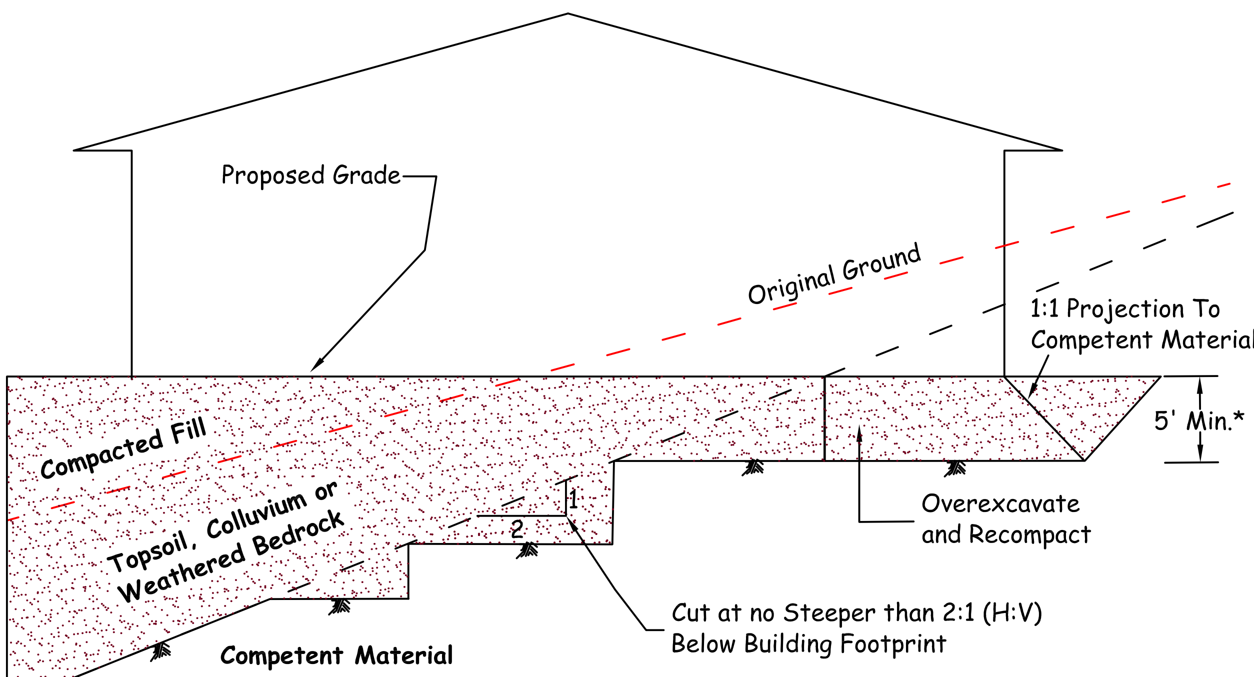
(Exposing Unsuitable Soils at Design Grade)



Note 1: Removal Bottom Should be Graded With Minimum 2% Fall Towards Street or Other Suitable Area (as Determined by Soils Engineer) to Avoid Ponding Below Building

Note 2: Where Design Cut Lots are Excavated Entirely Into Competent Material, Overexcavation May Still be Required for Hard-Rock Conditions or for Materials With Variable Expansion Characteristics.

Cut/Fill Transition Lot



*Deeper if Specified by Soils Engineer

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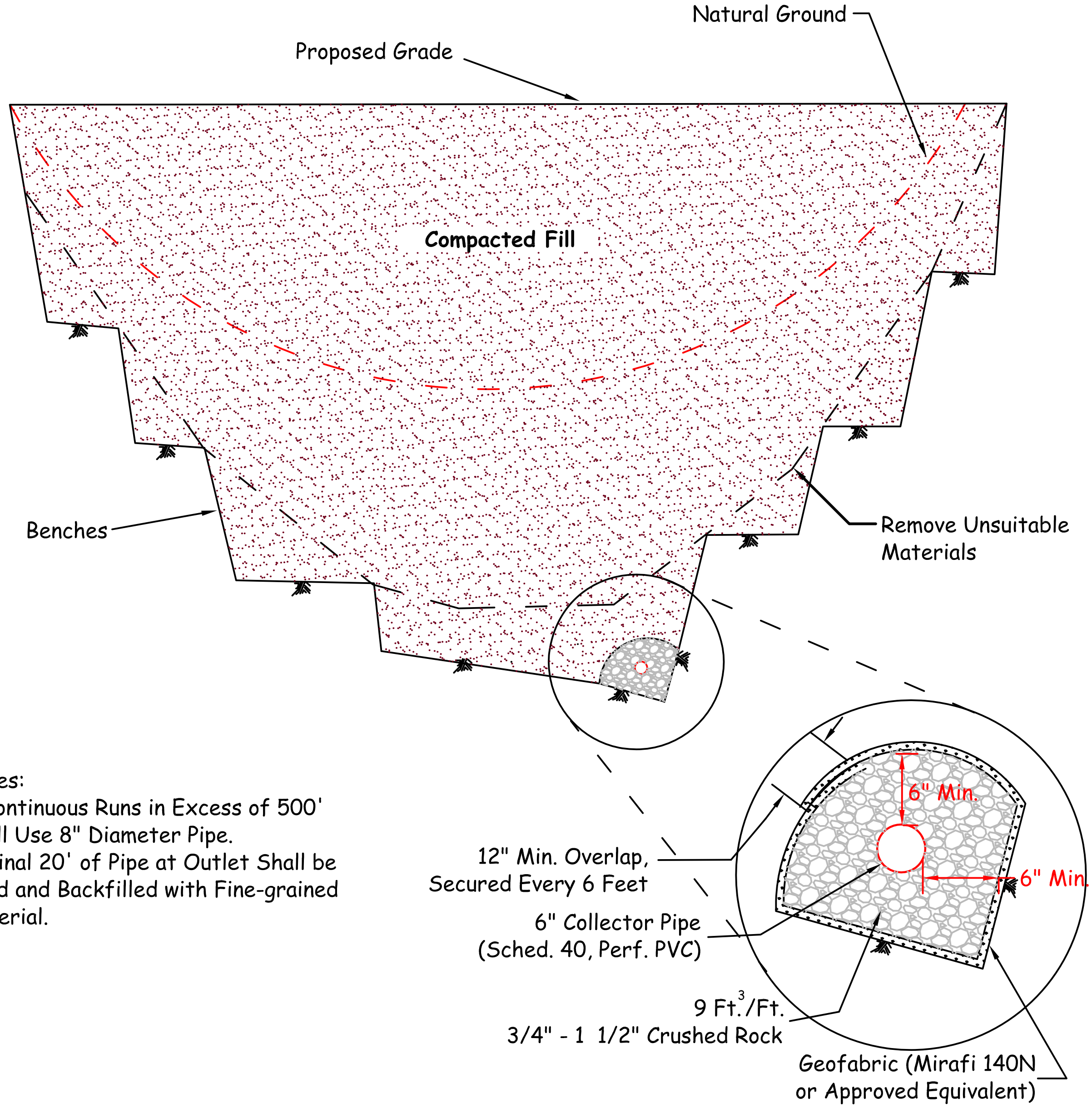
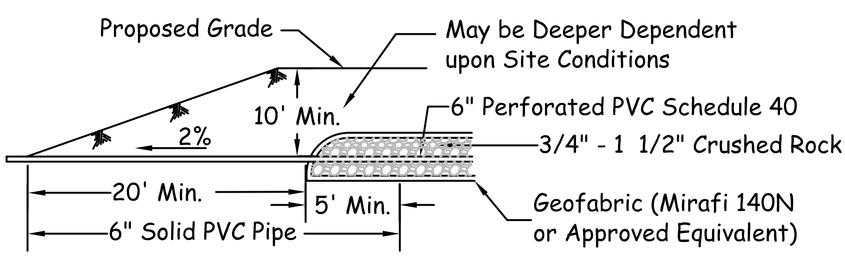
CUT AND TRANSITION LOT OVEREXCAVATION DETAIL



Notes:
1) Continuous Runs in Excess of 500' Shall Use 8" Diameter Pipe.
2) Final 20' of Pipe at Outlet Shall be Solid and Backfilled with Fine-grained Material.

Proposed Outlet Detail



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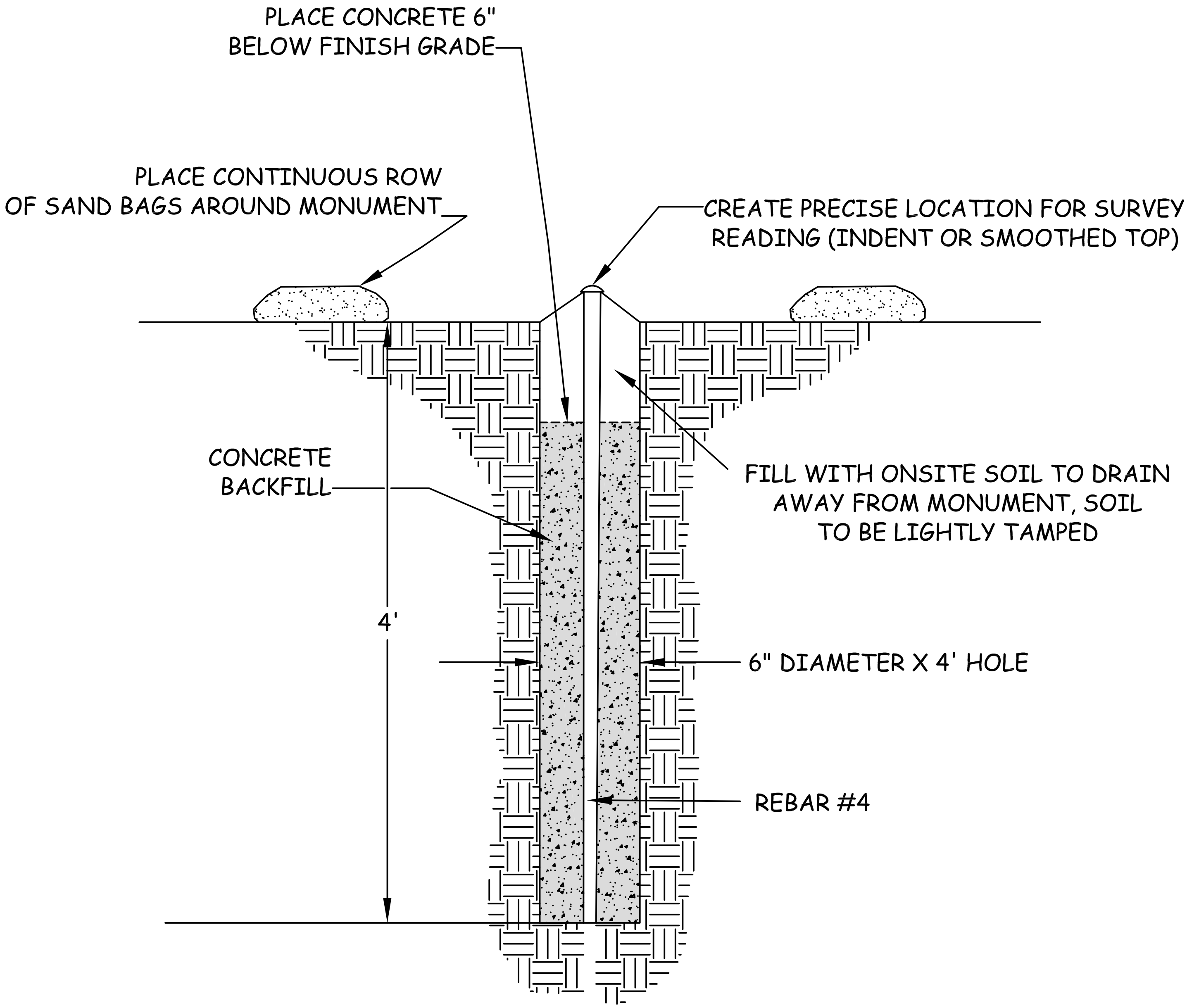
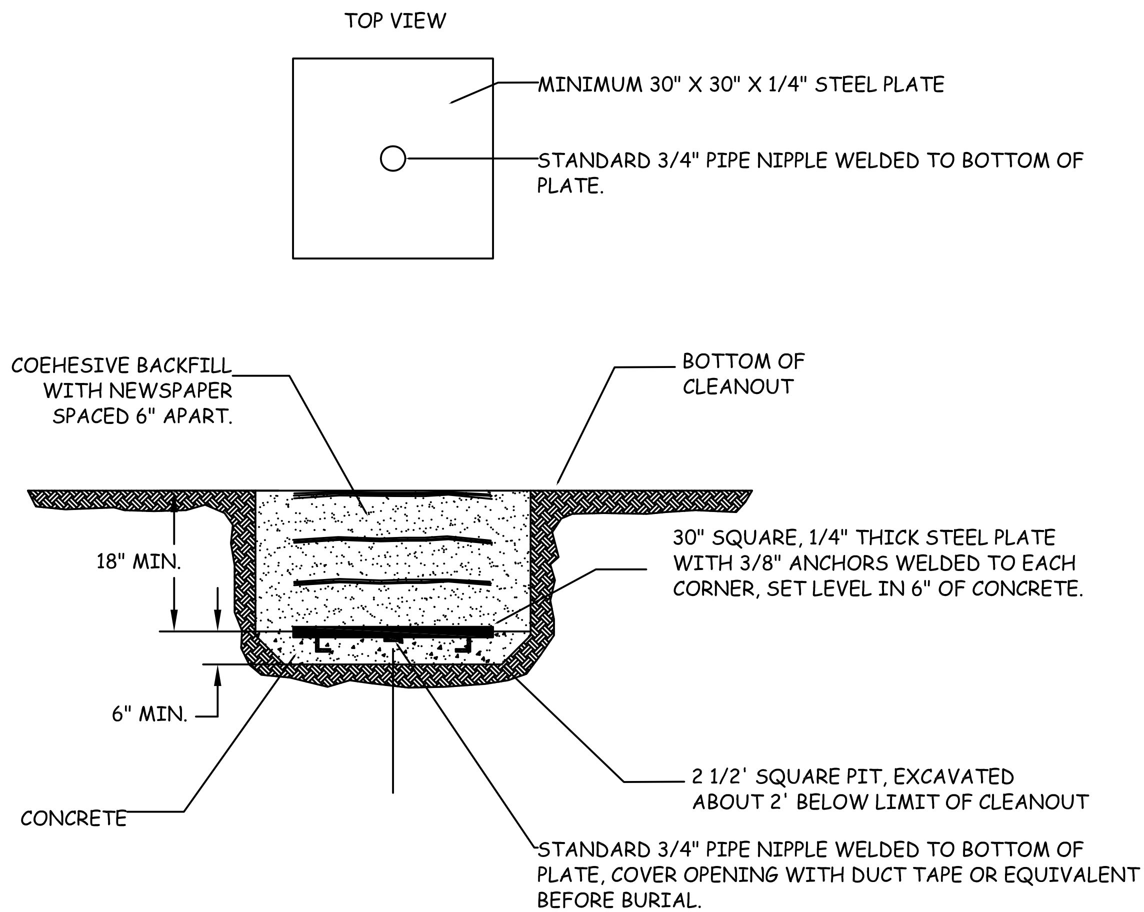
CANYON SUBDRAINS



NO CONSTRUCTION EQUIPMENT WITHIN 25 FEET
OF ANY INSTALLED SETTLEMENT MONUMENTS

LGC Geotechnical, Inc.

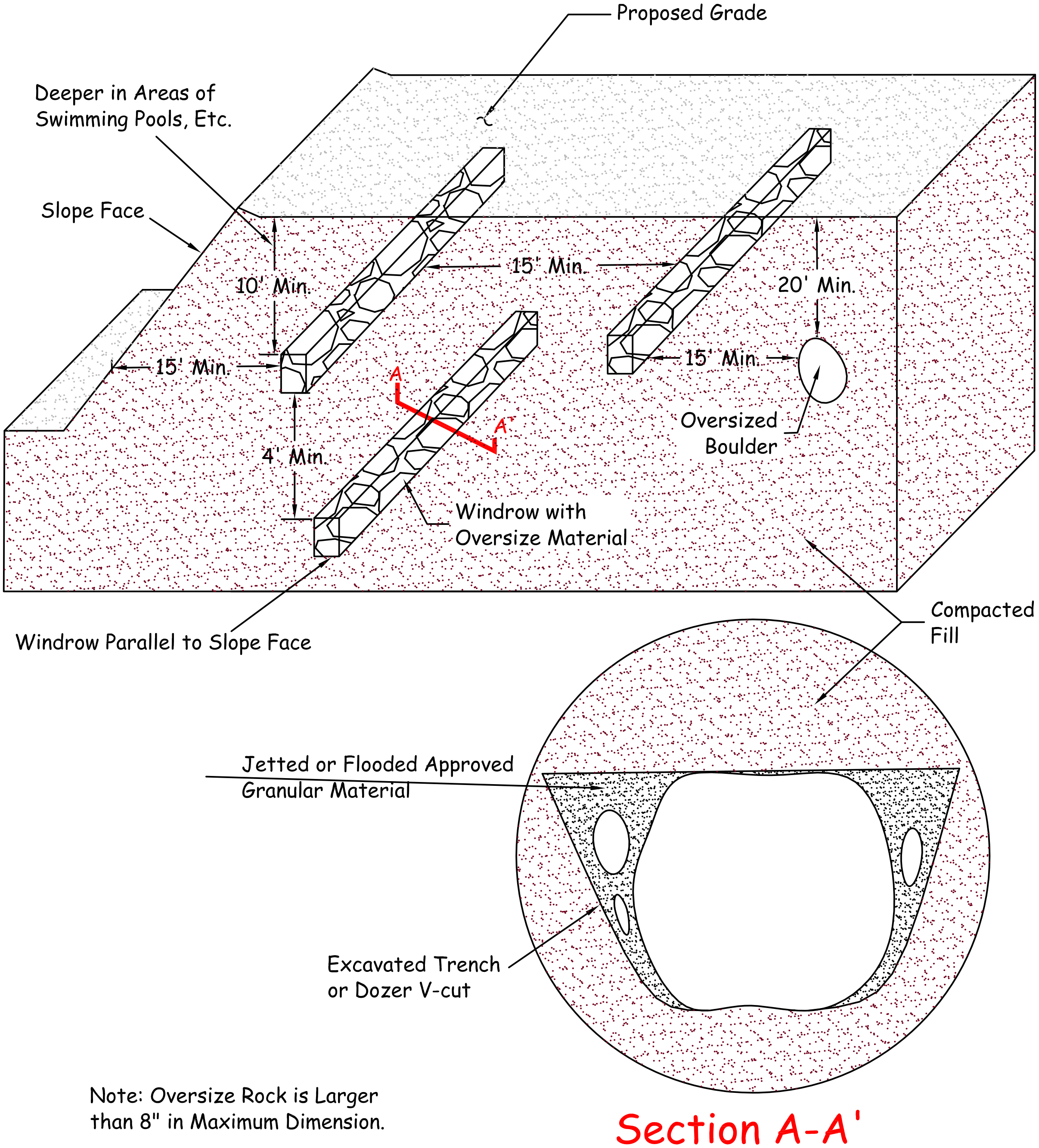
TYPICAL SURFACE SETTLEMENT MONUMENT



1. SURVEY FOR HORIZONTAL AND VERTICAL LOCATION TO NEAREST .01 INCH PRIOR TO BACKFILL USING KNOW LOCATIONS THAT WILL REMAIN INTACT DURING THE DURATION OF THE MONITORING PROGRAM. KNOW POINTS EXPLICITELY NOT ALLOWED ARE THOSE LOCATED ON FILL OR THAT WILL BE DESTROYED DURING GRADING.
2. IN THE EVENT OF DAMAGE TO SETTLEMENT PLATE DURING GRADING, CONTRACTOR SHALL IMMEDIATELY NOTIFY THE GEOTECHNICAL ENGINEER AND SHALL BE RESPONSIBLE FOR RESTORING THE SETTLEMENT PLATES TO WORKING ORDER.
3. DRILL TO RECOVER AND ATTACH RISER PIPE.

LGC Geotechnical, Inc.

TYPICAL SETTLEMENT PLATE AND RISER



Note: Oversize Rock is Larger than 8" in Maximum Dimension.

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OVERSIZE ROCK DISPOSAL DETAIL

LGC Geotechnical, Inc.

LGC Geotechnical, Inc.
131 Calle Iglesia, Ste. 200
San Clemente, CA 92672
TEL (949) 369-6141 FAX (949) 369-6142

Geotechnical Map
Stoneridge Industrial/Mixed-Use Development

CLIENT:
Richland Communities, Inc.
3161 Michelson Drive, Suite 425
Irvine, CA 92626

PROJECT NAME	Stoneridge
PROJECT NO.	13092-01
ENG. / GEOL.	RLD / KAD
SCALE	1" = 100'
DATE	September 2019

SHEET 1 of 3

LGC Geotechnical, Inc.

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SHEET 2 of 3

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SHEET 3 of 3

Appendix 4: Historical Site Conditions

Phase I Environmental Site Assessment or Other Information on Past Site Use

Appendix 5: LID Infeasibility

LID Technical Infeasibility Analysis

Appendix 6: BMP Design Details

BMP Sizing, Design Details and other Supporting Documentation

Santa Ana Watershed

V_{BMP} and Q_{BMP} worksheets

These worksheets are to be used to determine the required

Design Capture Volume (V_{BMP})
or the
Design Flow Rate (Q_{BMP})

for BMPs in the Santa Ana Watershed

To verify which watershed your project is located within, visit

www.rcflood.org/npdes

and use the 'Locate my Watershed' tool

If your project is not located in the Santa Ana Watershed,

Do not use these worksheets! Instead visit

www.rcflood.org/npdes/developers.aspx

To access worksheets applicable to your watershed

Use the tabs across the bottom
to access the worksheets for the Santa Ana Watershed

Santa Ana Watershed - BMP Design Volume, V_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name

Date

Designed by

Case No

Company Project Number/Name

BMP Identification

BMP NAME / ID

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

85th Percentile, 24-hour Rainfall Depth, from the Isohyetal Map in Handbook Appendix E

D_{85}= inches

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Storm Depth (in)*	*Design Capture Volume, V_{BMP} (cubic feet)*	*Proposed Volume on Plans (cubic feet)*
1	*658627*	*Mixed Surface Types*	*0.8*	*0.60*	*394712.5*			
	658627	***Total***			394712.5			

Notes:

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 1

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*1*	*658627*	*Mixed Surface Types*	*0.8*	*0.60*	*394712.5*			
		658627		**Total**		**394712.5**	**0.20**	**1.8**	**1.842**

Notes:

2 - 8x24 (1.38 cfs capacity), 1 - 8x16 (0.462 cfs capcity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. | Date: 4/30/2020

Designed by: Martin Parker | Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 2

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity: I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*2*	*128502*	*Mixed Surface Types*	*0.8*	*0.60*	*77010.7*			
		128502		**Total**		**77010.7**	**0.20**	**0.4**	**0.462**

Notes:

1 - 8x16 (0.462 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 3

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*3*	*304484*	*Mixed Surface Types*	*0.8*	*0.60*	*182476*			
		304484	***Total***			**182476**	**0.20**	***0.8***	***0.808***

Notes:

1 - 8x24 (0.693 cfs capacity), and 1 4x8 (0.115 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc.
Date: 4/30/2020
Designed by: Martin Parker
Case No:
Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 4

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity: I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
4	*492663*	*Mixed Surface Types*	*0.8*	*0.60*	*295251*			
	492663	***Total***			**295251**	**0.20**	***1.4***	***1.438***

DMAs

Notes:

2 - 8'x24' (1.386 cfs capacity) and 1 - 4'x4' (0.052 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc.

Date: 4/30/2020

Designed by: Martin Parker

Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 5

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*5*	*124146*	*Mixed Surface Types*	*0.8*	*0.60*	*74400.2*			
		124146	***Total***			**74400.2**	**0.20**	***0.3***	***0.346***

Notes:

1 - 8'x12' (0.346 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	Hunsaker & Associates Irvine, Inc.	Date	4/30/2020
Designed by	Martin Parker	Case No	
Company Project Number/Name	Stoneridge		

BMP Identification

BMP NAME / ID 6

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*6*	*463478*	*Mixed Surface Types*	*0.8*	*0.60*	*277760.5*			
		463478		***Total***		**277760.5**	**0.20**	***1.3***	***1.386***

Notes:

2 - 8'x24' (1.386 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries | Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	Hunsaker & Associates Irvine, Inc.	Date	4/30/2020
Designed by	Martin Parker	Case No	
Company Project Number/Name	Stoneridge		

BMP Identification

BMP NAME / ID 7

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imprevious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*7*	*3326241*	*Mixed Surface Types*	*0.8*	*0.60*	*1993402.9*			
		3326241	***Total***			**1993402.9**	**0.20**	***9.2***	***9.206***

Notes:

13 - 8'x24' (9.0 cfs capacity) & 1 - 4'x17' (0.206 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	Hunsaker & Associates Irvine, Inc.	Date	4/30/2020
Designed by	Martin Parker	Case No	
Company Project Number/Name	Stoneridge		

BMP Identification

BMP NAME / ID 8

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMAs

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
8	*714819*	*Mixed Surface Types*	*0.8*	*0.60*	*428388.2*			
	714819	***Total***			**428388.2**	**0.20**	**2**	***2.07***

Notes:

3 - 8'x24' (2.07 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 9

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
9	*564537*	*Concrete or Asphalt*	*1*	*0.89*	*503567*			
	564537	***Total***			503567	0.20	2.3	2.316

DMAs

Notes:

3 - 8'x24' (2.07 cfs capacity) & 1 4'x19' (0.237 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries | Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 10

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*10*	*3014787*	*Mixed Surface Types*	*0.8*	*0.60*	*1806749.8*			
		3014787	***Total***			**1806749.8**	**0.20**	***8.3***	***8.316***

Notes:

12 - 8'x24' (8.316 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	Hunsaker & Associates Irvine, Inc.	Date	4/30/2020
Designed by	Martin Parker	Case No	
Company Project Number/Name	Stoneridge		

BMP Identification

BMP NAME / ID 11

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
11	*1537232*	*Mixed Surface Types*	*0.8*	*0.60*	*921257*			
	1537232		**Total**		**921257**	**0.20**	**4.2**	**4.21**

DMAs

Notes:

6 - 8'x24' (4.158 cfs capacity) & 1 - 4'x4' (0.052 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. | Date: 4/30/2020

Designed by: Martin Parker | Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 12

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity: I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*1*	*471319*	*Mixed Surface Types*	*0.8*	*0.60*	*282459.6*			
		471319		**Total**		**282459.6**	**0.20**	**1.3**	**1.386**

Notes:

2 - 8'x24' (1.386 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. | Date: 4/30/2020

Designed by: Martin Parker | Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 13

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*13*	*36590*	*Mixed Surface Types*	*0.8*	*0.60*	*21928.2*			
		36590		**Total**		**21928.2**	**0.20**	**0.1**	**0.115**

Notes:

1 - 4'x8' (0.115 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries | Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. Date: 4/30/2020

Designed by: Martin Parker Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 14

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*14*	*21870*	*Ornamental Landscaping*	*0.1*	*0.11*	*2415.7*			
		21870	***Total***			**2415.7**	**0.20**	***0***	

Notes:

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc.
Date: 4/30/2020
Designed by: Martin Parker
Case No:
Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 15

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*15*	*226512*	*Mixed Surface Types*	*0.8*	*0.60*	*135747.7*			
		226512	**Total**			**135747.7**	**0.20**	**0.6**	**0.693**

Notes:

1 - 8'x24' (0.693 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 16

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*16*	*228524*	*Mixed Surface Types*	*0.8*	*0.60*	*136953.5*			
		228524	***Total***			**136953.5**	**0.20**	***0.6***	***0.693***

Notes:

1 - 8'x24' (0.693 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 17

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*17*	*186436*	*Mixed Surface Types*	*0.8*	*0.60*	*111730.3*			
		186436	***Total***			**111730.3**	**0.20**	***0.5***	***0.577***

Notes:

1 - 8'x20' (0.577 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc.
Date: 4/30/2020
Designed by: Martin Parker
Case No:
Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 18

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*18*	*120225*	*Mixed Surface Types*	*0.8*	*0.60*	*72050.4*			
		120225		**Total**		**72050.4**	**0.20**	**0.3**	**0.346**

Notes:

1 - 8'x12' (0.346 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. | Date: 4/30/2020

Designed by: Martin Parker | Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 19

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity: I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imprevious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*19*	*117176*	*Mixed Surface Types*	*0.8*	*0.60*	*70223.1*			
		117176		***Total***		**70223.1**	**0.20**	***0.3***	***0.346***

Notes:

1 - 8'x12' (0.346 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. | Date: 4/30/2020

Designed by: Martin Parker | Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 20

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity: I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*20*	*105415*	*Mixed Surface Types*	*0.8*	*0.60*	*63174.8*			
		105415	***Total***			**63174.8**	**0.20**	***0.3***	***0.346***

Notes:

1 - 8'x12' (0.346 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	Hunsaker & Associates Irvine, Inc.	Date	4/30/2020
Designed by	Martin Parker	Case No	
Company Project Number/Name	Stoneridge		

BMP Identification

BMP NAME / ID 21

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*21*	*141570*	*Mixed Surface Types*	*0.8*	*0.60*	*84842.3*			
		141570		**Total**		**84842.3**	**0.20**	**0.4**	**0.462**

Notes:

1 - 8'x16' (0.462 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 22

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMAs

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
22	*104544*	*Concrete or Asphalt*	*1*	*0.89*	*93253.2*			
	104544	***Total***			93253.2	0.20	*0.4*	*0.462*

Notes:

1 - 8'x16' (0.462 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries; Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc.
Date: 4/30/2020
Designed by: Martin Parker
Case No:
Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 23

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity: I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	Design Rainfall Intensity (in/hr)	Design Flow Rate (cfs)	Proposed Flow Rate (cfs)
23	456944	Mixed Surface Types	0.8	0.60	273844.7			
	456944	Total			273844.7	0.20	1.3	1.386

DMAs

Notes:

2 - 8'x24' (1.386 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc.
Date: 4/30/2020
Designed by: Martin Parker
Case No:
Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 24

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity: I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
24	*298821*	*Concrete or Asphalt*	*1*	*0.89*	*266548.3*			
	298821	**Total**			**266548.3**	**0.20**	**1.2**	**1.27**

DMAs

Notes:

1 - 8'x24' (0.693cfs capacity) & 1 - 8'x16' (0.577 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries | Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. | Date: 4/30/2020

Designed by: Martin Parker | Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 25

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity: I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*25*	*65340*	*Concrete or Asphalt*	*1*	*0.89*	*58283.3*			
		65340	***Total***			**58283.3**	**0.20**	***0.3***	***0.346***

Notes:

1 - 8'x12' (0.346 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. | Date: 4/30/2020

Designed by: Martin Parker | Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 26

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imprevious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*26*	*397702*	*Mixed Surface Types*	*0.8*	*0.60*	*238341.2*			
		397702		***Total***		**238341.2**	**0.20**	***1.1***	***1.155***

Notes:

1 - 8'x24' (0.693 cfs capacity) & 1- 8'x16' (0.462 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 27

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
27	*1146934*	*Mixed Surface Types*	*0.8*	*0.60*	*687353*			
	1146934		**Total**		687353	0.20	*3.2*	*3.234*

DMAs

Notes:

4-8'x24' (cfs capacity 2.772) & 1-8'x16' (0.462 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 28

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
28	*240075*	*Mixed Surface Types*	*0.8*	*0.60*	*143876*			
	240075	**Total**			**143876**	**0.20**	**0.7**	**0.745**

DMAs

Notes:

1-8'x24' (0.693 cfs capacity) & 1-4'x4' (0.052 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	Hunsaker & Associates Irvine, Inc.	Date	4/30/2020
Designed by	Martin Parker	Case No	
Company Project Number/Name	Stoneridge		

BMP Identification

BMP NAME / ID 29

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*29*	*261360*	*Concrete or Asphalt*	*1*	*0.89*	*233133.1*			
		261360		***Total***		**233133.1**	**0.20**	**1.1**	**1.155**

Notes:

1-8'x24' (0.693 cfs capacity) & 1-8'x16' (0.462 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 30

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
30	*36590*	*Concrete or Asphalt*	*1*	*0.89*	*32638.3*			
	36590	***Total***			**32638.3**	**0.20**	***0.1***	***0.115***

DMAs

Notes:

1-4'x8' (0.115 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	Hunsaker & Associates Irvine, Inc.	Date	4/30/2020
Designed by	Martin Parker	Case No	
Company Project Number/Name	Stoneridge		

BMP Identification

BMP NAME / ID 31

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*31*	*37098*	*Mixed Surface Types*	*0.8*	*0.60*	*22232.7*			
		37098		***Total***		**22232.7**	**0.20**	***0.1***	***0.115***

Notes:

1-4'x8' (0.115 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name	Hunsaker & Associates Irvine, Inc.	Date	4/30/2020
Designed by	Martin Parker	Case No	
Company Project Number/Name	Stoneridge		

BMP Identification

BMP NAME / ID 32

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*32*	*203425*	*Mixed Surface Types*	*0.8*	*0.60*	*121911.8*			
		203425	***Total***			**121911.8**	**0.20**	***0.6***	***0.693***

Notes:

1-8'x24' (0.693 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries | Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc. — Date: 4/30/2020

Designed by: Martin Parker — Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 33

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*33*	*211701*	*Mixed Surface Types*	*0.8*	*0.60*	*126871.6*			
		211701	***Total***			**126871.6**	**0.20**	***0.6***	***0.693***

Notes:

1-8'x24' (0.693 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc.
Date: 4/30/2020
Designed by: Martin Parker
Case No:
Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 34

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity: I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*34*	*202554*	*Mixed Surface Types*	*0.8*	*0.60*	*121389.8*			
		202554	**Total**			121389.8	**0.20**	**0.6**	**0.693**

Notes:

1-8'x24' (0.693 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries / Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc.

Date: 4/30/2020

Designed by: Martin Parker

Case No:

Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 35

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity: I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

DMAs	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
	35	*202554*	*Mixed Surface Types*	*0.8*	*0.60*	*121389.8*			
		202554	**Total**			**121389.8**	**0.20**	**0.6**	**0.693**

Notes:

1-8'x24' (0.693 cfs capacity)

Santa Ana Watershed - BMP Design Flow Rate, Q_{BMP}

(Rev. 10-2011)

Legend: Required Entries | Calculated Cells

*(Note this worksheet shall **only** be used in conjunction with BMP designs from the **LID BMP Design Handbook**)*

Company Name: Hunsaker & Associates Irvine, Inc.
Date: 4/30/2020
Designed by: Martin Parker
Case No:
Company Project Number/Name: Stoneridge

BMP Identification

BMP NAME / ID: 36

Must match Name/ID used on BMP Design Calculation Sheet

Design Rainfall Depth

Design Rainfall Intensity — I = 0.20 in/hr

Drainage Management Area Tabulation

Insert additional rows if needed to accommodate all DMAs draining to the BMP

	DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type (use pull-down menu)	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Design Rainfall Intensity (in/hr)*	*Design Flow Rate (cfs)*	*Proposed Flow Rate (cfs)*
DMAs	*36*	*273992*	*Mixed Surface Types*	*0.8*	*0.60*	*164202.3*			
		273992	***Total***			**164202.3**	**0.20**	***0.8***	***0.808***

Notes:

1-8'x24' (0.692 cfs capacity) & 1- 4'x8' (0.115 cfs capacity)

Effective Impervious Fraction

Developed Cover Types	Effective Impervious Fraction
Roofs	1.00
Concrete or Asphalt	1.00
Grouted or Gapless Paving Blocks	1.00
Compacted Soil (e.g. unpaved parking)	0.40
Decomposed Granite	0.40
Permeable Paving Blocks w/ Sand Filled Gap	0.25
Class 2 Base	0.30
Gravel or Class 2 Permeable Base	0.10
Pervious Concrete / Porous Asphalt	0.10
Open and Porous Pavers	0.10
Turf block	0.10
Ornamental Landscaping	0.10
Natural (A Soil)	0.03
Natural (B Soil)	0.15
Natural (C Soil)	0.30
Natural (D Soil)	0.40

Mixed Surface Types

Use this table to determine the effective impervious fraction for the V_{BMP} and Q_{BMP} calculation sheets

Bio Clean

A Forterra Company

Modular Wetlands® System Linear

A Stormwater Biofiltration Solution

OVERVIEW

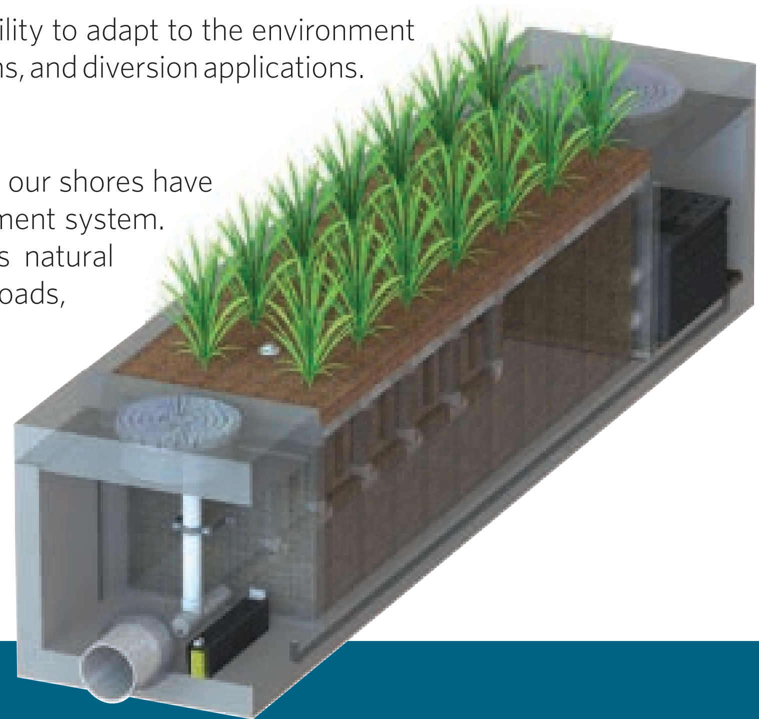
The Bio Clean Modular Wetlands® System Linear represents a pioneering breakthrough in stormwater technology as the only biofiltration system to utilize patented horizontal flow, allowing for a smaller footprint, higher treatment capacity, and a wide range of versatility. While most biofilters use little or no pretreatment, the Modular Wetlands® incorporates an advanced pretreatment chamber that includes separation and pre-filter cartridges. In this chamber, sediment and hydrocarbons are removed from runoff before entering the biofiltration chamber, reducing maintenance costs and improving performance.

Horizontal flow also gives the system the unique ability to adapt to the environment through a variety of configurations, bypass orientations, and diversion applications.

The Urban Impact

For hundreds of years, natural wetlands surrounding our shores have played an integral role as nature's stormwater treatment system. But as cities grow and develop, our environment's natural filtration systems are blanketed with impervious roads, rooftops, and parking lots.

Bio Clean understands this loss and has spent years re-establishing nature's presence in urban areas, and rejuvenating waterways with the Modular Wetlands® System Linear.



PERFORMANCE

The Modular Wetlands® continues to outperform other treatment methods with superior pollutant removal for TSS, heavy metals, nutrients, hydrocarbons, and bacteria. Since 2007 the Modular Wetlands® has been field tested on numerous sites across the country and is proven to effectively remove pollutants through a combination of physical, chemical, and biological filtration processes. In fact, the Modular Wetlands® harnesses some of the same biological processes found in natural wetlands in order to collect, transform, and remove even the most harmful pollutants.

66% REMOVAL OF DISSOLVED ZINC	**69%** REMOVAL OF TOTAL ZINC	**38%** REMOVAL OF DISSOLVED COPPER	**64%** REMOVAL OF TOTAL PHOSPHORUS	
45% REMOVAL OF NITROGEN	**50%** REMOVAL OF TOTAL COPPER	**95%** REMOVAL OF MOTOR OIL	**67%** REMOVAL OF ORTHO PHOSPHORUS	**85%** REMOVAL OF TSS

APPROVALS

The Modular Wetlands® System Linear has successfully met years of challenging technical reviews and testing from some of the most prestigious and demanding agencies in the nation and perhaps the world. Here is a list of some of the most high-profile approvals, certifications, and verifications from around the country.

State of Washington TAPE GULD Basic Enhanced/Metals Phosphorus

Washington State Department of Ecology TAPE Approved
The MWS Linear is approved for General Use Level Designation (GULD) for Basic, Enhanced, and Phosphorus treatment at 1 gpm/ft^2 loading rate. The highest performing BMP on the market for all main pollutant categories.

CA

California Water Resources Control Board, Full Capture Certification
The Modular Wetlands® System is the first biofiltration system to receive certification as a full capture trash treatment control device.

VA

Virginia Department of Environmental Quality, Assignment
The Virginia Department of Environmental Quality assigned the MWS Linear the highest phosphorus removal rating for manufactured treatment devices to meet the new Virginia Stormwater Management Program (VSMP) regulation technical criteria.

MD

Maryland Department of the Environment, Approved ESD
Granted Environmental Site Design (ESD) status for new construction, redevelopment, and retrofitting when designed in accordance with the design manual.

MA

MASTEP Evaluation
The University of Massachusetts at Amherst – Water Resources Research Center issued a technical evaluation report noting removal rates up to 84% TSS, 70% total phosphorus, 68.5% total zinc, and more.

RI

Rhode Island Department of Environmental Management, Approved BMP
Approved as an authorized BMP and noted to achieve the following minimum removal efficiencies: 85% TSS, 60% pathogens, 30% total phosphorus, and 30% total nitrogen.

ADVANTAGES

- HORIZONTAL FLOW BIOFILTRATION
- GREATER FILTER SURFACE AREA
- PRETREATMENT CHAMBER
- PATENTED PERIMETER VOID AREA
- FLOW CONTROL
- NO DEPRESSED PLANTER AREA
- AUTO DRAINDOWN MEANS NO MOSQUITO VECTOR

OPERATION

The Modular Wetlands® System Linear is the most efficient and versatile biofiltration system on the market, and it is the only system with horizontal flow which:

- Improves performance
- Reduces footprint
- Minimizes maintenance

Figure 1 & Figure 2 illustrate the invaluable benefits of horizontal flow and the multiple treatment stages.

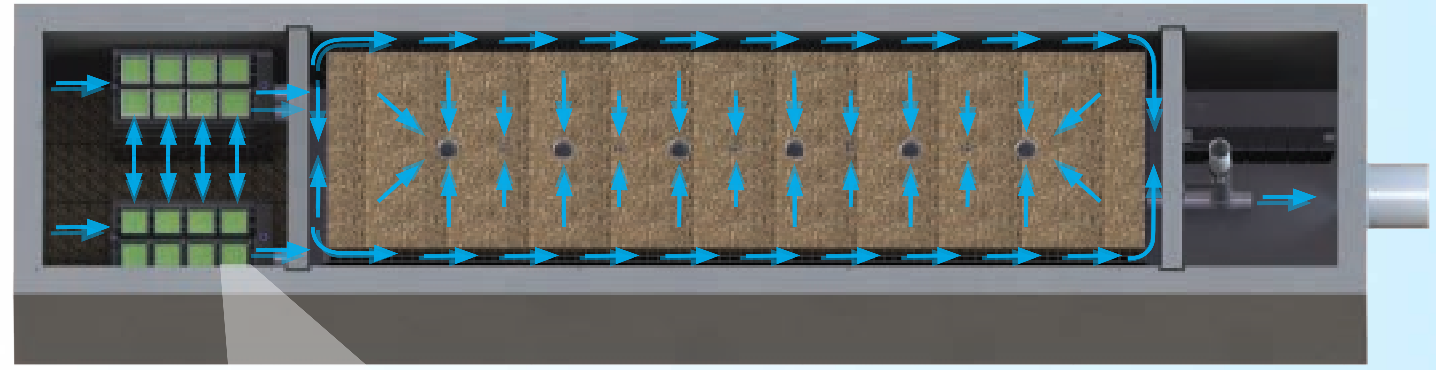
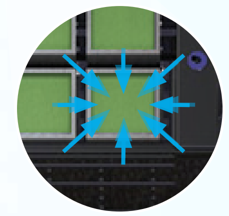


Figure 2, Top View



2x to 3x more surface area than traditional downward flow bioretention systems.

1 PRETREATMENT

SEPARATION

- Trash, sediment, and debris are separated before entering the pre-filter cartridges
- Designed for easy maintenance access

PRE-FILTER CARTRIDGES

- Over 25 sq. ft. of surface area per cartridge
- Utilizes BioMediaGREEN™ filter material
- Removes over 80% of TSS and 90% of hydrocarbons
- Prevents pollutants that cause clogging from migrating to the biofiltration chamber

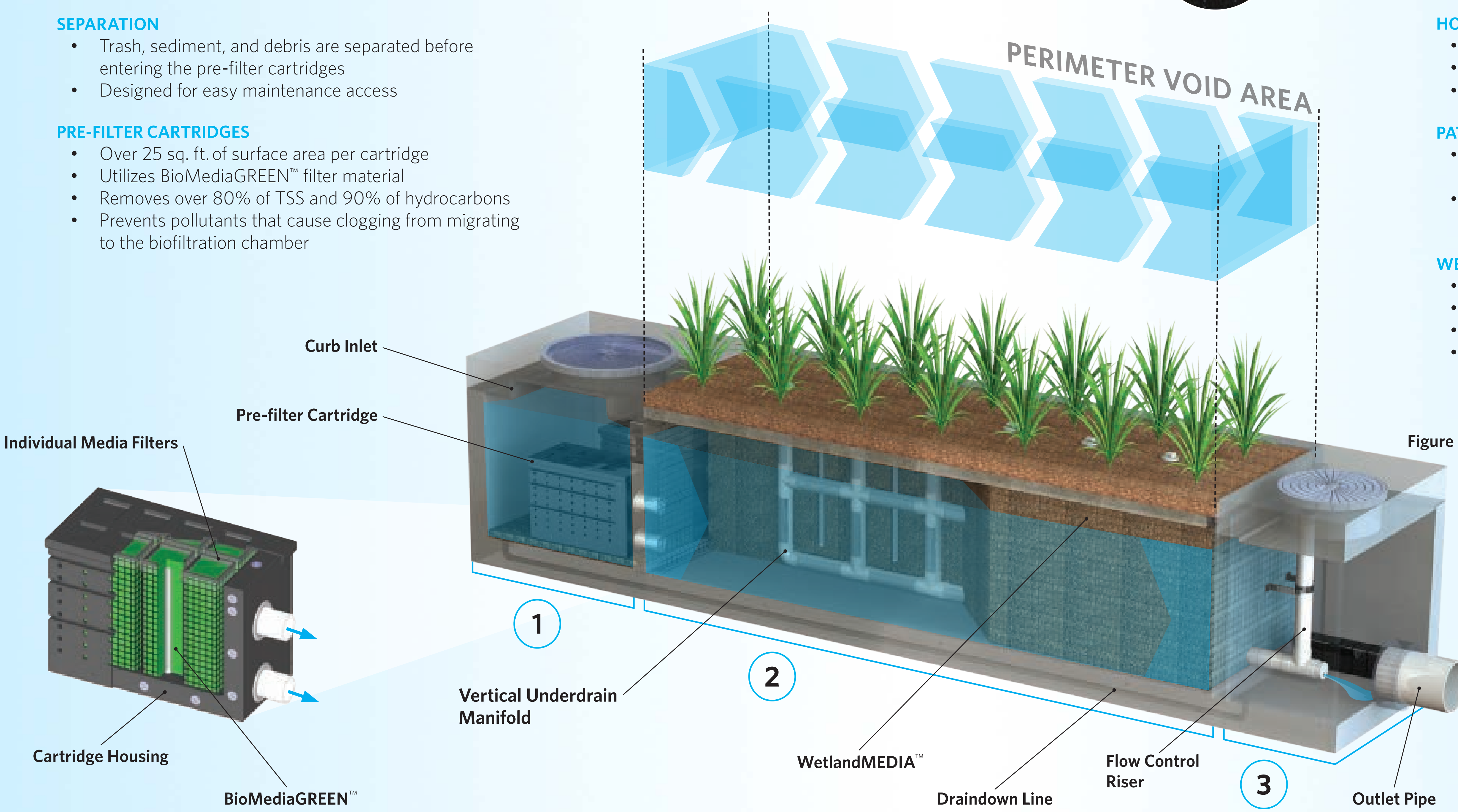


Figure 1

2 BIOFILTRATION

HORIZONTAL FLOW

- Less clogging than downward flow biofilters
- Water flow is subsurface
- Improves biological filtration

PATENTED PERIMETER VOID AREA

- Vertically extends void area between the walls and the WetlandMEDIA™ on all four sides
- Maximizes surface area of the media for higher treatment capacity

WETLANDMEDIA

- Contains no organics and removes phosphorus
- Greater surface area and 48% void space
- Maximum evapotranspiration
- High ion exchange capacity and lightweight

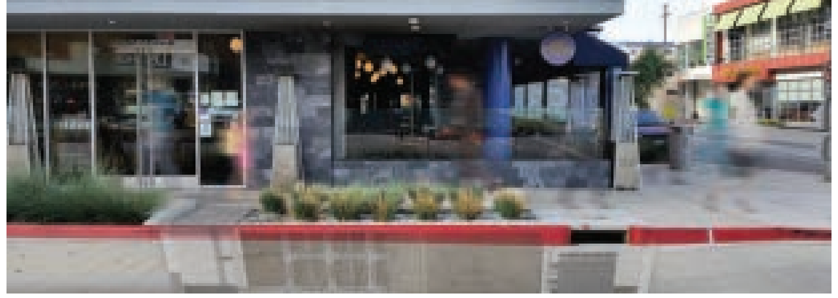
3 DISCHARGE

FLOW CONTROL

- Orifice plate controls flow of water through WetlandMEDIA™ to a level lower than the media's capacity
- Extends the life of the media and improves performance

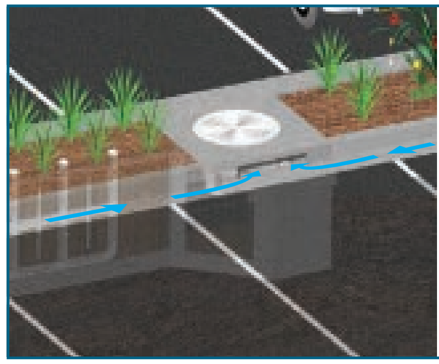
DRAINDOWN FILTER

- The draindown is an optional feature that completely drains the pretreatment chamber
- Water that drains from the pretreatment chamber between storm events will be treated



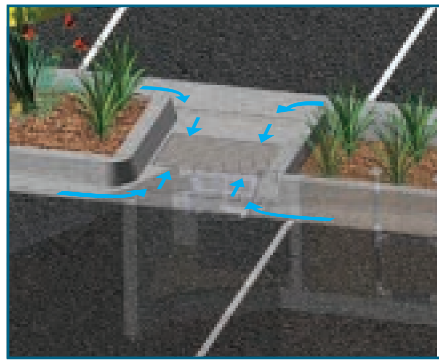
CONFIGURATIONS

The Modular Wetlands® System Linear is the preferred biofiltration system of civil engineers across the country due to its versatile design. This highly versatile system has available "pipe-in" options on most models, along with built-in curb or grated inlets for simple integration into your storm drain design.



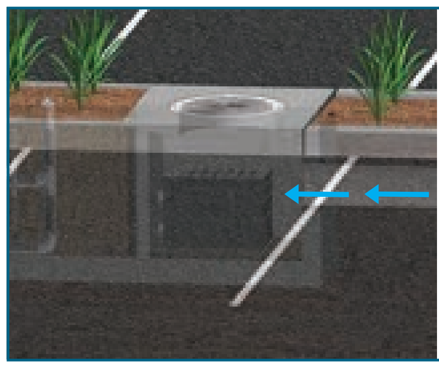
CURB TYPE

The Curb Type configuration accepts sheet flow through a curb opening and is commonly used along roadways and parking lots. It can be used in sump or flow-by conditions. Length of curb opening varies based on model and size.



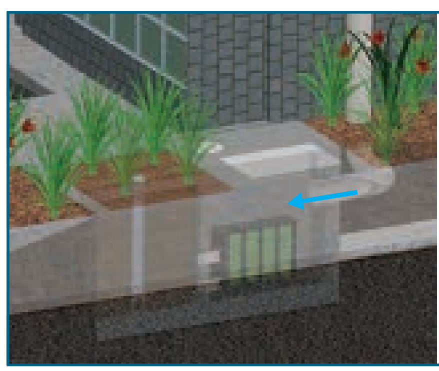
GRATE TYPE

The Grate Type configuration offers the same features and benefits as the Curb Type but with a grated/drop inlet above the systems pretreatment chamber. It has the added benefit of allowing pedestrian access over the inlet. ADA-compliant grates are available to assure easy and safe access. The Grate Type can also be used in scenarios where runoff needs to be intercepted on both sides of landscape islands.



VAULT TYPE

The system's patented horizontal flow biofilter is able to accept inflow pipes directly into the pretreatment chamber, meaning the Modular Wetlands® can be used in end-of-the-line installations. This greatly improves feasibility over typical decentralized designs that are required with other biofiltration/bioretention systems. Another benefit of the "pipe-in" design is the ability to install the system downstream of underground detention systems to meet water quality volume requirements.



DOWNSPOUT TYPE

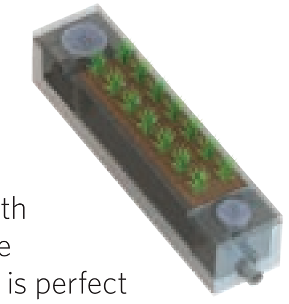
The Downspout Type is a variation of the Vault Type and is designed to accept a vertical downspout pipe from rooftop and podium areas. Some models have the option of utilizing an internal bypass, simplifying the overall design. The system can be installed as a raised planter, and the exterior can be stuccoed or covered with other finishes to match the look of adjacent buildings.

ORIENTATIONS

SIDE-BY-SIDE

The Side-By-Side orientation places the pretreatment and discharge chamber adjacent to one another with the biofiltration chamber running parallel on either side. This minimizes the system length, providing a highly compact footprint. It has been proven useful in situations such as streets with directly adjacent sidewalks, as half of the system can be placed under that sidewalk. This orientation also offers internal bypass options as discussed below.

END-TO-END



The End-To-End orientation places the pretreatment and discharge chambers on opposite ends of the biofiltration chamber, therefore minimizing the width of the system to 5 ft. (outside dimension). This orientation is perfect for linear projects and street retrofits where existing utilities and sidewalks limit the amount of space available for installation. One limitation of this orientation is that bypass must be external.

BYPASS

INTERNAL BYPASS WEIR (SIDE-BY-SIDE ONLY)

The Side-By-Side orientation places the pretreatment and discharge chambers adjacent to one another allowing for integration of internal bypass. The wall between these chambers can act as a bypass weir when flows exceed the system's treatment capacity, thus allowing bypass from the pretreatment chamber directly to the discharge chamber.

EXTERNAL DIVERSION WEIR STRUCTURE

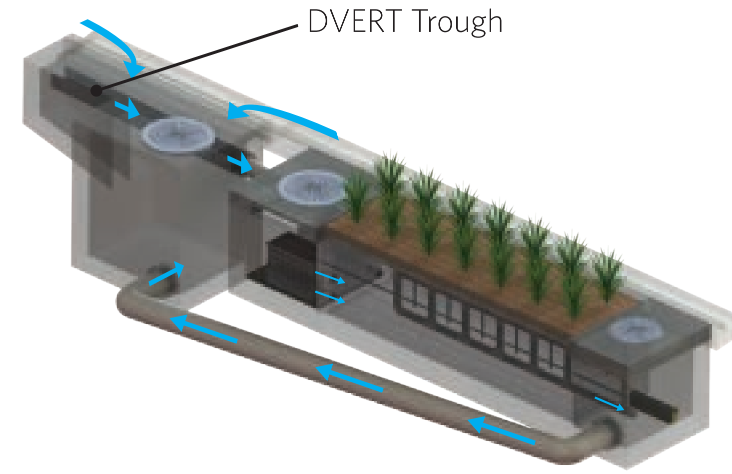
This traditional offline diversion method can be used with the Modular Wetlands® in scenarios where runoff is being piped to the system. These simple and effective structures are generally configured with two outflow pipes. The first is a smaller pipe on the upstream side of the diversion weir - to divert low flows over to the Modular Wetlands® for treatment. The second is the main pipe that receives water once the system has exceeded treatment capacity and water flows over the weir.

FLOW-BY-DESIGN

This method is one in which the system is placed just upstream of a standard curb or grate inlet to intercept the first flush. Higher flows simply pass by the Modular Wetlands® and into the standard inlet downstream.

DVERT LOW FLOW DIVERSION

This simple yet innovative diversion trough can be installed in existing or new curb and grate inlets to divert the first flush to the Modular Wetlands® via pipe. It works similar to a rain gutter and is installed just below the opening into the inlet. It captures the low flows and channels them over



to a connecting pipe exiting out the wall of the inlet and leading to the MWS Linear. The DVERT is perfect for retrofit and green street applications that allow the Modular Wetlands® to be installed anywhere space is available.

SPECIFICATIONS

FLOW-BASED DESIGNS

The Modular Wetlands® System Linear can be used in stand-alone applications to meet treatment flow requirements. Since the Modular Wetlands® is the only biofiltration system that can accept inflow pipes several feet below the surface, it can be used not only in decentralized design applications but also as a large central end-of-the-line application for maximum feasibility.

MODEL #	DIMENSIONS	WETLANDMEDIA SURFACE AREA (sq. ft.)	TREATMENT FLOW RATE (cfs)
MWS-L-4-4	4' x 4'	23	0.052
MWS-L-4-6	4' x 6'	32	0.073
MWS-L-4-8	4' x 8'	50	0.115
MWS-L-4-13	4' x 13'	63	0.144
MWS-L-4-15	4' x 15'	76	0.175
MWS-L-4-17	4' x 17'	90	0.206
MWS-L-4-19	4' x 19'	103	0.237
MWS-L-4-21	4' x 21'	117	0.268
MWS-L-6-8	7' x 9'	64	0.147
MWS-L-8-8	8' x 8'	100	0.230
MWS-L-8-12	8' x 12'	151	0.346
MWS-L-8-16	8' x 16'	201	0.462
MWS-L-8-20	9' x 21'	252	0.577
MWS-L-8-24	9' x 25'	302	0.693
MWS-L-10-20	10' x 20'	302	0.693

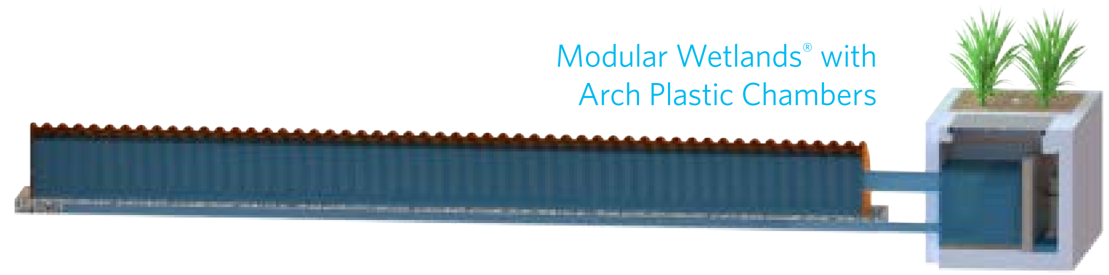
VOLUME-BASED DESIGNS

HORIZONTAL FLOW BIOFILTRATION ADVANTAGE

Modular Wetlands® with Box Culvert Prestorage

The Modular Wetlands® System Linear offers a unique advantage in the world of biofiltration due to its exclusive horizontal flow design: Volume-Based Design. No other biofilter has the ability to be placed downstream of detention ponds, extended dry detention basins, underground storage systems and permeable paver reservoirs. The systems horizontal flow configuration and built-in orifice control allows it to be installed with just 6" of fall between inlet and outlet pipe for a simple connection to projects with shallow downstream tie-in points. In the example above, the Modular Wetlands® is installed downstream of underground box culvert storage. Designed for the water quality volume, the Modular Wetlands® will treat and discharge the required volume within local draindown time requirements.

Modular Wetlands® with Arch Plastic Chambers



DESIGN SUPPORT

Bio Clean engineers are trained to provide you with superior support for all volume sizing configurations throughout the country. Our vast knowledge of state and local regulations allow us to quickly and efficiently size a system to maximize feasibility. Volume control and hydromodification regulations are expanding the need to decrease the cost and size of your biofiltration system. Bio Clean will help you realize these cost savings with the Modular Wetlands®, the only biofilter than can be used downstream of storage BMPs.

ADVANTAGES

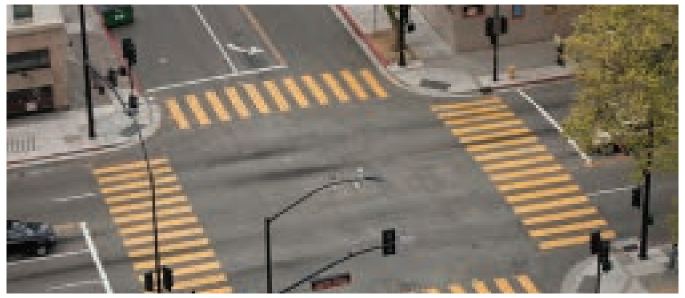
- LOWER COST THAN FLOW-BASED DESIGN
- MEETS LID REQUIREMENTS
- BUILT-IN ORIFICE CONTROL STRUCTURE
- WORKS WITH DEEP INSTALLATIONS

APPLICATIONS

The Modular Wetlands® System Linear has been successfully used on numerous new construction and retrofit projects. The system's superior versatility makes it beneficial for a wide range of stormwater and waste water applications - treating rooftops, streetscapes, parking lots, and industrial sites.

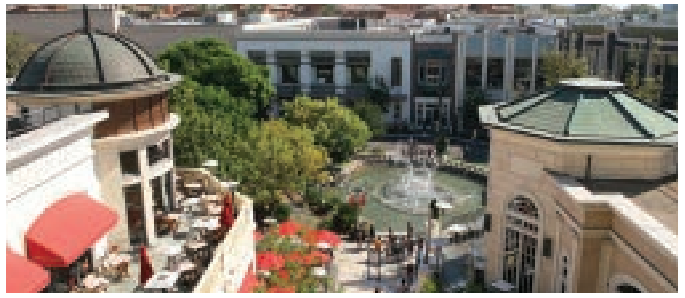
INDUSTRIAL
Many states enforce strict regulations for discharges from industrial sites. The Modular Wetlands® has helped various sites meet difficult EPA-mandated effluent limits for dissolved metals and other pollutants.

RESIDENTIAL
Low to high density developments can benefit from the versatile design of the Modular Wetlands®. The system can be used in both decentralized LID design and cost-effective end-of-the-line configurations.



STREETS
Street applications can be challenging due to limited space. The Modular Wetlands® is very adaptable, and it offers the smallest footprint to work around the constraints of existing utilities on retrofit projects.

PARKING LOTS
Parking lots are designed to maximize space and the Modular Wetlands'® 4 ft. standard planter width allows for easy integration into parking lot islands and other landscape medians.



COMMERCIAL
Compared to bioretention systems, the Modular Wetlands® can treat far more area in less space, meeting treatment and volume control requirements.

MIXED USE
The Modular Wetlands® can be installed as a raised planter to treat runoff from rooftops or patios, making it perfect for sustainable "live-work" spaces.

More applications include:
• Agriculture • Reuse • Low Impact Development • Waste Water

PLANT SELECTION

Abundant plants, trees, and grasses bring value and an aesthetic benefit to any urban setting, but those in the Modular Wetlands® System Linear do even more - they increase pollutant removal. What's not seen, but very important, is that below grade, the stormwater runoff/flow is being subjected to nature's secret weapon: a dynamic physical, chemical, and biological process working to break down and remove non-point source pollutants. The flow rate is controlled in the Modular Wetlands®, giving the plants more contact time so that pollutants are more successfully decomposed, volatilized, and incorporated into the biomass of the Modular Wetlands'® micro/macro flora and fauna.

A wide range of plants are suitable for use in the Modular Wetlands®, but selections vary by location and climate. View suitable plants by visiting biocleanenvironmental.com/plants.

INSTALLATION

The Modular Wetlands® is simple, easy to install, and has a space-efficient design that offers lower excavation and installation costs compared to traditional tree-box type systems. The structure of the system resembles precast catch basin or utility vaults and is installed in a similar fashion.

The system is delivered fully assembled for quick installation. Generally, the structure can be unloaded and set in place in 15 minutes. Our experienced team of field technicians is available to supervise installations and provide technical support.

MAINTENANCE

Reduce your maintenance costs, man hours, and materials with the Modular Wetlands®. Unlike other biofiltration systems that provide no pretreatment, the Modular Wetlands® is a self-contained treatment train which incorporates simple and effective pretreatment.

Maintenance requirements for the biofilter itself are almost completely eliminated, as the pretreatment chamber removes and isolates trash, sediments, and hydrocarbons. What's left is the simple maintenance of an easily accessible pretreatment chamber that can be cleaned by hand or with a standard vac truck. Only periodic replacement of low-cost media in the pre-filter cartridges is required for long-term operation, and there is absolutely no need to replace expensive biofiltration media.

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Appendix 7: Hydromodification

Supporting Detail Relating to Hydrologic Conditions of Concern

Appendix 8: Source Control

Pollutant Sources/Source Control Checklist

Appendix 9: O&M

Operation and Maintenance Plan and Documentation of Finance, Maintenance and Recording Mechanisms

Appendix 10: Educational Materials

BMP Fact Sheets, Maintenance Guidelines and Other End-User BMP Information