APPENDIX N: PROJECT SPECIFIC WATER QUALITY MANAGEMENT PLAN

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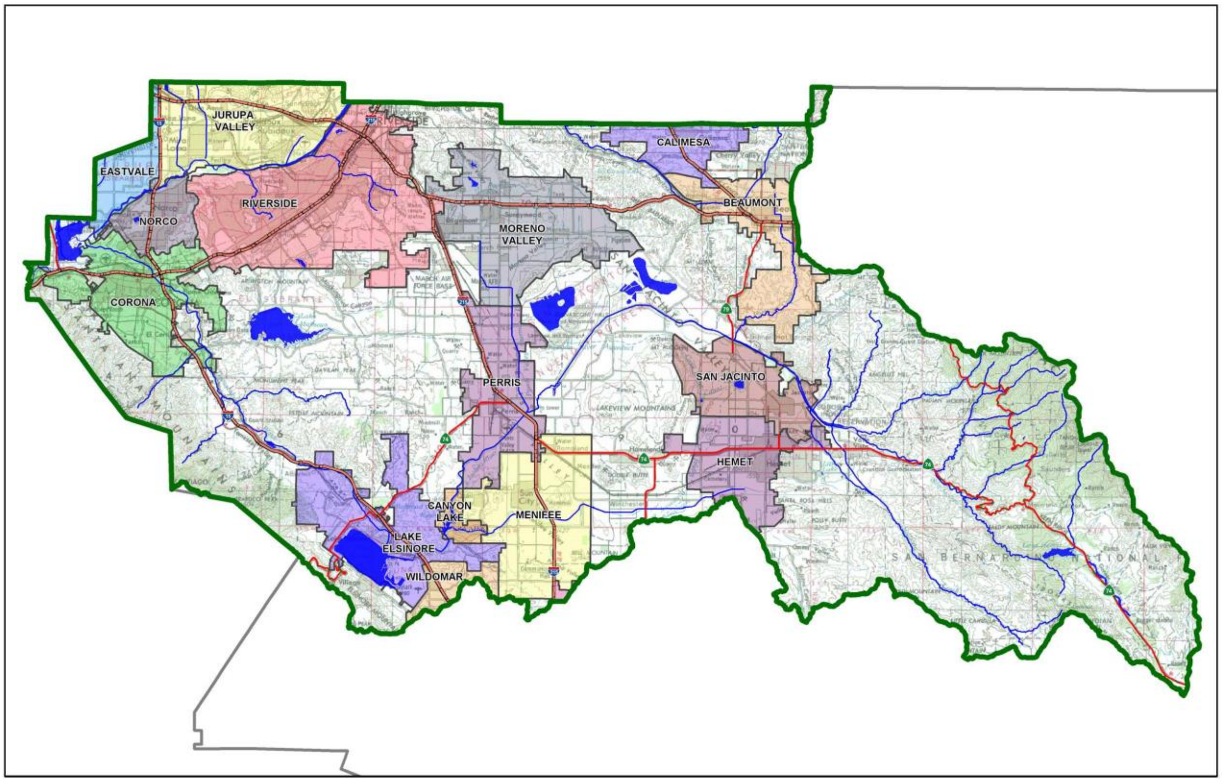
Project Specific Water Quality Management Plan

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

Project Title: PALOMINO BUSINESS PARK

Development No: TBD

Design Review/Case No: TBD



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☒ **Preliminary**
☐ **Final**

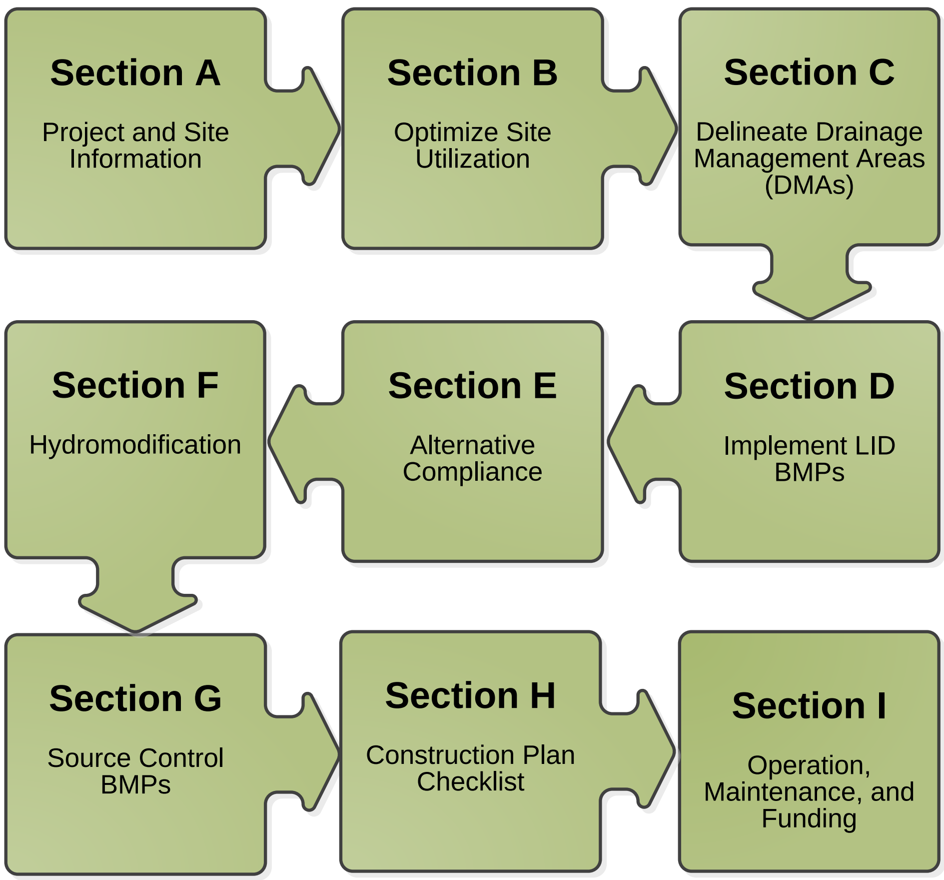
Original Date Prepared: October 30, 2019

Revision Date(s):

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

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 CapRock Acquisitions, LLC by Michael Baker International for the Palomino Business Park Project.

This WQMP is intended to comply with the requirements of City of Norco and the National Pollutant Discharge Elimination System (NPDES) permit and waste discharge requirements for the Riverside County Flood Control and Water Conservation District. The County of Riverside, and the incorporated cities of Riverside County within the Santa Ana region area-wide urban runoff management program (Order No. R8-2010-0033) include 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 City of Norco Water Quality Ordinance (Municipal Code Section 15.70).

"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."

______________________________	October 30, 2019
Preparer's Signature	Date
Terrence Chen	Surface Water Project Manager
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/Commercial	
Planning Area:	Gateway Specific Plan	
Community Name:	N/A	
Development Name:	Palomino Business Park	
PROJECT LOCATION		
Latitude & Longitude (DMS): 33.905788, -117.569126		
Project Watershed: Santa Ana Watershed		
Project Sub-Watershed: Lake Norconian-Temescal Wash		
Gross Acres: 107.83		
APN(s): Project encompasses 41 parcels. Refer to Tentative Tract Map, Sheet 3 of 8, for list and legal description of each parcel.		
PROJECT CHARACTERISTICS		
Proposed or Potential Land Use(s)		Industrial/Commercial
Proposed or Potential SIC Code(s)		4225
Area of Project Footprint (SF)		4,697,075
Total Area of <u>proposed</u> Impervious Surfaces within the Project Footprint (SF)/or Replacement		2,729,417
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)		1,682,723
Is the project located within any MSHCP Criteria Cell?		☐ Y ☒ N
If so, identify the Cell number:		N/A
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?		0.78 inches

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
South/North Norco Channel (Site is divided)	N/A	N/A	N/A
Temescal Creek, Reach 1	pH	MUN, REC1, REC2, WARM, WILD	N/A
Santa Ana River, Reach 3	Copper, Lead, Pathogens	AGR, GWR, MUN, RARE, REC1, REC2, SPWN, WARM, WILD	3.3 miles
Prado Basin Management Zone	N/A	MUN, REC1, REC2, WARM, WILD, RARE	2,700 feet
Santa Ana River, Reach 2	Indicator Bacteria	AGR, GWR, WARM, WILD, MUN, RARE, REC1, REC2	4.6 miles
Santa Ana River, Reach 1	None	REC1, REC2, WARM, WILD, MUN	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)* Construction Permits, Grading Permits	☒ Y	☐ N

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?

Existing off-site drainage patterns have been preserved. The South Norco Channel conveys off-site flows through the project in a southwesterly direction. Off-site flows enter the project site from the culverts on Mountain Avenue to the culvert crossings on First Street, covering roughly 800 feet. The channel meanders through the site as an unimproved, natural channel.

Existing drainage patterns within the project site have been preserved to the maximum extent practical. Currently, most of the project area (approximately 90 to 95 percent) is tributary to the South Norco Channel. The remaining area descends to the north and is tributary to the North Norco Channel. In the developed condition, the South Norco Channel will continue to flow through the site; however, the channel will be improved to a rectangular channel, per the Riverside County Flood Control Master Drainage Plan. The channel will also be increased in capacity to accommodate the ultimate flow conditions, as directed by the Riverside County Flood Control District.

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

The existing condition consists of agricultural, commercial and single-family homes. Most of the project area is currently undeveloped with fair vegetation. Due to the nature of the project, existing vegetation cannot be preserved, as the developed condition consists of large industrial buildings, parking and drive aisles. Ornamental landscaping, however, has been incorporated into the design to the maximum extent feasible.

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

Natural infiltration capacity will be preserved to the maximum extent feasible. The site consists of Type C and Type D soils, which typically do not have favorable infiltration rates (e.g., less than 1.6 inches/hour). The geotechnical report included in Appendix 3:, however, found that areas in which the basins were proposed have favorable infiltration rates (e.g., 4 inches/hour and 11.8 inches/hour). For this reason, infiltration is being proposed as the primary method of treatment for the Design Capture Volume. Harvest and Use BMPs were determined to be infeasible for this project due to inadequate demand for harvested stormwater.

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

Due to the nature of the project, there will be a significant increase in impervious surfaces. Impervious surfaces are proposed to support the industrial and commercial facilities. Impervious surfaces were limited to the areas needed for the development and to meet the minimum code requirements for parking and traveled ways. Although there will be an increase of impervious area, design alternatives have been implemented to minimize impervious area. Ornamental landscaping has also been incorporated into the design to the maximum extent feasible.

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

Due to the nature of the project, it is not feasible to direct runoff from impervious areas to the adjacent pervious areas due to site constraints. All stormwater runoff from the site will be conveyed to infiltration basins.

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)[1,2]	Area (Sq. Ft.)	DMA Type
DMA A			
DMA A-1	Roofs	755,194	Type D
DMA A-2	Concrete or Asphalt	741,900	Type D
DMA A-3	Ornamental Landscape	245,800	Type D
Total		*1,742,894 sf or 40.01 Acres*	
DMA A1			
DMA A1-1	Roofs	202,636	Type D
DMA A1-2	Concrete or Asphalt	106,900	Type D
DMA A1-3	Ornamental Landscape	94,100	Type D
Total		*403,636 sf or 9.27 Acres*	
DMA B			
DMA B-1	Roofs	21,410	Type D
DMA B-2	Concrete or Asphalt	74,332	Type D
DMA B-3	Ornamental Landscape	59,318	Type D
Total		*155,060 sf or 3.56 Acres*	
DMA AB			
DMA AB	Ornamental Landscape	*233,610 sf or 5.36 Acres*	Type D
DMA C			
DMA C-1	Roofs	480,245	Type D
DMA C-2	Concrete or Asphalt	346,800	Type D
DMA C-3	Ornamental Landscape	194,600	Type D
Total		*1,021,645 sf or 23.45 Acres*	

[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)	Storm Depth (inches)	DMA Name / ID	[C] from Table C.4 =	Required Retention Depth (inches)
		[A]	[B]		[C]	[D]
Not Applicable						

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

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

DMA					**Receiving Self-Retaining DMA**		
DMA Name/ ID	Area (square feet)	Post-project surface type	Impervious fraction	Product	DMA name /ID	Area (square feet)	Ratio
	[A]		[B]	[C] = [A] x [B]		[D]	[C]/[D]
Not Applicable							

Table C.5 Type 'D', Areas Draining to BMPs

DMA Name or ID	BMP Name or ID
DMA A, DMA B & DMA AB	Infiltration Basin 1
DMA A1	Infiltration Basin 2
DMA C	Infiltration Basin 3

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.

Description of Drainage Areas

DMA A, DMA B, and DMA AB are tributary to Infiltration Basin 1. DMA A1 is tributary to Infiltration Basin 2. DMA C is tributary to Infiltration Basin 3.

Drainage Management Area A: DMA A is located in the center portion of the project site between Pacific Avenue and Mountain Avenue and includes DMA A-1, DMA A-2 and DMA A-3. DMA A-1 is 17.34 acres and consists of Buildings 1, 2, 5, 6 ,7a, 11, 12, 13, and 14. DMA A-2 is 17.03 acres and consists of the concrete and streets within DMA A. DMA A-3 is 5.64 acres and consists of the landscaped area within DMA A. The total area within DMA A is 40.01 acres. The DCV from DMA A will be treated at Infiltration Basin 1.

Drainage Management Area A1: DMA A1 is located in the southeast portion of the project site, north of the South Norco Channel, and between Pacific Avenue and Mountain Avenue. It includes DMA A1-1, DMA A1-2 and DMA A1-3. DMA A1-1 is 4.65 acres and consists of Buildings 3, 4, 11, and 12. DMA A1-2 is 2.45 acres and consists of the concrete and streets within DMA A1. DMA A1-3 is 2.16 acres and consists of the landscaped area within DMA A1. The total area within DMA A1 is 9.27 acres. The DCV from DMA A1 will be treated at Infiltration Basin 2.

Drainage Management Area B: DMA B is located in the northwest corner of Mountain Avenue and First Street and includes DMA B-1, DMA B-2, and DMA B-3. DMA B-1 is 0.49 acres and consists of Buildings A, B and C. DMA B-2 is 1.71 acres and consists of the concrete and streets within DMA B. DMA B-3 is 1.36 acres and consists of the landscaped area within DMA B. The total area within DMA B is 3.56 acres. The DCV from DMA B will be treated at Infiltration Basin 1.

Drainage Management Area AB: DMA AB is located in the southwest corner of Mountain Avenue and First street and is also the location of Infiltration Basin 1 and an adjacent detention basin. DMA AB consists is a total of 5.36 acres.

Drainage Management Area C: DMA C is located in the north portion of the project site and includes DMA C-1, DMA C-2, and DMA C-3. DMA C-1 is 11.02 acres and consists of Buildings 7b, 8, 9, 10, 15, 16, 17 and 18. DMA C-2 is 7.96 acres and consists of the concrete and streets within DMA C. DMA C-3 is 4.47 acres and consists of the landscaped area within DMA C. The total area within DMA C is 23.45 acres. The DCV from DMA C will be treated at Infiltration Basin 3.

Other Areas:

Improvements to public streets are proposed within the project limits. A separate Transportation WQMP will not be required, however, as the Transportation Project Guidance does not apply. The Guidance does not apply to transportation projects that are part of a private new development or significant redevelopment project and required to prepare a WQMP. Given site-specific characteristics and right of way constraints, FlexStorm Inlet Filters will be installed at off-site storm drain inlets (within the project limits) to capture sediment, litter, and debris in runoff. The FlexStorm Inlet Filters installed at off-site storm drain inlets shall be maintained by the City of Norco.

Drainage Management Areas east of Mountain Avenue (i.e., DMA D, DMA E, and DMA F) are scoped for Phase II of this project and will be considered for coverage under a separate WQMP. Therefore, stormwater from the Phase II DMAs will not drain to the BMPs proposed in this WQMP. The Phase II information included below and in Appendix 6 is for reference only.

Since infiltration BMPs proved to be feasible for Phase I of the project, infiltration BMPs will also be proposed for each of the Phase II DMAs.

Drainage Management Area D: DMA D is located in the south portion of the Phase II project site, north of the South Norco Channel, and east of Mountain Avenue. DMA D includes DMA D-1, DMA D-2 and DMA D-3. DMA D-1 is 2.89 acres and consists of Buildings 19, 20, and 21. DMA D-2 is 3.29 acres and consists of the concrete and streets within DMA D. DMA D-3 is 1.09 acres and consists of the landscaped area within DMA D. The total area within DMA D is 7.27 acres. The DCV from DMA D will be treated at an underground infiltration chamber.

Drainage Management Area E: DMA E is located in the center portion of the Phase II project site, north of the South Norco Channel, and east of Mountain Avenue. It includes DMA E-1, DMA E-2 and DMA E-3. DMA E-1 is 6.67 acres and consists of Buildings 22, 23, 24, 25, 26, 27, 28, 29, 30, 31 and 32. DMA E-2 is 4.16 acres and consists of the concrete and streets within DMA E. DMA E-3 is 1.91 acres and consists of the landscaped area within DMA E. The total area within DMA E is 12.74 acres. The DCV from DMA E will be treated at an underground infiltration chamber.

Drainage Management Area F: DMA F is located in in the north portion of the Phase II project site, north of the South Norco Channel, and east of Mountain Avenue. It includes DMA F-1, DMA F-2, and DMA F-3. DMA F-1 is 2.89 acres and consists of Buildings 33, 34 and 35. DMA F-2 is 2.35 acres and consists of the concrete and streets within DMA F. DMA F-3 is 0.93 acres and consists of the landscaped area within DMA F. The total area within DMA F is 6.17 acres. The DCV from DMA F will be treated at an underground infiltration chamber.

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: Yes, a portion of DMA AB has an infiltration rate of 0.4 inches/hour. The areas in which infiltration basins are proposed, however, have infiltration rates higher than 1.6 inches/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: N/A

Type of Landscaping: Landscape Coefficient, KL= N/A

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: N/A

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: N/A

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: N/A

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)
N/A	N/A

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: N/A

Project Type: N/A

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: N/A

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: N/A

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: N/A

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)**
N/A	N/A

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.

N/A

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: N/A

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: N/A

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: N/A

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: N/A

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)**
N/A	N/A

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	
DMA A	☒	☐	☐	☐	☐
DMA A1	☒	☐	☐	☐	☐
DMA B	☒	☐	☐	☐	☐
DMA AB	☒	☐	☐	☐	☐
DMA C	☒	☐	☐	☐	☐

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.

N/A

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	*Infiltration Basin 1*		
	[A]		[B]	[C]	[A] x [C]			
DMA A-1						*Design Storm Depth (in)*	*Design Capture Volume, V_{BMP} (cubic feet)*	*Proposed Volume on Plans (cubic feet)*
Bldg. 1	*41600*	*Roofs*	*1*	*0.89*	*37107.2*			
Bldg. 2	*41600*	*Roofs*	*1*	*0.89*	*37107.2*			
Bldg. 5	*117075*	*Roofs*	*1*	*0.89*	*104430.9*			
Bldg. 6	*157275*	*Roofs*	*1*	*0.89*	*140289.3*			
Bldg. 7a	*65350*	*Roofs*	*1*	*0.89*	*58292.2*			
Bldg. 11	*40597*	*Roofs*	*1*	*0.89*	*36212.5*			

Bldg. 12	*16117*	*Roofs*	*1*	*0.89*	*14376.4*			
Bldg. 13	*133480*	*Roofs*	*1*	*0.89*	*119064.2*			
Bldg. 14	*142100*	*Roofs*	*1*	*0.89*	*126753.2*			
DMA A-2	*741900*	*Concrete or Asphalt*	*1*	*0.89*	*661774.8*			
DMA A-3	*245800*	*Ornamental Landscaping*	*0.1*	*0.11*	*27150.6*			
DMA B-1								
Bldg. A	*13040*	*Roofs*	*1*	*0.89*	*11631.7*			
Bldg. B	*4095*	*Roofs*	*1*	*0.89*	*3652.7*			
Bldg. C	*4275*	*Roofs*	*1*	*0.89*	*3813.3*			
DMA B-2	*74332*	*Concrete or Asphalt*	*1*	*0.89*	*6552.2*			
DMA B-3	*59318*	*Ornamental Landscaping*	*0.1*	*0.11*	*6525.0*			
DMA AB	*233610*	*Ornamental Landscaping*	*0.1*	*0.11*	*25804.1*			
	$A_T = \Sigma[A]$ 2131564				$\Sigma= [D]$ 1480316.6	[E] 0.78	$[F] = \frac{[D]x[E]}{12}$ 96220.6	[G] 131787

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	***Infiltration Basin 2***		
	[A]		[B]	[C]	[A] x [C]	*Design Storm Depth (in)*	*Design Capture Volume, V_{BMP} (cubic feet)*	*Proposed Volume on Plans (cubic feet)*
DMA A1-1								
Bldg. 3	*41600*	*Roofs*	*1*	*0.89*	37107.2			
Bldg. 4	*41600*	*Roofs*	*1*	*0.89*	37107.2			
Bldg. 11	*46243*	*Roofs*	*1*	*0.89*	41248.8			
Bldg. 12	*73193*	*Roofs*	*1*	*0.89*	65141.77			
DMA A1-2	*106900*	*Concrete or Asphalt*	*1*	*0.89*	95354.8			
DMA A1-3	*94100*	*Ornamental Landscaping*	*0.1*	*0.11*	10394.1			
	$A_T = \Sigma[A]$ 403636				$\Sigma= [D]$ 286500.3	[E] 0.78	$[F] = \frac{[D]x[E]}{12}$ 18622.5	[G] 21190

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Impervious Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor	*Infiltration Basin 3*		
	[A]		[B]	[C]	[A] x [C]	*Design Storm Depth (in)*	*Design Capture Volume, V_{BMP} (cubic feet)*	*Proposed Volume on Plans (cubic feet)*
DMA C-1								
BLDG 7b	*91925*	*Roofs*	*1*	*0.89*	81997.1			
BLDG 8	*69730*	*Roofs*	*1*	*0.89*	62199.2			
BLDG 9	*64270*	*Roofs*	*1*	*0.89*	57328.8			
BLDG 10	*42300*	*Roofs*	*1*	*0.89*	37731.6			
BLDG 15	*61290*	*Roofs*	*1*	*0.89*	54670.7			
BLDG 16	*61290*	*Roofs*	*1*	*0.89*	54670.7			
BLDG 17	*54080*	*Roofs*	*1*	*0.89*	48239.4			
BLDG 18	*35360*	*Roofs*	*1*	*0.89*	31541.1			
DMA C-2	*346800*	*Concrete or Asphalt*	*1*	*0.89*	309345.6			
DMA C-3	*194600*	*Ornamental Landscaping*	*0.1*	*0.11*	21495.1			
	$A_T = \Sigma[A]$ 1021645				$\Sigma =$ [D] 759219.3	[E] 0.78	$[F] = \frac{[D]x[E]}{12}$ 49349.3	[G] 58293

[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 ft^2)	P	N	N	N	N	N	P	P
☐ Hillside Development (>5,000 ft^2)	P	N	P	P	N	P	P	P
☒ Parking Lots (>5,000 ft^2)	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]
N/A	
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]
Not Applicable		

[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	N/A	N/A	N/A
Volume (Cubic Feet)	N/A	N/A	N/A

[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

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.

Based on the Riverside County GIS Mapping (See Appendix 7), North Norco Channel is non-exempt for hydromodification and South Norco Channel is exempt. Since a portion of the project site drains to North Norco Channel and another portion drains to South Norco Channel, the site would have been partially exempt from hydromodification requirements. However, a site visit was conducted and revealed that South Norco Channel appears to be susceptible to hydromodification. As a result of the site visit, it was determined that the project site does not qualify for HCOC exemptions, and the entire project area will be mitigated for HCOCs.

Stormwater runoff from DMAs A and B will be mitigated through Infiltration Basin 1 and an adjacent Detention Basin. DMA A1 will be mitigated through Infiltration Basin 2. DMA C will be mitigated through Infiltration Basin 3 and an adjacent Detention Basin. The post-development hydrograph for the project site will not exceed the pre-development hydrograph by 10% for the 2-year return frequency storm. All pertinent documentation will be provided in Appendix 7 for the final WQMP submittal.

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 (Plazas, Sidewalks, and Parking Lots within Project Limits)	- All inlets will be marked with the words "Only Rain Down the Storm Drain" or similar. - FlexStorm Inlet Filters will be installed at on-site storm drain inlets to capture sediment, litter, and debris in runoff prior to entering the on-site storm drain system	- Maintain and periodically repaint or replace inlet markers - Stormwater pollution prevention information will be provided to new site owners, lessees, and/or operators - Maintain FlexStorm Inlet Filters per the Specifications and Work Instructions in Appendix 9 - See Fact Sheet SC-44 in Appendix 10

		- Sweep plazas, sidewalks, and parking lots regularly to prevent accumulation of litter and debris. - Collect debris from pressure washing to prevent entry into the storm drain system. - Collect washwater containing any cleaning agent or degreaser and discharge to the sanitary sewer, not the storm drain.
Off-site Storm Drain Inlets (Public Streets within Project Limits) to be maintained by the City of Norco	- All inlets will be marked with the words “Only Rain Down the Storm Drain” or similar. - FlexStorm Inlet Filters will be installed at off-site storm drain inlets to capture sediment, litter, and debris in runoff prior to entering the on-site storm drain system	- Maintain and periodically repaint or replace inlet markers - Maintain FlexStorm Inlet Filters per the Specifications and Work Instructions in Appendix 9 - See Fact Sheet SC-44 in Appendix 10 - Street sweeping regularly to prevent accumulation of litter and debris.
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. - Consider using pest-resistant plants, especially adjacent to hardscape - Plants appropriate to site conditions will be selected	- Maintain landscaping using minimum or no pesticides - Reference Educational Fact Sheet “What you should know for Landscaping and Gardening” in Appendix 10
Refuse Areas	- Refuse areas will be surrounded by concrete walls and drain inward such that runoff does not co-mingle with runoff from project areas - Signs will be posted on or near dumpsters with the words “Do not dump hazardous materials here” or similar	- An adequate number of waste receptacles will be provided based on the number of people occupying the building - Inspect receptacles on a weekly basis for leaks and overflowing waste. Receptacles must be covered. Empty receptacles on a weekly basis or more frequently as needed

		- Ensure “no hazardous materials” sign is legible. Inspect on a monthly basis and replace or repaint as needed. - Litter shall be picked up around the project site daily. Spills shall be cleaned up immediately. Spill kits shall be readily available on-site. - See Fact Sheet SC-34 in Appendix 10
Industrial Processes	- All process activities are to be performed indoors. No processes will drain to exterior or to the storm drain system.	- See Fact Sheet SC-10 in Appendix 10
Loading Docks	- Door skirts will be installed at each bay that encloses the end of the trailer	- Loaded and unloaded items will be moved indoors directly from the end of the trailer
Fire Sprinkler Test Water	N/A	- Fire sprinkler test water will be drained to the sanitary sewer or otherwise discharged using an acceptable method
Rooftop Equipment and Roofing, gutters, and trim	- Rooftop equipment with potential to produce pollutants shall be roofed and/or have secondary containment -Roofing, gutters, and trim will be made of protected metals that cannot leach into runoff	- Inspect on a monthly basis - Empty secondary containment as needed

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)
Infiltration Basin 1	Infiltration Basin	36	33.901368, -117.567927
Infiltration Basin 2	Infiltration Basin	37	33.903111, -117.568892
Infiltration Basin 3	Infiltration Basin	38	33.909056, -117.570913

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: All funding will be provided by the property owners.

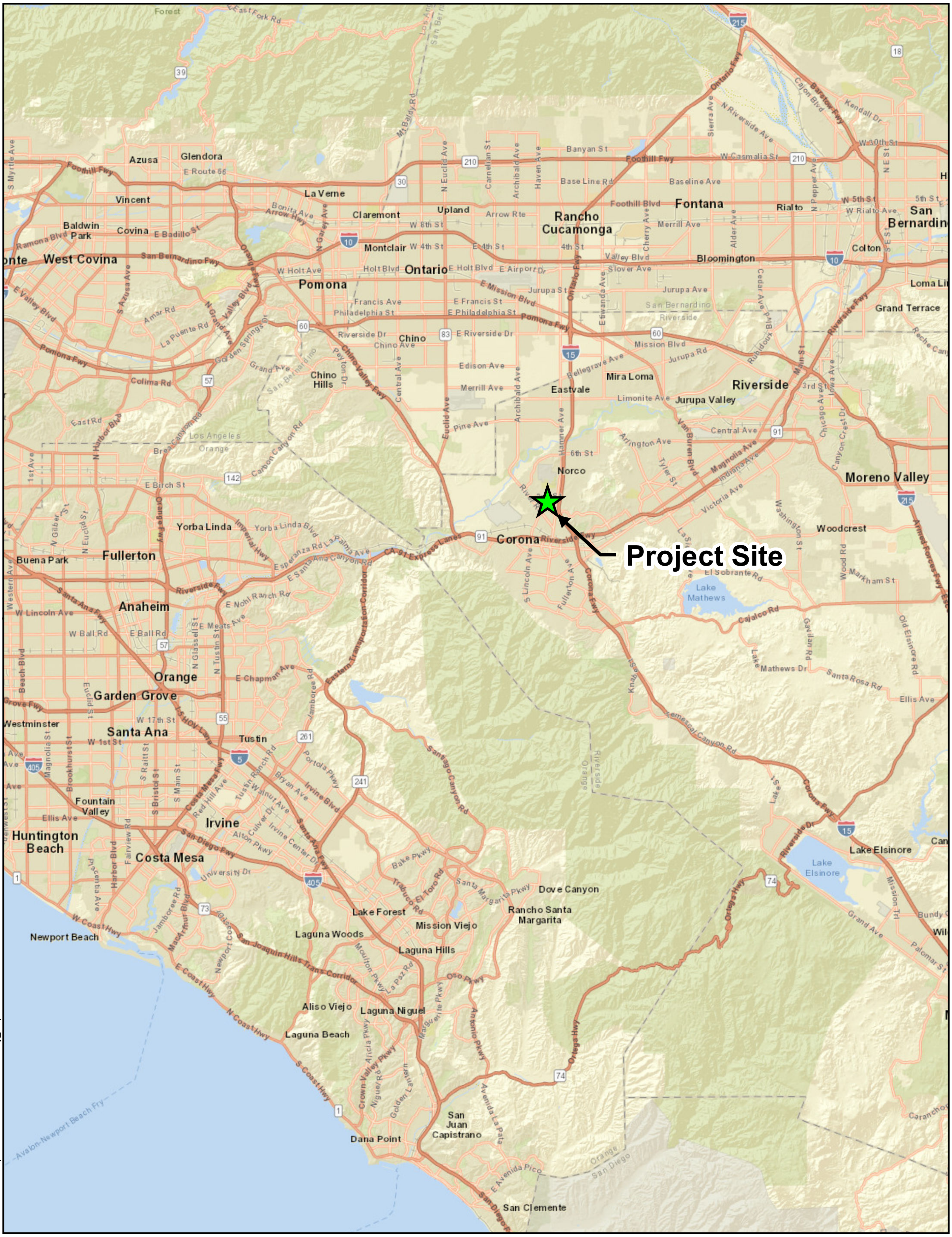
Will the proposed BMPs be maintained by a Home Owners' Association (HOA) or Property Owners Association (POA)?

☒ 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

Vicinity Map, WQMP Site Plan, Receiving Waters Map, Isohyetal Map



12/11/2018 JN H:\pdata\163874\GIS\MXD\Vicinity_Map.mxd <USER NAME>

Michael Baker INTERNATIONAL

0 3 6 12 Miles

Palomino Business Park

Vicinity Map

Exhibit

SUMMARY OF DRAINAGE MANAGEMENT AREAS (DMA)

DRAINAGE MANAGEMENT AREA A		
DMA A-1	AREA (SF)	SURFACE TYPE
Bldg. 1	41,600	ROOF
Bldg. 2	41,600	ROOF
Bldg. 5	117,075	ROOF
Bldg. 6	157,275	ROOF
Bldg. 7a	65,350	ROOF
Bldg. 11	40,597	ROOF
Bldg. 12	16,117	ROOF
Bldg. 13	133,480	ROOF
Bldg. 14	142,100	ROOF
Bldg. Total	755,194	
DMA A-2	AREA (SF)	SURFACE TYPE
CONCRETE OR ASPHALT	741,900	IMPERVIOUS
DMA A-3	AREA (SF)	SURFACE TYPE
ORNAMENTAL LANDSCAPE	245,800	PERVIOUS
TOTAL	1,742,894	

DRAINAGE MANAGEMENT AREA A1		
DMA A1-1	AREA (SF)	SURFACE TYPE
Bldg. 3	41,600	ROOF
Bldg. 4	41,600	ROOF
Bldg. 11	46,243	ROOF
Bldg. 12	73,193	ROOF
Bldg. Total	202,636	
DMA A1-2	AREA (SF)	SURFACE TYPE
CONCRETE OR ASPHALT	106,900	IMPERVIOUS
DMA A1-3	AREA (SF)	SURFACE TYPE
ORNAMENTAL LANDSCAPE	94,100	PERVIOUS
TOTAL	403,636	

DRIANAGE MANAGEMENT AREA B		
DMA B-1	AREA (SF)	SURFACE TYPE
Bldg. A	13,040	ROOF
Bldg. B	4,095	ROOF
Bldg. C	4,275	ROOF
Bldg. Total	21,410	
DMA B-2	AREA (SF)	SURFACE TYPE
CONCRETE OR ASPHALT	74,332	IMPVERVIOUS
DMA B-3	AREA (SF)	SURFACE TYPE
ORNAMENTAL LANDSCAPE	59,318	PERVIOUS
TOTAL	155,060	

DRAINAGE MANAGEMENT AREA AB		
DMA AB	AREA (SF)	SURFACE TYPE
ORNAMENTAL LANDSCAPE	233,610	PERVIOUS
TOTAL	233,610	

DRAINAGE MANAGEMENT AREA C		
DMA C-1	AREA (SF)	SURFACE TYPE
BLDG 7b	91,925	ROOF
BLDG 8	69,730	ROOF
BLDG 9	64,270	ROOF
BLDG 10	42,300	ROOF
BLDG 15	61,290	ROOF
BLDG 16	61,290	ROOF
BLDG 17	54,080	ROOF
BLDG 18	35,360	ROOF
BLDG. TOTAL	480,245	
DMA C-2	AREA (SF)	SURFACE TYPE
CONCRETE OR ASPHALT	346,800	IMPERVIOUS
DMA C-3	AREA (SF)	SURFACE TYPE
ORNAMENTAL LANDSCAPE	194,600	PERVIOUS
TOTAL	1,021,645	

DRAINAGE MANAGEMENT AREA D		
DMA C-1	AREA (SF)	SURFACE TYPE
BLDG 19	44,720	ROOF
BLDG 20	28,080	ROOF
BLDG 21	53,070	ROOF
BLDG. TOTAL	125,870	
DMA C-2	AREA (SF)	SURFACE TYPE
CONCRETE OR ASPHALT	143,309	IMPERVIOUS
DMA C-3	AREA (SF)	SURFACE TYPE
ORNAMENTAL LANDSCAPE	47,502	PERVIOUS
TOTAL	316,681	

DRAINAGE MANAGEMENT AREA E		
DMA C-1	AREA (SF)	SURFACE TYPE
BLDG 22	37,440	ROOF
BLDG 23	30,420	ROOF
BLDG 24	49,920	ROOF
BLDG 25	43,680	ROOF
BLDG 26	57,600	ROOF
BLDG 27	9,240	ROOF
BLDG 28	11,040	ROOF
BLDG 29	12,840	ROOF
BLDG 30	12,840	ROOF
BLDG 31	12,840	ROOF
BLDG 32	12,840	ROOF
BLDG. TOTAL	290,700	
DMA C-2	AREA (SF)	SURFACE TYPE
CONCRETE OR ASPHALT	181,011	IMPERVIOUS
DMA C-3	AREA (SF)	SURFACE TYPE
ORNAMENTAL LANDSCAPE	83,243	PERVIOUS
TOTAL	554,954	

DRAINAGE MANAGEMENT AREA F		
DMA C-1	AREA (SF)	SURFACE TYPE
BLDG 33	37,440	ROOF
BLDG 34	37,440	ROOF
BLDG 35	51,090	ROOF
BLDG. TOTAL	125,970	
DMA C-2	AREA (SF)	SURFACE TYPE
CONCRETE OR ASPHALT	102,480	IMPERVIOUS
DMA C-3	AREA (SF)	SURFACE TYPE
ORNAMENTAL LANDSCAPE	40,315	PERVIOUS
TOTAL	268,765	

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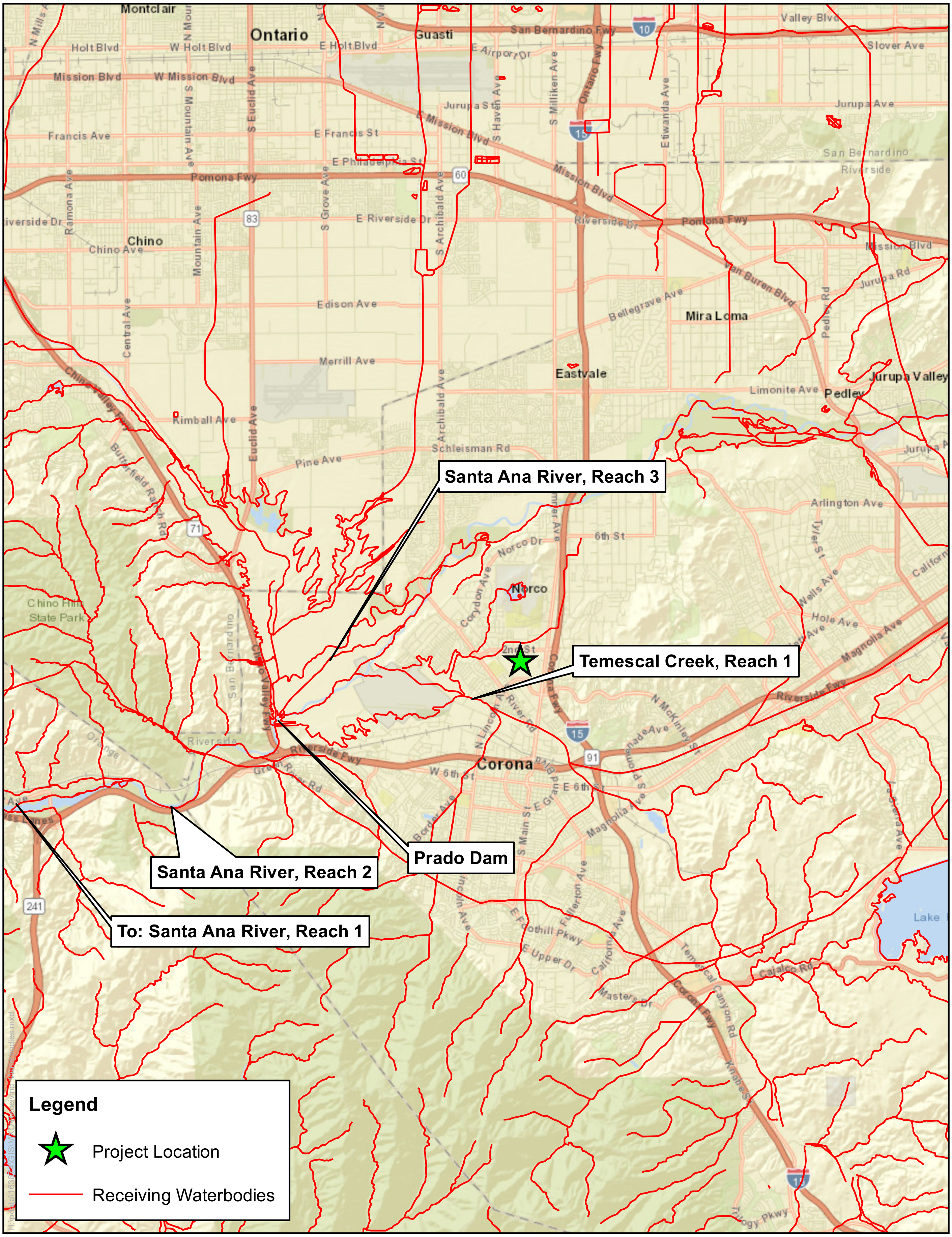
WQMP EXHIBIT

PALOMINO BUSINESS PARK

JULY 30, 2019



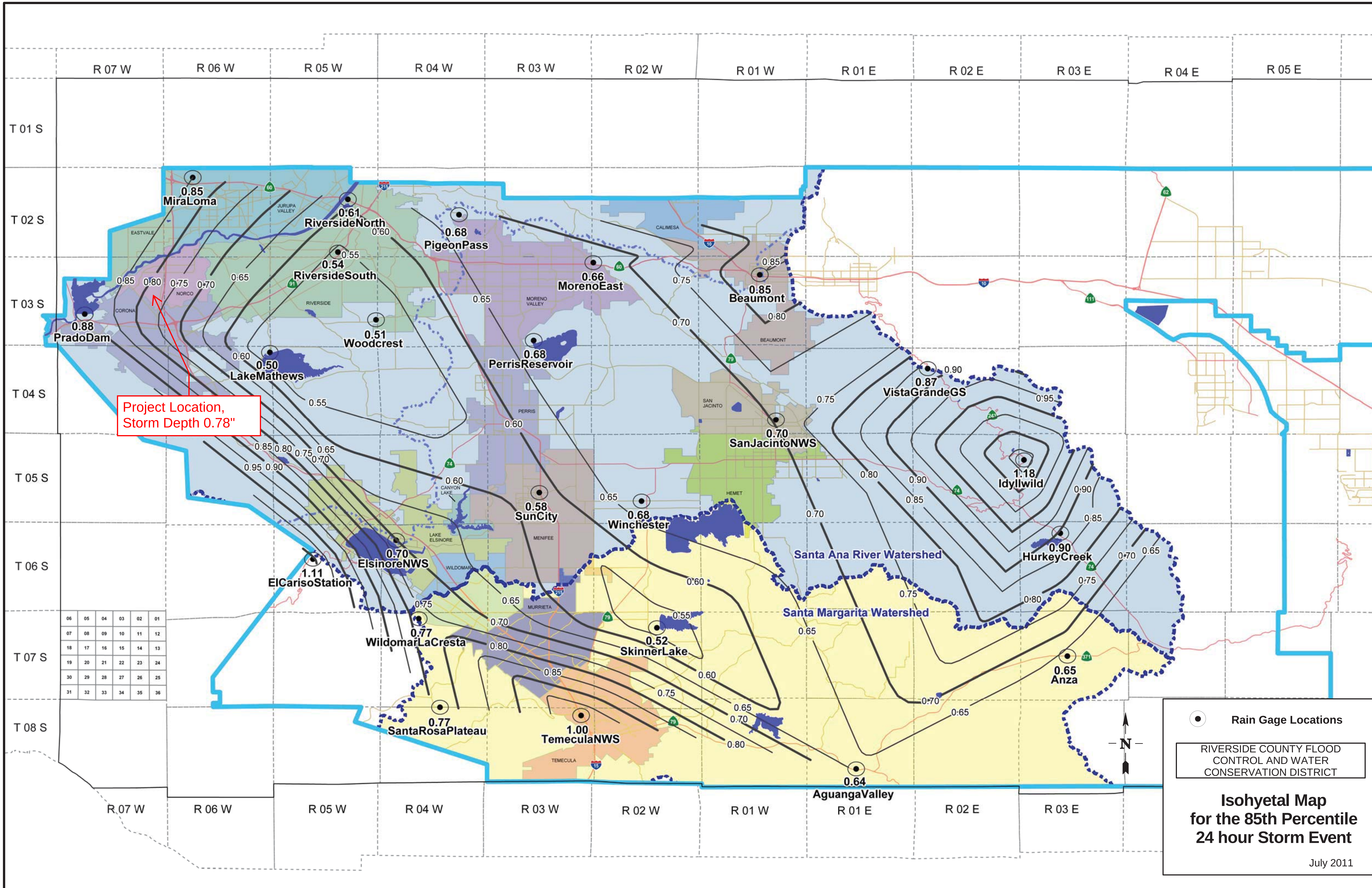
Michael Baker
INTERNATIONAL

0 6,000 12,000 24,000
Feet

Palomino Business Park

Receiving Waterbodies

Exhibit



Project Location,
Storm Depth 0.78"
0.85 MiraLoma
0.61 RiversideNorth
0.68 PigeonPass
0.54 RiversideSouth
0.66 MorenoEast
0.85 Beaumont
0.88 PradoDam
0.51 Woodcrest
0.68 PerrisReservoir
0.50 LakeMathews
0.87 VistaGrandeGS
0.70 SanJacintoNWS
1.18 Idyllwild
0.58 SunCity
0.68 Winchester
0.90 HurkeyCreek
0.70 ElsinoreNWS
1.11 ElCarisoStation
Santa Ana River Watershed
Santa Margarita Watershed
0.77 WildomarLaCresta
0.52 SkinnerLake
0.65 Anza
0.77 SantaRosaPlateau
1.00 TemeculaNWS
0.64 AguangaValley
Rain Gage Locations
RIVERSIDE COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
Isohyetal Map for the 85th Percentile 24 hour Storm Event
July 2011

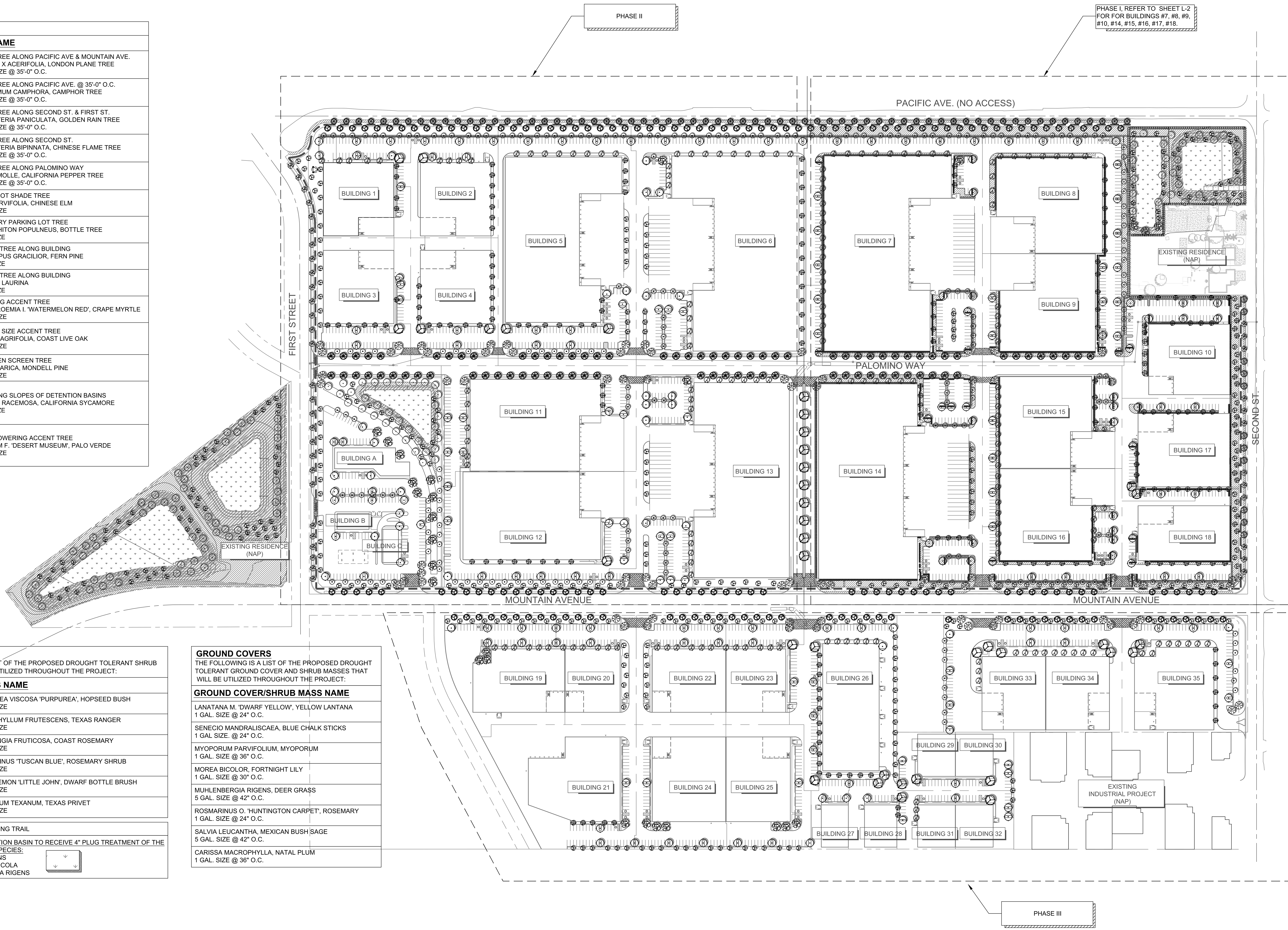
Appendix 2: Construction Plans

Grading and Drainage Plans

PLANTING LEGEND

PROPOSED **TREES**

SYMBOL	TREE NAME
	STREET TREE ALONG PACIFIC AVE & MOUNTAIN AVE. PLATANUS X ACERIFOLIA, LONDON PLANE TREE 36" BOX SIZE @ 35'-0" O.C.
	STREET TREE ALONG PACIFIC AVE. @ 35'-0" O.C. CINNAMOMUM CAMPHORA, CAMPHOR TREE 36" BOX SIZE @ 35'-0" O.C.
	STREET TREE ALONG SECOND ST. & FIRST ST. KOELREUTERIA PANICULATA, GOLDEN RAIN TREE 24" BOX SIZE @ 35'-0" O.C.
	STREET TREE ALONG SECOND ST. KOELREUTERIA BIPINNATA, CHINESE FLAME TREE 24" BOX SIZE @ 35'-0" O.C.
	STREET TREE ALONG PALOMINO WAY SCHINUS MOLLE, CALIFORNIA PEPPER TREE 24" BOX SIZE @ 35'-0" O.C.
	PARKING LOT SHADE TREE ULMUS PARVIFOLIA, CHINESE ELM 24" BOX SIZE
	SECONDARY PARKING LOT TREE BRACHYCHITON POPULNEUS, BOTTLE TREE 15 GAL. SIZE
	VERTICAL TREE ALONG BUILDING PODOCARPUS GRACILIOR, FERN PINE 15 GAL. SIZE
	VERTICAL TREE ALONG BUILDING TRISTANIA LAURINA 15 GAL. SIZE
	FLOWERING ACCENT TREE LAGERSTROEMIA I. 'WATERMELON RED', CRAPE MYRTLE 36" BOX SIZE
	SPECIMEN SIZE ACCENT TREE QUERCUS AGRIFOLIA, COAST LIVE OAK 48" BOX SIZE
	EVERGREEN SCREEN TREE PINUS ELDARICA, MONDELL PINE 24" BOX SIZE
	TREE ALONG SLOPES OF DETENTION BASINS PLATANUS RACEMOSA, CALIFORNIA SYCAMORE 15 GAL. SIZE
	LARGE FLOWERING ACCENT TREE CERCIDIUM F. 'DESERT MUSEUM', PALO VERDE 36" BOX SIZE



SHRUBS

THE FOLLOWING IS A LIST OF THE PROPOSED DROUGHT TOLERANT SHRUB SPECIES THAT WILL BE UTILIZED THROUGHOUT THE PROJECT:

SYMBOL	SHRUB NAME
	DODONAEA VISCOSA 'PURPUREA', HOPSEED BUSH 5 GAL. SIZE
	LEUCOPHYLLUM FRUTESCENS, TEXAS RANGER 5 GAL. SIZE
	WESTRINGIA FRUTICOSA, COAST ROSEMARY 5 GAL. SIZE
	ROSMARINUS 'TUSCAN BLUE', ROSEMARY SHRUB 5 GAL. SIZE
	CALLISTEMON 'LITTLE JOHN', DWARF BOTTLE BRUSH 5 GAL. SIZE
	LIGUSTRUM TEXANUM, TEXAS PRIVET 5 GAL. SIZE

— — — —	RIDING TRAIL

VEGETATED DETENTION BASIN TO RECEIVE 4" PLUG TREATMENT OF THE FOLLOWING PLUG-SPECIES:

- JUNCUS PATENS
- CAREX TUMULICOLA
- MUHLENBERGIA RIGENS

GROUND COVERS

THE FOLLOWING IS A LIST OF THE PROPOSED DROUGHT TOLERANT GROUND COVER AND SHRUB MASSES THAT WILL BE UTILIZED THROUGHOUT THE PROJECT:

GROUND COVER/SHRUB MASS NAME
LANATANA M. 'DWARF YELLOW', YELLOW LANTANA 1 GAL. SIZE @ 24" O.C.
SENECIO MANDRALISCAEA, BLUE CHALK STICKS 1 GAL SIZE. @ 24" O.C.
MYOPORUM PARVIFOLIUM, MYOPORUM 1 GAL. SIZE @ 36" O.C.
MOREA BICOLOR, FORTNIGHT LILY 1 GAL. SIZE @ 30" O.C.
MUHLENBERGIA RIGENS, DEER GRASS 5 GAL. SIZE @ 42" O.C.
ROSMARINUS O. 'HUNTINGTON CARPET', ROSEMARY 1 GAL. SIZE @ 24" O.C.
SALVIA LEUCANTHA, MEXICAN BUSH SAGE 5 GAL. SIZE @ 42" O.C.
CARISSA MACROPHYLLA, NATAL PLUM 1 GAL. SIZE @ 36" O.C.

Carlile Coatsworth Architects, Inc
18600 MACARTHUR BLVD. SUITE 300 - Irvine, CA 92612 - Phone: 949.833.1930 - Fax: 949.833.1140

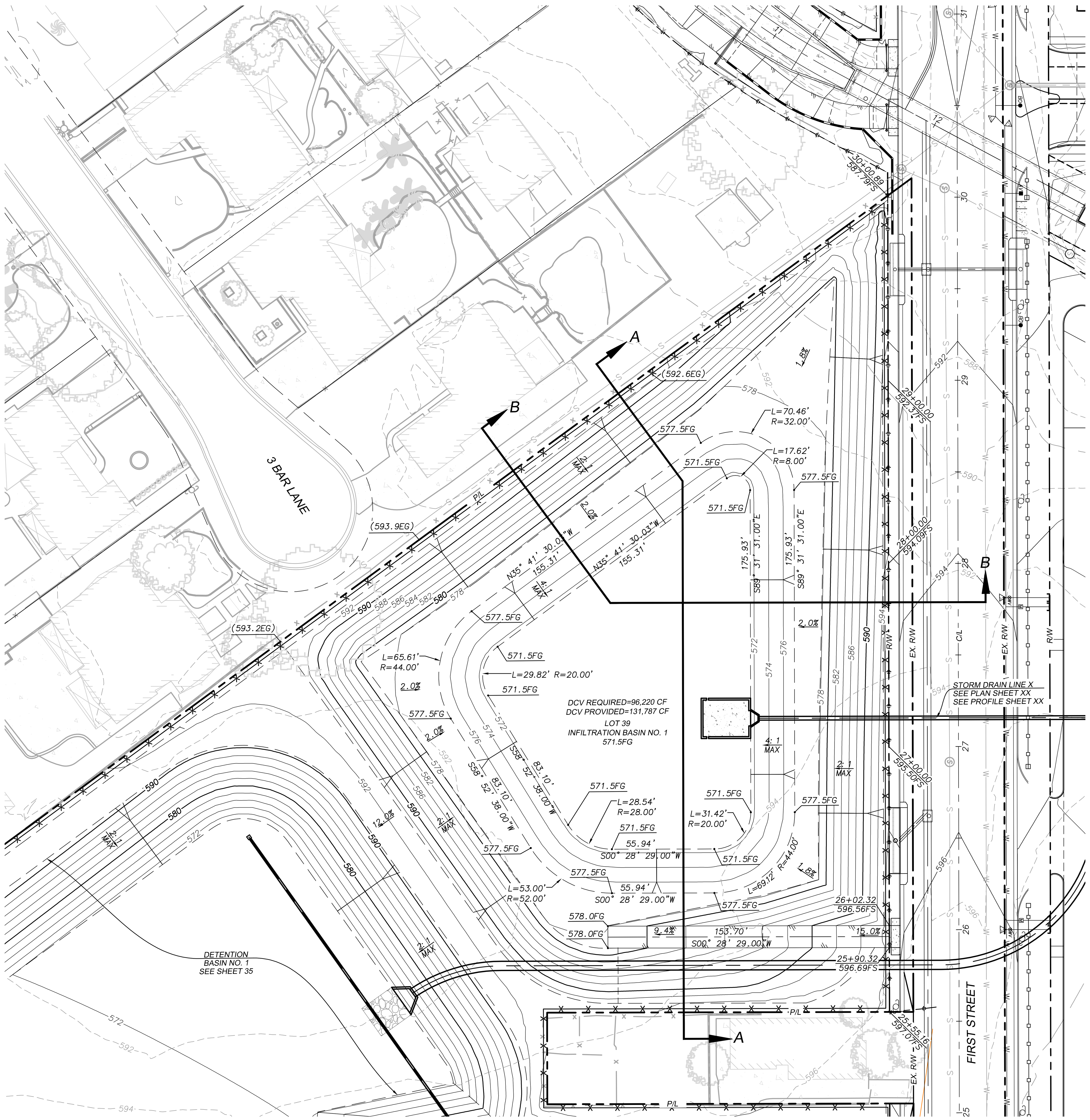
SPLA
2883 VIA RANCHEROS WAY
FALLBROOK, CA 92028
PH: 760-842-8993

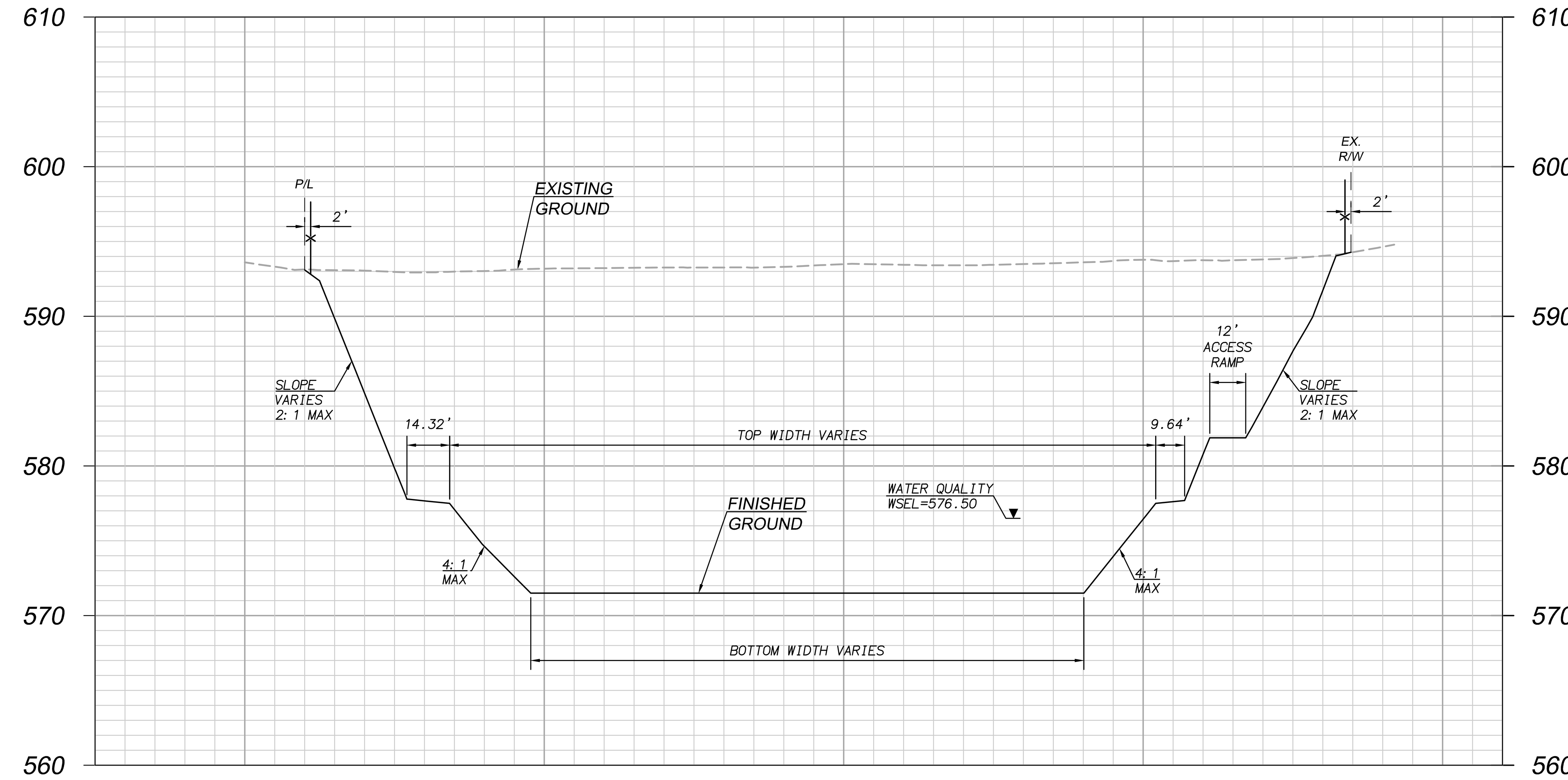
CONCEPTUAL MASTER PLAN
PALOMINO BUSINESS PARK

NORCO, CA

SEPTEMBER 30, 2019

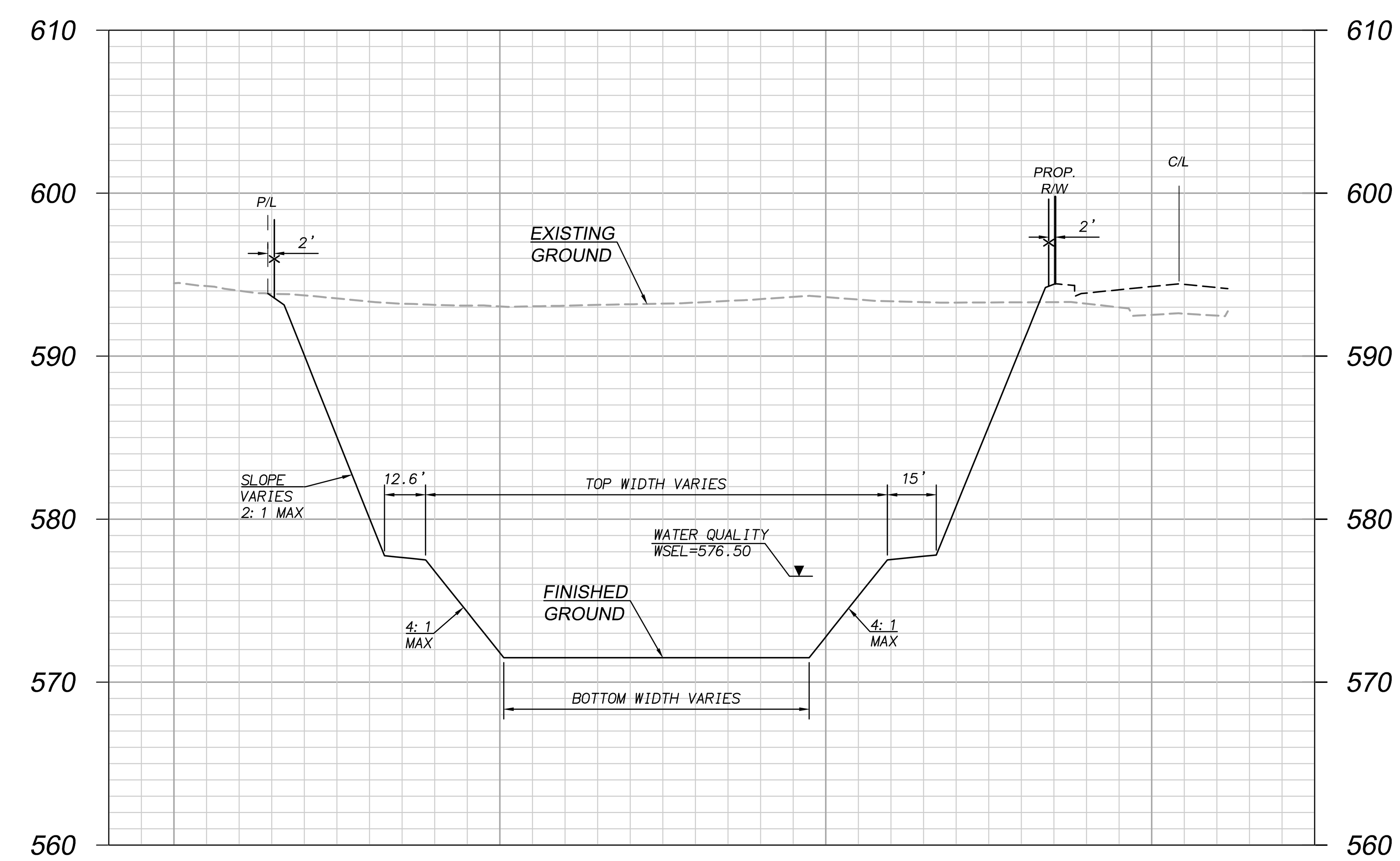
L-1





SECTION A-A

HORZ: 1"=20'
VERT: 1"=4'



SECTION B-B

HORZ: 1"=20'
VERT: 1"=4'

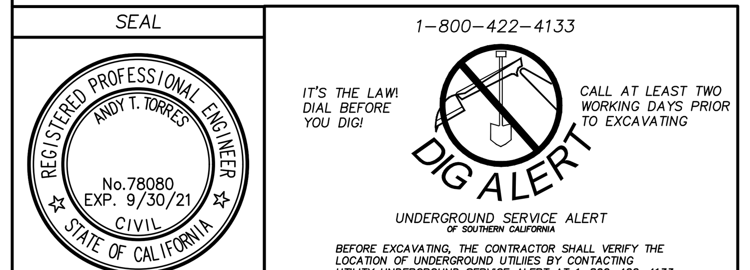
NOTE:
CONTRACTOR SHALL FIELD VERIFY EXISTING ELEVATIONS NOTED ON THIS PLAN PRIOR TO CONSTRUCTION

MONUMENTS AND PROPERTY PINS TO BE PRESERVED AND/OR RESTORED/REPLACED IF DAMAGED.

CAUTION!
LOCATION OF EXISTING UTILITIES ON THESE PLANS ARE APPROXIMATE AND SHALL BE VERIFIED BY CONTRACTOR PRIOR TO CONSTRUCTION.

NOTE:
CONTRACTOR TO PROTECT IN PLACE OR RELOCATE AND RECONNECT EX. UTILITIES WHERE NECESSARY.

SEAL



SCALE: 1" = 30'

WDID NO. 8 33C386938

REVISIONS

NO.	DATE	BY	DESCRIPTION	APPROVED

BASIS OF BEARING:
THE BASIS OF BEARINGS FOR THIS SURVEY IS THE CENTERLINE OF FIRST STREET BETWEEN MOUNTAIN ABENUE AND HAMNER AVENUE AS SHOWN ON PARCEL MAP NO. 31359, RECORDED IN BOOK 207, PGS 96-99. A BEARING OF N89°52'10"E.

BENCHMARK NO: C-102 ELEVATION: 569.419
LOCATION:
2-1/2" BRASS DISK SET IN THE TOP OF CURB, 5' NORTH OF THE E.C.R. OF THE NORTHEASTERLY CURB RETURN OF THE INTERSECTION OF CORYDON STREET AND KINGSFORD DRIVE. STAMPED "C-102"
(NOTE: ELEVATIONS SHOWN HEREON ARE IN TERMS OF NATIONAL GEODETIC VERTICAL DATUM 1929)

CITY OF NORCO
DEPARTMENT OF PUBLIC WORKS

APPROVED: ______ CITY ENGINEER ______ DATE

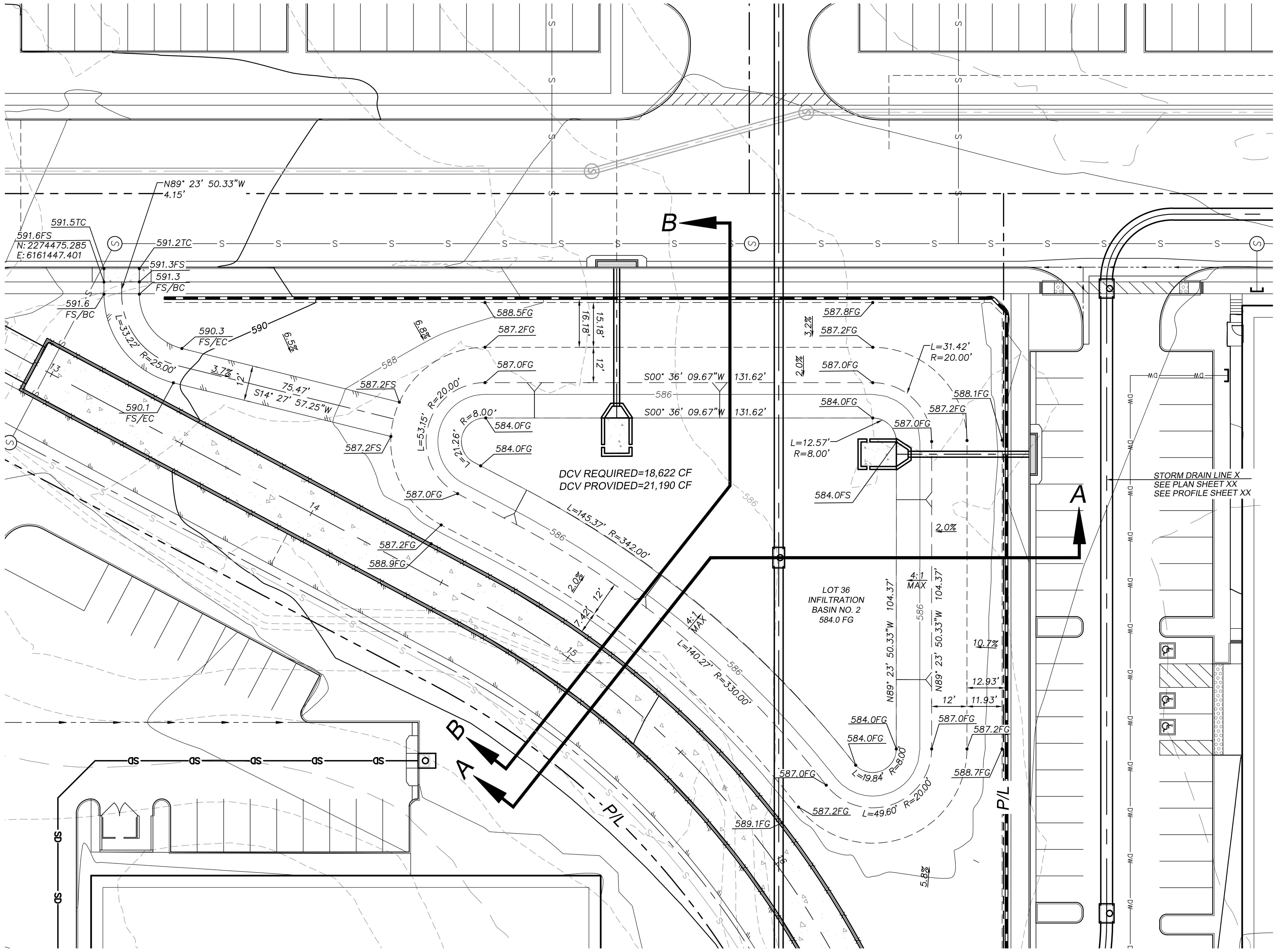
DESIGNED: ______ DATE: ______
DRAWN: ______ DATE: ______
CHECKED: ______ DATE: ______

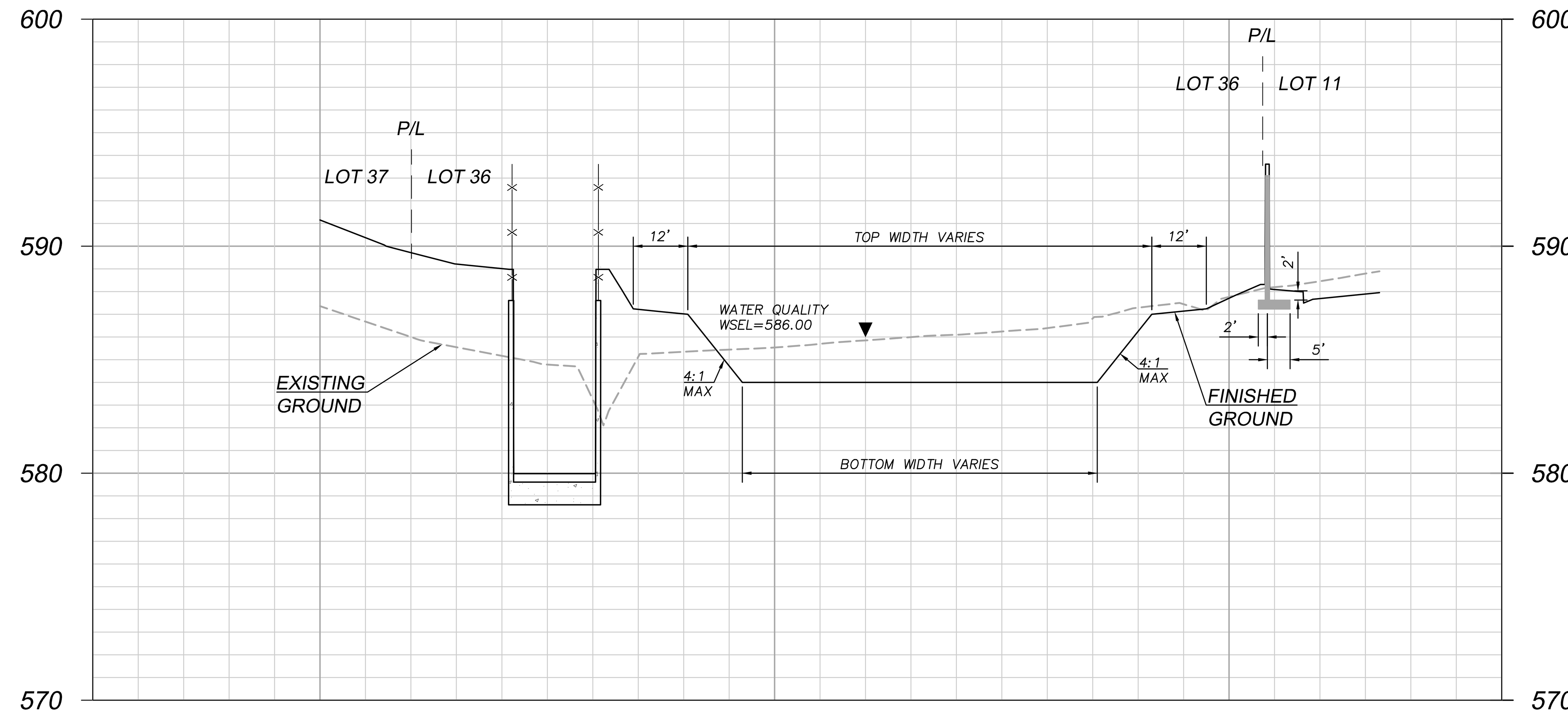
PREPARED BY:
Michael Baker
INTERNATIONAL
5 HUTTON CENTRE DR., STE 500, SANTA ANA, CA 92707
Phone: (949) 472.3505 · MBAKERINTL.COM

PRECISE GRADING PLAN
PALOMINO BUSINESS PARK
INFILTRATION BASIN NO. 1 PRECISE GRADING PLAN

SHEET 36 OF XX
CONTRACT N/A
ACCOUNT N/A
DWG. NO. XXXXXX

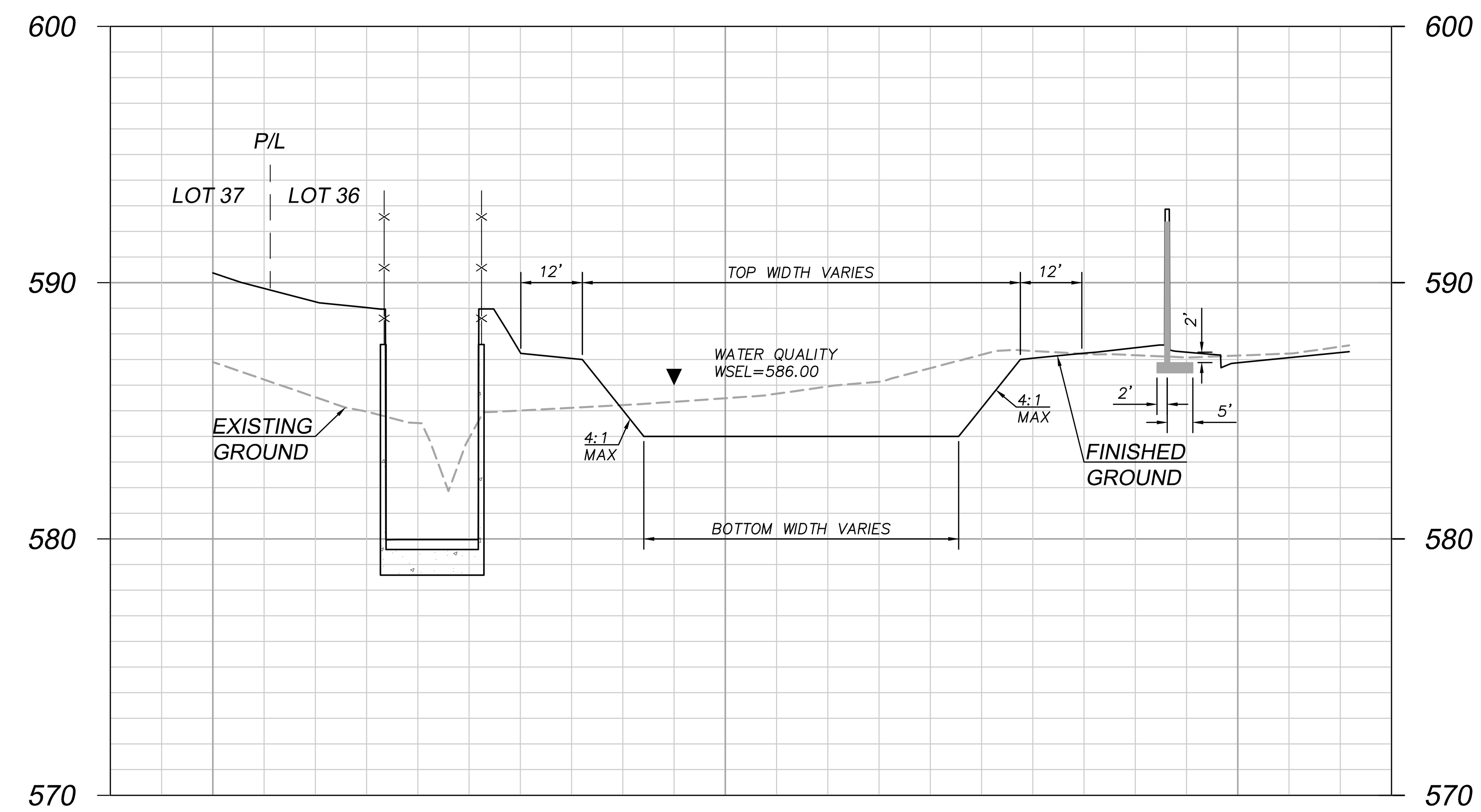
★PRELIMINARY★ SUBJECT TO REVISION





SECTION A-A

HORZ: 1"=20'
VERT: 1"=4'



SECTION B-B

HORZ: 1"=20'
VERT: 1"=4'

NOTE:
CONTRACTOR SHALL FIELD VERIFY EXISTING ELEVATIONS NOTED ON THIS PLAN PRIOR TO CONSTRUCTION

NOTE:
REFER TO CITY OF NORCO STREET IMPROVEMENT PLANS PREPARED BY MICHAEL BAKER INTERNATIONAL FOR OFF-SITE STREET IMPROVEMENTS. PROJECT NO. ____

MONUMENTS AND PROPERTY PINS TO BE PRESERVED AND/OR RESTORED/REPLACED IF DAMAGED.

CAUTION!
LOCATION OF EXISTING UTILITIES ON THESE PLANS ARE APPROXIMATE AND SHALL BE VERIFIED BY CONTRACTOR PRIOR TO CONSTRUCTION.

NOTE:
CONTRACTOR TO PROTECT IN PLACE OR RELOCATE AND RECONNECT EX. UTILITIES WHERE NECESSARY.

SEAL

1-800-422-4133

IT'S THE LAW! DIAL BEFORE YOU DIG!

CALL AT LEAST TWO WORKING DAYS PRIOR TO EXCAVATING

UNDERGROUND SERVICE ALERT OF SOUTHERN CALIFORNIA

BEFORE EXCAVATING, THE CONTRACTOR SHALL VERIFY THE LOCATION OF UNDERGROUND UTILIES BY CONTACTING UTILITY UNDERGROUND SERVICE ALERT AT 1-800-422-4133

20' 0' 10' 20'
SCALE: 1" = 20'

WDID NO. 8 33C386938

REVISIONS

NO.	DATE	BY	DESCRIPTION	APPROVED

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(NOTE: ELEVATIONS SHOWN HEREON ARE IN TERMS OF NATIONAL GEODETIC VERTICAL DATUM 1929)

CITY OF NORCO
DEPARTMENT OF PUBLIC WORKS

APPROVED: ____ CITY ENGINEER ____ DATE

DESIGNED: ____ DATE: ____
DRAWN: ____ DATE: ____
CHECKED: ____ DATE: ____

PREPARED BY:
Michael Baker
INTERNATIONAL
5 HUTTON CENTRE DR.,STE 500,SANTA ANA, CA 92707
Phone: (949) 472.3505 · MBAKERINTL.COM

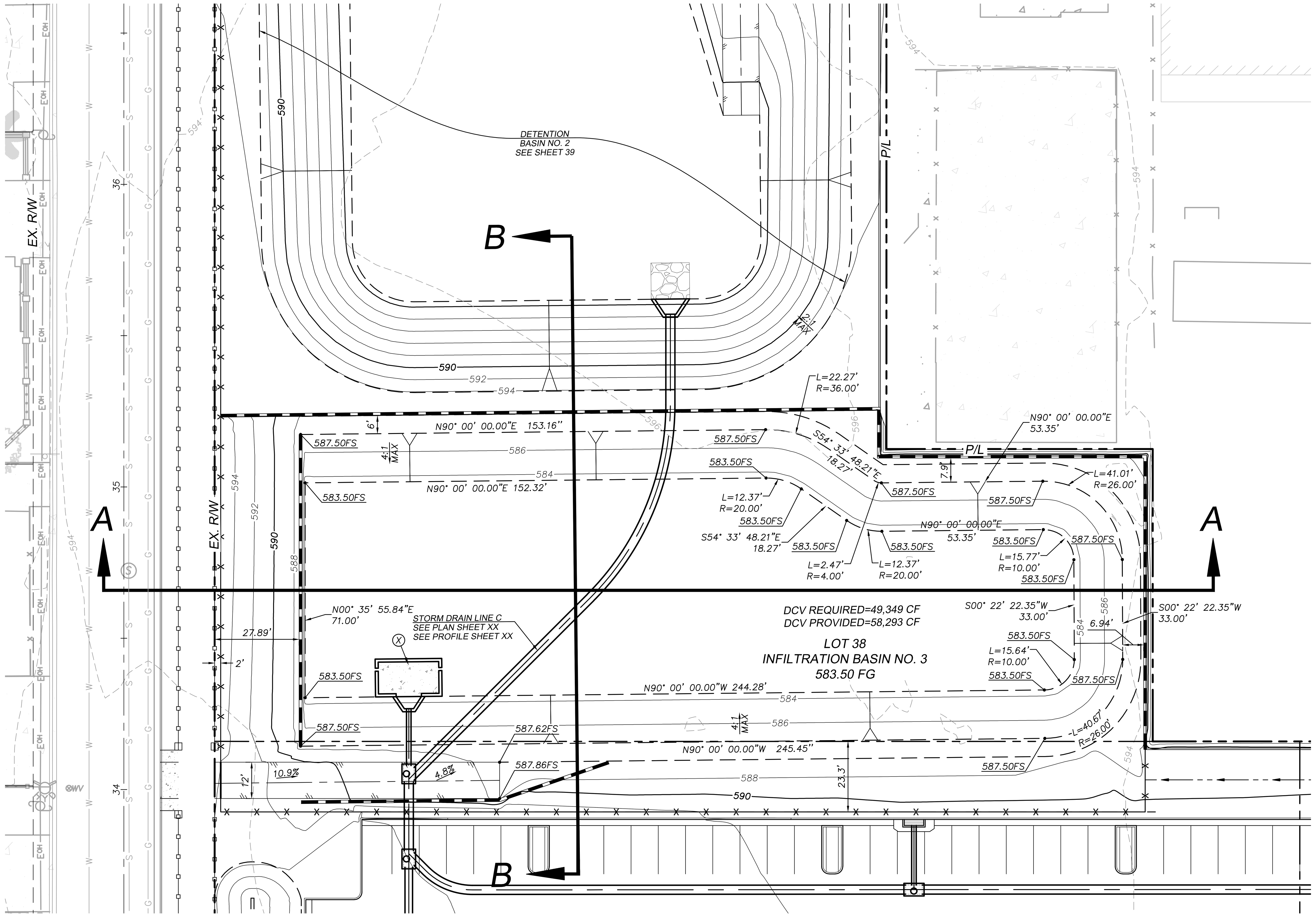
PRECISE GRADING PLAN
PALOMINO BUSINESS PARK
INFILTRATION BASIN NO. 2 PRECISE GRADING PLAN

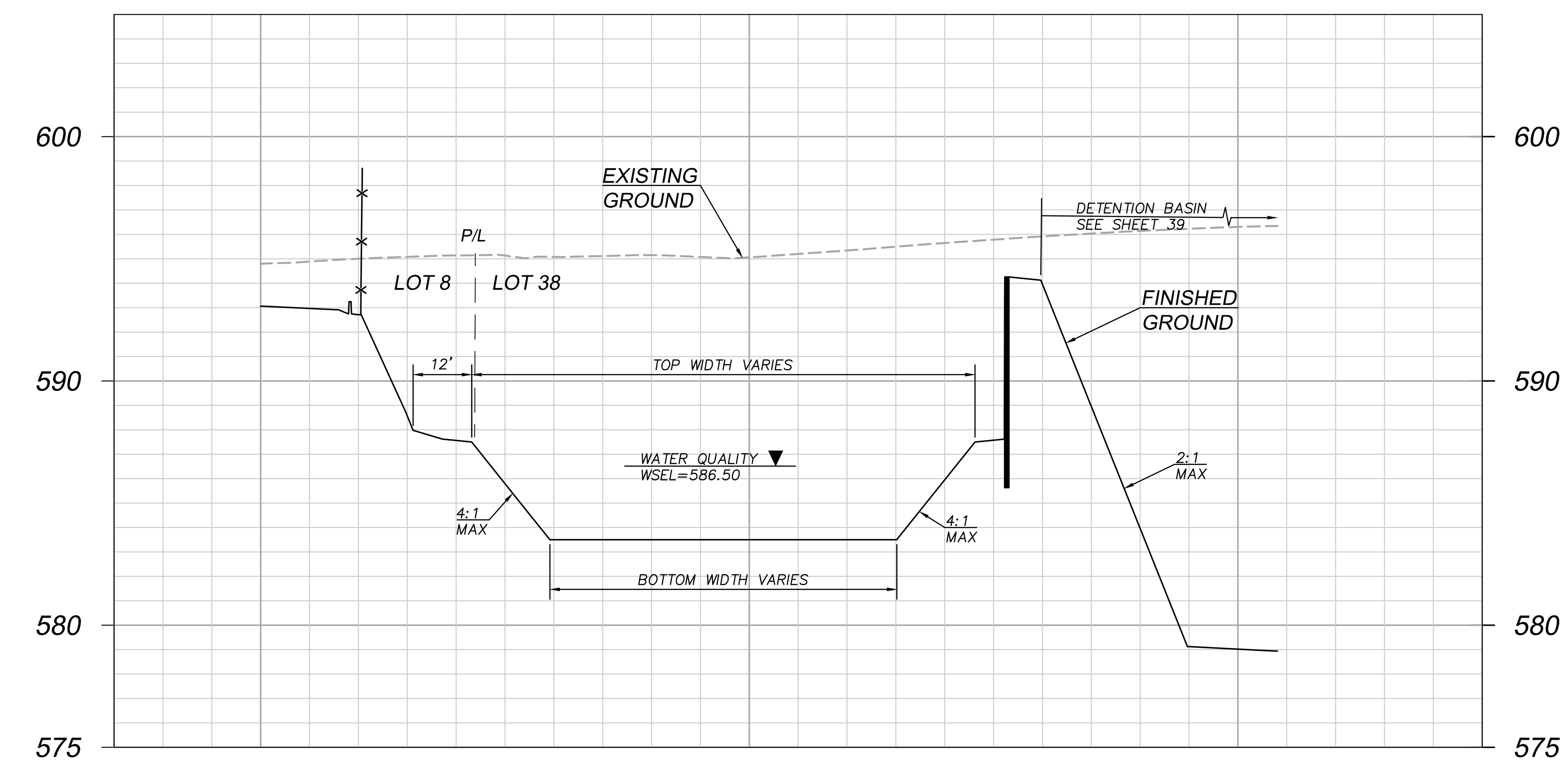
SHEET 37 OF XX
CONTRACT N/A
ACCOUNT N/A
DWG. NO. XXXXXX

★PRELIMINARY★
SUBJECT TO REVISION

PRECISE GRADING & DRAINAGE CONSTRUCTION NOTES:

9. PROPOSED 12' WIDE DRIVEWAY APPROACH PER CITY OF NORCO STANDARD DRAWING NO. 255
17. PROPOSED PRIVATE MAINTENANCE RAMP. 3" AC OVER 3" COMPACTED CLASS 2 AGGREGATE BASE
18. PROPOSED CHAIN LINK FENCE PER GREENBOOK STANDARD 600–3. PROPOSED 12' WIDE DRIVE GATE LOCATION SHALL BE IN LINE WITH PROPOSED MAINTENANCE RAMP
4. CONNECT TO OFFSITE STORM DRAIN, INSTALL CONCRETE COLLAR PER RCFCD STANDARD DWG NO. M803.
43. PROPOSED STRAIGHT HEADWALL PER DETAIL "X" SHEET XX.
44. BASIN B OUTLET STRUCTURE TBD





SECTION B-B
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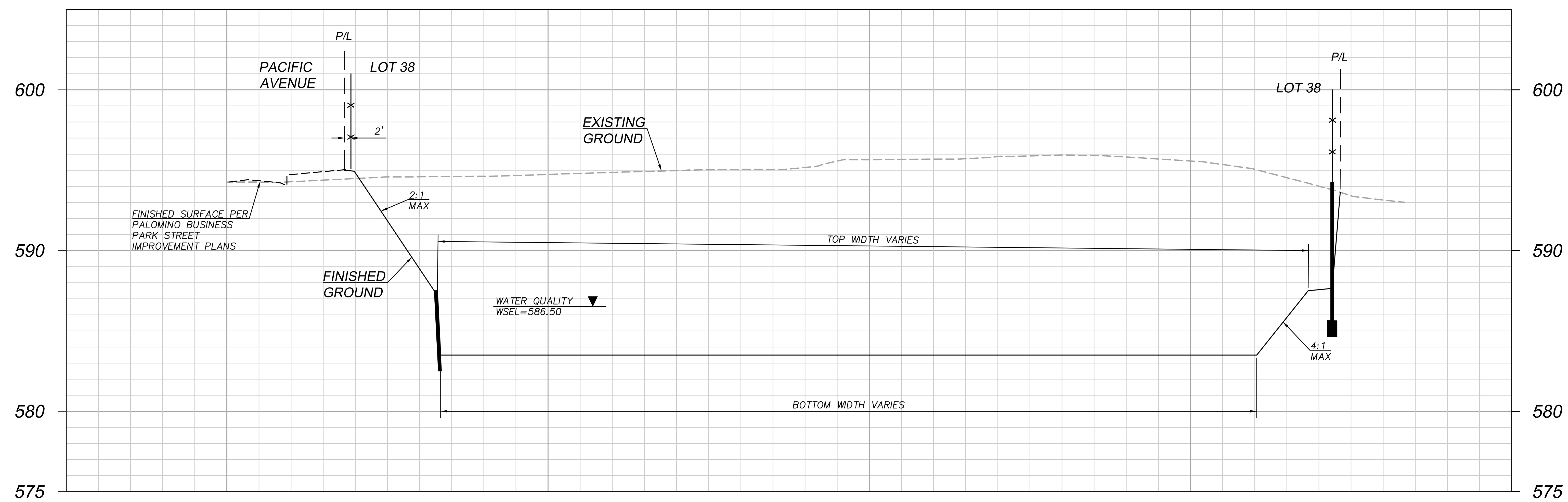
VERT: 1"=4'



SECTION A-A
HORZ: 1"=20'
VERT: 1"=4'

NOTE:
CONTRACTOR SHALL FIELD VERIFY EXISTING ELEVATIONS NOTED ON THIS PLAN PRIOR TO CONSTRUCTION

NOTE:
REFER TO CITY OF NORCO STREET IMPROVEMENT PLANS PREPARED BY MICHAEL BAKER INTERNATIONAL FOR OFF-SITE STREET IMPROVEMENTS. PROJECT NO. ____

MONUMENTS AND PROPERTY PINS TO BE PRESERVED AND/OR RESTORED/REPLACED IF DAMAGED.

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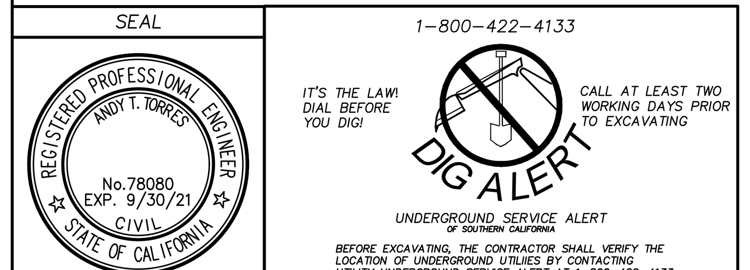
SEAL



SCALE: 1" = 20'

WDID NO. 8 33C386938

REVISIONS				
NO.	DATE	BY	DESCRIPTION	APPROVED

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(NOTE: ELEVATIONS SHOWN HEREON ARE IN TERMS OF NATIONAL GEODETIC VERTICAL DATUM 1929)

CITY OF NORCO
DEPARTMENT OF PUBLIC WORKS

APPROVED: ____ CITY ENGINEER ____ DATE

DESIGNED: ____ DATE: ____
DRAWN: ____ DATE: ____
CHECKED: ____ DATE: ____

PREPARED BY:
Michael Baker
INTERNATIONAL
5 HUTTON CENTRE DR.,STE 500,SANTA ANA, CA 92707
Phone: (949) 472.3505 · MBAKERINTL.COM

PRECISE GRADING PLAN
PALOMINO BUSINESS PARK
INFILTRATION BASIN NO. 3 PRECISE GRADING PLAN

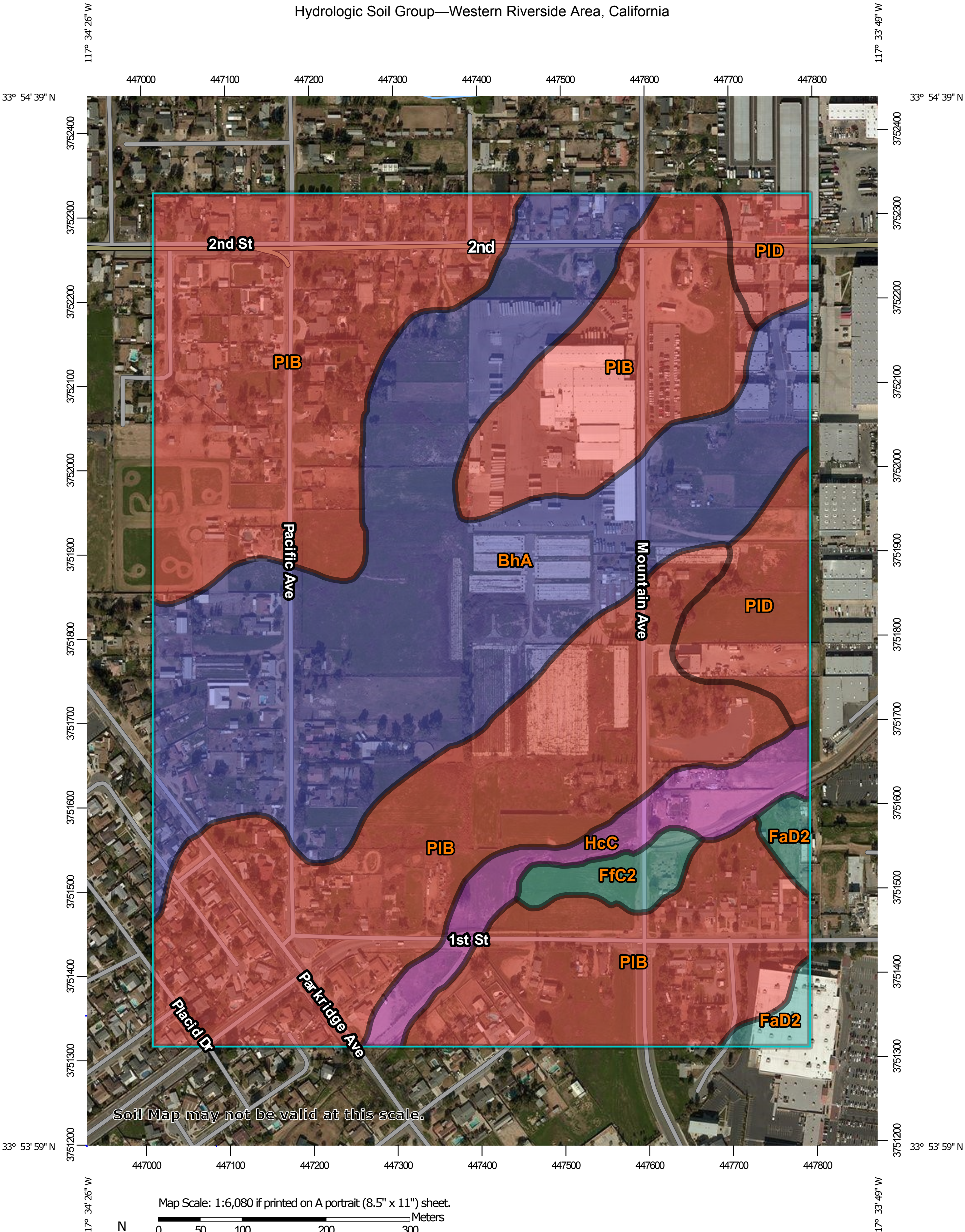
SHEET 38 OF XX
CONTRACT N/A
ACCOUNT N/A
DWG. NO. XXXXXX

★PRELIMINARY★ SUBJECT TO REVISION

Appendix 3: Soils Information

Geotechnical Study and Other Infiltration Testing Data

Hydrologic Soil Group—Western Riverside Area, California



Map Scale: 1:6,080 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 50, 100, 200, 300

Feet: 0, 250, 500, 1000, 1500

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Western Riverside Area, California
Survey Area Data: Version 11, Sep 12, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jan 5, 2015—Jan 18, 2015

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BhA	Buchenau loam, slightly saline-alkali, 0 to 2 percent slopes	B	61.9	31.4%
FaD2	Fallbrook sandy loam, 8 to 15 percent slopes, eroded	C	2.4	1.2%
FfC2	Fallbrook fine sandy loam, 2 to 8 percent slopes, eroded	C	2.8	1.4%
HcC	Hanford coarse sandy loam, 2 to 8 percent slopes	A	8.1	4.1%
PlB	Placentia fine sandy loam, 0 to 5 percent slopes	D	110.8	56.3%
PlD	Placentia fine sandy loam, 5 to 15 percent slopes	D	10.8	5.5%
Totals for Area of Interest			**196.9**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

May 31, 2019

CapRock Partners
1300 Dove Street, Suite 200
Newport Beach, California 92660

Attention: Mr. Patrick Daniels

Project No.: **17G105-2**

Subject: **Results of Infiltration Testing**
Proposed Palomino Business Park
NEC First Street and Pacific Avenue
Norco, California

References: Geotechnical Investigation and Liquefaction Evaluation, Proposed Norco Ranch Commerce Park, Mountain Avenue at 2nd Street, Norco, California, prepared by Southern California Geotechnical, Inc. (SCG) for Alere Property Group, LLC, SCG Project No. 11G114-1R, dated March 17, 2011.

Geotechnical Feasibility Study, Proposed Commercial/Industrial Development, NEC First Street and Pacific Avenue, Norco, California, prepared by SCG for CapRock Partners, SCG Project No. 17G105-1, dated March 2, 2017.

Dear Mr. Daniels:

In accordance with your request, we have conducted infiltration testing at the subject site. We are pleased to present this report summarizing the results of the infiltration testing and our design recommendations.

Scope of Services

The scope of services performed for this project was in general accordance with our Proposal No. 19P174, dated March 20, 2019. The scope of services included site reconnaissance, subsurface exploration, field testing, and engineering analysis to determine the infiltration rates of the onsite soils. The infiltration testing was performed in general accordance with the Riverside County – Low Impact Development BMP Design Handbook – Section 2.3 of Appendix A, prepared for the Riverside County Department of Environmental Health (RCDEH), dated December, 2013.

Site and Project Description

The subject site is located at the northeast corner of First Street and Pacific Avenue in Norco, California. The site is generally bounded to the north by Second Street, to the east by Mountain Avenue and commercial/industrial developments, to the south by First Street, and to the west by Pacific Avenue. The subject site also includes several additional parcels, which are located on the east side of Mountain Avenue and at the southwest corner of Mountain Avenue and First Street. The general location of the site is illustrated on the Site Location Map, enclosed as Plate 1 of this report.

22885 Savi Ranch Parkway ▾ Suite E ▾ Yorba Linda ▾ California ▾ 92887
voice: (714) 685-1115 ▾ fax: (714) 685-1118 ▾ www.socalgeo.com

The overall site consists of multiple rectangular and irregular-shaped parcels, which total 118± acres in size. The parcels located adjacent to Pacific Avenue, First Street, and Second Street are developed with single-family residences or consist of vacant lots. The single-family residences appear to be of wood-frame and stucco construction and are assumed to be supported on conventional shallow foundations with concrete slab-on-grade floors. The ground surface cover in these areas consists of concrete driveways, concrete flatwork, and areas of exposed soil with moderate to dense native grass and weed growth. Several medium to large-sized trees are located throughout these areas.

The existing parcels located on the east and west sides of Mountain Avenue are generally developed or consist of single-family residences, vacant lots, and a commercial/industrial building approximately 150,000 ft² in size, which is presently occupied. The commercial/industrial building appears to be a metal-frame structure and is assumed to be supported on conventional shallow foundations with a concrete slab-on-grade floor. The ground surface cover surrounding the building consists of asphaltic concrete in the parking and drive areas, and Portland cement concrete pavements in the loading dock areas. The single-family residences appear to consist of wood-frame and stucco construction and are assumed to be supported on conventional shallow foundations with concrete slab-on-grade floors. Several parcels in these areas contain concrete slabs from pre-existing structures. The ground surface cover in these areas consist of exposed soil with moderate to dense native grass and weed growth. In addition to the development described above, an asphalt parking lot, about 47,000 ft² in size, is located at the southeast corner of Second Street and Mountain Avenue.

Detailed topographic information was not available at the time of this report. Based on visual observations, the site topography within the area of the proposed development appears to be relatively level ground, sloping gently downward toward the west-southwest at a gradient of less than 1± percent.

Proposed Development

A preliminary site plan (Scheme 38) for the proposed development, which was prepared by Carlile Coatsworth Architects, Inc., was provided to our office by the client. This plan indicates that the site will be developed with a total of thirty-six (36) commercial/industrial buildings, identified as Building 1 through Building 33 and Buildings A, B, and C. The new buildings will range from 4,095 to 157,275± ft² in size. Several of the buildings will share a common wall. The larger buildings will possess dock high doors on one side. The buildings will be surrounded by asphaltic concrete pavements in the parking and drive lanes, and Portland cement concrete pavements in the truck court areas. The proposed development is also expected to include areas of concrete flatwork and landscape planters located throughout the site.

We understand that the proposed development will include on-site infiltration to dispose of storm water. Based on an infiltration test exhibit prepared by Michael Baker International (MBI), the proposed infiltration system will consist of two (2) infiltration/detention basins located in the northwestern and southeastern corners of the overall site. The bottom of the northwestern basin will extend to a depth of 15½± feet below the existing site grades and the southeastern basin will extend 20 to 21± feet below the existing site grades.

Previous Studies

Southern California Geotechnical, Inc. (SCG) previously conducted a geotechnical investigation and a feasibility study within the subject site, which are both referenced above. As part of these studies, a total of seventeen (17) borings were advanced to depths of 20 to 51± feet below the existing site grades. In addition to the borings, four (4) cone penetration test (CPT) soundings were performed at the site.

Artificial fill soils were encountered at the ground surface at one of the borings, extending to a depth of 2½± feet below the existing grade. The fill soils generally consisted of medium dense silty fine sands. Native alluvial soils were encountered beneath the artificial fill soils and at the ground surface at the remaining boring locations. The alluvial soils within the upper 4 to 12± feet generally consisted of loose to medium dense silty sands, clayey sands, and fine sandy silts. In addition, several zones of medium stiff to very stiff clayey silts and silty clays were present in the upper 2½ to 8± feet. At depths greater than 12± feet, the borings generally encountered medium dense to very dense fine to medium sands and fine to coarse sands with varying amounts of fine to coarse gravel content. At these depths, several strata of stiff to very stiff clayey silts, silty clays, and sandy clays were also encountered. The native alluvial soils extended to a depth of 37± feet and to at least the maximum depth explored of 51± feet. La Sierra Tonalite bedrock was encountered at one of the boring locations at a depth of 37± feet. The bedrock consisted of very dense, phaneritic, highly weathered and friable tonalite. Free water was encountered at several of the boring locations, at depths ranging from 22 to 41± feet below the existing site grades during the previous subsurface explorations.

Subsurface Exploration

Scope of Exploration

The subsurface exploration conducted for the infiltration testing consisted of three (3) infiltration test borings advanced to depths of 15½ to 21± feet below the existing site grades. The infiltration borings were advanced using a truck-mounted drilling rig, equipped with 8-inch diameter hollow stem augers and were logged during drilling by a member of our staff. The approximate locations of the infiltration test borings (identified as I-1 through I-3) are indicated on the Infiltration Test Location Plan, enclosed as Plate 2 of this report.

Upon the completion of the infiltration borings, the bottom of each test boring was covered with 2± inches of clean ¾-inch gravel. A sufficient length of 3-inch-diameter perforated PVC casing was then placed into each test hole so that the PVC casing extended from the bottom of the test hole to the ground surface. Clean ¾-inch gravel was then installed in the annulus surrounding the PVC casing.

Geotechnical Conditions

Native alluvial soils were encountered at the ground surface at all three (3) of the infiltration boring locations, extending to at least 21± feet below the existing site grades. The alluvium generally consists of very stiff fine to medium sandy clays and loose to dense clayey fine sands, silty fine sands, fine sandy silts, and fine to coarse sands. The Boring Logs, which illustrate the conditions encountered at the boring locations, are included with this report.

Groundwater

Free water was not encountered during the drilling of any of the borings. Based on the lack of any water within the borings and the moisture contents of the recovered soil samples, the static groundwater is considered to have been present at a depth in excess of 21± feet at the time of the subsurface exploration. As part of our research, we reviewed available groundwater data in order to determine recent groundwater levels in the vicinity of the subject site. The primary reference used to determine the groundwater depths in this area is the California Department of Water Resources website, http://www.water.ca.gov/waterdatalibrary/. The nearest monitoring well is located approximately 1.4 miles southwest from the site. Recent water level readings within this monitoring well indicates high groundwater levels ranging from of 22 to 33± feet (April 2013 to October 2017) below the ground surface.

Infiltration Testing

As previously mentioned, the infiltration testing was performed in general accordance with the guidelines published in the Riverside County – Low Impact Development BMP Design Handbook – Section 2.3 of Appendix A, prepared for the Riverside County Department of Environmental Health (RCDEH).

Pre-soaking

In accordance with the county infiltration standards, all three (3) of the infiltration test borings were pre-soaked prior to the infiltration testing. The pre-soaking process consisted of filling the test borings by inverting a full 5-gallon bottle of clear water supported over each hole so that the water level reaches a level of at least 5 times the hole's radius above the gravel at the bottom of each hole. The pre-soaking was completed after all of the water had percolated through each test hole or after 15 hours since initiating the pre-soak. Based on the results of the pre-soaking process, different infiltration procedures were used during the infiltration testing at the infiltration boring locations.

Infiltration Testing

Following the pre-soaking process of the infiltration test borings, SCG performed the infiltration testing. Each test hole was filled with water to a depth of at least 5 times the hole's radius above the gravel at the bottom of each test hole, and less than or equal to the water level used during the pre-soaking process. In accordance with the Riverside County guidelines, since "sandy soils" were encountered at the bottom of Infiltration Boring Nos. I-1 and I-2 (where 6 inches of water infiltrated into the surrounding soils for two-consecutive 25-minute readings), readings were taken at 10-minute intervals for a total of 1 hour at Infiltration Test Nos. I-1 and I-2. Since "non-sandy soils" were encountered at the bottom of Infiltration Boring No. I-3, readings were taken at 30-minute intervals for a total of 6 hours at Infiltration Test No. I-3. After each reading, the borings were refilled to the correct water level above the gravel at the bottom of each test hole. The water level readings are presented on the spreadsheets enclosed with this report. The infiltration rates for each of the timed intervals are also tabulated on the spreadsheets.

The infiltration rates from the test are tabulated in inches per hour. In accordance with the typically accepted practice, it is recommended that the most conservative reading from the latter part of the infiltration tests be used as the design infiltration rate. The rates are summarized below:

Infiltration Test No.	**Depth (feet)**	**Test Elevation (msl)**	**Soil Description**	**Infiltration Rate (inches/hour)**
I-1	15½	581	Fine to coarse Sand, trace Silt	4.0
I-2	20	573	Fine to coarse Sand	11.8
I-3	21	573	Fine to medium Sandy Clay	0.4

Laboratory Testing

Moisture Content

The moisture contents for the recovered soil samples within the borings were determined in accordance with ASTM D-2216 and are expressed as a percentage of the dry weight. These test results are presented on the Boring Logs.

Grain Size Analysis

The grain size distribution of selected soils collected from the bottom of each infiltration test boring have been determined using a range of wire mesh screens. These tests were performed in general accordance with ASTM D-422 and/or ASTM D-1140. The weight of the portion of the sample retained on each screen is recorded and the percentage finer or coarser of the total weight is calculated. The results of these tests are presented on Plates C-1 through C-3 of this report.

Design Recommendations

Three (3) infiltration tests were performed at the subject site. As noted above, the infiltration rates at these locations range from 0.4 to 11.8 inches per hour. The primary factor affecting the infiltration rates is the clay content of the soil encountered at the bottom of Infiltration Boring No. I-3. Based on the results of Infiltration Test No. I-1, we recommend a design infiltration rate of 4.0 inches per hour be used for the proposed infiltration/detention basin located in the northwestern corner of the site. Based on the results of Infiltration Test Nos. I-2 and I-3, we recommend a design infiltration rate of 0.4 inches per hour be used for the southeastern infiltration/detention basin.

We recommend that a representative from the geotechnical engineer be on-site during the construction of the proposed infiltration systems to identify the composition of the soil at the base of each basin. It should be confirmed that the soils at the base of the proposed infiltration systems correspond with those presented in this report to ensure that the performance of the systems will be consistent with the rates reported herein.

The design of the proposed storm water infiltration system should be performed by the project civil engineer, in accordance with the City of Norco and/or County of Riverside guidelines. However, it is recommended that the systems be constructed so as to facilitate removal of silt and clay, or other deleterious materials from any water that may enter the system. The presence of such materials would decrease the effective infiltration rate. **It is recommended that the project civil engineer apply an appropriate factor of safety. The infiltration rates recommended above are based on the assumption that only clean water will be introduced to the subsurface profile. Any fines, debris, or organic materials could significantly impact the infiltration rates.** It should be noted that the recommended infiltration rates are based on infiltration testing at three (3) discrete locations and the overall infiltration rates of the storm water infiltration systems could vary considerably.

Construction Considerations

The infiltration rates presented in this report are specific to the tested locations and tested depths. Infiltration rates can be significantly reduced if the soils are exposed to excessive disturbance or compaction during construction. Therefore, the subgrade soils within proposed infiltration system areas should not be over-excavated, undercut or compacted in any significant manner. **It is recommended that a note to this effect be added to the project plans and/or specifications.**

Infiltration versus Permeability

Infiltration rates are based on unsaturated flow. As water is introduced into soils by infiltration, the soils become saturated and the wetting front advances from the unsaturated zone to the saturated zone. Once the soils become saturated, infiltration rates become zero, and water can only move through soils by hydraulic conductivity at a rate determined by pressure head and soil permeability. The infiltration rates presented herein were determined in accordance with the ASTM Test Method D-3385-03 standard and are considered valid for the time and place of the actual test. Changes in soil moisture content will affect these infiltration rates. Infiltration rates should be expected to decrease until the soils become saturated. Soil permeability values will then govern groundwater movement. Permeability values may be on the order of 10 to 20 times less than infiltration rates. The system designer should incorporate adequate factors of safety and allow for overflow design into appropriate traditional storm drain systems, which would transport storm water off-site.

Location of Infiltration Systems

The use of on-site storm water infiltration systems carries a risk of creating adverse geotechnical conditions. Increasing the moisture content of the soil can cause the soil to lose internal shear strength and increase its compressibility, resulting in a change in the designed engineering properties. Overlying structures and pavements in the infiltration areas could potentially be damaged due to saturation of subgrade soils. **The proposed infiltration systems for this site should be located at least 25 feet away from any structures, including retaining walls.** Even with this provision of locating the infiltration system at least 25 feet from the building, it is possible that infiltrating water into the subsurface soils could have an adverse effect on the proposed or existing structures. It should also be noted that utility trenches which happen to collect storm water can also serve as conduits to transmit storm water toward the structure, depending on the slope of the utility trench. Therefore, consideration should also be given to the proposed locations of underground utilities which may pass near the proposed infiltration systems.

General Comments

This report has been prepared as an instrument of service for use by the client in order to aid in the evaluation of this property and to assist the architects and engineers in the design and preparation of the project plans and specifications. This report may be provided to the contractor(s) and other design consultants to disclose information relative to the project. However, this report is not intended to be utilized as a specification in and of itself, without appropriate interpretation by the project architect, structural engineer, and/or civil engineer. The design of the infiltration system is the responsibility of the civil engineer. The role of the geotechnical engineer is limited to determination of infiltration rate only. By using the design infiltration rates contained herein, the civil engineer agrees to indemnify, defend, and hold harmless the geotechnical engineer for all aspects of the design and performance of the infiltration system. The reproduction and distribution of this report must be authorized by the client and Southern California Geotechnical, Inc. Furthermore, any reliance on this report by an unauthorized third party is at such party's sole risk, and we accept no responsibility for damage or loss which may occur. The analysis of this site was based on a subsurface profile interpolated from limited discrete soil samples. While the materials encountered in the project area are considered to be representative of the total area, some variations should be expected between trench locations and testing depths. If the conditions encountered during construction vary significantly from those detailed herein, we should be contacted immediately to determine if the conditions alter the recommendations contained herein.

This report has been based on assumed or provided characteristics of the proposed development. It is recommended that the owner, client, architect, structural engineer, and civil engineer carefully review these assumptions to ensure that they are consistent with the characteristics of the proposed development. If discrepancies exist, they should be brought to our attention to verify that they do not affect the conclusions and recommendations contained herein. We also recommend that the project plans and specifications be submitted to our office for review to verify that our recommendations have been correctly interpreted. The analysis, conclusions, and recommendations contained within this report have been promulgated in accordance with generally accepted professional geotechnical engineering practice. No other warranty is implied or expressed.

Closure

We sincerely appreciate the opportunity to be of service on this project. We look forward to providing additional consulting services during the course of the project. If we may be of further assistance in any manner, please contact our office.

Respectfully Submitted,

SOUTHERN CALIFORNIA GEOTECHNICAL, INC.

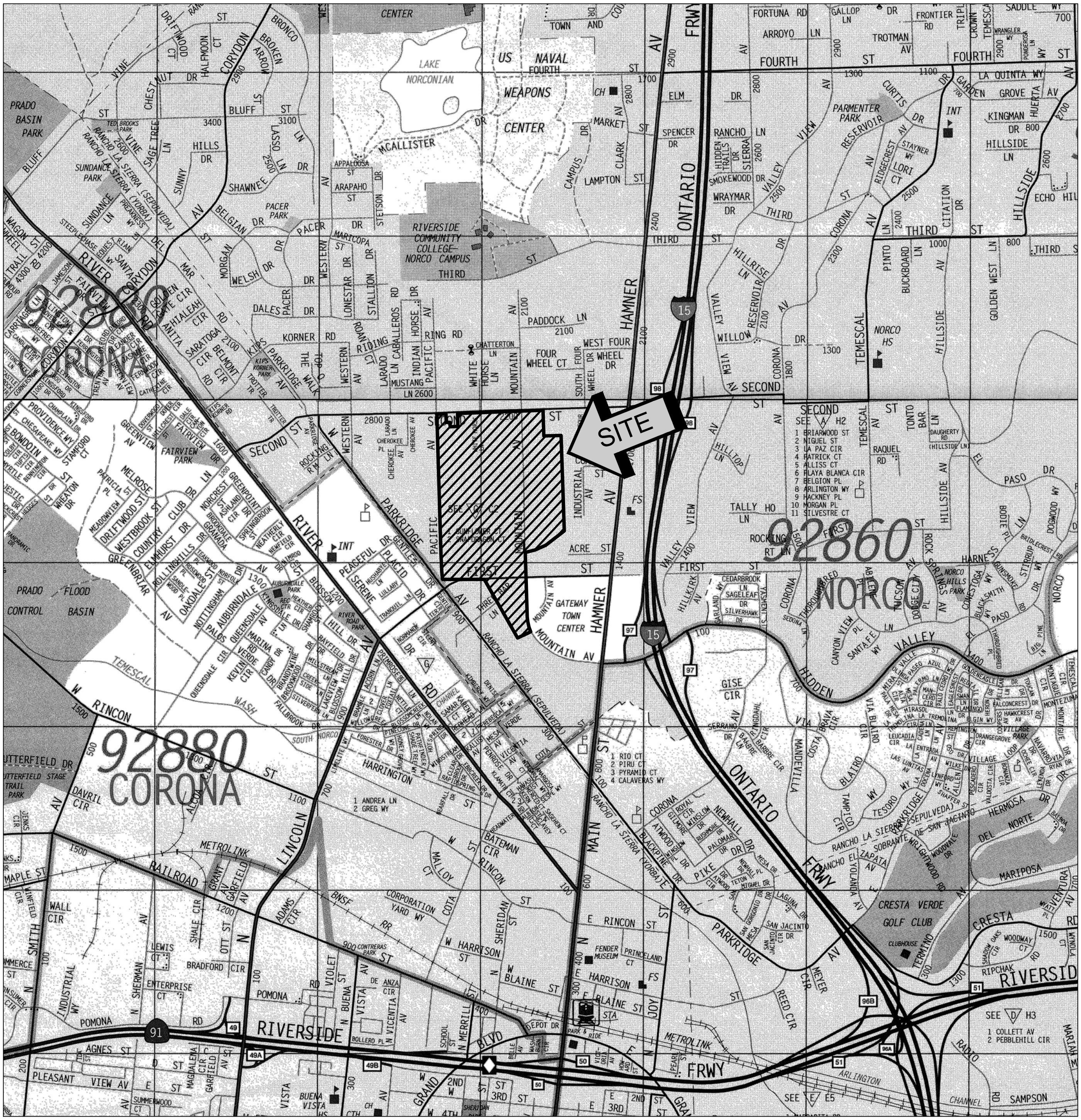
Scott McCann
Staff Scientist

REGISTERED PROFESSIONAL ENGINEER
ROBERT TRAZO
No. 2655
GEOTECHNICAL
STATE OF CALIFORNIA

Robert G. Trazo, GE 2655
Principal Engineer

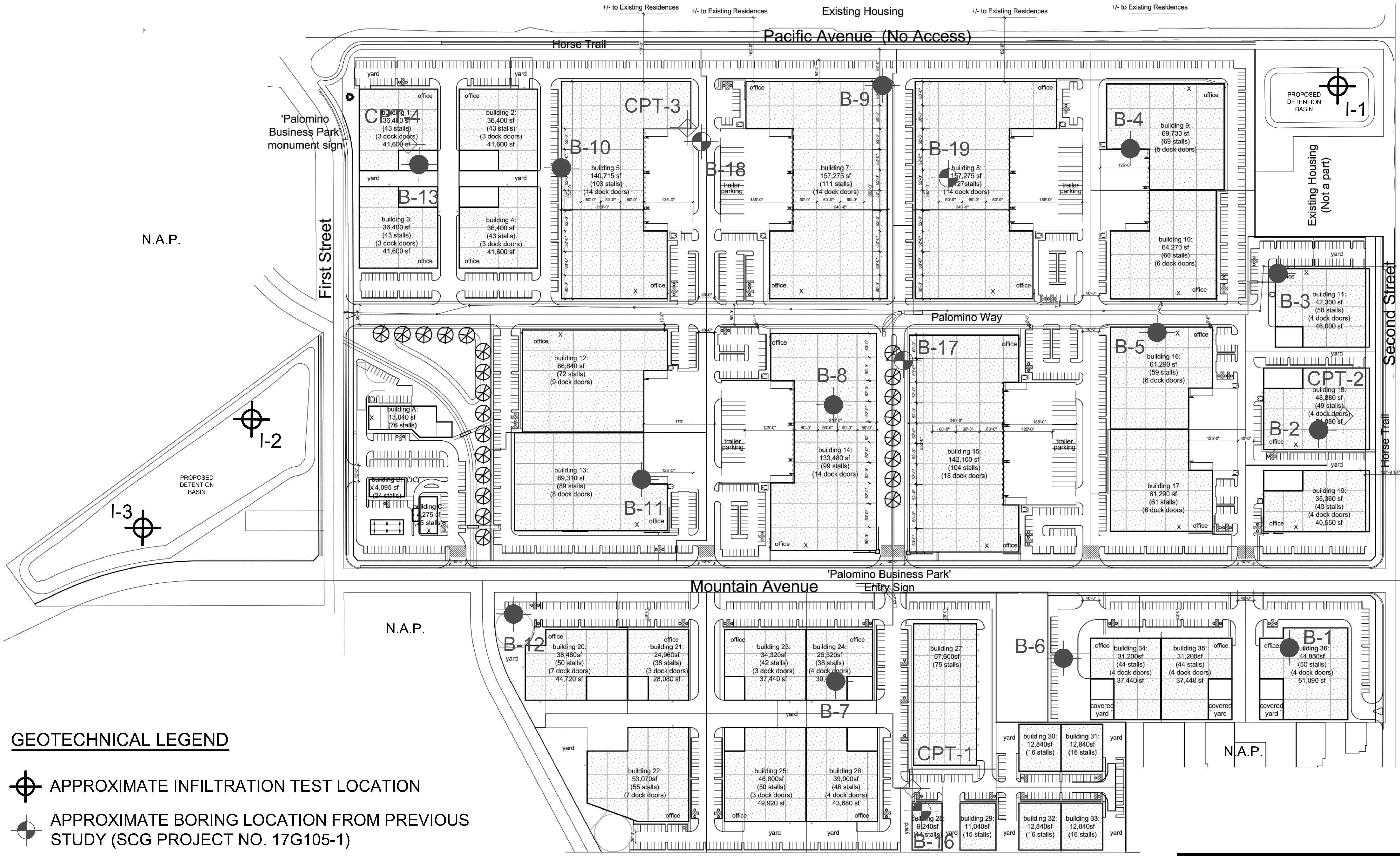
Distribution: (1) Addressee

Enclosures: Plate 1 - Site Location Map
Plate 2 - Infiltration Test Location Plan
Boring Log Legend and Logs (5 pages)
Infiltration Test Results Spreadsheets (3 pages)
Grain Size Distribution Graphs (3 pages)



SOURCE: RIVERSIDE COUNTY
THOMAS GUIDE, 2009

SITE LOCATION MAP	
PROPOSED PALOMINO BUSINESS PARK	
NORCO, CALIFORNIA	
SCALE: 1" = 2400'	SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
DRAWN: SAM CHKD: RGT	
SCG PROJECT 17G105-2	
PLATE 1	



GEOTECHNICAL LEGEND

- APPROXIMATE INFILTRATION TEST LOCATION
- APPROXIMATE BORING LOCATION FROM PREVIOUS STUDY (SCG PROJECT NO. 17G105-1)
- APPROXIMATE CPT LOCATION FROM PREVIOUS STUDY (SCG PROJECT NO. 17G105-1)
- APPROXIMATE BORING LOCATION FROM PREVIOUS STUDY (SCG PROJECT NO. 11G114-1)

NORTH
SoCalGeo

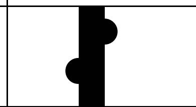
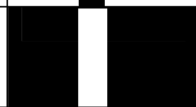
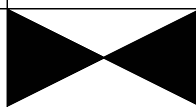
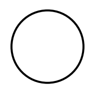
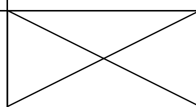
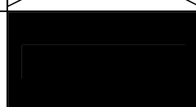
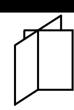
NOTE: SITE PLAN PREPARED BY CARLILE COATSWORTH ARCHITECTS, INC.

INFILTRATION TEST LOCATION PLAN
PROPOSED PALOMINO BUSINESS PARK
NORCO, CALIFORNIA

SCALE: 1" = 250'
DRAWN: SAM
CHKD: RGT
SCG PROJECT 17G105-2
PLATE 2

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL

BORING LOG LEGEND

SAMPLE TYPE	GRAPHICAL SYMBOL	SAMPLE DESCRIPTION
AUGER		SAMPLE COLLECTED FROM AUGER CUTTINGS, NO FIELD MEASUREMENT OF SOIL STRENGTH. (DISTURBED)
CORE		ROCK CORE SAMPLE: TYPICALLY TAKEN WITH A DIAMOND-TIPPED CORE BARREL. TYPICALLY USED ONLY IN HIGHLY CONSOLIDATED BEDROCK.
GRAB		SOIL SAMPLE TAKEN WITH NO SPECIALIZED EQUIPMENT, SUCH AS FROM A STOCKPILE OR THE GROUND SURFACE. (DISTURBED)
CS		CALIFORNIA SAMPLER: 2-1/2 INCH I.D. SPLIT BARREL SAMPLER, LINED WITH 1-INCH HIGH BRASS RINGS. DRIVEN WITH SPT HAMMER. (RELATIVELY UNDISTURBED)
NSR		NO RECOVERY: THE SAMPLING ATTEMPT DID NOT RESULT IN RECOVERY OF ANY SIGNIFICANT SOIL OR ROCK MATERIAL.
SPT		STANDARD PENETRATION TEST: SAMPLER IS A 1.4 INCH INSIDE DIAMETER SPLIT BARREL, DRIVEN 18 INCHES WITH THE SPT HAMMER. (DISTURBED)
SH		SHELBY TUBE: TAKEN WITH A THIN WALL SAMPLE TUBE, PUSHED INTO THE SOIL AND THEN EXTRACTED. (UNDISTURBED)
VANE		VANE SHEAR TEST: SOIL STRENGTH OBTAINED USING A 4 BLADED SHEAR DEVICE. TYPICALLY USED IN SOFT CLAYS-NO SAMPLE RECOVERED.

COLUMN DESCRIPTIONS

DEPTH: Distance in feet below the ground surface.

SAMPLE: Sample Type as depicted above.

BLOW COUNT: Number of blows required to advance the sampler 12 inches using a 140 lb hammer with a 30-inch drop. 50/3" indicates penetration refusal (>50 blows) at 3 inches. WH indicates that the weight of the hammer was sufficient to push the sampler 6 inches or more.

POCKET PEN.: Approximate shear strength of a cohesive soil sample as measured by pocket penetrometer.

GRAPHIC LOG: Graphic Soil Symbol as depicted on the following page.

DRY DENSITY: Dry density of an undisturbed or relatively undisturbed sample in lbs/ft^3.

MOISTURE CONTENT: Moisture content of a soil sample, expressed as a percentage of the dry weight.

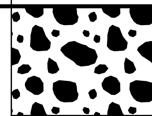
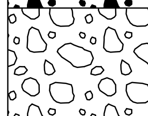
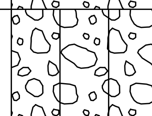
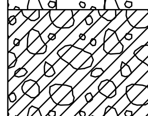
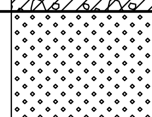
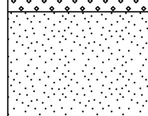
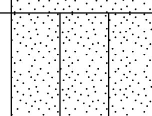
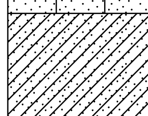
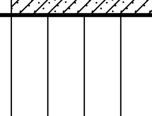
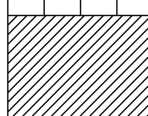
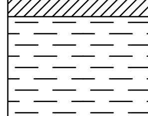
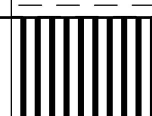
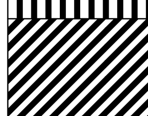
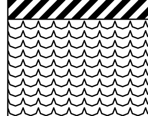
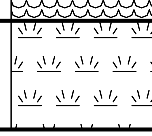
LIQUID LIMIT: The moisture content above which a soil behaves as a liquid.

PLASTIC LIMIT: The moisture content above which a soil behaves as a plastic.

PASSING #200 SIEVE: The percentage of the sample finer than the #200 standard sieve.

UNCONFINED SHEAR: The shear strength of a cohesive soil sample, as measured in the unconfined state.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
		(LITTLE OR NO FINES)		SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES		SM	SILTY SANDS, SAND - SILT MIXTURES
		(APPRECIABLE AMOUNT OF FINES)		SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

BORING NO. I-1

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

JOB NO.: 17G105-2
PROJECT: Proposed Palomino Business Park
LOCATION: Norco, California

DRILLING DATE: 5/8/19
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Anthony Luna

WATER DEPTH: Dry
CAVE DEPTH: ---
READING TAKEN: At Completion

SURFACE ELEVATION: 596.5 feet MSL

DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	ORGANIC CONTENT (%)	COMMENTS
					ALLUVIUM: Brown Clayey fine Sand, little medium Sand, loose-moist							
	X	9					11					
					Light Gray Brown Silty fine Sand to fine Sandy Silt, trace medium Sand, trace Calcareous veining, loose-very moist							
5	X	7					16					
					Light Gray Brown fine Sandy Silt, trace Iron oxide staining, loose to medium dense-moist to very moist							
	X	6					11					
10	X	24					16					
					Light Gray fine to coarse Sand, trace Silt, medium dense-dry							
15	X	19					1			5		

Boring Terminated at 15.5'

TBL 17G105-2.GPJ SOCALGEO.GDT 5/31/19

TEST BORING LOG

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. I-2

JOB NO.: 17G105-2
PROJECT: Proposed Palomino Business Park
LOCATION: Norco, California

DRILLING DATE: 5/8/19
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Anthony Luna

WATER DEPTH: Dry
CAVE DEPTH: ---
READING TAKEN: At Completion

DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION (SURFACE ELEVATION: 593 feet MSL)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	ORGANIC CONTENT (%)	COMMENTS
					ALLUVIUM: Brown Clayey fine Sand, little medium Sand, medium dense-damp to moist							
	X	16					10					
					Light Brown Silty fine Sand, little medium Sand, trace Clay, dense-damp							
	X	36					6					
5												
					Light Gray Brown Silty fine Sand to fine Sandy Silt, trace medium Sand, medium dense-damp							
	X	15					4					
	X	22					7					
10												
					Light Gray Brown fine Sandy Silt, trace Iron oxide staining, medium dense-damp							
	X	27					9					
15												
					Light Gray fine to coarse Sand, dense-dry							
	X	35					1			4		
20												

Boring Terminated at 20'

TBL 17G105-2.GPJ SOCALGEO.GDT 5/31/19

TEST BORING LOG **PLATE B-2**

BORING NO. I-3

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

JOB NO.: 17G105-2
PROJECT: Proposed Palomino Business Park
LOCATION: Norco, California

DRILLING DATE: 5/8/19
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Anthony Luna

WATER DEPTH: Dry
CAVE DEPTH: ---
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: 594 feet MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	ORGANIC CONTENT (%)	COMMENTS
					ALLUVIUM: Brown Clayey fine Sand, trace to little medium Sand, loose to medium dense-damp to moist							
	X	9					11					
	X	12					7					
5												
					Light Gray Brown Silty fine Sand to fine Sandy Silt, little medium Sand, trace Calcareous veining, medium dense-damp							
	X	28					2					
	X	26					6					
10												
					Light Gray Brown fine Sandy Silt, trace Clay, trace Iron oxide staining, medium dense-very moist							
	X	24					28					
15												
					Gray Brown fine to medium Sandy Clay, little Iron oxide staining, very stiff-moist							
20	X	23					11			60		
					Boring Terminated at 21'							

TEST BORING LOG

INFILTRATION CALCULATIONS

Project Name	Proposed Palomino Business Park
Project Location	Norco, CA
Project Number	17G105-2
Engineer	Scott McCann

Test Hole Radius	4	(in)
Test Depth	15.5	(ft)

Infiltration Test Hole	I-1

Interval Number		Time	Time Interval (min)	Water Depth (ft)	Change in Water Level (ft)	Average Head Height (ft)	Infiltration Rate Q (in/hr)	
P1	Initial	10:00 AM	10.0	12.60	0.63	2.59	2.75	Pre-Sat
	Final	10:10 AM		13.23				
P2	Initial	10:11 AM	10.0	13.24	0.69	1.92	3.98	
	Final	10:21 AM		13.93				
1	Initial	10:22 AM	10.0	13.65	0.60	1.55	4.19	Infiltration Testing
	Final	10:32 AM		14.25				
2	Initial	10:33 AM	10.0	13.75	0.55	1.48	4.02	
	Final	10:43 AM		14.30				
3	Initial	10:44 AM	10.0	13.65	0.58	1.56	4.03	
	Final	10:54 AM		14.23				
4	Initial	10:55 AM	10.0	13.80	0.53	1.44	3.97	
	Final	11:05 AM		14.33				
5	Initial	11:06 AM	10.0	13.80	0.53	1.44	3.97	
	Final	11:16 AM		14.33				
6	Initial	11:17 AM	10.0	13.80	0.53	1.44	3.97	
	Final	11:27 AM		14.33				

Per County Standards, Infiltration Rate calculated as follows:

$$\boxed{Q = \frac{\Delta H(60r)}{\Delta t(r + 2H_{avg})}}$$

Where: Q = Infiltration Rate (in inches per hour)

ΔH = Change in Height (Water Level) over the time interval

r = Test Hole (Borehole) Radius

Δt = Time Interval

H_{avg} = Average Head Height over the time interval

INFILTRATION CALCULATIONS

Project Name	Proposed Palomino Business Park
Project Location	Norco, CA
Project Number	17G105-2
Engineer	Scott McCann

Test Hole Radius	4	(in)
Test Depth	19.7	(ft)

Infiltration Test Hole	I-2

Interval Number		Time	Time Interval (min)	Water Depth (ft)	Change in Water Level (ft)	Average Head Height (ft)	Infiltration Rate Q (in/hr)	
P1	Initial	2:10 PM	5.0	18.00	0.90	1.25	15.25	Pre-Sat
	Final	2:15 PM		18.90				
P2	Initial	2:16 PM	5.0	18.00	0.80	1.30	13.09	
	Final	2:21 PM		18.80				
1	Initial	2:22 PM	10.0	18.00	1.30	1.05	12.82	Infiltration Testing
	Final	2:32 PM		19.30				
2	Initial	2:33 PM	10.0	18.00	1.28	1.06	12.52	
	Final	2:43 PM		19.28				
3	Initial	2:44 PM	10.0	18.00	1.26	1.07	12.23	
	Final	2:54 PM		19.26				
4	Initial	2:55 PM	10.0	18.00	1.25	1.08	12.08	
	Final	3:05 PM		19.25				
5	Initial	3:06 PM	10.0	18.00	1.25	1.08	12.08	
	Final	3:16 PM		19.25				
6	Initial	3:17 PM	10.0	18.00	1.23	1.09	11.79	
	Final	3:27 PM		19.23				

Per County Standards, Infiltration Rate calculated as follows:

$$\boxed{Q = \frac{\Delta H(60r)}{\Delta t(r + 2H_{avg})}}$$

Where: Q = Infiltration Rate (in inches per hour)

ΔH = Change in Height (Water Level) over the time interval

r = Test Hole (Borehole) Radius

Δt = Time Interval

H_{avg} = Average Head Height over the time interval

INFILTRATION CALCULATIONS

Project Name	Proposed Palomino Business Park
Project Location	Norco, CA
Project Number	17G105-2
Engineer	Scott McCann

Test Hole Radius	4	(in)
Test Depth	21.2	(ft)

Infiltration Test Hole	I-3

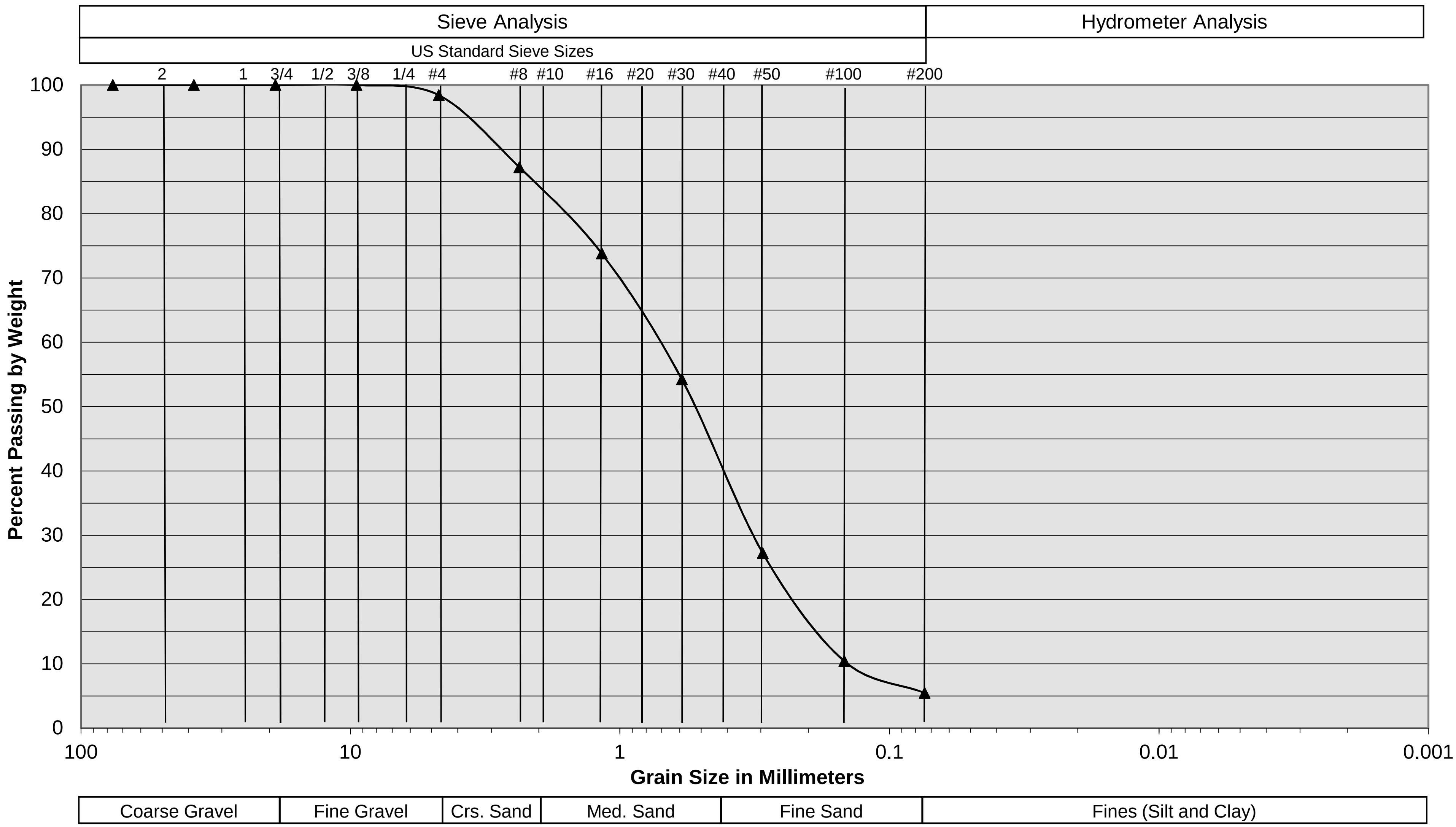
Interval Number		Time	Time Interval (min)	Water Depth (ft)	Change in Water Level (ft)	Average Head Height (ft)	Infiltration Rate Q (in/hr)
1	Initial	8:00 AM	30.0	19.25	0.24	1.83	0.48
	Final	8:30 AM		19.49			
2	Initial	8:30 AM	30.0	19.39	0.18	1.72	0.38
	Final	9:00 AM		19.57			
3	Initial	9:00 AM	30.0	19.32	0.23	1.77	0.48
	Final	9:30 AM		19.55			
4	Initial	9:30 AM	30.0	19.40	0.21	1.70	0.45
	Final	10:00 AM		19.61			
5	Initial	10:00 AM	30.0	19.45	0.20	1.65	0.44
	Final	10:30 AM		19.65			
6	Initial	10:30 AM	30.0	19.45	0.20	1.65	0.44
	Final	11:00 AM		19.65			
7	Initial	11:00 AM	30.0	19.50	0.19	1.61	0.43
	Final	11:30 AM		19.69			
8	Initial	11:30 AM	30.0	19.49	0.18	1.62	0.40
	Final	12:00 PM		19.67			
9	Initial	12:00 PM	30.0	19.50	0.18	1.61	0.41
	Final	12:30 PM		19.68			
10	Initial	12:30 PM	30.0	19.47	0.18	1.64	0.40
	Final	1:00 PM		19.65			
11	Initial	1:00 PM	30.0	19.49	0.18	1.62	0.40
	Final	1:30 PM		19.67			
12	Initial	1:30 PM	30.0	19.50	0.18	1.61	0.41
	Final	2:00 PM		19.68			

Per County Standards, Infiltration Rate calculated as follows:

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

Where:
- Q = Infiltration Rate (in inches per hour)
- ΔH = Change in Height (Water Level) over the time interval
- r = Test Hole (Borehole) Radius
- Δt = Time Interval
- H_{avg} = Average Head Height over the time interval

Grain Size Distribution

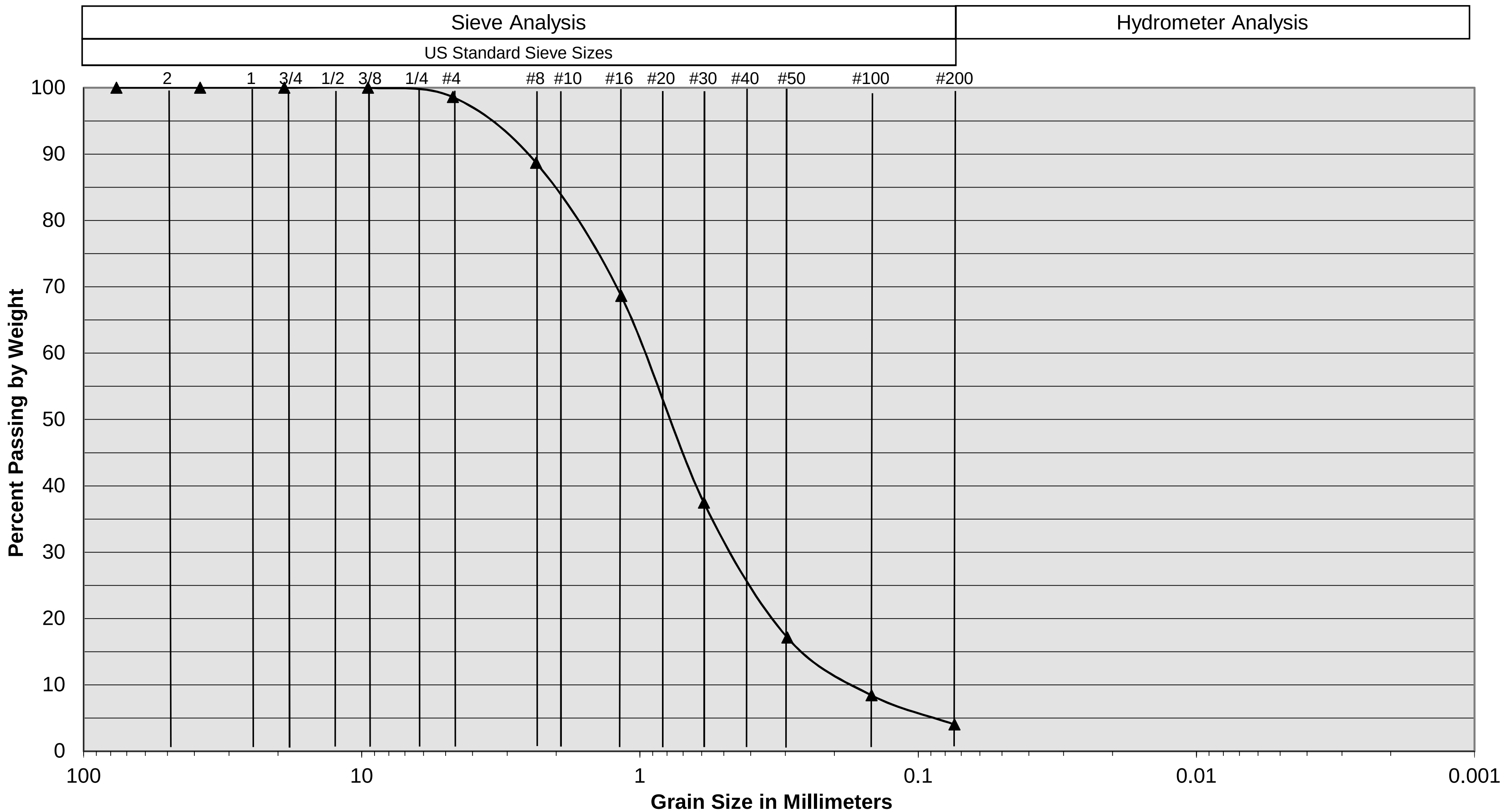


Sample Description	I-1 @ 14 to 15½ feet
Soil Classification	Light Gray fine to coarse Sand, trace Silt

Proposed Palomino Business Park
Norco, California
Project No. 17G105-2
PLATE C-1

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Grain Size Distribution

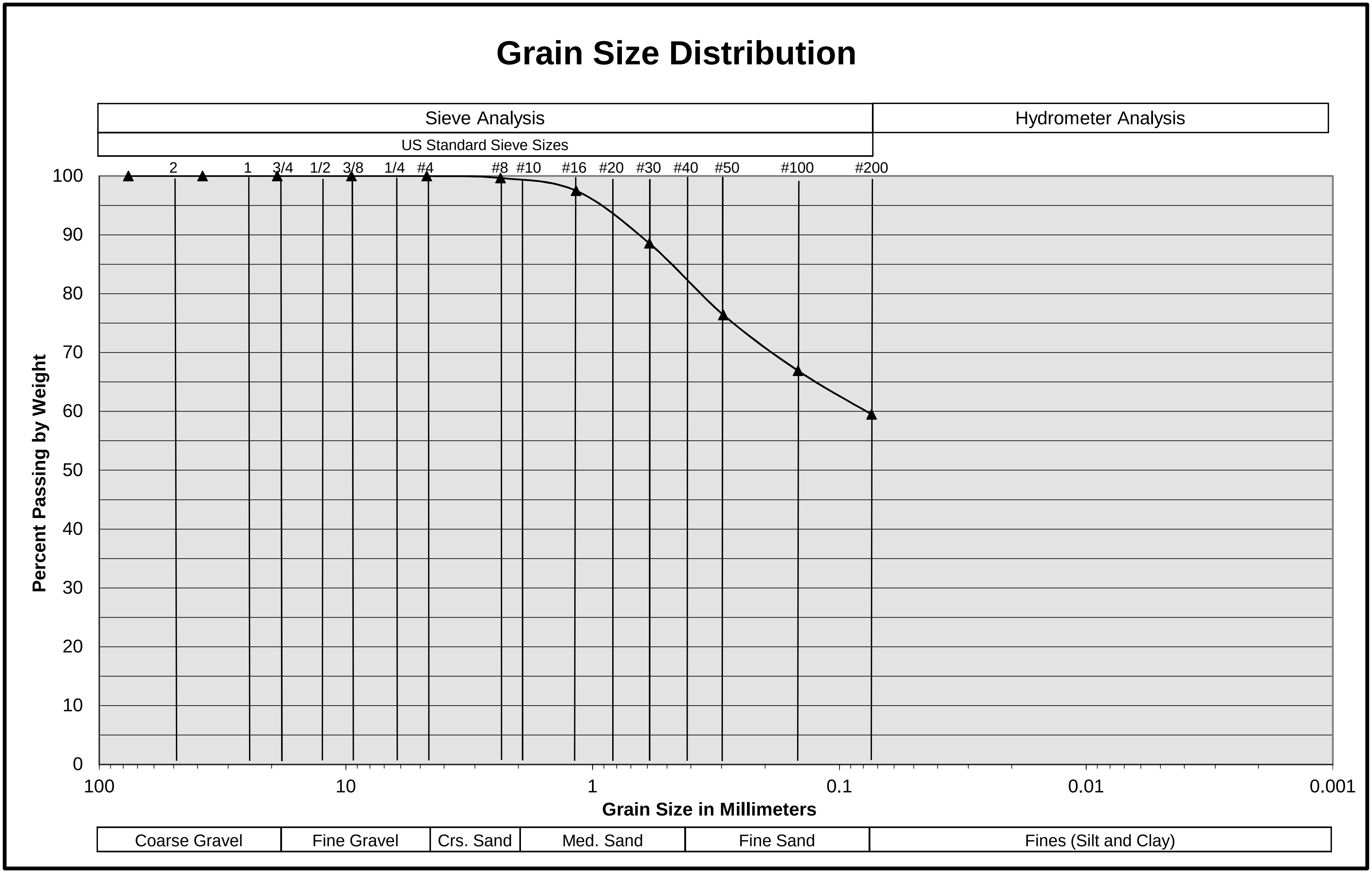


Coarse Gravel	Fine Gravel	Crs. Sand	Med. Sand	Fine Sand	Fines (Silt and Clay)

Sample Description	I-2 @ 18½ to 20 feet
Soil Classification	Light Gray fine to coarse Sand

Proposed Palomino Business Park
Norco, California
Project No. 17G105-2
PLATE C-2

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



Sample Description	I-3 @ 19½ to 21 feet
Soil Classification	Gray Brown fine to medium Sandy Clay

Proposed Palomino Business Park
Norco, California
Project No. 17G105-2
PLATE C-3

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL A California Corporation

GEOTECHNICAL FEASIBILITY STUDY
PROPOSED COMMERCIAL/INDUSTRIAL DEVELOPMENT

NEC First Street and Pacific Avenue
Norco, California
for
CapRock Partners

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

March 2, 2017

CapRock Partners
2050 Main Street, Suite 240
Irvine, California 92614

Attention: Mr. Russell Fenton, PE
Director of Development

Project No.: **17G105-1**

Subject: **Geotechnical Feasibility Study**
Proposed Commercial/Industrial Development
NEC First Street and Pacific Avenue
Norco, California

Reference: Geotechnical Investigation and Liquefaction Evaluation, Proposed Norco Ranch Commerce Park, Mountain Avenue at 2nd Street, Norco, California, prepared by Southern California Geotechnical, Inc. (SCG), prepared for Alere Property Group, LLC, SCG Project No. 11G114-1R, dated March 17, 2011

Gentlemen:

In accordance with your request, we have conducted a geotechnical feasibility study at the subject site. We are pleased to present this report summarizing the conclusions and recommendations developed from our investigation.

We sincerely appreciate the opportunity to be of service on this project. We look forward to providing additional consulting services during the course of the project. If we may be of further assistance in any manner, please contact our office.

Respectfully Submitted,

SOUTHERN CALIFORNIA GEOTECHNICAL, INC.

Daniel W. Nielsen, RCE 77915
Project Engineer

REGISTERED PROFESSIONAL ENGINEER
DANIEL W. NIELSEN
No. 77915
CIVIL
STATE OF CALIFORNIA

Robert G. Trazo, M.Sc., GE 2655
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
ROBERT TRAZO
No. 2655
GEOTECHNICAL
STATE OF CALIFORNIA

Distribution: (1) Addressee

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

Presented below is a brief summary of the conclusions and recommendations of this investigation. Since this summary is not all inclusive, it should be read in complete context with the entire report.

It should be noted that this investigation was focused on determining the geotechnical feasibility of the proposed development. It was not intended to be a design level investigation. An additional study will be necessary to refine the preliminary design parameters that are presented within this feasibility report.

Geotechnical Design Considerations

- The results of the liquefaction evaluation indicate that total dynamic settlements of 0 to 2.4± inches could occur at the site during the design seismic event concurrent with historically high groundwater levels.
- The near surface soils encountered at most of the borings consists of native alluvium. The upper zone of alluvium possesses loose to medium dense relative densities and low to moderate strengths. Some of the alluvial soils in the upper 2 to 4± feet possess minor to moderate consolidation and collapse potentials.
- One of the borings performed for a previous study at this site encountered a surficial layer of fill soils, extending to a depth of 2½± feet. Additional fill soils are expected to be present in and around the existing building areas.
- Based on the presence of undocumented fill soils and variable density alluvium, the near surface soils are not considered suitable for support of the proposed structures, in their present condition. Remedial grading is considered warranted to remove a portion of these soils and replace them as compacted structural fill.
- The groundwater table is considered to have been present at depths between 29 and 41± feet at the boring locations at the time of the subsurface exploration.

Preliminary Site Preparation Recommendations

- Demolition of the existing buildings and associated improvements including asphaltic concrete parking lots and driveways, and flatwork will be required at this site. Demolition should include all subsurface remnants of the existing structures, including foundations, floor slabs, and any utilities that will not be reutilized.
- Initial site stripping should include removal of the existing vegetation including turf grass, as well as any underlying topsoil, and any trees that will not remain with the proposed development. Stripping should also include the removal of any tree root masses. These materials should be disposed of offsite or in non-structural areas of the property.
- Overexcavation will be necessary within the proposed building areas to remove any existing fill soils, any soils disturbed during demolition and stripping, and a portion of the near-surface native alluvium. Overexcavation to depths on the order of 3 to 4± feet below existing grades and proposed pad grades is anticipated to be necessary. Overexcavation within the foundation areas is expected to extend to depths of 2 to 3± feet below proposed foundation bearing grade.
- No significant overexcavation is expected to be necessary in new pavement or flatwork areas, unless zones of unsuitable existing fill or native alluvium are encountered.

Preliminary Foundation Design Parameters

- Spread footing foundations, supported in newly placed structural fill soils.
- Maximum, net allowable soil bearing pressure: 2,500 to 3,000 lbs/ft^2. The design of the proposed structures should include sufficient rigidity to resist the differential settlements that may occur as a result of liquefaction and the potential heave from low to medium expansive soils.
- The estimated allowable bearing pressures provided above should be refined during the design level geotechnical investigation, based on actual column loads and detailed settlement analyses.

Preliminary Building Floor Slab Recommendations

- Conventional Slabs-on-Grade, minimum 6 inches thick
- The geotechnical design recommendations for the floor slabs will depend in part on the results of the future geotechnical study, including a more detailed liquefaction evaluation. The floor slabs should include sufficient rigidity to resist the effects of differential settlements that may occur during liquefaction.
- The actual thickness and reinforcement of the floor slabs should be determined by the structural engineer.

Preliminary Pavement Thickness Recommendations

ASPHALT PAVEMENTS (R = 25)					
Materials	**Thickness (inches)**				
	Auto Parking (TI = 4.0)	Auto Drive Lanes (TI = 5.0)	Truck Traffic (TI = 6.0)	Truck Traffic (TI = 7.0)	Truck Traffic (TI = 8.0)
Asphalt Concrete	3	3	3½	4	5
Aggregate Base	4	7	9	11	12
Compacted Subgrade (90% minimum compaction)	12	12	12	12	12

PORTLAND CEMENT CONCRETE PAVEMENTS				
Materials	**Thickness (inches)**			
	Auto Parking & Drives (TI = 5.0)	Truck Traffic		
		(TI =6.0)	(TI = 7.0)	(TI = 8.0)
PCC	5	5½	6½	8
Compacted Subgrade (95% minimum compaction)	12	12	12	12

2.0 SCOPE OF SERVICES

The scope of services performed for this project was in accordance with our Proposal No. 17P110-2, dated January 12, 2016. The scope of services included a visual site reconnaissance, subsurface exploration, field and laboratory geotechnical testing, and geotechnical engineering analysis to determine the geotechnical feasibility of the proposed development. This report also contains preliminary design criteria for building foundations, building floor slabs, and parking lot pavements. The evaluation of the environmental aspects of this site was beyond the scope of services for this feasibility study.

It should be noted that additional subsurface exploration, laboratory testing and engineering analysis will be necessary to provide a design level geotechnical investigation with specific foundation, floor slab, and grading recommendations.

3.0 SITE AND PROJECT DESCRIPTION

3.1 Site Conditions

The subject site is located at the northeast corner of 1st Street and Pacific Avenue in Norco, California. The site is generally bounded to the north by 2nd Street, to the east by Mountain Avenue, to the south by 1st Street, and to the west by Pacific Avenue. The subject site also includes two additional parcels which are located on the east side of Mountain Avenue, south of 2nd Street. The general location of the site is illustrated on the Site Location Map, included as Plate 1 in Appendix A of this report.

The overall site consists of multiple rectangular and irregular shaped parcels, which total 99± acres in size. The parcels located adjacent to Pacific Avenue, First Street, and Second Street are developed with single family residences or consist of vacant lots. The single-family residences appear to be of wood frame and stucco construction and are assumed to be supported on conventional shallow foundations with concrete slab-on-grade floors. The ground surface cover in these areas consists of concrete driveways, concrete flatwork, and areas of exposed soil with moderate to dense native grass and weed growth. Several large trees are located throughout this area of the site.

The existing parcels located adjacent to both the east and west sides of Mountain Avenue are developed with of single-family residences, vacant lots, and a commercial/industrial building approximately 150,000 ft² in size which is presently occupied. The commercial/industrial building appears to be a metal frame structure and is assumed to be supported on conventional shallow foundations with a concrete slab-on-grade floor. The ground surface cover surrounding the building consists of asphaltic concrete in the parking and drive areas and Portland cement concrete pavements in the loading dock areas. The single-family residences appear to consist of wood frame and stucco construction and are assumed to be supported on conventional shallow foundations with concrete slab-on-grade floors. Several parcels in these areas contain concrete slabs from pre-existing structures. Ground surface cover in these areas consist of exposed soil with moderate to dense native grass and weed growth. In addition to the development described above, an asphalt parking lot, about 47,000 ft² in size, is located at the southeast corner of Second Street and Mountain Avenue.

Detailed topographic information was not available at the time of this report. Based on visual observations, the site topography within the area of the proposed development appears to be relatively level ground, sloping gently downward toward the southwest at a gradient of less than 1± percent.

3.2 Proposed Development

A preliminary site plan for the proposed development, prepared by HPA Architects, was provided to our office by the client. This plan indicates that the site will be developed with a total of twenty-three (23) commercial/industrial buildings identified as Building 1 through Building 23. The new buildings will range from 9,800 to 278,480± ft² in size. Buildings 5 and 6, Buildings 9 and 10, Buildings 13 and 14, and Buildings 16 and 17 will share a common wall. The larger buildings, including Buildings 1, 2, 3, 12, 19, and 20 through 23 will possess dock high doors on one side. The buildings will be surrounded by asphaltic concrete pavements in the parking and drive lanes and Portland cement concrete pavements in the truck court areas. The proposed development may also contain areas of concrete flatwork and landscape planters in various locations throughout the site. Based on a discussion with the client, we understand that planning for the proposed development is the preliminary stages and the building locations, sizes, and overall site layout are subject to change from what is currently proposed at the time of this geotechnical feasibility study.

Detailed structural information has not been provided. It is assumed that the new buildings will be single story structures of tilt-up concrete construction, supported on conventional shallow foundations with concrete slab-on-grade floors. These buildings are expected to have maximum column and wall loads on the order of 80 kips and 3 to 5 kips per linear foot, respectively.

No significant amounts of below grade construction, such as basements or crawl spaces, are expected to be included in the proposed development. Based on the assumed relatively level site topography, cuts and fills of less than 5± feet are expected to be necessary to achieve the proposed building pad grades.

3.3 Previous Studies

Southern California Geotechnical, Inc. (SCG) previously conducted a geotechnical investigation within the subject site. The previous report is identified as follows:

> Geotechnical Investigation and Liquefaction Evaluation, Proposed Norco Ranch Commerce, Mountain Avenue at 2nd Street, Norco, California, prepared by Southern California Geotechnical, Inc. (SCG) for Alere Property Group, LLC, SCG Project No. 11G114-1R, dated March 17, 2011.

As part of this investigation, a total of thirteen (13) borings were advanced to depths of 20 to 50± feet. The 50-foot deep borings were performed as part of the liquefaction evaluation. Artificial fill soils were encountered at the ground surface at one of the borings, Boring No. B-5, extending to a depth of 2½± feet below the existing grade. The fill soils generally consisted of medium dense silty fine sands. The alluvial soils extending from the ground surface or beneath the fill materials to depths of 8½ to 17± feet generally consist of loose to medium dense silty sand, clayey sands, and fine sandy silts. In addition, several zones of medium stiff to stiff clayey silts and silty clays are present in the upper 10± feet. At depths greater than 17± feet, the borings encountered medium dense to very dense fine to medium sands and fine to coarse sands with varying amounts of fine to coarse gravel content. At these depths, several strata of medium stiff to very stiff clayey silts, silty clays and sandy clays were also encountered. The native alluvial soils extended to at least the maximum depth explored of 50± feet.

Groundwater was encountered during drilling of Boring Nos. B-1, B-4, B-11, B-12, and B-13. Delayed water level readings taken at times ranging from boring completion to 8 hours after boring completion generally did not identify any water above the boring cave depths. Water was measured at a depth of 22± feet within Boring No. B-13 at the time of boring completion. Based on the water level measurements, and the moisture contents of the recovered soil samples, the static groundwater table is considered to have existed at a depth of 18 to 29± feet at the time of the subsurface exploration.

4.0 SUBSURFACE EXPLORATION

4.1 Scope of Exploration/Sampling Methods

The subsurface exploration performed for this feasibility consisted of four (4) borings (identified as Boring Nos. B-16 through B-19) advanced to depths of 20 to 51± feet below the existing site grades. In addition to the borings, four (4) cone penetration test (CPT) soundings were performed at the site. As discussed in the previous section of this report, thirteen borings were previously drilled at the subject site extending to depths of 20 to 50± feet, identified as Borings B-1 through B-13. Boring Nos. B-14 and B-15 were performed for a supplemental investigation to the referenced study, but these borings were not performed within the subject area of this feasibility study, and are not included with this investigation. All of the borings were logged during drilling by a member of our staff.

Hollow Stem Auger Borings

The borings were advanced with hollow-stem augers, by a conventional truck-mounted drilling rig. Representative bulk and undisturbed soil samples were taken during drilling. Relatively undisturbed samples were taken with a split barrel "California Sampler" containing a series of one inch long, 2.416± inch diameter brass rings. This sampling method is described in ASTM Test Method D-3550. Undisturbed samples were also taken using a 1.4± inch inside diameter split spoon sampler, in general accordance with ASTM D-1586. Both of these samplers were driven into the ground with successive blows of a 140-pound weight falling 30 inches. The blow counts obtained during driving are recorded for further analysis. Bulk samples were collected in plastic bags to retain their original moisture content. The relatively undisturbed ring samples were placed in molded plastic sleeves that were then sealed and transported to our laboratory.

Cone Penetration Test (CPT) Soundings

The CPT soundings were performed by Kehoe Testing and Engineering (KTE) under the supervision of a geologist. The cone system used for this project was manufactured by Vertek. The CPT soundings were performed in general accordance with ASTM standards (D-5778). The cone penetrometers were pushed using 30-ton CPT rig. The cones used during the program recorded the cone resistance, sleeve friction, and dynamic core pressure at 2.5 centimeter depth intervals. The CPT soundings were advanced to depths of 34 to 60± feet. A more complete description of the CPT program as well as the results of the data interpretation are enclosed in Appendix G of this report. The CPT soundings do not result in any recovered soil samples. However, correlations have been developed that utilize the cone resistance and the sleeve friction to estimate the soil type that is present at each 2.5 centimeter interval in the subsurface profile. These soil classifications are presented graphically on the CPT output forms enclosed in Appendix G.

The raw data generated by the cone penetrometer equipment has been reduced using CPeT-IT, V1.6, published by Geologismiki Geotechnical Software. The CPeT-IT program output as well as more details regarding the interpretation procedure are presented a report prepared by KTE, which is provided in Appendix G of this report.

General

The approximate locations of the borings and CPT soundings are indicated on the Boring and CPT Location Plan, included as Plate 2 in Appendix A of this report. The Boring Logs, which illustrate the conditions encountered at the boring locations, as well as the results of some of the laboratory testing, are included in Appendix B. The Boring Logs for the referenced previous study, including Boring Nos. B-1 through B-13, are included in Appendix H of this report.

4.2 Geotechnical Conditions

Alluvium

The near surface soils at this site generally consist of interbedded sands, silts, and clays. Native alluvial soils were encountered at the ground surface at all four of the boring locations drilled for this feasibility study. The alluvial soils within the upper 4 to 12± feet generally consist of loose to medium dense silty sands, clayey sands, and fine sandy silts. In addition, several zones of medium stiff to very stiff clayey silts, silty clays, and silty clays are present in the upper 2½ to 8± feet.

At depths greater than 12± feet, the borings generally encountered medium dense to very dense fine to medium sands and fine to coarse sands with varying amounts of fine to coarse gravel content. At these depths, several strata of stiff to very stiff clayey silts, silty clays and sandy clays were also encountered. The native alluvial soils extended to depths of 37± feet to at least the maximum depth explored of 51± feet.

La Sierra Tonalite

La Sierra Tonalite bedrock was encountered at Boring No. B-16 at a depth of 37± feet and extended to the maximum depth explored of 50± feet. The bedrock consists very dense, gray brown, phaneritic, highly weathered and friable tonalite.

Groundwater

Free water was encountered at Boring Nos. B-16, B-17, and B-18 at depths of 41, 30 and 29± feet, respectively, below the existing site grades. Based on the moisture contents of the recovered soil samples and the water measurements taken within the open boreholes, the static groundwater table is considered to have been present at a depth of 29 and 41± feet below the site existing site grades at the time of subsurface exploration.

In addition, we performed research of available groundwater data in an attempt to determine the historic high groundwater table at the subject site. Research from the Western Municipal Water District (WMWD) includes three wells that are located within approximately 1 mile of the subject site. Data obtained from these wells is presented below. It should be noted that the groundwater data for these wells extends from the present time back to the Spring of 1993.

WMWD Data

Well Number	Location	Elevation (ft)	Depth (ft)
03S/07W-13	0.3± miles E	605	26 to 34
03S/07W-14C	1,800± feet SW	569	21
03S/07W-12R	1,900± feet SW	620	30

Based on this data, the long-term groundwater depths in the vicinity of the subject site are expected to be in the range of 21 to 34± feet.

4.3 Geologic Conditions

Regional geologic conditions were obtained from the Geologic Map of the Corona North 7.5' Quadrangle, Riverside and San Bernardino Counties, California, by Douglas M. Morton and C.H. Gray, Jr., 2002. This map indicates that the site is underlain by La Sierra Tonalite (Map Symbol Klst). The Cretaceous age granitic bedrock is described as a dark colored, massive, structure-less, medium to coarse grained, biotite tonalite. The La Sierra Tonalite is part of the composite Peninsular Ranges batholith that underlies the local region.

Based on the materials encountered at Boring No. B-16, it is our opinion the site is underlain by La Sierra formation tonalite. At this boring location, the bedrock consisted of very dense, medium to coarse grained, jointed, weathered tonalite bedrock. Therefore, the geologic conditions at the site are considered to be consistent with the mapped geologic conditions.

5.0 LABORATORY TESTING

The soil samples recovered from the subsurface exploration were returned to our laboratory for further testing to determine selected physical and engineering properties of the soils. The tests are briefly discussed below. It should be noted that the test results are specific to the actual samples tested, and variations could be expected at other locations and depths.

Classification

All recovered soil samples were classified using the Unified Soil Classification System (USCS), in accordance with ASTM D-2488. Field identifications were then supplemented with additional visual classifications and/or by laboratory testing. The USCS classifications are shown on the Boring Logs and are periodically referenced throughout this report.

Dry Density and Moisture Content

The dry densities have been determined for selected relatively undisturbed ring samples. These densities were determined in general accordance with the method presented in ASTM D-2937. The results are recorded as dry unit weight in pounds per cubic foot. The moisture contents are determined in accordance with ASTM D-2216, and are expressed as a percentage of the dry weight. These test results are presented on the Boring Logs.

Consolidation

Selected soil samples have been tested to determine their consolidation potential, in accordance with ASTM D-2435. The testing apparatus is designed to accept either natural or remolded samples in a one-inch high ring, approximately 2.416 inches in diameter. Each sample is then loaded incrementally in a geometric progression and the resulting deflection is recorded at selected time intervals. Porous stones are in contact with the top and bottom of the sample to permit the addition or release of pore water. The samples are typically inundated with water at an intermediate load to determine their potential for collapse or heave. The results of the consolidation testing are plotted on Plates C-1 through C-4 in Appendix C of this report. The results of consolidation testing performed for the referenced geotechnical investigation are presented in Appendix H of this report.

Grain Size Analysis

Limited grain size analyses have been performed on several selected samples, in accordance with ASTM D-1140. These samples were washed over a #200 sieve to determine the percentage of fine-grained material in each sample, which is defined as the material which passes the #200 sieve. The weight of the portion of the sample retained on each screen is recorded and the percentage finer or coarser of the total weight is calculated. The results of these laboratory tests are shown on the attached boring logs.

Atterberg Limits

Atterberg Limits testing (ASTM D-4318) was performed on selected samples of various soil strata encountered at the site. This test is used to determine the Liquid Limit and Plastic Limit of the soil. The Plasticity Index is the difference between the two limits. Plasticity Index is a general indicator of the expansive potential of the soil, with higher numbers indicating higher expansive potential. Soils with a PI greater than 25 are considered to have a high plasticity, and a high expansion potential. Soils with a PI greater than 18 are not considered to be susceptible to liquefaction when the moisture content of the soil is less than 80 percent of the liquid limit. Soils with a PI between 12 and 18 may be moderately susceptible to liquefaction, depending on the moisture content of the soil. The results of the Atterberg Limits testing are presented on the boring logs.

Soluble Sulfates

Representative samples of the near-surface soils were submitted to a subcontracted analytical laboratory for determination of soluble sulfate content. Soluble sulfates are naturally present in soils, and if the concentration is high enough, can result in degradation of concrete which comes into contact with these soils. The results of the soluble sulfate testing are presented below, and are discussed further in a subsequent section of this report.

Sample Identification	**Soluble Sulfates (%)**	**ACI Classification**
B-1 @ 0 to 5 feet	0.002	Negligible
B-5 @ 0 to 5 feet	0.003	Negligible
B-13 @ 0 to 5 feet	<0.001	Negligible
B-16 @ 0 to 5 feet	0.005	Negligible
B-19 @ 0 to 5 feet	<0.001	Negligible

Maximum Dry Density and Optimum Moisture Content

A representative bulk sample was tested for its maximum dry density and optimum moisture content. The results have been obtained using the Modified Proctor procedure, per ASTM D-1557. These tests are generally used to compare the in-situ densities of undisturbed field samples, and for later compaction testing. Additional testing of other soil type or soil mixes may be necessary at a later date. The results of the testing are plotted on Plate C-5 in Appendix C of this report. The results of previous testing performed for the referenced study are presented in Appendix H of this report.

Direct Shear

At the time of the referenced previous study, two direct shear tests were performed on selected soil samples to determine their shear strength parameters. The tests were performed in accordance with ASTM D-3080. The testing apparatus is designed to accept either natural or remolded samples in a one-inch high ring, approximately 2.416 inches in diameter. Three samples of the same soil are prepared by remolding them to 90± percent compaction and near optimum moisture. Each of the three samples is then loaded with different normal loads and the resulting shear strength is determined for that particular normal load. The shearing of the samples is performed at a rate slow enough to permit the dissipation of excess pore water pressure. Porous stones are in contact with the top and bottom of the sample to permit the addition or release of pore water. The results of the direct shears test are presented in Appendix H of this report.

Expansion Index

The expansion potential of the on-site soils was determined in general accordance with ASTM D-4829. The testing apparatus is designed to accept a 4-inch diameter, 1-in high, remolded sample. The sample is initially remolded to 50 $\pm$ 1 percent saturation and then loaded with a surcharge equivalent to 144 pounds per square foot. The sample is then inundated with water, and allowed to swell against the surcharge. The resultant swell or consolidation is recorded after a 24-hour period. The results of the EI testing are as follows:

Sample Identification	Expansion Index	Expansive Potential
B-1 @ 0 to 5 feet	2	Very Low
B-9 @ 0 to 5 feet	51	Medium
B-13 @ 0 to 5 feet	5	Very Low
B-16 @ 0 to 5 feet	49	Low
B-19 @ 0 to 5 feet	52	Medium

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on results of our document review, field exploration, laboratory testing, and geotechnical analysis, the proposed development is considered feasible from a geotechnical standpoint. However, several geotechnical issues are present at the subject site which may require specialized design or construction techniques to overcome. These geotechnical issues are discussed further in subsequent sections of this report.

The preliminary recommendations and conclusions in this report should be supplemented by a detailed geotechnical investigation in order to prepare final grading plans as well as foundation and floor slab designs. The recommendations within this report should be considered preliminary in nature and may be superseded by the detailed geotechnical investigation to be conducted at a later date.

6.1 Seismic Design Considerations

The subject site is located in an area which is subject to strong ground motions due to earthquakes. The performance of a site specific seismic hazards analysis was beyond the scope of this investigation. However, numerous faults capable of producing significant ground motions are located near the subject site. Due to economic considerations, it is not generally considered reasonable to design a structure that is not susceptible to earthquake damage. Therefore, significant damage to structures may be unavoidable during large earthquakes. The proposed structure should, however, be designed to resist structural collapse and thereby provide reasonable protection from serious injury, catastrophic property damage and loss of life.

Faulting and Seismicity

Research of available maps indicates that the subject site is not located within an Alquist-Priolo Earthquake Fault Zone. Therefore, the possibility of significant fault rupture on the site is considered to be low.

Seismic Design Parameters

The 2016 California Building Code (CBC) was generally adopted by municipalities within Southern California on January 1, 2017. The CBC provides procedures for earthquake resistant structural design that include considerations for on-site soil conditions, occupancy, and the configuration of the structure including the structural system and height. The seismic design parameters presented below are based on the soil profile and the proximity of known faults with respect to the subject site.

The 2016 CBC Seismic Design Parameters have been generated using U.S. Seismic Design Maps, a web-based software application developed by the United States Geological Survey. This software application, available at the USGS web site, calculates seismic design parameters in accordance with the 2016 CBC, utilizing a database of deterministic site accelerations at 0.01 degree intervals. The table below is a compilation of the data provided by the USGS application. A copy of the output generated from this program is included as Plate E-1 in Appendix E of this report. A copy of the Design Response Spectrum, as generated by the USGS application is also included in Appendix E. Based on this output, the following parameters may be utilized for the subject site:

2016 CBC SEISMIC DESIGN PARAMETERS

Parameter		Value
Mapped Spectral Acceleration at 0.2 sec Period	S_S	2.482
Mapped Spectral Acceleration at 1.0 sec Period	S_1	1.137
Site Class	---	F*
Site Modified Spectral Acceleration at 0.2 sec Period	S_{MS}	2.482
Site Modified Spectral Acceleration at 1.0 sec Period	S_{M1}	1.706
Design Spectral Acceleration at 0.2 sec Period	S_{DS}	1.655
Design Spectral Acceleration at 1.0 sec Period	S_{D1}	1.137

*The 2016 CBC requires that Site Class F be assigned to any profile containing soils vulnerable to potential failure or collapse under seismic loading, such as liquefiable soils. For Site Class F, the site coefficients are to be determined in accordance with Section 11.4.7 of ASCE 7-10. However, Section 20.3.1 of ASCE 7-10 indicates that for sites with structures having a fundamental period of vibration equal to or less than 0.5 seconds, the site coefficient factors (F_a and F_v) may be determined using the standard procedures. <u>The seismic design parameters tabulated above were calculated using the site coefficient factors for Site Class D, assuming that the fundamental period of the structure is less than 0.5 seconds.</u> However, the results of the liquefaction evaluation indicate that the subject site is underlain by potentially liquefiable soils. Therefore, if the proposed structure has a fundamental period greater than 0.5 seconds, a site specific seismic hazards analysis would be required and additional subsurface exploration would be necessary.

Ground Motion Parameters

For the liquefaction evaluation, we utilized a site acceleration consistent with maximum considered earthquake ground motions, as required by the 2016 CBC. The peak ground acceleration (PGA) was determined in accordance with Section 11.8.3 of ASCE 7-10. The parameter PGA_M is the maximum considered earthquake geometric mean (MCE_G) PGA, multiplied by the appropriate site coefficient from Table 11.8-1 of ASCE 7-10. The web-based software application U.S. Seismic Design Maps (described in the previous section) was used to determine PGA_M, which is 0.607g. A portion of the program output is included as Plate E-2 of this report. An associated earthquake magnitude was obtained from the 2008 USGS Interactive Deaggregation application available on the USGS website. The deaggregated modal magnitude is 6.98, based on the peak ground acceleration and NEHRP soil classification D.

Liquefaction

Review of the Riverside County GIS website indicates that the subject site is located within a zone of medium to high liquefaction susceptibility. Therefore, the scope of this feasibility study included a detailed liquefaction evaluation in order to determine the site-specific liquefaction potential.

Liquefaction is the loss of strength in generally cohesionless, saturated soils when the pore-water pressure induced in the soil by a seismic event becomes equal to or exceeds the overburden pressure. The primary factors which influence the potential for liquefaction include groundwater table elevation, soil type and plasticity characteristics, relative density of the soil, initial confining pressure, and intensity and duration of ground shaking. The depth within which the occurrence of liquefaction may impact surface improvements is generally identified as the upper 50 feet below the existing ground surface. Liquefaction potential is greater in saturated, loose, poorly graded fine sands with a mean (d_{50}) grain size in the range of 0.075 to 0.2 mm (Seed and Idriss, 1971). Non-sensitive clayey (cohesive) soils which possess a plasticity index of at least 18 (Bray and Sancio, 2006) are generally not considered to be susceptible to liquefaction, nor are those soils which are above the historic static groundwater table.

The liquefaction analysis was conducted in accordance with the requirements of Special Publication 117A (CDMG, 2008), and currently accepted practice (SCEC, 1997). The liquefaction potential of the subject site was evaluated using the empirical method developed by Boulanger and Idriss (Boulanger and Idriss, 2008, 2014). This method predicts the earthquake-induced liquefaction potential of the site based on a given design earthquake magnitude and peak ground acceleration at the subject site. This procedure essentially compares the cyclic resistance ratio (CRR) [the cyclic stress ratio required to induce liquefaction for a cohesionless soil stratum at a given depth] with the earthquake-induced cyclic stress ratio (CSR) at that depth from a specified design earthquake (defined by a peak ground surface acceleration and an associated earthquake moment magnitude). CRR is determined as a function of the corrected SPT N-value $(N_1)_{60\text{-}cs}$, adjusted for fines content or the corrected CPT tip stress, q_{c1Ncs}. The factor of safety against liquefaction is defined as CRR/CSR. Based on Special Publication 117A, a factor of safety of at least 1.3 is required in order to demonstrate that a given soil stratum is non-liquefiable. Additionally, in accordance with Special Publication 117A, clayey soils which do not meet the criteria for liquefiable soils defined by Bray and Sancio (2006), loose soils with a plasticity index (PI) less than 12 and moisture content greater than 85 percent of the liquid limit, are not considered to be susceptible to liquefaction. Non-sensitive soils with a PI greater than 18 are also considered non-liquefiable. Soils possessing a PI between 12 and 18, may also be moderately susceptible to liquefaction if the moisture content is greater than 85 percent of the liquid limit.

Liquefaction potential was evaluated for the subject site using field and laboratory data from three (3) of the boring locations and all four (4) of the CPT locations. The liquefaction potential was analyzed for the design level earthquake utilizing a PGA_M of 0.607g related to a 6.98 magnitude seismic event, assuming historic high groundwater levels of 21± feet.

The liquefaction analysis procedure for the three boring locations, Boring Nos. B-16, B-17 and B-18, which were each advanced to depths of at least 50 ± feet, is tabulated on the spreadsheet forms included in Appendix F of this report. The liquefaction potential for the on-site soils was also determined using data obtained at the four CPT locations. This data was analyzed using the computer program Cliq V1.7, which was developed by Geologismiki, copyright 2006. The output of this computer program is also provided in Appendix F. The analysis method for both the boring and CPT data is based on Boulanger and Idriss, 2014.

If liquefiable soils are identified, the potential settlements that could occur as a result of liquefaction are determined using the equation for volumetric strain due to post-cyclic reconsolidation (Yoshimine et. al, 2006). This procedure uses an empirical relationship between the induced cyclic shear strain and the corrected N-value or CPT tip stress to determine the expected volumetric strain of saturated soils subjected to earthquake shaking. The settlement analysis is also provided on the spreadsheets and Cliq program output included in Appendix F.

Conclusions and Recommendations

The results of the liquefaction analysis identified potentially liquefiable soil strata at Boring Nos. B-16, between depths of 22 to 31 feet, and at Boring No. B-18, between depths of 47 and 50 feet. However, the results of the liquefaction analysis did not identify any potentially liquefiable soil strata at Boring No. B-17. Soils which are located above the historic groundwater table (21 feet), or possessing factors of safety in excess of 1.3 are considered non-liquefiable. Several strata of silty clay and fine sandy clays were determined to be non-liquefiable due to their cohesive characteristics and the results of the Atterberg limits testing with respect to the criteria of Bray and Sancio (2006) and Special Publication 117A. Settlement analyses were conducted for each of the potentially liquefiable strata. The results of the settlement analyses indicate a potential total settlement of 1.39± inches at Boring No. B-16, and 1.10± inches at Boring No. B-18.

Liquefiable soils were generally encountered at similar depths at the four CPT locations. Settlement analyses were conducted for each of the potentially liquefiable strata. The total liquefaction settlement for each CPT is presented below:

- CPT-1: 0.68± inches
- CPT-2: 1.10± inches
- CPT-3: 2.38± inches
- CPT-4: 2.00± inches

Based on the estimated total settlements for the boring and CPT locations, differential settlements are expected to be on the order of 1½± inches. The estimated differential settlement can be assumed to occur across a distance of 100 feet, indicating a maximum angular distortion of approximately 0.0013 inches per inch.

Based on our understanding of the proposed development and the owner's risk tolerances, it is considered feasible to support the proposed structures on a shallow foundation systems. Such a foundation system can be designed to resist the effects of the anticipated differential settlements, to the extent that the structures would not catastrophically fail. Designing the proposed structures to remain completely undamaged during a major seismic event is not considered to be economically feasible. Based on this understanding, the use of shallow foundation systems is considered to be the most economical means of supporting the proposed structures.

In order to support the proposed structures on shallow foundations (such as spread footings) the structural engineer should verify that the structures would not catastrophically fail due to the predicted dynamic differential settlements. Any utility connections to the structures should be designed to withstand the estimated differential settlements. It should also be noted that minor to moderate repairs, including re-leveling, restoration of utility connections, repair of damaged drywall and stucco, etc., would likely be required after occurrence of the liquefaction-induced settlements.

The use of a shallow foundation system, as described in this report, is typical for buildings of this type, where they are underlain the extent of liquefiable soils encountered at this site. The post-liquefaction damage that could occur within the buildings proposed for this site will also be typical of similar buildings in the vicinity of this project. However, if the owner determines that this level of potential damage is not acceptable, other geotechnical and structural options are available, including the use of ground improvement, deep foundations or a mat foundation.

6.2 Geotechnical Design Considerations

General

The subsurface conditions at this site generally consist of low to moderate strength alluvium, extending to depths of 3 to 12± feet, underlain by moderate to high strength alluvium and bedrock at greater depths. The results of laboratory testing indicate that some of the alluvium within the upper 3 to 4± feet possess minor to moderate collapse potentials. One of the borings for the referenced previous study, Boring No. B-5, also encountered artificial fill soils within the upper 2½± feet. Additional fill soils are expected to be encountered beneath and around the numerous structures which currently exist on the subject site. Based on the age of the existing developments, no documentation regarding the placement or compaction of any existing fill soils is expected to be available. Any fill soils are therefore considered to represent undocumented fill, not suitable for support of new structures. Based on these considerations, remedial grading will be necessary to remove and replace the existing undocumented fill soils as well as the surficial low strength alluvium.

Extensive demolition will be necessary since numerous structures currently occupy various parcels throughout the site. Demolition of these existing structures is expected to result in significant disturbance of the upper 2 to 4± feet of the existing soils.

As discussed in a previous section of this report, several strata of potentially liquefiable soils were identified at this site. The presence of the recommended layer of newly placed compacted structural fill above these liquefiable soils will help to reduce any surface manifestations that could occur as a result of liquefaction. The foundation and floor slab design recommendations presented in the subsequent sections of this report also contain recommendations to provide additional rigidity in order to reduce the potential effects of differential settlement that could occur as a result of liquefaction.

Settlement

Laboratory testing indicates that the upper zone of native alluvium is potentially compressible and/or collapsible. The existing undocumented fill soils are also considered to be potentially compressible. The recommended remedial grading will remove all of these soils from within the proposed building areas. Provided that the recommended remedial grading is completed, the post construction settlement of the proposed structures is expected to be within tolerable limits.

Expansion

The near surface soils at this site consist of variable materials ranging from sands and silty sands to clayey silts and silty clays. Expansion index testing indicates that these materials possess very low to medium expansion potentials (EI = 2 to 52). Based on the presence of expansive soils, special care should be taken to properly moisture condition and maintain adequate moisture content within all subgrade soils as well as newly placed fill soils. The foundation and floor slab design recommendations contained within this report are made in consideration of the expansion index test results. It is recommended that additional expansion index testing be conducted at the completion of rough grading to verify the expansion potential of the as-graded building pads.

Soluble Sulfates

The results of the soluble sulfate testing indicate that the selected samples of the on-site soils contain negligible concentrations of soluble sulfates, in accordance with American Concrete Institute (ACI) guidelines. Therefore, specialized concrete mix designs are not considered to be necessary, with regard to sulfate protection purposes. It is, however, recommended that additional soluble sulfate testing be conducted at the completion of rough grading to verify the soluble sulfate concentrations of the soils which are present at pad grade within the building area.

Shrinkage/Subsidence

Removal and recompaction of the near surface native soils is estimated to result in an average shrinkage of 7 to 12 percent. Minor ground subsidence is expected to occur in the soils below the zone of removal, due to settlement and machinery working. The subsidence is estimated to be 0.10± feet. Additional borings and in-place density tests should be performed at the time of the design level investigation in order to confirm these values.

These estimates are based on previous experience and the subsurface conditions encountered at the boring locations. The actual amount of subsidence is expected to be variable and will be dependent on the type of machinery used, repetitions of use, and dynamic effects, all of which are difficult to assess precisely.

Grading and Foundation Plan Review

As discussed previously, detailed grading and foundation plans were not available at the time of this report. It is therefore recommended that we be provided with copies of the preliminary plans, when they become available, for review with regard to the conclusions, recommendations, and assumptions contained within this report.

6.3 Preliminary Site Grading Recommendations

The grading recommendations presented below are based on the subsurface conditions encountered at the boring locations and our understanding of the proposed development. We recommend that all grading activities be completed in accordance with the Grading Guide Specifications included as Appendix D of this report, unless superseded by site-specific recommendations presented below.

Site Stripping and Demolition

Demolition of the existing buildings and associated improvements, including asphaltic concrete parking lots, driveways, and concrete flatwork will be required at this site. Demolition should include all subsurface remnants of the existing structures, including foundations, floor slabs, any utilities that will not be reutilized with the proposed development. Any debris resultant from demolition should be disposed of offsite in accordance with local regulations. Alternatively, asphalt and concrete debris may be crushed to a maximum 2-inch particle size, well mixed with onsite soils, and incorporated into new structural fills or crushed to make miscellaneous base, if desired. Any excavations associated with demolition should be backfilled with compacted fill soils.

Several areas of the site are landscaped with medium to large trees, shrubs, turf grass and other organic materials. Any organic materials that are currently present on the site should be removed and disposed of offsite or in non-structural areas of the property. The actual extent of site stripping should be determined by the geotechnical engineer at the time of grading, based on the organic content and the stability of the encountered materials.

Treatment of Existing Soils: Building Pads

Remedial grading will be necessary within the proposed building pad areas to remove any existing fill soils, the upper portion of the low strength native alluvium, and any soils disturbed during stripping and demolition procedures. The overall depth of overexcavation should be determined during the design level geotechnical investigation. On a preliminary basis, overexcavation to depths of 3 to 4± feet below the existing grades and proposed pad grades should be anticipated. Overexcavation within the foundation areas will likely be in the range of 2 to 3± feet below the foundation bearing grade.

Artificial fill soils extend to a depth of 2½± at one of the boring locations. However, due to the extent and variety of the existing developments on the subject site, additional depths of undocumented fill soils are expected to be encountered during the grading process. Any undocumented fill soils that are encountered during grading should be removed in their entirety. Additional borings will be performed at the time of the design level investigation, in order to better characterize the existing fill depths within the proposed building areas.

Based on the conditions encountered at the exploratory boring locations, some zones of very moist silty clays and clayey silts will be encountered at or near the base of the recommended overexcavation. Stabilization of the exposed overexcavation subgrade soils may be necessary in some localized areas. Scarification and air drying of these materials may be sufficient to obtain a stable subgrade. However, if highly unstable soils are identified, and if the construction schedule does not allow for delays associated with drying, mechanical stabilization, usually consisting of coarse crushed stone or geotextile, could be necessary. In this event, the geotechnical engineer should be contacted for supplementary recommendations.

Treatment of Existing Soils: Retaining Walls and Site Walls

Although not indicated on the site plan, it may be necessary to construct some small retaining walls or site walls at or near the existing surface grade. Overexcavation will also be necessary in these areas to remove the existing fill soils and lower strength potentially compressible alluvium. The overexcavation depth should be expected to be on the order of 2 to 3± feet below proposed foundation bearing grade, and to depths of 3 to 4± feet below existing grade.

Treatment of Existing Soils: Parking and Drive Areas

Based on economic considerations, overexcavation of the existing soils in the new parking areas is not considered warranted, with the exception of areas where lower strength, or unstable soils are identified by the geotechnical engineer during grading.

Subgrade preparation in the new parking areas should initially consist of removal of all soils disturbed during stripping and demolition operations. The geotechnical engineer should then evaluate the subgrade to identify any areas of additional unsuitable soils. The subgrade soils should then be scarified to a depth of 12± inches, moisture conditioned to 2 to 4 percent above optimum, and recompacted to at least 90 percent of the ASTM D-1557 maximum dry density. Based on the presence of variable strength alluvial soils throughout the site, it is expected that some isolated areas of additional overexcavation may be required to remove zones of lower strength, unsuitable soils.

The grading recommendations presented above for the proposed parking and drive areas assume that the owner and/or developer can tolerate minor amounts of settlement within the proposed parking areas. The grading recommendations presented above do not mitigate the extent of undocumented fill soils and compressible/collapsible native alluvium in the parking areas. As such, settlement and associated pavement distress could occur. Typically, repair of such distressed areas involves significantly lower costs than completely mitigating these soils at the time of construction. If the owner cannot tolerate the risk of such settlements, all of the existing undocumented fill soils and existing collapsible native alluvium within these areas should be removed and replaced as structural fill.

Fill Placement

- Fill soils should be placed in thin (6± inches), near-horizontal lifts, moisture conditioned to 2 to 4 percent above the optimum moisture content, and compacted.
- On-site soils may be used for fill provided they are cleaned of any debris to the satisfaction of the geotechnical engineer.
- All grading and fill placement activities should be completed in accordance with the requirements of the 2016 CBC and the grading code of the city of Norco.
- All fill soils should be compacted to at least 90 percent of the ASTM D-1557 maximum dry density. Fill soils should be well mixed.
- Compaction tests should be performed periodically by the geotechnical engineer as random verification of compaction and moisture content. These tests are intended to aid the contractor. Since the tests are taken at discrete locations and depths, they may not be indicative of the entire fill and therefore should not relieve the contractor of his responsibility to meet the job specifications.

Imported Structural Fill

All imported structural fill should consist of very low expansive (EI < 20), well graded soils possessing at least 10 percent fines (that portion of the sample passing the No. 200 sieve). Additional specifications for structural fill are presented in the Grading Guide Specifications, included as Appendix D.

Utility Trench Backfill

In general, all utility trench backfill soils should be compacted to at least 90 percent of the ASTM D-1557 maximum dry density. As an alternative, a clean sand (minimum Sand Equivalent of 30) may be placed within trenches and compacted in place (jetting or flooding is not recommended). It is recommended that materials in excess of 3 inches in size not be used for utility trench backfill.

Compacted trench backfill should conform to the requirements of the local grading code, and more restrictive requirements may be indicated by city of Norco. All utility trench backfills should be witnessed by the geotechnical engineer. The trench backfill soils should be compaction tested where possible; probed and visually evaluated elsewhere.

Utility trenches which parallel a footing, and extending below a 1h:1v plane projected from the outside edge of the footing should be backfilled with structural fill soils, compacted to at least 90 percent of the ASTM D-1557 standard. Pea gravel backfill should not be used for these trenches.

6.4 Preliminary Construction Considerations

Excavation Considerations

The near surface soils generally consist of fine sands and silty sands. These materials will likely be subject to caving within shallow excavations. Where caving occurs within shallow excavations, flattened excavation slopes may be sufficient to provide excavation stability. On a preliminary basis, the inclination of temporary slopes should not exceed 2h:1v. Deeper excavations may require some form of external stabilization such as shoring or bracing. Maintaining adequate moisture content within the near-surface soils will improve excavation stability. All excavation activities on this site should be conducted in accordance with Cal-OSHA regulations.

Moisture Sensitive Subgrade Soils

The near surface soils possess appreciable silt and clay content and may become unstable if exposed to significant moisture infiltration or disturbance by construction traffic. If grading occurs during a period of relatively wet weather, an increase in subgrade instability should also be expected. The site should, therefore, be graded to prevent ponding of surface water and to prevent water from running into excavations.

If the construction schedule dictates that site grading will occur during a period of wet weather, allowances should be made for costs and delays associated with drying the on-site soils or import of a drier, less moisture sensitive fill material. Grading during wet or cool weather may also increase the depth of overexcavation in the pad areas as well as the need for subgrade stabilization as discussed in Section 6.3 of this report.

Expansive Soils

The near surface on-site soils have been determined to possess a low to medium expansion potential. Therefore, care should be given to proper moisture conditioning of all building pad subgrade soils to a moisture content of 2 to 4 percent above the Modified Proctor optimum during site grading. All imported fill soils should have low expansive (EI < 50) characteristics. **In addition to adequately moisture conditioning the subgrade soils and fill soils during grading, special care must be taken to maintain moisture content of these soils at 2 to 4 percent above the Modified Proctor optimum. This will require the contractor to frequently moisture condition these soils throughout the grading process, unless grading occurs during a period of relatively wet weather**.

Due to the presence of expansive soils at this site, provisions should be made to limit the potential for surface water to penetrate the soils immediately adjacent to the structures. These provisions should include directing surface runoff into rain gutters and area drains, reducing the extent of landscaped areas around the structure, and sloping the ground surface away from the residence. Where possible, it is recommended that landscaped planters not be located immediately adjacent to the building. If landscaped planters around the building are necessary, it is recommended that drought tolerant plants or a drip irrigation system be utilized, to minimize the potential for deep moisture penetration around the structures. Presented below is a list of additional soil moisture control recommendations that should be considered by the owner, developer, and civil engineer:

- Ponding and areas of low flow gradients in unpaved walkways, grass and planter areas should be avoided. In general, minimum drainage gradients of 2 percent should be maintained in unpaved areas.
- Bare soil within five feet of proposed structures should be sloped at a minimum 5 percent gradient away from the structure (about three inches of fall in five feet), or the same area could be paved with a minimum surface gradient of one percent. Pavement is preferable.
- Decorative gravel ground cover tends to provide a reservoir for surface water and may hide areas of ponding or poor drainage. Decorative gravel is, therefore, not recommended and should not be utilized for landscaping unless equipped with a subsurface drainage system designed by a licensed landscape architect.
- Positive drainage devices, such as graded swales, paved ditches, and catch basins should be installed at appropriate locations within the area of the proposed development.
- Concrete walks and flatwork should not obstruct the free flow of surface water to the appropriate drainage devices.
- Area drains should be recessed below grade to allow free flow of water into the drain. Concrete or brick flatwork joints should be sealed with mortar or flexible mastic.
- Gutter and downspout systems should be installed to capture all discharge from roof areas. Downspouts should discharge directly into a pipe or paved surface system to be conveyed offsite.
- Enclosed planters adjoining, or in close proximity to proposed structures, should be sealed at the bottom and provided with subsurface collection systems and outlet pipes.
- Depressed planters should be raised with soil to promote runoff (minimum drainage gradient two percent or five percent, see above), and/or equipped with area drains to eliminate ponding.
- Drainage outfall locations should be selected to avoid erosion of slopes and/or properly armored to prevent erosion of graded surfaces. No drainage should be directed over or towards adjoining slopes.
- All drainage devices should be maintained on a regular basis, including frequent observations during the rainy season to keep the drains free of leaves, soil and other debris.
- Landscape irrigation should conform to the recommendations of the landscape architect and should be performed judiciously to preclude either soaking or excessive drying of the foundation soils. This should entail regular watering during the drier portions of the year and little or no irrigation during the rainy season. Automatic sprinkler systems should, therefore, be switched to manual operation during the rainy season. Good irrigation practice typically requires frequent application of limited quantities of water that are sufficient to sustain plant growth, but do not excessively wet the soils. Ponding and/or run-off of irrigation water are indications of excessive watering.

Other provisions, as determined by the landscape architect or civil engineer, may also be appropriate.

Groundwater

The static groundwater table at this site is considered to be present at a depths between 29 and 41± feet. Therefore, groundwater is not expected to impact the grading or foundation construction activities.

6.5 Preliminary Foundation Design Recommendations

Based on the preceding geotechnical design considerations and preliminary grading recommendations, it is assumed that the new buildings will be underlain by newly placed structural fill soils, extending to depths of at least 2 to 3 feet below foundation bearing grade. Based on this subsurface profile and assuming that the proposed structures can tolerate the estimated liquefaction-induced settlements, the proposed structures may be supported on conventional spread footing foundations.

The foundation design parameters presented below provide anticipated ranges for the allowable soil bearing pressures. These ranges should be refined during the subsequent design level geotechnical investigation.

Spread Footing Foundation Design Parameters

New square and rectangular footings may be designed using the following approximate values:

- Maximum, net allowable soil bearing pressure: 2,500 to 3,000 lbs/ft^2.

General Foundation Design Recommendations

The allowable bearing pressures presented above may be increased by one-third when considering short duration wind or seismic loads. The minimum steel reinforcement recommended above is based on geotechnical considerations; additional reinforcement may be necessary for structural considerations. The actual design of the foundations should be determined by the structural engineer.

Estimated Foundation Settlements

Typically, foundations designed in accordance with the preliminary foundation design parameters presented above will experience total and differential static settlements of less than 1.0 and 0.5 inches, respectively. A detailed settlement analysis should be conducted as part of the design level geotechnical investigation, once detailed foundation loading information is available.

The estimated settlements provided above are based only on static conditions. As discussed previously, portions of the subject site are underlain by potentially liquefiable soils. Additional liquefaction-induced settlements will occur during the design seismic event. Design of the foundations for the proposed structure should allow for the occurrence of these liquefaction-induced settlements.

Lateral Load Resistance

Lateral load resistance will be developed by a combination of friction acting at the base of foundations and slabs and the passive earth pressure developed by footings below grade. The following friction and passive pressure may be used to resist lateral forces:

- Passive Earth Pressure: 275 - 325 lbs/ft^3
- Friction Coefficient: 0.28 to 0.30

6.6 Preliminary Floor Slab Design and Construction

Subgrades which will support new floor slabs should be prepared in accordance with the recommendations contained in the ***Site Grading Recommendations*** section of this report. Based on the anticipated grading which will occur at this site, the floors of the new structures may be constructed as conventional slabs-on-grade supported on newly placed structural fill soils. Based on geotechnical considerations, the floor slabs may be designed as follows:

- Minimum slab thickness: 6 inches.

- Modulus of Subgrade Reaction: k = 100 to 150 psi/in.

- Minimum slab reinforcement: Based on the presence of low to medium expansive soils and potentially liquefiable soils, we recommend that new floor slabs be reinforced with No. 3 rebars at a maximum spacing 18-inches on center, in both directions However, additional slab reinforcement may be required to resist the effects of liquefaction-induced settlements or for other structural design considerations. The actual floor slab reinforcement should be determined by the structural engineer, based upon the imposed loading, after completion of the design level geotechnical investigation..

- Slab underlayment: If moisture sensitive floor coverings will be used the minimum slab underlayment should consist of a moisture vapor barrier constructed below the entire area where such moisture sensitive floor coverings are anticipated. The moisture vapor barrier should meet or exceed the Class A rating as defined by ASTM E 1745-97 and have a permeance rating less than 0.01 perms as described in ASTM E 96-95 and ASTM E 154-88. A polyolefin material such as Stego® Wrap Vapor Barrier or equivalent will meet these specifications. The moisture vapor barrier should be properly constructed in accordance with all applicable manufacturer specifications. Given that a rock free subgrade is anticipated and that a capillary break is not required, sand below the barrier is not required. The need for sand and/or the amount of sand above the moisture vapor barrier should be specified by the structural engineer or concrete contractor. The selection of sand above the barrier is not a geotechnical engineering issue and hence outside our purview.

The actual design of the floor slab should be based on the results of the future detailed geotechnical investigation, and completed by the structural engineer to verify adequate thickness and reinforcement.

6.7 Preliminary Retaining Wall Design and Construction

Small retaining walls are expected to be necessary in the area of the new truck loading docks and may also be required to facilitate the new site grades. The parameters recommended for use in the design of these walls are presented below.

Retaining Wall Design Parameters

Based on the soil conditions encountered at the boring locations, the following parameters may be used in the design of new retaining walls for this site. We have provided parameters assuming the use of on-site soils for retaining wall backfill. The near surface soils generally consist silty sands, clayey sands and sandy silts, as well as imported select granular material. Based on laboratory testing, the on-site soils possess ultimate friction angles of 28 to 31 degrees when compacted to 90 percent of the ASTM D-1557 maximum dry density. To account for variations in the quality of the on-site soils, the following retaining wall design parameters are based on a friction angle of 28 degrees. It is recommended that silty clays, sandy clays, and clayey silts, be excluded from retaining wall backfills since some these materials possess medium expansion potentials.

If desired, SCG could provide design parameters for an alternative select backfill material behind the retaining walls. The use of select backfill material could result in lower lateral earth pressures. In order to use the design parameters for the imported select fill, this material must be placed within the entire active failure wedge. This wedge is defined as extending from the heel of the retaining wall upwards at an angle of approximately 60° from horizontal. If select backfill material behind the retaining wall is desired, SCG should be contacted for supplementary recommendations.

RETAINING WALL DESIGN PARAMETERS

Design Parameter		Soil Type
		On-Site Sands and Silts
Internal Friction Angle (ϕ)		28°
Unit Weight		130 lbs/ft^3
Equivalent Fluid Pressure:	Active Condition (level backfill)	47 lbs/ft^3
	Active Condition (2h:1v backfill)	82 lbs/ft^3
	At-Rest Condition (level backfill)	69 lbs/ft^3

The active earth pressure may be used for the design of retaining walls that do not directly support structures or support soils that in turn support structures and which will be allowed to deflect. The at-rest earth pressure should be used for walls that will not be allowed to deflect such as those which will support foundation bearing soils, or which will support foundation loads directly.

Where the soils on the toe side of the retaining wall are not covered by a "hard" surface such as a structure or pavement, the upper 1 foot of soil should be neglected when calculating passive resistance due to the potential for the material to become disturbed or degraded during the life of the structure.

Seismic Lateral Earth Pressures

In accordance with the 2016 CBC, any retaining walls more than 6 feet in height must be designed for seismic lateral earth pressures. If walls 6 feet or more are required for this site, the geotechnical engineer should be contacted for supplementary seismic lateral earth pressure recommendations.

Retaining Wall Foundation Design

The retaining wall foundations should be supported within newly placed compacted structural fill. Foundations to support new retaining walls should be designed in accordance with the general Foundation Design Parameters presented in a previous section of this report.

Backfill Material

On-site soils may be used to backfill the retaining walls. However, all backfill material placed within 3 feet of the back wall face should have a particle size no greater than 3 inches. The retaining wall backfill materials should be well graded.

It is recommended that a properly installed prefabricated drainage composite such as the MiraDRAIN 6000XL (or approved equivalent), which is specifically designed for use behind retaining walls be used. If the drainage composite material is not covered by an impermeable surface, such as a structure or pavement, a 12-inch thick layer of a low permeability soil should be placed over the backfill to reduce surface water migration to the underlying soils. The drainage composite should be separated from the backfill soils by a suitable geotextile, approved by the geotechnical engineer.

All retaining wall backfill should be placed and compacted under engineering controlled conditions in the necessary layer thicknesses to ensure an in-place density between 90 and 93 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D 1557). Care should be taken to avoid over-compaction of the soils behind the retaining walls, and the use of heavy compaction equipment should be avoided.

Subsurface Drainage

As previously indicated, the retaining wall design parameters are based upon drained backfill conditions. Consequently, some form of permanent drainage system will be necessary in conjunction with the appropriate backfill material. Subsurface drainage may consist of either:

- A weep hole drainage system typically consisting of a series of 4-inch diameter holes in the wall situated slightly above the ground surface elevation on the exposed side of the wall and at an approximate 8-foot on-center spacing. The weep holes should include a one cubic foot gravel pocket surrounded by a suitable geotextile at each weep hole location.

- A 4-inch diameter perforated pipe surrounded by 2 cubic feet of gravel per linear foot of drain placed behind the wall, above the retaining wall footing. The gravel layer should be wrapped in a suitable geotextile fabric to reduce the potential for migration of fines. The footing drain should be extended to daylight or tied into a storm drainage system.

6.8 Preliminary Pavement Design Parameters

Presented below are preliminary recommendations for pavements that may be required around the perimeters of the proposed structures. Grading recommendations for these pavement areas should be developed during the design level geotechnical investigation.

Pavement Subgrades

It is anticipated that the new pavements will be supported on the existing fill and/or native soils. These materials generally consist of silty sands, sandy silts, sandy clays and occasional clayey silts. These materials are expected to exhibit fair to good pavement support characteristics, with estimated R-values of 25 to 40. Since R-value testing was not included in the scope of services for this feasibility study, the subsequent pavement design is based upon an assumed R-value of 25. Any fill material imported to the site should have support characteristics equal to or greater than that of the on-site soils and be placed and compacted under engineering controlled conditions. It may be desirable to perform R-value testing after the completion of rough grading to verify the R-value of the as-graded parking subgrade.

Asphaltic Concrete

Presented below are the recommended thicknesses for new flexible pavement structures consisting of asphaltic concrete over a granular base. The pavement designs are based on the traffic indices (TI's) indicated. The client and/or civil engineer should verify that these TI's are representative of the anticipated traffic volumes. If the client and/or civil engineer determine that the expected traffic volume will exceed the applicable traffic index, we should be contacted for supplementary recommendations. The design traffic indices equate to the following approximate daily traffic volumes over a 20 year design life, assuming six operational traffic days per week.

Traffic Index	No. of Heavy Trucks per Day
4.0	0
5.0	1
6.0	3
7.0	11
8.0	35

For the purpose of the traffic volumes indicated above, a truck is defined as a 5-axle tractor trailer unit with one 8-kip axle and two 32-kip tandem axles. All of the traffic indices allow for 1,000 automobiles per day.

ASPHALT PAVEMENTS (R = 25)					
Materials	**Thickness (inches)**				
	Auto Parking (TI = 4.0)	Auto Drive Lanes (TI = 5.0)	Truck Traffic		
			(TI = 6.0)	(TI = 7.0)	(TI = 8.0)
Asphalt Concrete	3	3	3½	4	5
Aggregate Base	4	7	9	11	12
Compacted Subgrade (90% minimum compaction)	12	12	12	12	12

The aggregate base course should be compacted to at least 95 percent of the ASTM D-1557 maximum dry density. The asphaltic concrete should be compacted to at least 95 percent of the Marshall maximum density, as determined by ASTM D-2726. The aggregate base course may consist of crushed aggregate base (CAB) or crushed miscellaneous base (CMB), which is a recycled gravel, asphalt and concrete material. The gradation, R-Value, Sand Equivalent, and Percentage Wear of the CAB or CMB should comply with appropriate specifications contained in the current edition of the "Greenbook" Standard Specifications for Public Works Construction.

Portland Cement Concrete

The preparation of the subgrade soils within concrete pavement areas should be performed as previously described for proposed asphalt pavement areas. The minimum recommended thicknesses for the Portland Cement Concrete pavement sections are as follows:

PORTLAND CEMENT CONCRETE PAVEMENTS				
Materials	**Thickness (inches)**			
	Auto Parking & Drives (TI = 5.0)	Truck Traffic		
		(TI =6.0)	(TI = 7.0)	(TI = 8.0)
PCC	5	5½	6½	8
Compacted Subgrade (95% minimum compaction)	12	12	12	12

The concrete should have a 28-day compressive strength of at least 3,000 psi. The maximum joint spacing within all of the PCC pavements is recommended to be equal to or less than 30 times the pavement thickness.

7.0 GENERAL COMMENTS

This report has been prepared as an instrument of service for use by the client, in order to aid in the evaluation of this property and to assist the architects and engineers in the design and preparation of the project plans and specifications. This report may be provided to the contractor(s) and other design consultants to disclose information relative to the project. However, this report is not intended to be utilized as a specification in and of itself, without appropriate interpretation by the project architect, civil engineer, and/or structural engineer. The reproduction and distribution of this report must be authorized by the client and Southern California Geotechnical, Inc. Furthermore, any reliance on this report by an unauthorized third party is at such party's sole risk, and we accept no responsibility for damage or loss which may occur. The client(s)' reliance upon this report is subject to the Engineering Services Agreement, incorporated into our proposal for this project.

The analysis of this site was based on a subsurface profile interpolated from limited discrete soil samples. While the materials encountered in the project area are considered to be representative of the total area, some variations should be expected between boring locations and sample depths. If the conditions encountered during construction vary significantly from those detailed herein, we should be contacted immediately to determine if the conditions alter the recommendations contained herein.

This report has been based on assumed or provided characteristics of the proposed development. It is recommended that the owner, client, architect, structural engineer, and civil engineer carefully review these assumptions to ensure that they are consistent with the characteristics of the proposed development. If discrepancies exist, they should be brought to our attention to verify that they do not affect the conclusions and recommendations contained herein. We also recommend that the project plans and specifications be submitted to our office for review to verify that our recommendations have been correctly interpreted.

The analysis, conclusions, and recommendations contained within this report have been promulgated in accordance with generally accepted professional geotechnical engineering practice. No other warranty is implied or expressed.

8.0 REFERENCES

California Division of Mines and Geology (CDMG), "Guidelines for Evaluating and Mitigating Seismic Hazards in California," State of California, Department of Conservation, Division of Mines and Geology, Special Publication 117A, 2008.

Idriss, I. M. and Boulanger, R.W., "Soil Liquefaction During Earthquakes", Earthquake Engineering Research Institute, 2008.

National Research Council (NRC), "Liquefaction of Soils During Earthquakes," Committee on Earthquake Engineering, National Research Council, Washington D. C., Report No. CETS-EE-001, 1985.

Seed, H. B., and Idriss, I. M., "Simplified Procedure for Evaluating Soil Liquefaction Potential using field Performance Data," Journal of the Soil Mechanics and Foundations Division, American Society of Civil Engineers, September 1971, pp. 1249-1273.

Sadigh, K., Chang, C. –Y., Egan, J. A., Makdisi. F., Youngs, R. R., "*Attenuation Relationships for Shallow Crustal Earthquakes Based on California Strong Motion Data*", Seismological Research Letters, Seismological Society of America, Volume 68, Number 1, January/ February 1997, pp. 180-189.

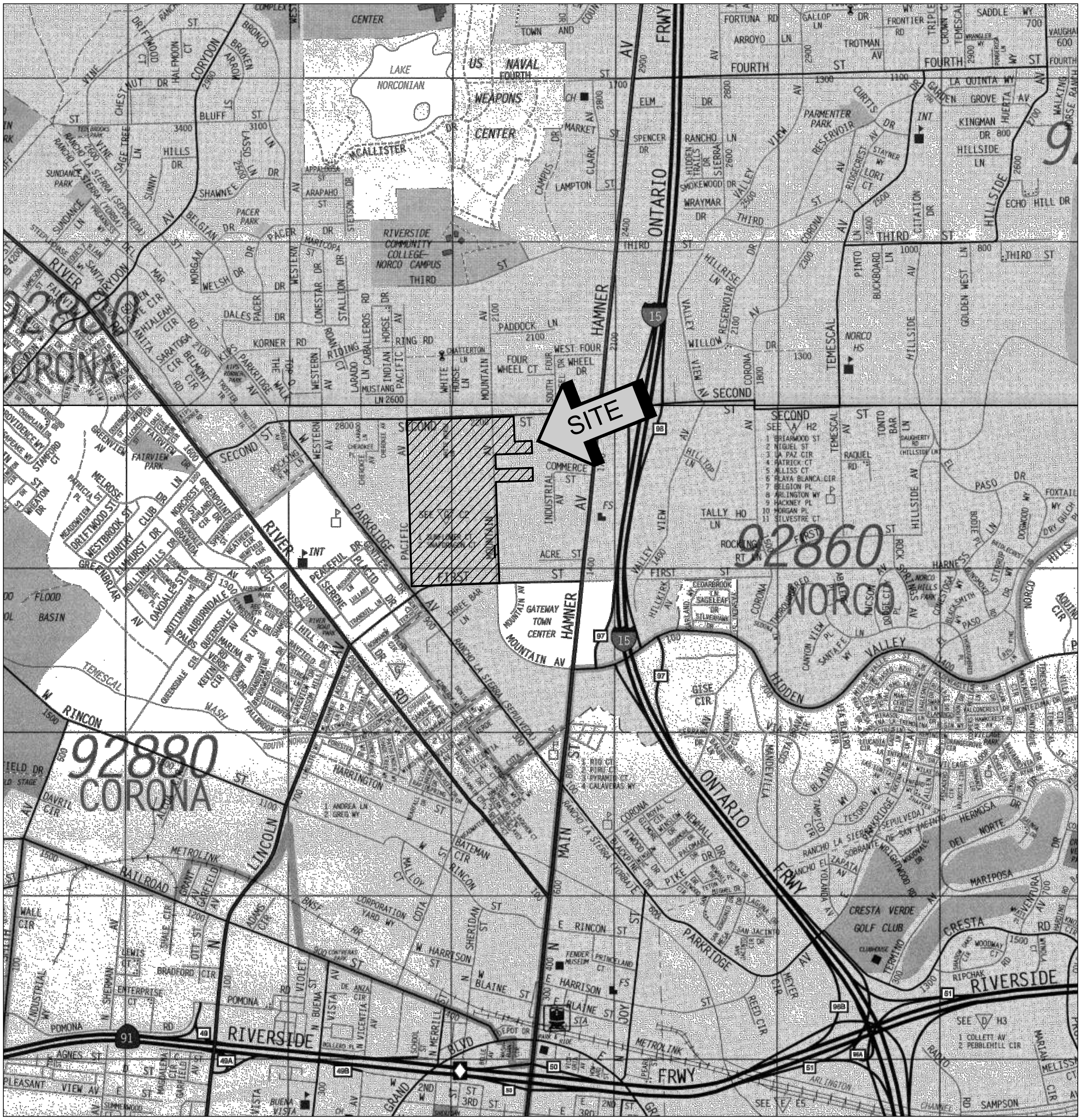
Southern California Earthquake Center (SCEC), University of Southern California, "Recommended Procedures for Implementation of DMG Special Publication 117, Guidelines for Analyzing and Mitigating Liquefaction in California," Committee formed 1997.

Tokimatsu K., and Seed, H. B., "Evaluation of Settlements in Sands Due to Earthquake Shaking," Journal of the Geotechnical Engineering Division, American society of Civil Engineers, Volume 113, No. 8, August 1987, pp. 861-878.

Tokimatsu, K. and Yoshimi, Y., "*Empirical Correlations of Soil Liquefaction Based on SPT N-value and Fines Content,*" Seismological Research Letters, Eastern Section Seismological Society Of America, Volume 63, Number 1, p. 73.

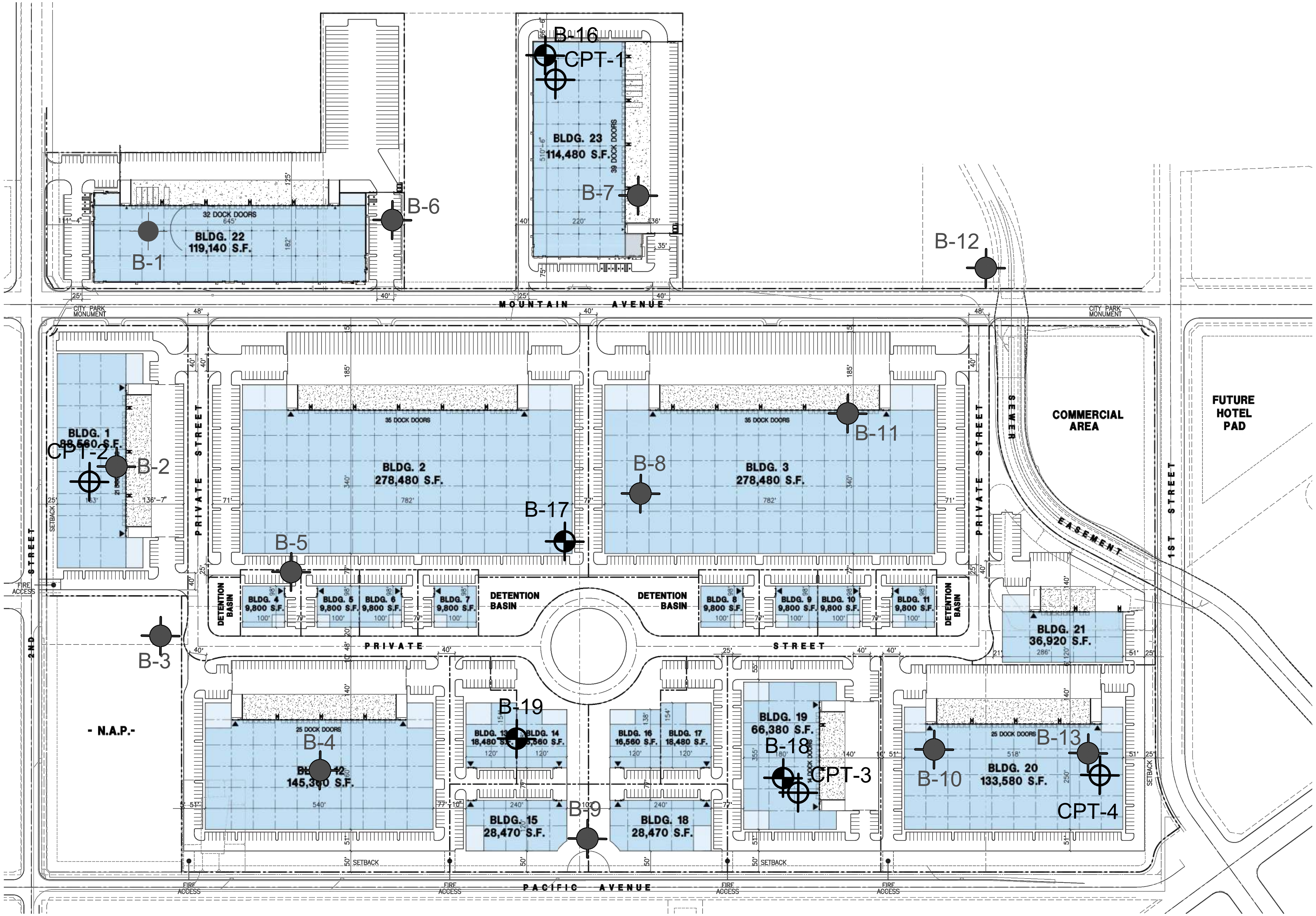
Youd, T. L. and Idriss, I. M. (Editors), "Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils," Salt Lake City, UT, January 5-6 1996, NCEER Technical Report NCEER-97-0022, Buffalo, NY.

APPENDIX A



SOURCE: RIVERSIDE COUNTY THOMAS GUIDE, 2009

SITE LOCATION MAP	
PROPOSED COMMERCIAL/INDUSTRIAL DEVELOPMENT	
NORCO, CALIFORNIA	
SCALE: 1" = 2400'	SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
DRAWN: AL CHKD: RGT	
SCG PROJECT 17G105-1	
PLATE 1	



NORTH
SoCalGeo

GEOTECHNICAL LEGEND

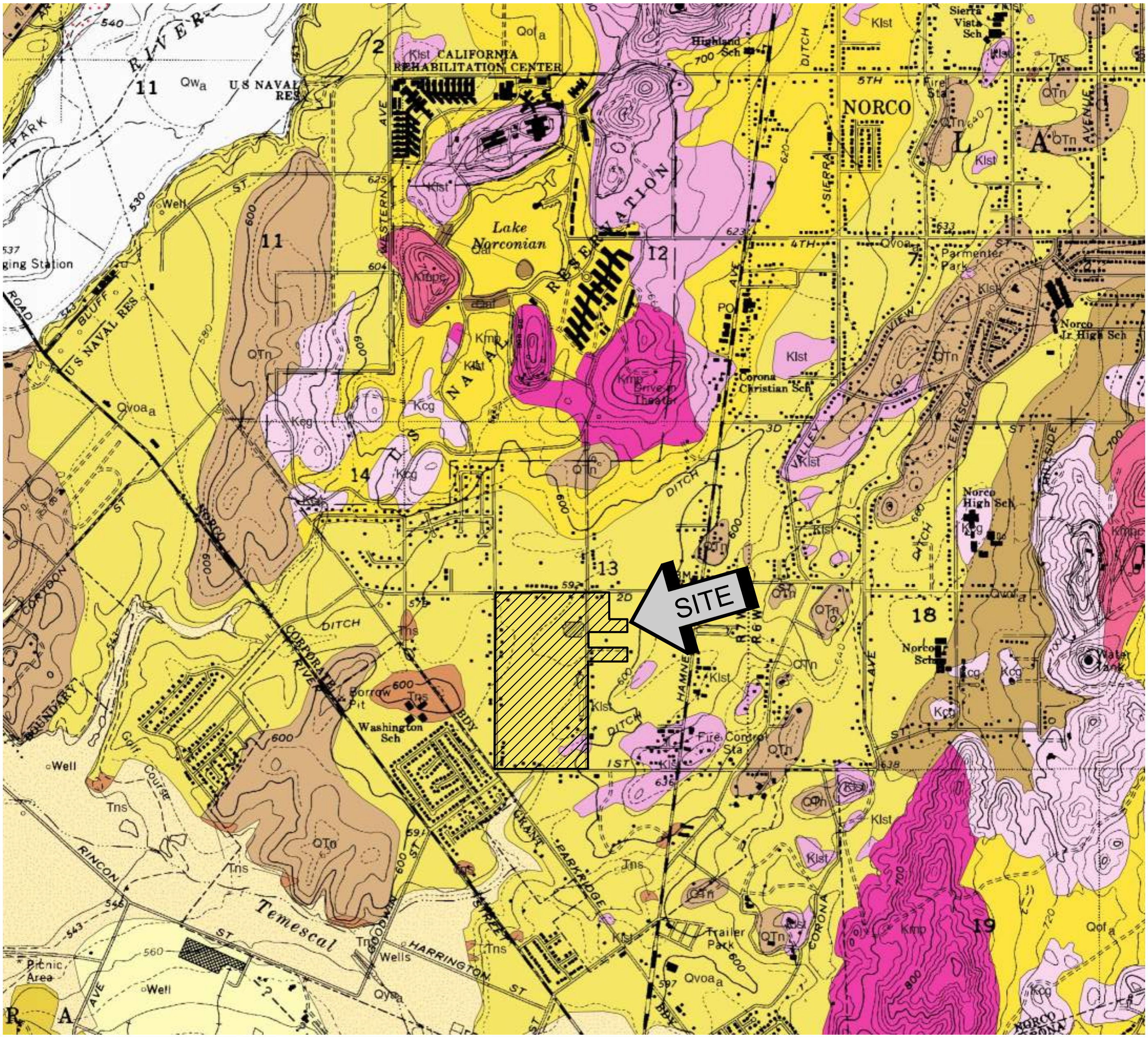
- APPROXIMATE BORING LOCATION
- APPROXIMATE CPT LOCATION
- APPROXIMATE BORING LOCATION FROM PREVIOUS STUDY (SCG PROJECT NO. 11G114-1)

NOTE: BASE MAP PREPARED BY HPA ARCHITECTS

BORING LOCATION PLAN
PROPOSED COMMERCIAL/INDUSTRIAL DEVELOPMENT
NORCO, CALIFORNIA

SCALE: 1" = 250'
DRAWN: AL
CHKD: RGT
SCG PROJECT 17G105-1
PLATE

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL



DESCRIPTION OF MAP UNITS

Qvof — **Very old alluvial fan deposits (early Pleistocene)**—Mostly well-dissected, well-indurated, reddish-brown sand deposits. Commonly contains duripans and locally silcretes. Forms large area east of Norco generally flanking steep bedrock slopes. North of Santa Ana River, forms broad area that is part of fans emanating from Puente Hills west of quadrangle

Qvoa — **Very old alluvial channel deposits (early Pleistocene)**—Gravel, sand, and silt; reddish-brown, well-indurated, surfaces well-dissected. Underlies large area between Santa Ana River and Temescal Wash

QTn — **Late Cenozoic sedimentary rocks in Norco area (early Pleistocene to late Pliocene?)**—Moderately indurated sandstone, conglomeratic sandstone, and conglomerate. In Norco area, unit includes locally derived clasts as well as clasts derived from San Bernardino Mountains. Found in and west of Norco, on both sides of Santa Ana River

Klst — **La Sierra Tonalite (Cretaceous)**—Massive biotite tonalite. Fairly dark-colored compared to other units in region containing no hornblende, but alteration found in much of rock tends to darken it. Medium- to coarse-grained; structureless. Much of tonalite is altered to secondary minerals, especially epidote and chlorite, and contains localized zones that are thoroughly altered to epidote, quartz, and chlorite; some highly altered rocks contain tourmaline and sulfide minerals. Large body exposed west of La Sierra and larger mass, partly covered by Quaternary deposits, underlies Norco area. Named by Larsen (1948) for exposures in vicinity of La Sierra.

SOURCE: "GEOLOGIC MAP OF THE CORONA NORTH 7.5' QUADRANGLE, RIVERSIDE AND SAN BERNARDINO COUNTIES, CALIFORNIA" MORTON AND GRAY, JR., 2002

GEOLOGIC MAP

PROPOSED COMMERCIAL/INDUSTRIAL DEVELOPMENT

NORCO, CALIFORNIA

SCALE: 1" = 2000'

DRAWN: AL
CHKD: RGT

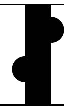
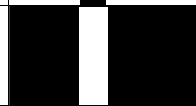
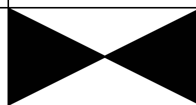
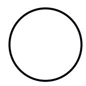
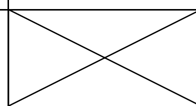
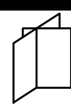
SCG PROJECT
17G105-1

PLATE [illegible]

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL

APPENDIX B

BORING LOG LEGEND

SAMPLE TYPE	GRAPHICAL SYMBOL	SAMPLE DESCRIPTION
AUGER		SAMPLE COLLECTED FROM AUGER CUTTINGS, NO FIELD MEASUREMENT OF SOIL STRENGTH. (DISTURBED)
CORE		ROCK CORE SAMPLE: TYPICALLY TAKEN WITH A DIAMOND-TIPPED CORE BARREL. TYPICALLY USED ONLY IN HIGHLY CONSOLIDATED BEDROCK.
GRAB		SOIL SAMPLE TAKEN WITH NO SPECIALIZED EQUIPMENT, SUCH AS FROM A STOCKPILE OR THE GROUND SURFACE. (DISTURBED)
CS		CALIFORNIA SAMPLER: 2-1/2 INCH I.D. SPLIT BARREL SAMPLER, LINED WITH 1-INCH HIGH BRASS RINGS. DRIVEN WITH SPT HAMMER. (RELATIVELY UNDISTURBED)
NSR		NO RECOVERY: THE SAMPLING ATTEMPT DID NOT RESULT IN RECOVERY OF ANY SIGNIFICANT SOIL OR ROCK MATERIAL.
SPT		STANDARD PENETRATION TEST: SAMPLER IS A 1.4 INCH INSIDE DIAMETER SPLIT BARREL, DRIVEN 18 INCHES WITH THE SPT HAMMER. (DISTURBED)
SH		SHELBY TUBE: TAKEN WITH A THIN WALL SAMPLE TUBE, PUSHED INTO THE SOIL AND THEN EXTRACTED. (UNDISTURBED)
VANE		VANE SHEAR TEST: SOIL STRENGTH OBTAINED USING A 4 BLADED SHEAR DEVICE. TYPICALLY USED IN SOFT CLAYS-NO SAMPLE RECOVERED.

COLUMN DESCRIPTIONS

DEPTH: Distance in feet below the ground surface.

SAMPLE: Sample Type as depicted above.

BLOW COUNT: Number of blows required to advance the sampler 12 inches using a 140 lb hammer with a 30-inch drop. 50/3" indicates penetration refusal (>50 blows) at 3 inches. WH indicates that the weight of the hammer was sufficient to push the sampler 6 inches or more.

POCKET PEN.: Approximate shear strength of a cohesive soil sample as measured by pocket penetrometer.

GRAPHIC LOG: Graphic Soil Symbol as depicted on the following page.

DRY DENSITY: Dry density of an undisturbed or relatively undisturbed sample in lbs/ft^3.

MOISTURE CONTENT: Moisture content of a soil sample, expressed as a percentage of the dry weight.

LIQUID LIMIT: The moisture content above which a soil behaves as a liquid.

PLASTIC LIMIT: The moisture content above which a soil behaves as a plastic.

PASSING #200 SIEVE: The percentage of the sample finer than the #200 standard sieve.

UNCONFINED SHEAR: The shear strength of a cohesive soil sample, as measured in the unconfined state.

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-16

JOB NO.: 17G105
PROJECT: Proposed C/I Development
LOCATION: Norco, California
DRILLING DATE: 2/2/17
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Anthony Luna
WATER DEPTH: 41 feet
CAVE DEPTH: 27 feet
READING TAKEN: At Completion

SURFACE ELEVATION: --- MSL

DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					ALLUVIUM: Orange Brown Clayey fine Sand to fine Sandy Clay, little medium Sand, medium dense to very stiff-damp							
	X	26	4.5				9					EI = 49 @ 0 to 5'
					Dark Orange Brown Silty fine to coarse Sand, trace fine Gravel, trace Clay, noduels, loose to medium dense-moist							
	X	10					8					
5												
					Light Orange Brown fine to coarse Sand, trace Silt, trace fine to coarse Gravel, medium dense-dry to damp							
	X	16					3					
	X	24					2					
10												
					Gray Brown fine Sandy Silt, trace Clay, medium dense-moist							
	X	14					13					
15												
					Light Gray fine to coarse Sand, trace Silt, trace fine Gravel, dense-dry to damp							
	X	36					2					
20												
					Gray Brown Silty fine Sand, little Clay nodules, trace Iron oxide staining, medium dense-very moist							
	X	13					29			30		
25												
					Brown Clayey fine to medium Sand, medium dense-moist to very moist							
	X	17					15			46		
30												
					Brown Clayey fine to coarse Sand, very dense-damp							
	X	60					6					

TBL 17G105.GPJ SOCALGEO.GDT 3/2/17

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-16

JOB NO.: 17G105	DRILLING DATE: 2/2/17	WATER DEPTH: 41 feet
PROJECT: Proposed C/I Development	DRILLING METHOD: Hollow Stem Auger	CAVE DEPTH: 27 feet
LOCATION: Norco, California	LOGGED BY: Anthony Luna	READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION (Continued)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					Brown Clayey fine to coarse Sand, very dense-damp							
					LA SIERRA TONALITE (Klst) BEDROCK: Gray Brown Tonalite Bedrock, highly weathered, friable, phaneritic, very dense-damp to wet							
	X	78/3"					7					
40												
	X	50/4"					16					
45												
	X	50/5"					12					
50												
					Boring Terminated at 50'							

TBL 17G105.GPJ SOCALGEO.GDT 3/2/17

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-17

JOB NO.: 17G105	DRILLING DATE: 2/2/17	WATER DEPTH: 30 feet
PROJECT: Proposed C/I Development	DRILLING METHOD: Hollow Stem Auger	CAVE DEPTH: 20 feet
LOCATION: Norco, California	LOGGED BY: Anthony Luna	READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					ALLUVIUM: Gray Brown fine Sandy Silt, loose-very moist							
	X	8					17					
					Light Gray Brown Silty Clay, abundant calcareous veining, stiff-very moist							
	X	10	1.0				17					
5												
					Brown Silty fine Sand, loose to medium dense-moist							
	X	10					10					
					Light Brown fine Sand, little Silt, medium dense-damp							
	X	11					7					
10												
					Light Gray fine to medium Sand, medium dense-dry to damp							
	X	24					3					
15												
					Light Gray fine to coarse Sand, trace fine Gravel, trace Silt, medium dense to dense-dry to damp							
	X	27					3					
20												
	X	46					4					
25												
	X	34			@ 28½ feet, wet		11					
30												
					Dark Brown Silty Clay, little Silt, trace fine Sand, stiff-very moist to wet							
	X	10	1.0				22	37	19	59		

TBL 17G105.GPJ SOCALGEO.GDT 3/2/17

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-17

JOB NO.: 17G105
PROJECT: Proposed C/I Development
LOCATION: Norco, California

DRILLING DATE: 2/2/17
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Anthony Luna

WATER DEPTH: 30 feet
CAVE DEPTH: 20 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION (Continued)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					Dark Brown Silty Clay, little Silt, trace fine Sand, stiff-very moist to wet							
					Gray Brown Clayey fine Sand to fine Sandy Clay, mottled, stiff to very stiff-very moist							
	X	15	3.5				15	25	12	51		
40												
	X	12	2.5				18			45		
45												
					Light Brown Clayey fine Sand, trace Iron oxide staining, very stiff-wet							
	X	23					17			39		
50												
					Boring Terminated at 50'							

TBL 17G105.GPJ SOCALGEO.GDT 3/2/17

TEST BORING LOG

BORING NO. B-18

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

JOB NO.: 17G105
PROJECT: Proposed C/I Development
LOCATION: Norco, California

DRILLING DATE: 2/2/17
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Anthony Luna

WATER DEPTH: 29 feet
CAVE DEPTH: 23 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
	X	16			ALLUVIUM: Brown Silty fine Sand, slightly porous, medium dense-dry to damp		3					
	X	34	2.5		Brown Clayey fine Sand to fine Sandy Clay, dense to hard-damp		6					
5	X	30	2.5				5					
	X	30			Brown Clayey fine Sand, medium dense to dense-damp		7					
10												
	X	24			Brown Clayey fine to coarse Sand, medium dense-damp		7					
15												
	X	50			Brown fine to coarse Sand, trace Clay nodules, trace fine Gravel, very dense-damp		5					
20												
	X	34			Gray Brown Gravelly fine to coarse Sand, little Clay nodules, dense-damp to moist		8					
25												
	X	42			Gray fine to medium Sand, little coarse Sand, trace Silt, dense-wet		14					
30												
	X	12	2.0		Gray fine Sandy Clay, stiff-wet		21	31	17	55		

TBL 17G105.GPJ SOCALGEO.GDT 3/2/17

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-18

JOB NO.: 17G105
PROJECT: Proposed C/I Development
LOCATION: Norco, California

DRILLING DATE: 2/2/17
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Anthony Luna

WATER DEPTH: 29 feet
CAVE DEPTH: 23 feet
READING TAKEN: At Completion

FIELD RESULTS					DESCRIPTION	LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	(Continued)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					Gray fine Sandy Clay, stiff-wet							
					Gray Brown Clayey fine Sand, trace fine Gravel, medium dense-wet							
		23					17			37		
40												
					Gray Brown fine Sandy Clay, little Silt, very stiff-very moist to wet							
		17	3.0				22			59		
45												
					Brown Silty Clay, trace fine Sand, medium stiff to stiff-wet							
		8	0.5				31	34	17	78		
50		13				92	33					
					Boring Terminated at 50'							

TBL 17G105.GPJ SOCALGEO.GDT 3/2/17

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-19

JOB NO.: 17G105
PROJECT: Proposed C/I Development
LOCATION: Norco, California

DRILLING DATE: 2/2/17
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Anthony Luna

WATER DEPTH: Dry
CAVE DEPTH: 9 feet
READING TAKEN: At Completion

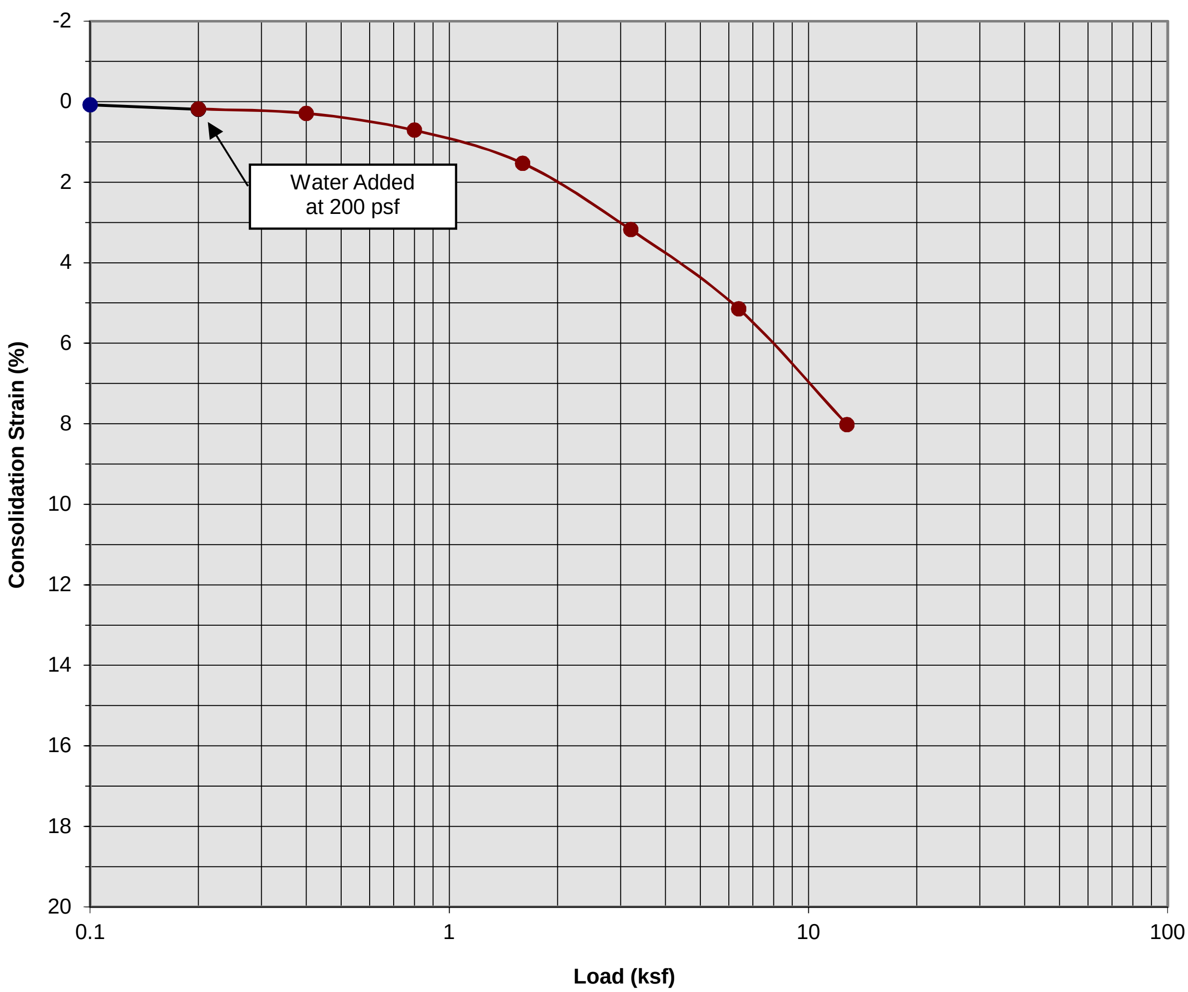
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
		7			ALLUVIUM: Dark Brown Silty Clay, medium stiff-moist to very moist	103	20					EI = 52 @ 0 to 5'
		20			Gray Brown Silty Clay, abundant calcareous veining, stiff to very stiff-very moist	104	20					
5		23			Light Gray to White Silt, little Clay, medium dense-damp	105	7					
		18			Light Gray fine to medium Sand, trace coarse Sand, trace fine Gravel, medium dense-dry							No Sample Recovered
10		24				126	1					
15		20			Gray Brown fine to medium Sand, little coarse Sand, trace fine Gravel, trace Clay nodules, medium dense-damp		5					
		40			Light Gray fine to coarse Sand, little fine Gravel, dense-dry		1					
20					Boring Terminated at 20'							

TBL 17G105.GPJ SOCALGEO.GDT 3/2/17

TEST BORING LOG

APPENDIX C

Consolidation/Collapse Test Results



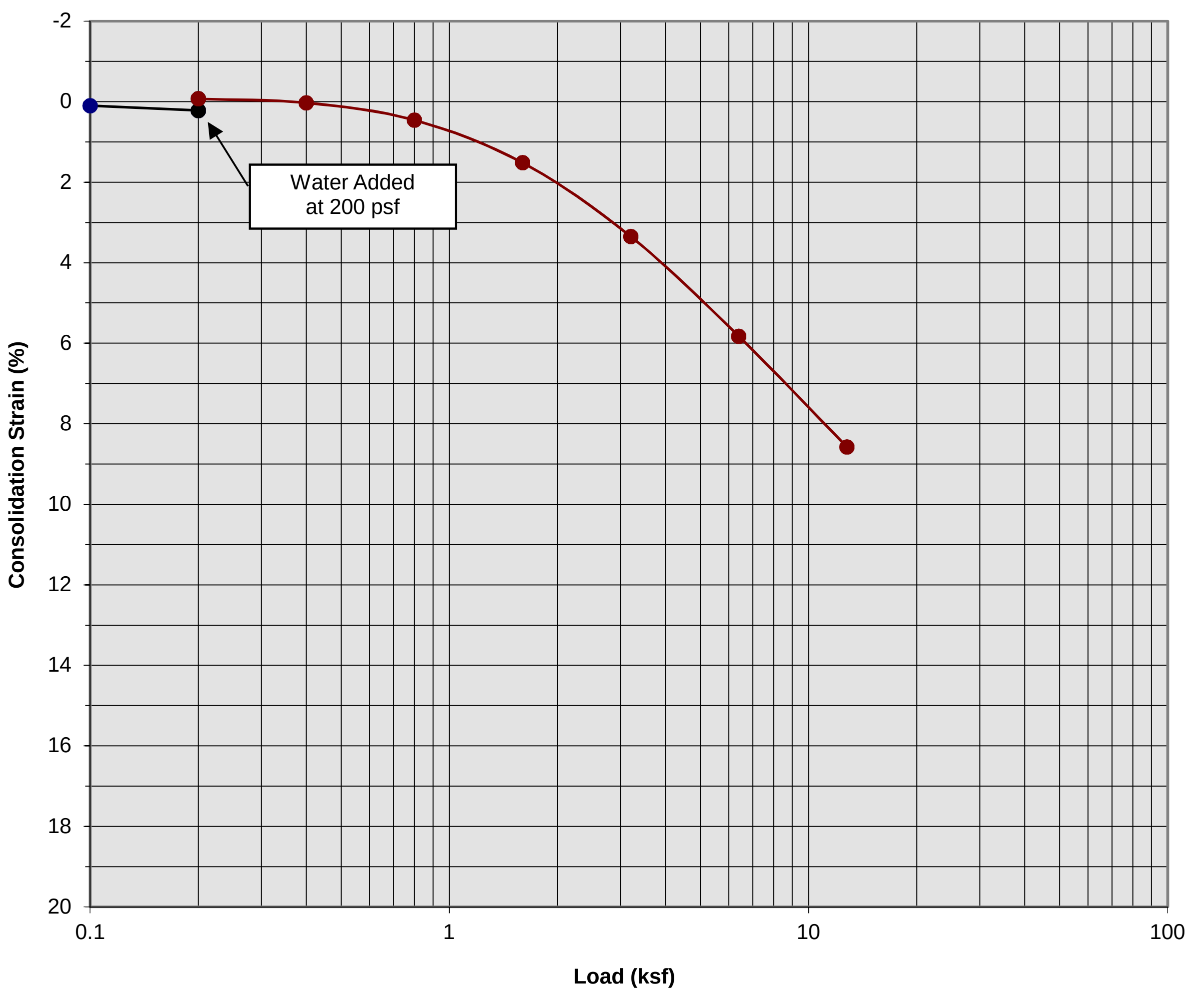
Classification: Dark Brown Silty Clay

Boring Number:	B-19	Initial Moisture Content (%)	20
Sample Number:	---	Final Moisture Content (%)	21
Depth (ft)	1 to 2	Initial Dry Density (pcf)	103.6
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	112.6
Specimen Thickness (in)	1.0	Percent Collapse (%)	-0.01

Proposed Commercial/Industrial Development
Norco, California
Project No. 17G105
PLATE C- 1

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results

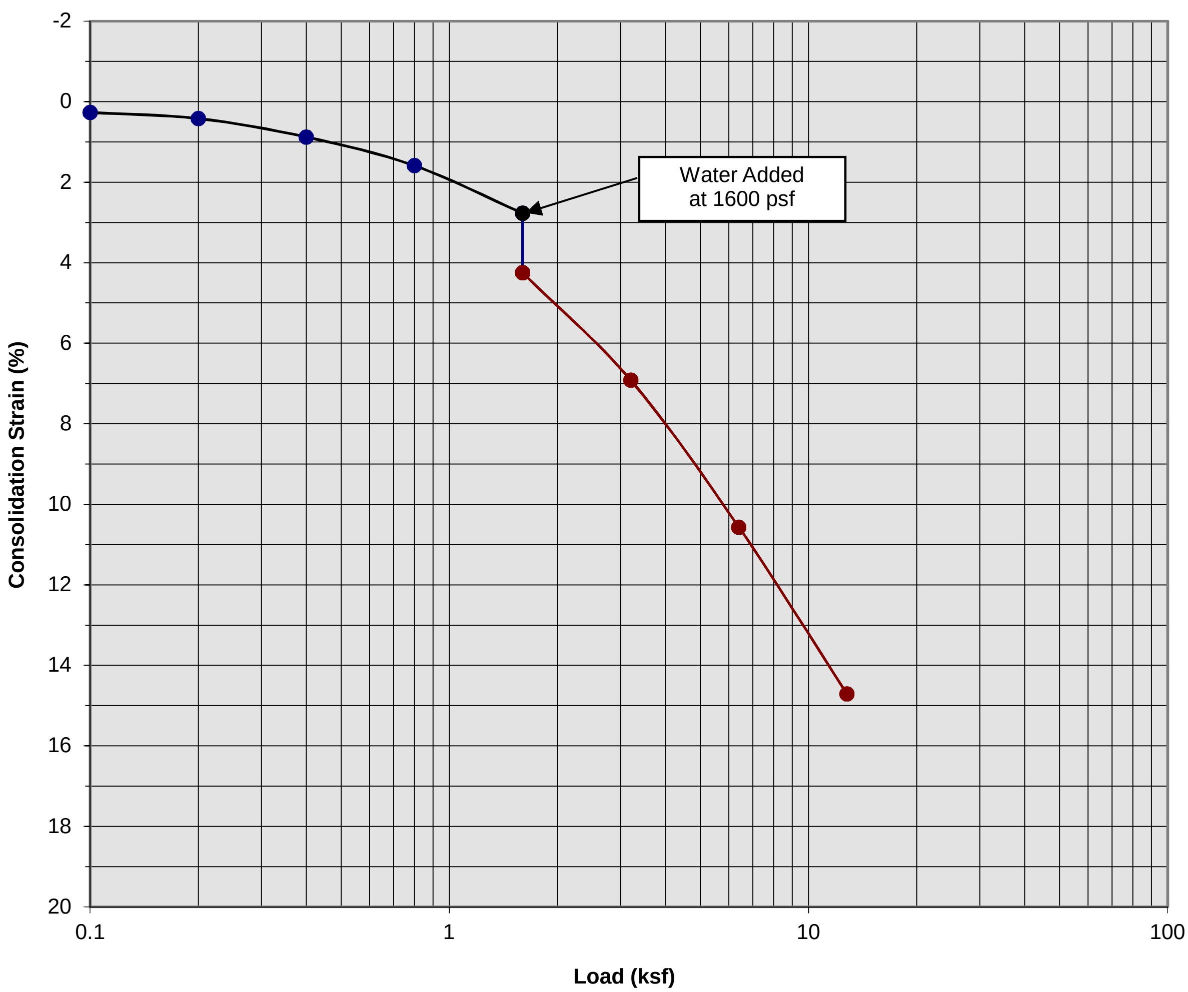


Classification: Gray Brown Silty Clay

Boring Number:	B-19	Initial Moisture Content (%)	20
Sample Number:	---	Final Moisture Content (%)	22
Depth (ft)	3 to 4	Initial Dry Density (pcf)	104.4
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	114.1
Specimen Thickness (in)	1.0	Percent Collapse (%)	-0.29

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL *A California Corporation*

Consolidation/Collapse Test Results



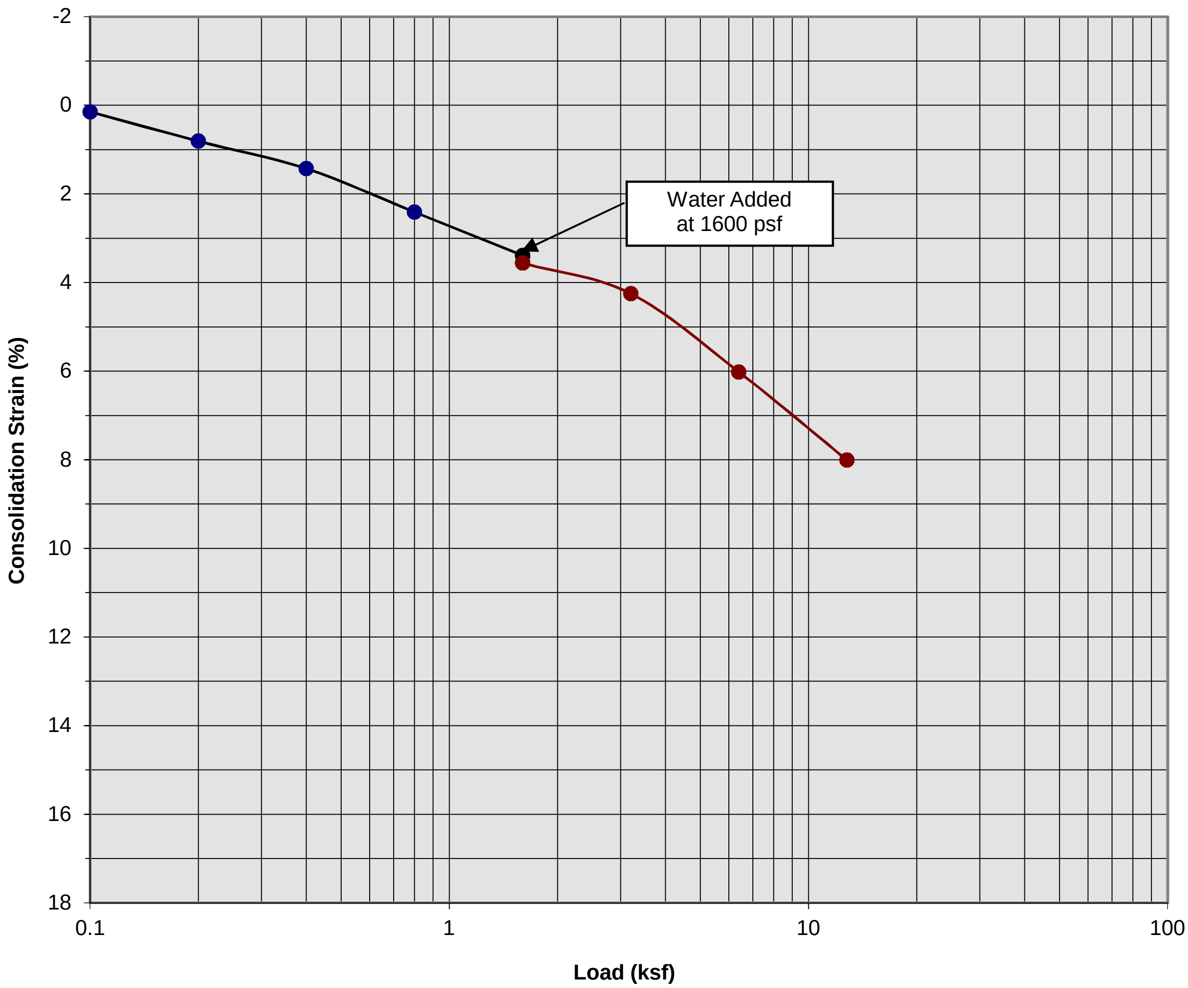
Classification: Light Gray to White Silt, little Clay

Boring Number:	B-19	Initial Moisture Content (%)	7
Sample Number:	---	Final Moisture Content (%)	17
Depth (ft)	5 to 6	Initial Dry Density (pcf)	105.2
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	123.5
Specimen Thickness (in)	1.0	Percent Collapse (%)	1.48

Proposed Commercial/Industrial Development
Norco, California
Project No. 17G105
PLATE C- 3

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results

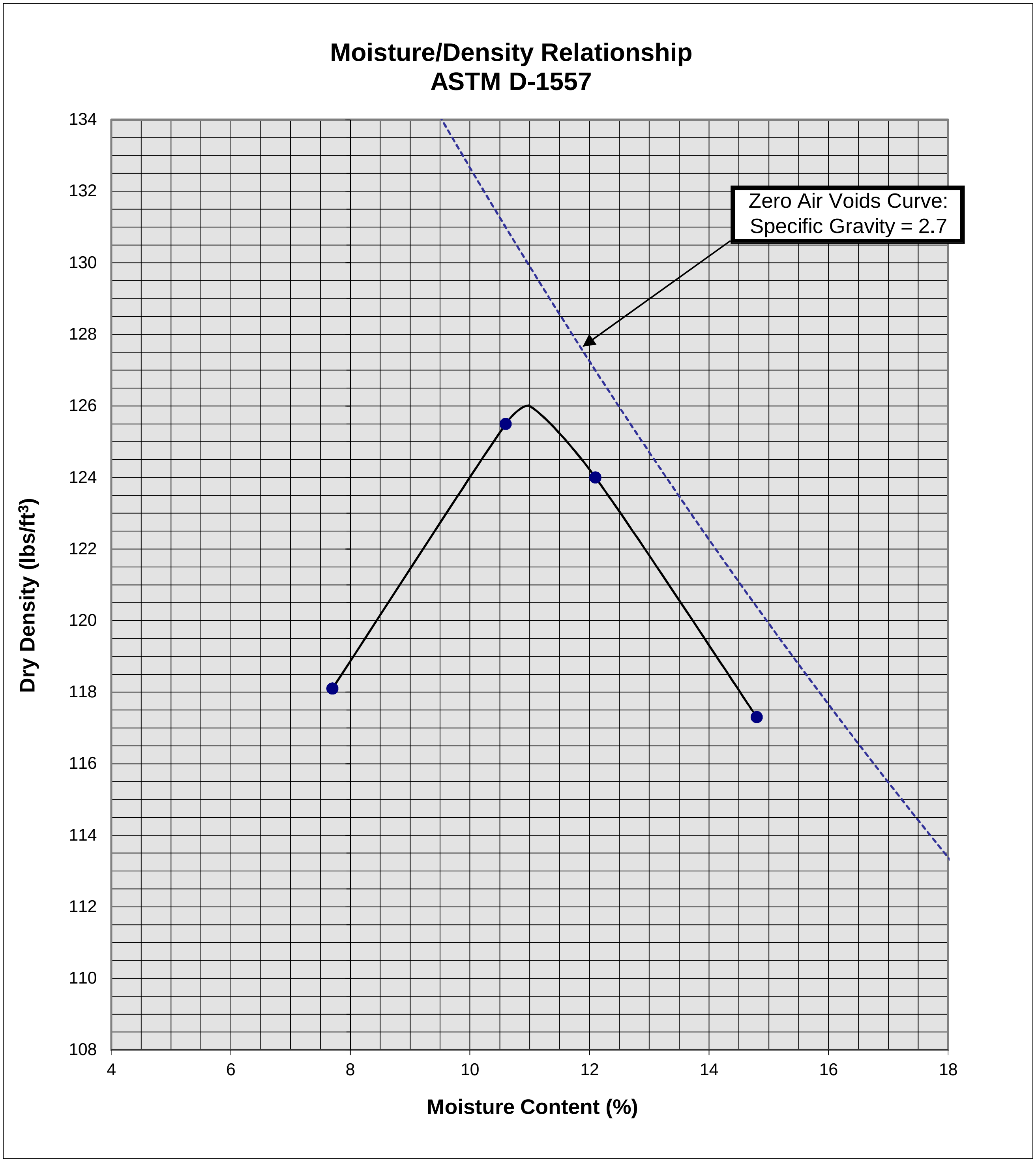


Classification: Light Gray fine to medium Sand, trace coarse Sand, trace fine Gravel

Boring Number:	B-19	Initial Moisture Content (%)	1
Sample Number:	---	Final Moisture Content (%)	8
Depth (ft)	9 to 10	Initial Dry Density (pcf)	126.1
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	137.3
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.17

Proposed Commercial/Industrial Development
Norco, California
Project No. 17G105
PLATE C- 4

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



Soil ID Number	B-19 @ 0 to 5'
Optimum Moisture (%)	11
Maximum Dry Density (pcf)	126
Soil Classification	Light Brown Clayey fine Sand to fine Sandy Clay

Proposed C/I Development
Norco, California
Project No. 17G105
PLATE C-5

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

APPENDIX D

GRADING GUIDE SPECIFICATIONS

These grading guide specifications are intended to provide typical procedures for grading operations. They are intended to supplement the recommendations contained in the geotechnical investigation report for this project. Should the recommendations in the geotechnical investigation report conflict with the grading guide specifications, the more site specific recommendations in the geotechnical investigation report will govern.

General

- The Earthwork Contractor is responsible for the satisfactory completion of all earthwork in accordance with the plans and geotechnical reports, and in accordance with city, county, and applicable building codes.

- The Geotechnical Engineer is the representative of the Owner/Builder for the purpose of implementing the report recommendations and guidelines. These duties are not intended to relieve the Earthwork Contractor of any responsibility to perform in a workman-like manner, nor is the Geotechnical Engineer to direct the grading equipment or personnel employed by the Contractor.

- The Earthwork Contractor is required to notify the Geotechnical Engineer of the anticipated work and schedule so that testing and inspections can be provided. If necessary, work may be stopped and redone if personnel have not been scheduled in advance.

- The Earthwork Contractor is required to have suitable and sufficient equipment on the job-site to process, moisture condition, mix and compact the amount of fill being placed to the approved compaction. In addition, suitable support equipment should be available to conform with recommendations and guidelines in this report.

- Canyon cleanouts, overexcavation areas, processed ground to receive fill, key excavations, subdrains and benches should be observed by the Geotechnical Engineer prior to placement of any fill. It is the Earthwork Contractor's responsibility to notify the Geotechnical Engineer of areas that are ready for inspection.

- Excavation, filling, and subgrade preparation should be performed in a manner and sequence that will provide drainage at all times and proper control of erosion. Precipitation, springs, and seepage water encountered shall be pumped or drained to provide a suitable working surface. The Geotechnical Engineer must be informed of springs or water seepage encountered during grading or foundation construction for possible revision to the recommended construction procedures and/or installation of subdrains.

Site Preparation

- The Earthwork Contractor is responsible for all clearing, grubbing, stripping and site preparation for the project in accordance with the recommendations of the Geotechnical Engineer.

- If any materials or areas are encountered by the Earthwork Contractor which are suspected of having toxic or environmentally sensitive contamination, the Geotechnical Engineer and Owner/Builder should be notified immediately.

- Major vegetation should be stripped and disposed of off-site. This includes trees, brush, heavy grasses and any materials considered unsuitable by the Geotechnical Engineer.

- Underground structures such as basements, cesspools or septic disposal systems, mining shafts, tunnels, wells and pipelines should be removed under the inspection of the Geotechnical Engineer and recommendations provided by the Geotechnical Engineer and/or city, county or state agencies. If such structures are known or found, the Geotechnical Engineer should be notified as soon as possible so that recommendations can be formulated.

- Any topsoil, slopewash, colluvium, alluvium and rock materials which are considered unsuitable by the Geotechnical Engineer should be removed prior to fill placement.

- Remaining voids created during site clearing caused by removal of trees, foundations basements, irrigation facilities, etc., should be excavated and filled with compacted fill.

- Subsequent to clearing and removals, areas to receive fill should be scarified to a depth of 10 to 12 inches, moisture conditioned and compacted

- The moisture condition of the processed ground should be at or slightly above the optimum moisture content as determined by the Geotechnical Engineer. Depending upon field conditions, this may require air drying or watering together with mixing and/or discing.

<u>Compacted Fills</u>

- Soil materials imported to or excavated on the property may be utilized in the fill, provided each material has been determined to be suitable in the opinion of the Geotechnical Engineer. Unless otherwise approved by the Geotechnical Engineer, all fill materials shall be free of deleterious, organic, or frozen matter, shall contain no chemicals that may result in the material being classified as "contaminated," and shall be very low to non-expansive with a maximum expansion index (EI) of 50. The top 12 inches of the compacted fill should have a maximum particle size of 3 inches, and all underlying compacted fill material a maximum 6-inch particle size, except as noted below.

- All soils should be evaluated and tested by the Geotechnical Engineer. Materials with high expansion potential, low strength, poor gradation or containing organic materials may require removal from the site or selective placement and/or mixing to the satisfaction of the Geotechnical Engineer.

- Rock fragments or rocks less than 6 inches in their largest dimensions, or as otherwise determined by the Geotechnical Engineer, may be used in compacted fill, provided the distribution and placement is satisfactory in the opinion of the Geotechnical Engineer.

- Rock fragments or rocks greater than 12 inches should be taken off-site or placed in accordance with recommendations and in areas designated as suitable by the Geotechnical Engineer. These materials should be placed in accordance with Plate D-8 of these Grading Guide Specifications and in accordance with the following recommendations:

  - Rocks 12 inches or more in diameter should be placed in rows at least 15 feet apart, 15 feet from the edge of the fill, and 10 feet or more below subgrade. Spaces should be left between each rock fragment to provide for placement and compaction of soil around the fragments.

  - Fill materials consisting of soil meeting the minimum moisture content requirements and free of oversize material should be placed between and over the rows of rock or concrete. Ample water and compactive effort should be applied to the fill materials as they are placed in order that all of the voids between each of the fragments are filled and compacted to the specified density.

- Subsequent rows of rocks should be placed such that they are not directly above a row placed in the previous lift of fill. A minimum 5-foot offset between rows is recommended.

- To facilitate future trenching, oversized material should not be placed within the range of foundation excavations, future utilities or other underground construction unless specifically approved by the soil engineer and the developer/owner representative.

- Fill materials approved by the Geotechnical Engineer should be placed in areas previously prepared to receive fill and in evenly placed, near horizontal layers at about 6 to 8 inches in loose thickness, or as otherwise determined by the Geotechnical Engineer for the project.

- Each layer should be moisture conditioned to optimum moisture content, or slightly above, as directed by the Geotechnical Engineer. After proper mixing and/or drying, to evenly distribute the moisture, the layers should be compacted to at least 90 percent of the maximum dry density in compliance with ASTM D-1557-78 unless otherwise indicated.

- Density and moisture content testing should be performed by the Geotechnical Engineer at random intervals and locations as determined by the Geotechnical Engineer. These tests are intended as an aid to the Earthwork Contractor, so he can evaluate his workmanship, equipment effectiveness and site conditions. The Earthwork Contractor is responsible for compaction as required by the Geotechnical Report(s) and governmental agencies.

- Fill areas unused for a period of time may require moisture conditioning, processing and recompaction prior to the start of additional filling. The Earthwork Contractor should notify the Geotechnical Engineer of his intent so that an evaluation can be made.

- Fill placed on ground sloping at a 5-to-1 inclination (horizontal-to-vertical) or steeper should be benched into bedrock or other suitable materials, as directed by the Geotechnical Engineer. Typical details of benching are illustrated on Plates D-2, D-4, and D-5.

- Cut/fill transition lots should have the cut portion overexcavated to a depth of at least 3 feet and rebuilt with fill (see Plate D-1), as determined by the Geotechnical Engineer.

- All cut lots should be inspected by the Geotechnical Engineer for fracturing and other bedrock conditions. If necessary, the pads should be overexcavated to a depth of 3 feet and rebuilt with a uniform, more cohesive soil type to impede moisture penetration.

- Cut portions of pad areas above buttresses or stabilizations should be overexcavated to a depth of 3 feet and rebuilt with uniform, more cohesive compacted fill to impede moisture penetration.

- Non-structural fill adjacent to structural fill should typically be placed in unison to provide lateral support. Backfill along walls must be placed and compacted with care to ensure that excessive unbalanced lateral pressures do not develop. The type of fill material placed adjacent to below grade walls must be properly tested and approved by the Geotechnical Engineer with consideration of the lateral earth pressure used in the design.

Foundations

- The foundation influence zone is defined as extending one foot horizontally from the outside edge of a footing, and proceeding downward at a ½ horizontal to 1 vertical (0.5:1) inclination.

- Where overexcavation beneath a footing subgrade is necessary, it should be conducted so as to encompass the entire foundation influence zone, as described above.

- Compacted fill adjacent to exterior footings should extend at least 12 inches above foundation bearing grade. Compacted fill within the interior of structures should extend to the floor subgrade elevation.

Fill Slopes

- The placement and compaction of fill described above applies to all fill slopes. Slope compaction should be accomplished by overfilling the slope, adequately compacting the fill in even layers, including the overfilled zone and cutting the slope back to expose the compacted core

- Slope compaction may also be achieved by backrolling the slope adequately every 2 to 4 vertical feet during the filling process as well as requiring the earth moving and compaction equipment to work close to the top of the slope. Upon completion of slope construction, the slope face should be compacted with a sheepsfoot connected to a sideboom and then grid rolled. This method of slope compaction should only be used if approved by the Geotechnical Engineer.

- Sandy soils lacking in adequate cohesion may be unstable for a finished slope condition and therefore should not be placed within 15 horizontal feet of the slope face.

- All fill slopes should be keyed into bedrock or other suitable material. Fill keys should be at least 15 feet wide and inclined at 2 percent into the slope. For slopes higher than 30 feet, the fill key width should be equal to one-half the height of the slope (see Plate D-5).

- All fill keys should be cleared of loose slough material prior to geotechnical inspection and should be approved by the Geotechnical Engineer and governmental agencies prior to filling.

- The cut portion of fill over cut slopes should be made first and inspected by the Geotechnical Engineer for possible stabilization requirements. The fill portion should be adequately keyed through all surficial soils and into bedrock or suitable material. Soils should be removed from the transition zone between the cut and fill portions (see Plate D-2).

Cut Slopes

- All cut slopes should be inspected by the Geotechnical Engineer to determine the need for stabilization. The Earthwork Contractor should notify the Geotechnical Engineer when slope cutting is in progress at intervals of 10 vertical feet. Failure to notify may result in a delay in recommendations.

- Cut slopes exposing loose, cohesionless sands should be reported to the Geotechnical Engineer for possible stabilization recommendations.

- All stabilization excavations should be cleared of loose slough material prior to geotechnical inspection. Stakes should be provided by the Civil Engineer to verify the location and dimensions of the key. A typical stabilization fill detail is shown on Plate D-5.

- Stabilization key excavations should be provided with subdrains. Typical subdrain details are shown on Plates D-6.

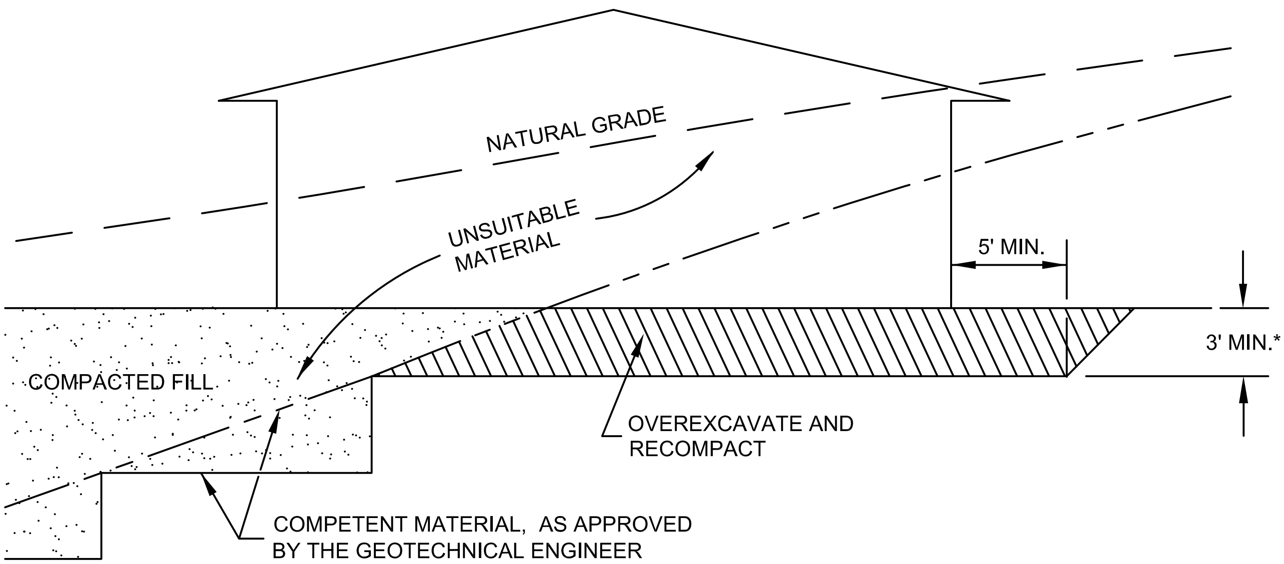
Subdrains

- Subdrains may be required in canyons and swales where fill placement is proposed. Typical subdrain details for canyons are shown on Plate D-3. Subdrains should be installed after approval of removals and before filling, as determined by the Soils Engineer.

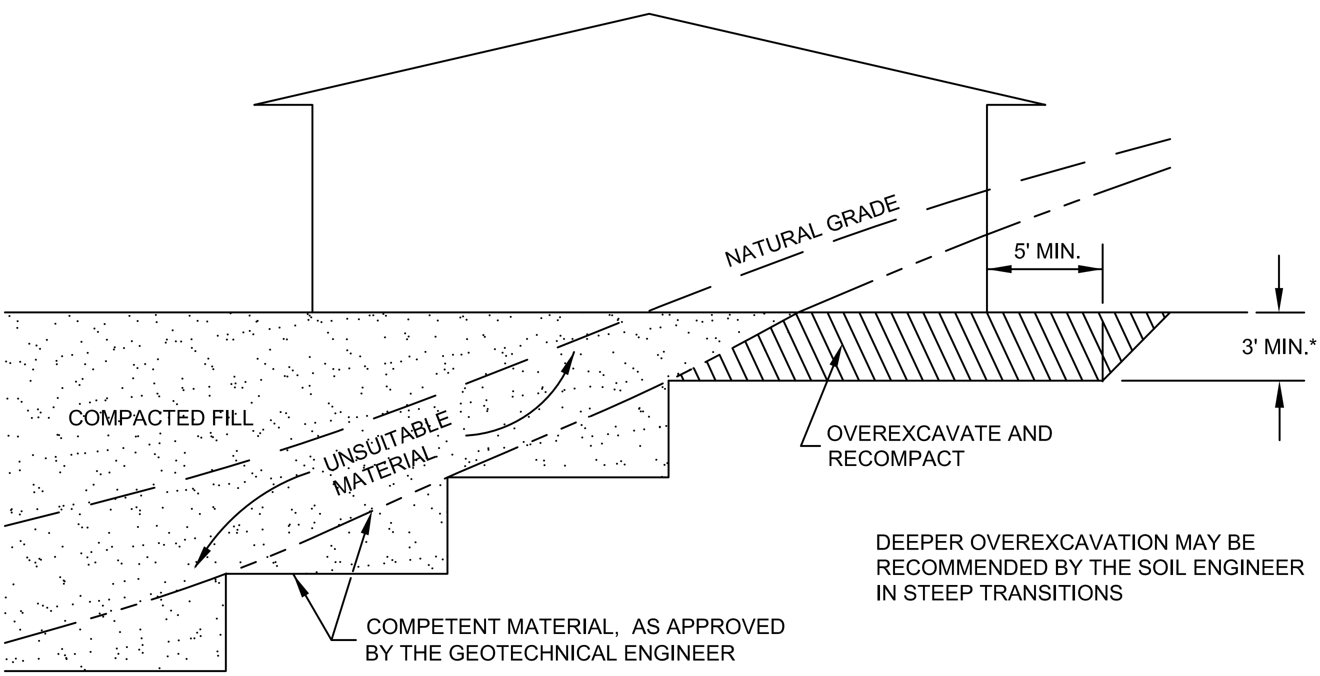
- Plastic pipe may be used for subdrains provided it is Schedule 40 or SDR 35 or equivalent. Pipe should be protected against breakage, typically by placement in a square-cut (backhoe) trench or as recommended by the manufacturer.

- Filter material for subdrains should conform to CALTRANS Specification 68-1.025 or as approved by the Geotechnical Engineer for the specific site conditions. Clean ¾-inch crushed rock may be used provided it is wrapped in an acceptable filter cloth and approved by the Geotechnical Engineer. Pipe diameters should be 6 inches for runs up to 500 feet and 8 inches for the downstream continuations of longer runs. Four-inch diameter pipe may be used in buttress and stabilization fills.

CUT LOT



CUT/FILL LOT (TRANSITION)



DEEPER OVEREXCAVATION MAY BE RECOMMENDED BY THE SOIL ENGINEER IN STEEP TRANSITIONS

*SEE TEXT OF REPORT FOR SPECIFIC RECOMMENDATION.
ACTUAL DEPTH OF OVEREXCAVATION MAY BE GREATER.

TRANSITION LOT DETAIL

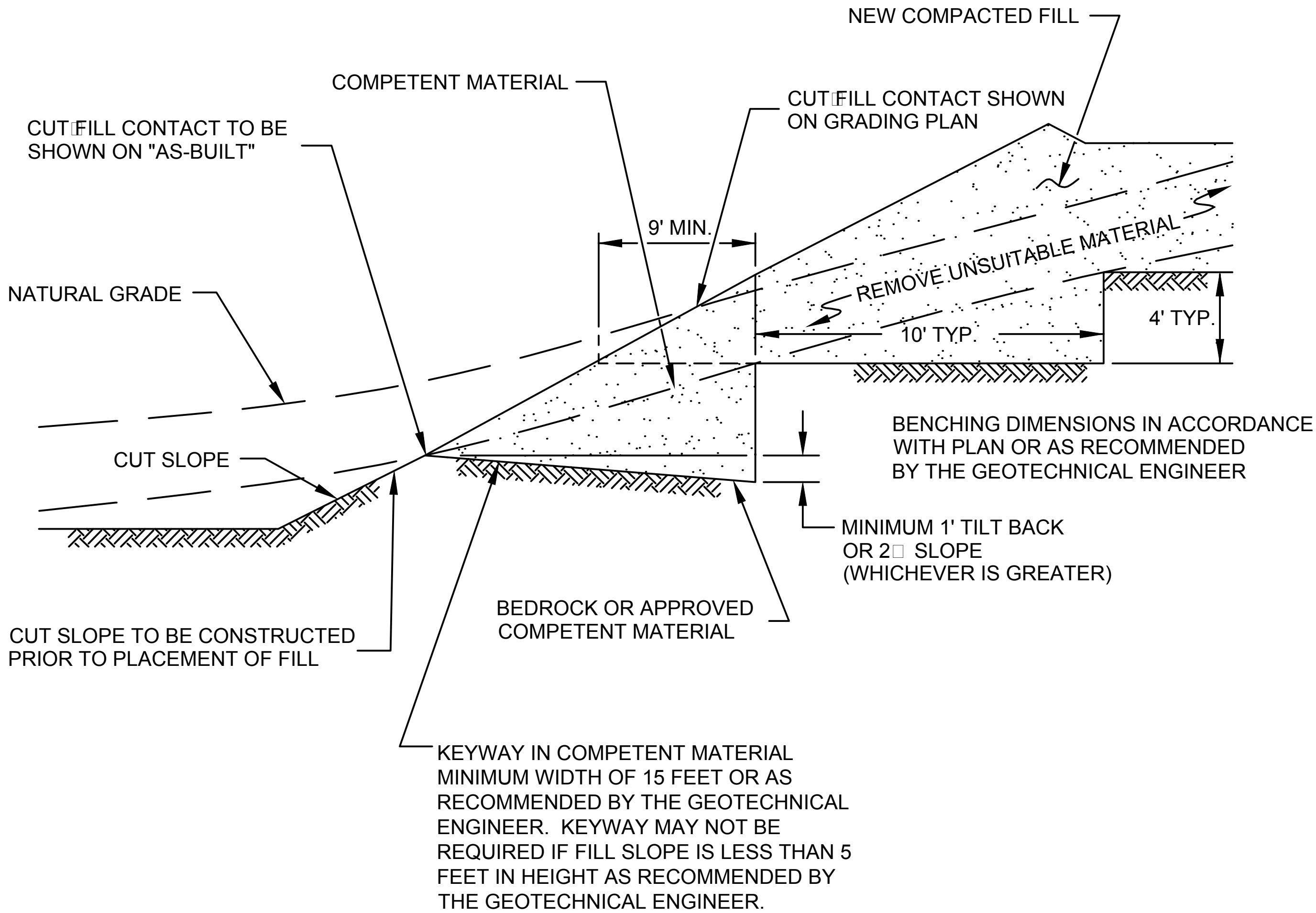
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-1

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL



FILL ABOVE CUT SLOPE DETAIL

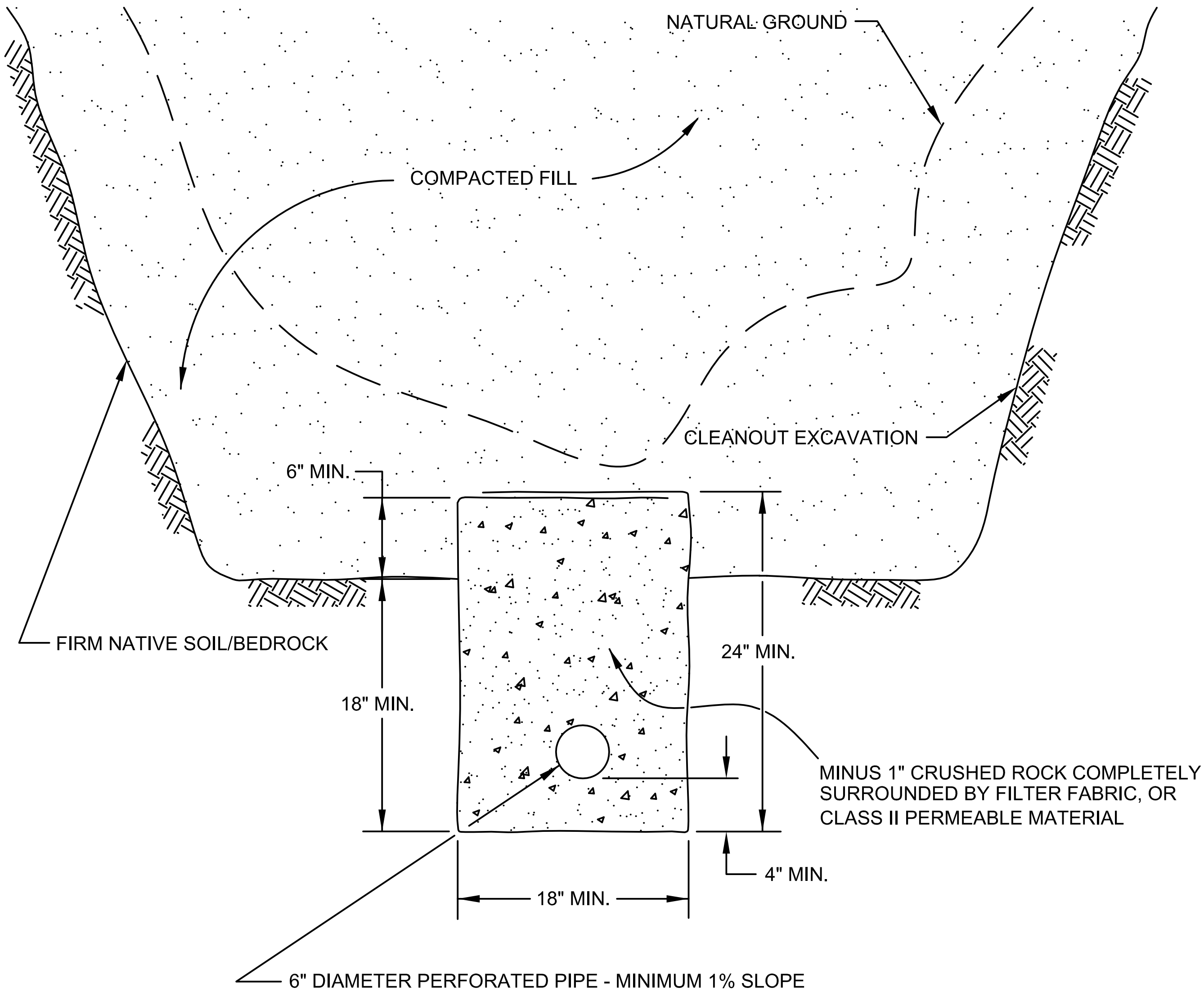
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-[illegible]

SOUTHERN CALIFORNIA GEOTECHNICAL



PIPE MATERIAL	DEPTH OF FILL OVER SUBDRAIN
ADS (CORRUGATED POLETHYLENE)	8
TRANSITE UNDERDRAIN	20
PVC OR ABS: SDR 35	35
SDR 21	100

SCHEMATIC ONLY
NOT TO SCALE

CANYON SUBDRAIN DETAIL

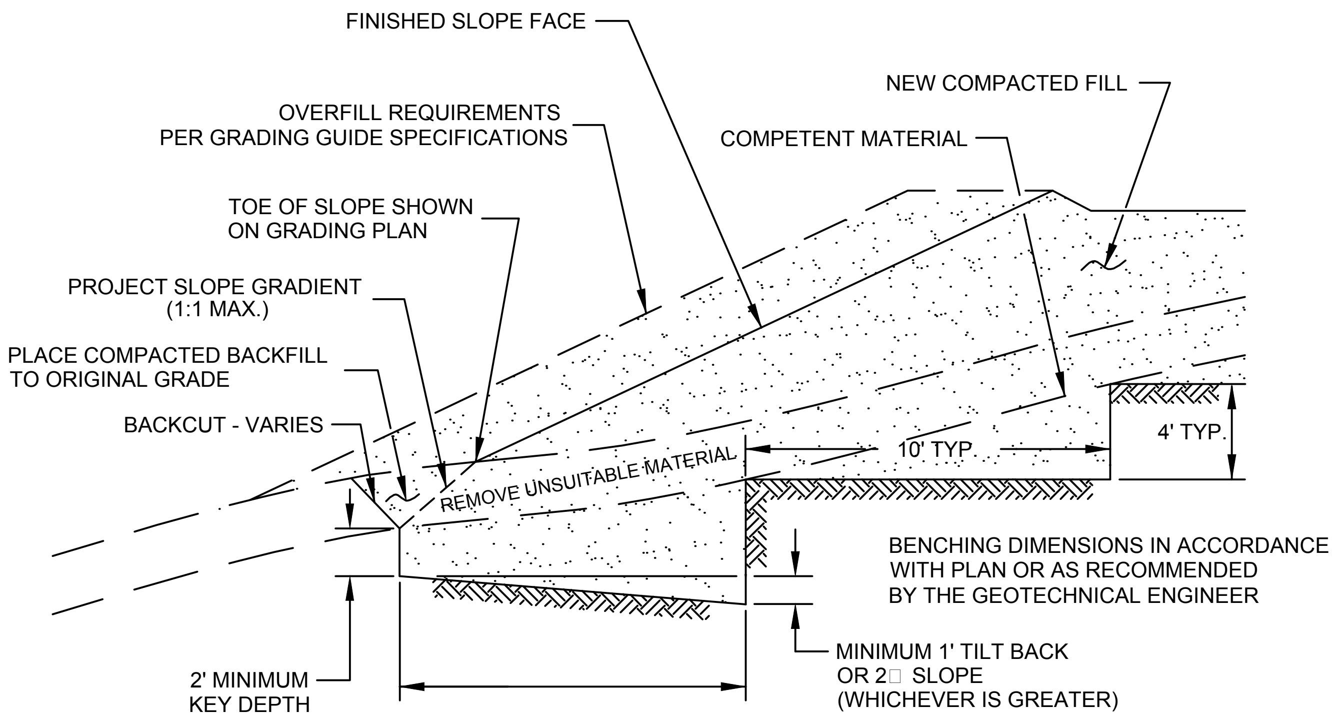
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-3

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL



KEYWAY IN COMPETENT MATERIAL. MINIMUM WIDTH OF 15 FEET OR AS RECOMMENDED BY THE GEOTECHNIAL ENGINEER. KEYWAY MAY NOT BE REQUIRED IF FILL SLOPE IS LESS THAN 5' IN HEIGHT AS RECOMMENDED BY THE GEOTECHNICAL ENGINEER.

NOTE:
BENCHING SHALL BE REQUIRED WHEN NATURAL SLOPES ARE EQUAL TO OR STEEPER THAN 5:1 OR WHEN RECOMMENDED BY THE GEOTECHNICAL ENGINEER.

FILL ABOVE NATURAL SLOPE DETAIL

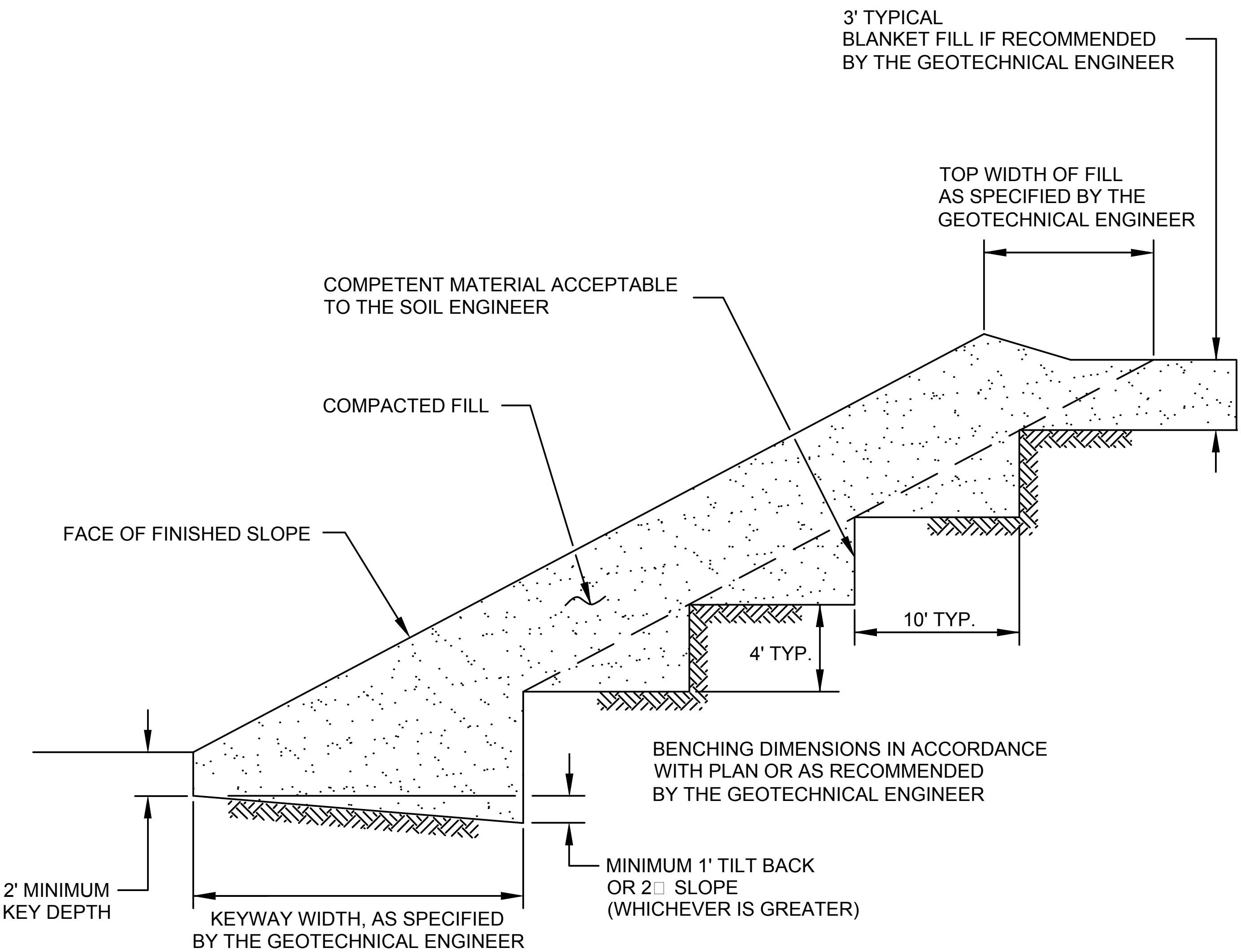
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-[illegible]

SOUTHERN CALIFORNIA GEOTECHNICAL



STABILIZATION FILL DETAIL

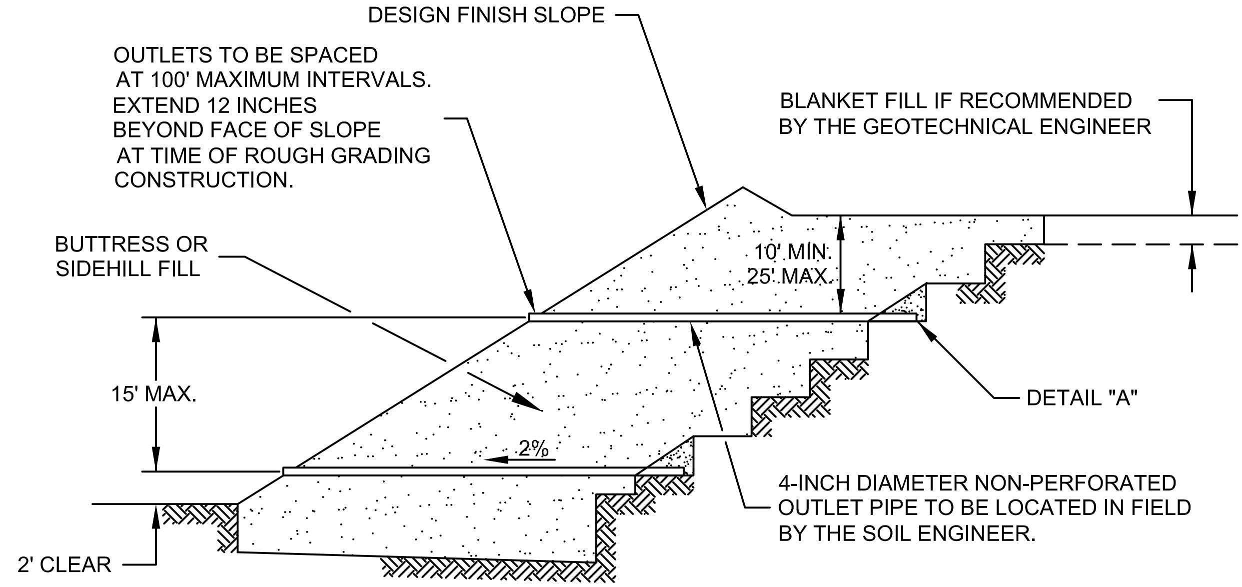
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL



"FILTER MATERIAL" TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUIVALENT: (CONFORMS TO EMA STD. PLAN 323)

SIEVE SIZE	PERCENTAGE PASSING
1"	100
3/4"	90-100
3/8"	40-100
NO. 4	25-40
NO. 8	18-33
NO. 30	5-15
NO. 50	0-7
NO. 200	0-3

"GRAVEL" TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUIVALENT:

SIEVE SIZE	MAXIMUM PERCENTAGE PASSING
1 1/2"	100
NO. 4	50
NO. 200	8

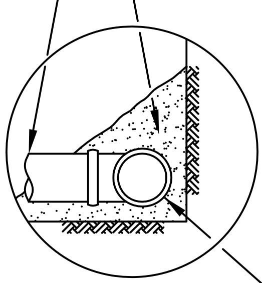
SAND EQUIVALENT = MINIMUM OF 50

OUTLET PIPE TO BE CONNECTED TO SUBDRAIN PIPE WITH TEE OR ELBOW

FILTER MATERIAL - MINIMUM OF FIVE CUBIC FEET PER FOOT OF PIPE. SEE ABOVE FOR FILTER MATERIAL SPECIFICATION.

ALTERNATIVE: IN LIEU OF FILTER MATERIAL FIVE CUBIC FEET OF GRAVEL PER FOOT OF PIPE MAY BE ENCASED IN FILTER FABRIC. SEE ABOVE FOR GRAVEL SPECIFICATION.

FILTER FABRIC SHALL BE MIRAFI 140 OR EQUIVALENT. FILTER FABRIC SHALL BE LAPPED A MINIMUM OF 12 INCHES ON ALL JOINTS.



DETAIL "A"

MINIMUM 4-INCH DIAMETER PVC SCH 40 OR ABS CLASS SDR 35 WITH A CRUSHING STRENGTH OF AT LEAST 1,000 POUNDS, WITH A MINIMUM OF 8 UNIFORMLY SPACED PERFORATIONS PER FOOT OF PIPE INSTALLED WITH PERFORATIONS ON BOTTOM OF PIPE. PROVIDE CAP AT UPSTREAM END OF PIPE. SLOPE AT 2 PERCENT TO OUTLET PIPE.

NOTES:
1. TRENCH FOR OUTLET PIPES TO BE BACKFILLED WITH ON-SITE SOIL.

SLOPE FILL SUBDRAINS

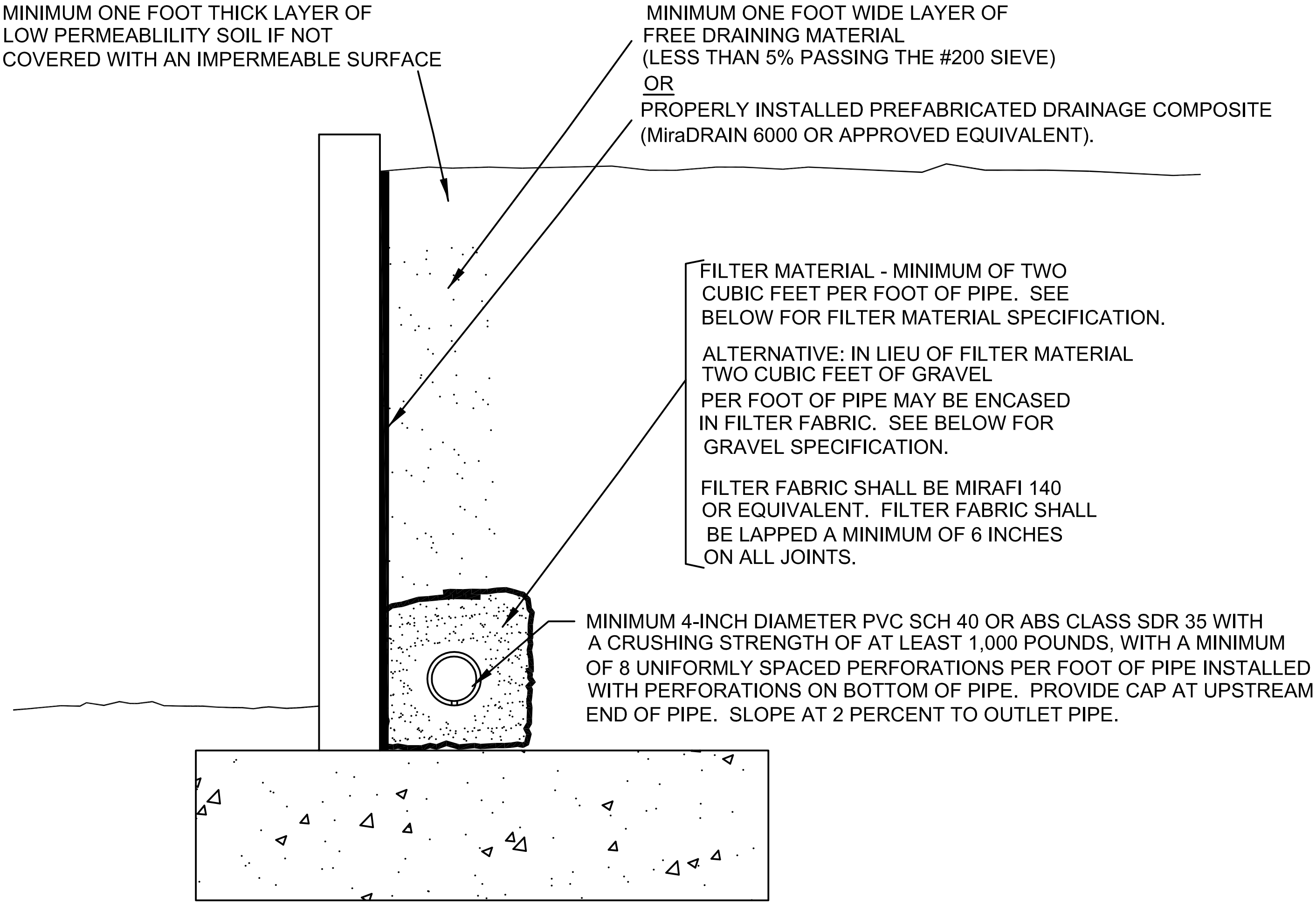
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: JAS
CHKD: GKM

PLATE D-6

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL



"FILTER MATERIAL" TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUIVALENT: (CONFORMS TO EMA STD. PLAN 323)

SIEVE SIZE	PERCENTAGE PASSING
1"	100
3/4"	90-100
3/8"	40-100
NO. 4	25-40
NO. 8	18-33
NO. 30	5-15
NO. 50	0-7
NO. 200	0-3

"GRAVEL" TO MEET FOLLOWING SPECIFICATION OR APPROVED EQUIVALENT:

SIEVE SIZE	MAXIMUM PERCENTAGE PASSING
1 1/2"	100
NO. 4	50
NO. 200	8

SAND EQUIVALENT = MINIMUM OF 50

RETAINING WALL BACKDRAINS

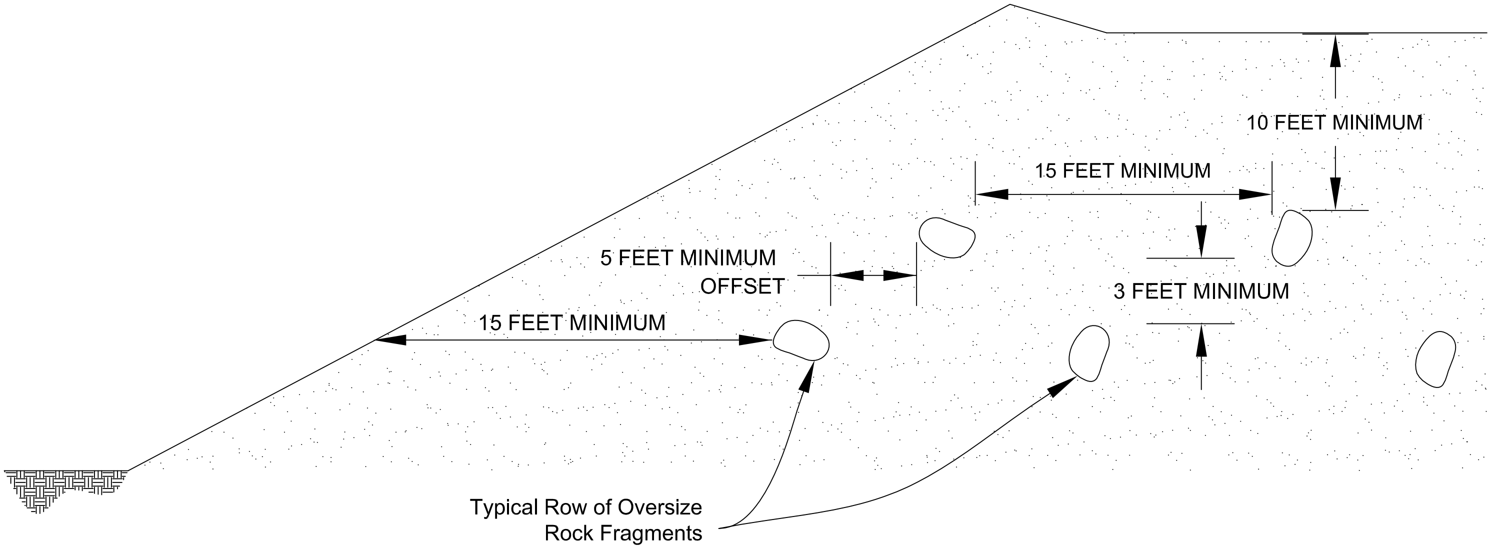
GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

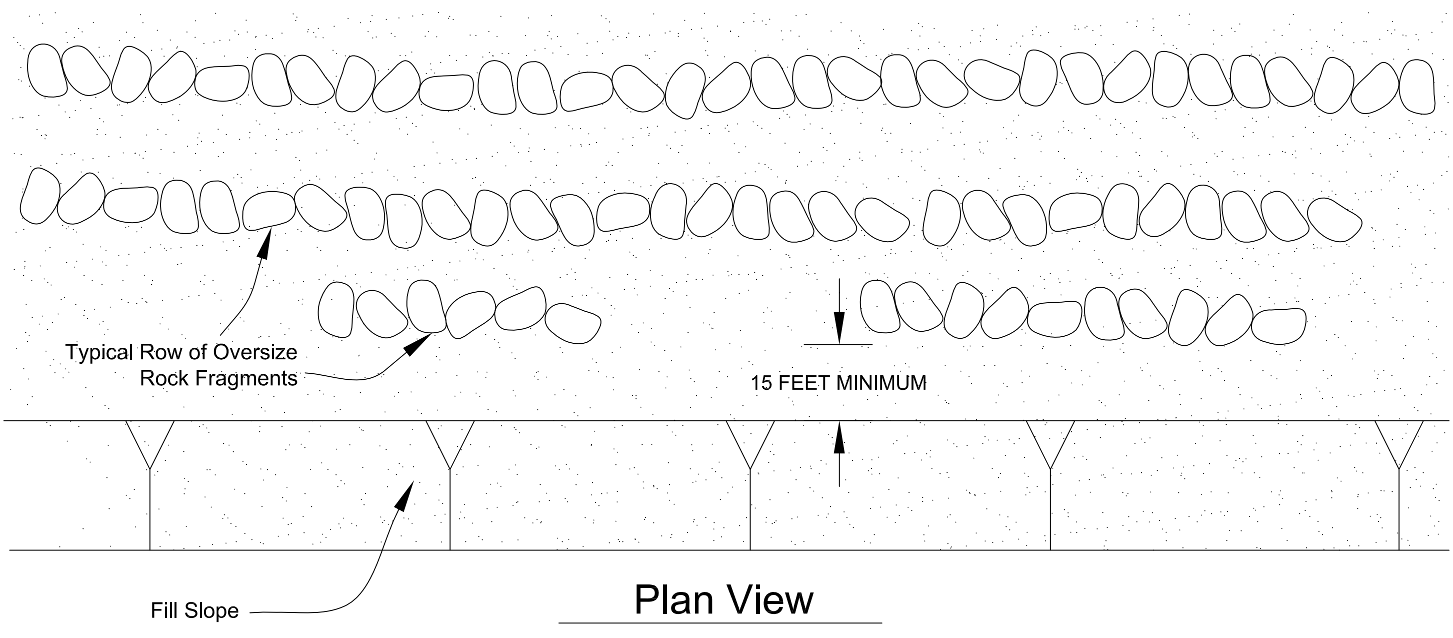
DRAWN: JAS
CHKD: GKM

PLATE D-7

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL



Section View



Plan View

PLACEMENT OF OVERSIZED MATERIAL

GRADING GUIDE SPECIFICATIONS

NOT TO SCALE

DRAWN: PM
CHKD: GKM

PLATE D-8

SoCalGeo

SOUTHERN
CALIFORNIA
GEOTECHNICAL

APPENDIX E

Design Maps Summary Report

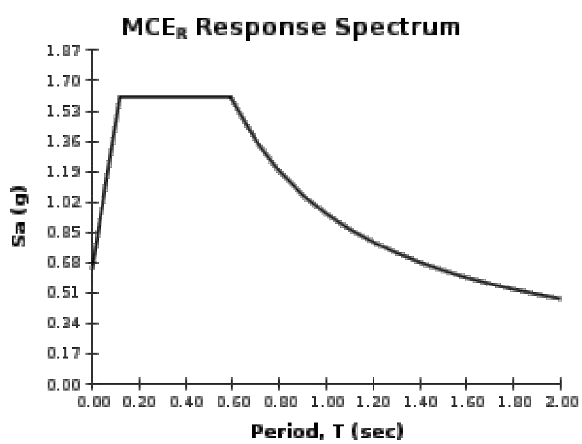
User–Specified Input

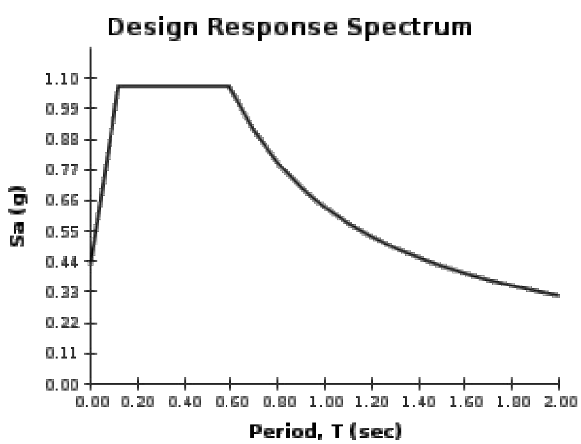
Building Code Reference Document	ASCE 7-10 Standard (which utilizes USGS hazard data available in 2008)
Site Coordinates	33.90621°N, 117.56823°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

S_S =	1.606 g	S_{MS} =	1.606 g	S_{DS} =	1.071 g
S_1 =	0.635 g	S_{M1} =	0.952 g	S_{D1} =	0.635 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





SOURCE: U.S. GEOLOGICAL SURVEY (USGS)
(http://geohazards.usgs.gov/designmaps/us/application.php)

SEISMIC DESIGN PARAMETERS	
PROPOSED COMMERCIAL/INDUSTRIAL DEVELOPMENT	
NORCO, CALIFORNIA	
DRAWN: AL CHKD: RGT	SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
SCG PROJECT 17G105-1	
PLATE E-1	

Section 11.8.3 — Additional Geotechnical Investigation Report Requirements for Seismic Design Categories D through F

From Figure 22-7 [4]	PGA = 0.607
Equation (11.8–1):	$PGA_M = F_{PGA}PGA = 1.000 \times 0.607 = 0.607$ g

Table 11.8–1: Site Coefficient F_{PGA}

Site Class	Mapped MCE Geometric Mean Peak Ground Acceleration, PGA				
	PGA ≤ 0.10	PGA = 0.20	PGA = 0.30	PGA = 0.40	PGA ≥ 0.50
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7 of ASCE 7				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 0.607 g, F_{PGA} = 1.000

Section 21.2.1.1 — Method 1 (from Chapter 21 – Site-Specific Ground Motion Procedures for Seismic Design)

From Figure 22-17 [5]	C_{RS} = 1.019
From Figure 22-18 [6]	C_{R1} = 1.021

SOURCE: U.S. GEOLOGICAL SURVEY (USGS)
(https://geohazards.usgs.gov/designmaps/us/application.php)

MCE PEAK GROUND ACCELERATION
PROPOSED COMMERCIAL/INDUSTRIAL DEVELOPMENT
NORCO, CALIFORNIA

DRAWN: AL
CHKD: RGT
SCG PROJECT
17G105-1
PLATE E-[illegible]

SOUTHERN CALIFORNIA GEOTECHNICAL

APPENDIX F

LIQUEFACTION EVALUATION

Project Name	Proposed Comm/Ind Development	MCE_G Design Acceleration	0.607 (g)
Project Location	Norco, CA	Design Magnitude	6.98
Project Number	17G105	Historic High Depth to Groundwater	21 (ft)
Engineer	DWN	Depth to Groundwater at Time of Drilling	41 (ft)
		Borehole Diameter	6 (in)
Boring No.	B-16		

Sample Depth (ft)	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Depth to Midpoint (ft)	Uncorrected SPT N-Value	Unit Weight of Soil (pcf)	Fines Content (%)	Energy Correction	C_B	C_S	C_N	Rod Length Correction	$(N_1)_{60}$	$(N_1)_{60CS}$	Overburden Stress (σ_o) (psf)	Eff. Overburden Stress (Hist. Water) (σ_o') (psf)	Eff. Overburden Stress (Curr. Water) (σ_o') (psf)	Stress Reduction Coefficient (r_d)	MSF	Ks	Cyclic Resistance Ratio (M=7.5)	Cyclic Resistance Ratio (M=6.98)	Cyclic Stress Ratio Induced by Design Earthquake	Factor of Safety	Comments
							(1)	(2)	(3)	(4)	(5)	(6)	(7)				(8)	(9)	(10)	(11)	(12)	(13)		
7.5	0	21	10.5		120		1.3	1.05	1.1	1.50	0.75	0.0	0.0	1260	1260	1260	0.97	1.02	1.03	0.06	0.06	N/A	N/A	Above Ground Water
19.5	21	22	21.5	36	120		1.3	1.05	1.3	0.96	0.95	58.4	58.4	2580	2549	2580	0.92	1.22	0.94	2.00	2.00	0.37	5.43	Non-Liquefiable
24.5	22	26	24	13	120	30	1.3	1.05	1.17	0.88	0.95	17.4	22.8	2880	2693	2880	0.91	1.11	0.96	0.25	0.26	0.38	0.69	**Liquefiable**
29.5	26	31	28.5	17	120	46	1.3	1.05	1.23	0.83	0.95	22.5	28.2	3420	2952	3420	0.89	1.16	0.94	0.39	0.43	0.40	1.05	**Liquefiable**
34.5	31	37	34	60	120		1.3	1.05	1.3	1.01	1	107.3	107.3	4080	3269	4080	0.86	1.22	0.87	2.00	2.00	0.42	4.75	Non-Liquefiable
39.5	37	50	43.5	50	120		1.3	1.05	1.3	0.93	1	82.2	82.2	5220	3816	5064	0.80	1.22	0.82	2.00	2.00	0.43	4.62	Non-Liquefiable

Notes:

(1) Energy Correction for N_{90} of automatic hammer to standard N_{60}

(2) Borehole Diameter Correction (Skempton, 1986)

(3) Correction for split-spoon sampler with room for liners, but liners are absent, (Seed et al., 1984, 2001)

(4) Overburden Correction, Caluclated by Eq. 39 (Boulanger and Idriss, 2008)

(5) Rod Length Correction for Samples <10 m in depth

(6) N-value corrected for energy, borehole diameter, sampler with absent liners, rod length, and overburden

(7) N-value corrected for fines content per Eqs. 75 and 76 (Boulanger and Idriss, 2008)

(8) Stress Reduction Coefficient calculated by Eq. 22 (Boulanger and Idriss, 2008)

(9) Magnitude Scaling Factor calculated by Eqns. A.8 & A.10 (Boulanger and Idriss, 2014)

(10) Overburden Correction Factor calcuated by Eq. 54 (Boulanger and Idriss, 2008)

(11) Calcuated by Eq. 70 (Boulanger and Idriss, 2008)

(12) Calcuated by Eq. 72 (Boulanger and Idriss, 2008)

(13) Calcuated by Eq. 25 (Boulanger and Idriss, 2008)

LIQUEFACTION INDUCED SETTLEMENTS

Project Name	Proposed Comm/Ind Development
Project Location	Norco, CA
Project Number	17G105
Engineer	DWN

Boring No.	B-16

Sample Depth (ft)	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Depth to Midpoint (ft)	$(N_1)_{60}$	DN for fines content	$(N_1)_{60\text{-}CS}$	Liquefaction Factor of Safety	Limiting Shear Strain γ_{min}	Parameter $F\alpha$	Maximum Shear Strain γ_{max}	Height of Layer		Vertical Reconsolidation Strain ε_v		Total Deformation of Layer (in)	Comments
				(1)	(2)	(3)	(4)	(5)	(6)	(7)			(8)			
7.5	0	21	10.5	0.0	0.0	0.0	N/A	0.50	0.95	0.00	21.00		0.000		0.00	Above Ground Water
19.5	21	22	21.5	58.4	0.0	58.4	5.43	0.00	-2.28	0.00	1.00		0.000		0.00	Non-Liquefiable
24.5	22	26	24	17.4	5.4	22.8	0.69	0.12	0.36	0.09	4.00		0.021		0.99	**Liquefiable**
29.5	26	31	28.5	22.5	5.6	28.2	1.05	0.06	0.03	0.03	5.00		0.007		0.40	**Liquefiable**
34.5	31	37	34	107.3	0.0	107.3	4.75	0.00	-6.77	0.00	6.00		0.000		0.00	Non-Liquefiable
39.5	37	50	43.5	82.2	0.0	82.2	4.62	0.00	-4.40	0.00	13.00		0.000		0.00	Non-Liquefiable
											Total Deformation (in)				1.39	

Notes:

(1) $(N_1)_{60}$ calculated previously for the individual layer

(2) Correction for fines content per Equation 76 (Boulanger and Idriss, 2008)

(3) Corrected $(N_1)_{60}$ for fines content

(4) Factor of Safety against Liquefaction, calculated previously for the individual layer

(5) Calcuated by Eq. 86 (Boulanger and Idriss, 2008)

(6) Calcuated by Eq. 89 (Boulanger and Idriss, 2008)

(7) Calcuated by Eqs. 90, 91, and 92 (Boulanger and Idriss, 2008)

(8) Volumetric Strain Induced in a Liquefiable Layer, Calcuated by Eq. 96 (Boulanger and Idriss, 2008)
(Strain N/A if Factor of Safety against Liquefaction > 1.3)

LIQUEFACTION EVALUATION

Project Name	Proposed Comm/Ind Development	MCE$_G$ Design Acceleration	0.607	(g)
Project Location	Norco, CA	Design Magnitude	6.98	
Project Number	17G105	Historic High Depth to Groundwater	21	(ft)
Engineer	DWN	Depth to Groundwater at Time of Drilling	30	(ft)
		Borehole Diameter	6	(in)
Boring No.	B-17			

Sample Depth (ft)	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Depth to Midpoint (ft)	Uncorrected SPT N-Value	Unit Weight of Soil (pcf)	Fines Content (%)	Energy Correction	C_B	C_S	C_N	Rod Length Correction	$(N_1)_{60}$	$(N_1)_{60CS}$	Overburden Stress (σ_o) (psf)	Eff. Overburden Stress (Hist. Water) (σ_o') (psf)	Eff. Overburden Stress (Curr. Water) (σ_o') (psf)	Stress Reduction Coefficient (r_d)	MSF	Ks	Cyclic Resistance Ratio (M=7.5)	Cyclic Resistance Ratio (M=6.98)	Cyclic Stress Ratio Induced by Design Earthquake	Factor of Safety	Comments
							(1)	(2)	(3)	(4)	(5)	(6)	(7)				(8)	(9)	(10)	(11)	(12)	(13)		
7.5	0	21	10.5		120		1.3	1.05	1.1	1.50	0.75	0.0	0.0	1260	1260	1260	0.97	1.02	1.03	0.06	0.06	N/A	N/A	Above Ground Water
19.5	21	22	21.5	27	120		1.3	1.05	1.3	0.95	0.95	43.1	43.1	2580	2549	2580	0.92	1.22	0.94	2.00	2.00	0.37	5.43	Non-Liquefiable
24.5	22	27	24.5	46	120		1.3	1.05	1.3	0.96	0.95	74.5	74.5	2940	2722	2940	0.91	1.22	0.92	2.00	2.00	0.39	5.18	Non-Liquefiable
29.5	27	31	29	34	120		1.3	1.05	1.3	0.89	0.95	51.0	51.0	3480	2981	3480	0.88	1.22	0.9	2.00	2.00	0.41	4.92	Non-Liquefiable
34.5	31	37	34	10	120	59	1.3	1.05	1.12	0.76	1	11.5	17.2	4080	3269	3830	0.86	1.07	0.95	0.18	N/A	N/A	N/A	Non-liq: PI>18
39.5	37	42	39.5	15	120	51	1.3	1.05	1.18	0.76	1	18.4	24.1	4740	3586	4147	0.82	1.12	0.92	0.27	N/A	N/A	N/A	Non-liq: 12<PI<18, w<.8*LL
44.5	42	47	44.5	12	120	45	1.3	1.05	1.13	0.72	1	13.3	18.9	5340	3874	4435	0.80	1.08	0.92	0.19	N/A	N/A	N/A	Non-liq: 12<PI<18, w<.8*LL
49.5	47	50	48.5	23	120	39	1.3	1.05	1.3	0.78	1	31.8	37.4	5820	4104	4666	0.77	1.22	0.8	1.94	1.90	0.43	4.38	Non-Liq: PI>18

Notes:

(1) Energy Correction for N_{90} of automatic hammer to standard N_{60}

(2) Borehole Diameter Correction (Skempton, 1986)

(3) Correction for split-spoon sampler with room for liners, but liners are absent, (Seed et al., 1984, 2001)

(4) Overburden Correction, Caluclated by Eq. 39 (Boulanger and Idriss, 2008)

(5) Rod Length Correction for Samples <10 m in depth

(6) N-value corrected for energy, borehole diameter, sampler with absent liners, rod length, and overburden

(7) N-value corrected for fines content per Eqs. 75 and 76 (Boulanger and Idriss, 2008)

(8) Stress Reduction Coefficient calculated by Eq. 22 (Boulanger and Idriss, 2008)

(9) Magnitude Scaling Factor calculated by Eqns. A.8 & A.10 (Boulanger and Idriss, 2014)

(10) Overburden Correction Factor calcuated by Eq. 54 (Boulanger and Idriss, 2008)

(11) Calcuated by Eq. 70 (Boulanger and Idriss, 2008)

(12) Calcuated by Eq. 72 (Boulanger and Idriss, 2008)

(13) Calcuated by Eq. 25 (Boulanger and Idriss, 2008)

LIQUEFACTION INDUCED SETTLEMENTS

Project Name	Proposed Comm/Ind Development
Project Location	Norco, CA
Project Number	17G105
Engineer	DWN

Boring No. B-17

Sample Depth (ft)	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Depth to Midpoint (ft)	$(N_1)_{60}$	DN for fines content	$(N_1)_{60\text{-CS}}$	Liquefaction Factor of Safety	Limiting Shear Strain γ_{min}	Parameter Fα	Maximum Shear Strain γ_{max}	Height of Layer		Vertical Reconsolidation Strain ε_v		Total Deformation of Layer (in)	Comments
				(1)	(2)	(3)	(4)	(5)	(6)	(7)			(8)			
7.5	0	21	10.5	0.0	0.0	0.0	N/A	0.50	0.95	0.00	21.00		0.000		0.00	Above Ground Water
19.5	21	22	21.5	43.1	0.0	43.1	5.43	0.00	-1.04	0.00	1.00		0.000		0.00	Non-Liquefiable
24.5	22	27	24.5	74.5	0.0	74.5	5.18	0.00	-3.70	0.00	5.00		0.000		0.00	Non-Liquefiable
29.5	27	31	29	51.0	0.0	51.0	4.92	0.00	-1.67	0.00	4.00		0.000		0.00	Non-Liquefiable
34.5	31	37	34	11.5	5.6	17.2	N/A	0.22	0.66	0.00	6.00		0.000		0.00	**Non-liq: PI>18**
39.5	37	42	39.5	18.4	5.6	24.1	N/A	0.10	0.29	0.00	5.00		0.000		0.00	Non-liq: 12<PI<18, w<.8*LL
44.5	42	47	44.5	13.3	5.6	18.9	N/A	0.18	0.57	0.00	5.00		0.000		0.00	Non-liq: 12<PI<18, w<.8*LL
49.5	47	50	48.5	31.8	5.6	37.4	4.38	0.01	-0.61	0.00	3.00		0.000		0.00	Non-Liq: PI>18
											Total Deformation (in)				0.00	

Notes:

(1) $(N_1)_{60}$ calculated previously for the individual layer

(2) Correction for fines content per Equation 76 (Boulanger and Idriss, 2008)

(3) Corrected $(N_1)_{60}$ for fines content

(4) Factor of Safety against Liquefaction, calculated previously for the individual layer

(5) Calcuated by Eq. 86 (Boulanger and Idriss, 2008)

(6) Calcuated by Eq. 89 (Boulanger and Idriss, 2008)

(7) Calcuated by Eqs. 90, 91, and 92 (Boulanger and Idriss, 2008)

(8) Volumetric Strain Induced in a Liquefiable Layer, Calcuated by Eq. 96 (Boulanger and Idriss, 2008)
(Strain N/A if Factor of Safety against Liquefaction > 1.3)

LIQUEFACTION EVALUATION

Project Name	Proposed Comm/Ind Development	MCE_G Design Acceleration	0.607 (g)
Project Location	Norco, CA	Design Magnitude	6.98
Project Number	17G105	Historic High Depth to Groundwater	21 (ft)
Engineer	DWN	Depth to Groundwater at Time of Drilling	29 (ft)
		Borehole Diameter	6 (in)
Boring No.	B-18		

Sample Depth (ft)	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Depth to Midpoint (ft)	Uncorrected SPT N-Value	Unit Weight of Soil (pcf)	Fines Content (%)	Energy Correction	C_B	C_S	C_N	Rod Length Correction	$(N_1)_{60}$	$(N_1)_{60CS}$	Overburden Stress (σ_o) (psf)	Eff. Overburden Stress (Hist. Water) (σ_o') (psf)	Eff. Overburden Stress (Curr. Water) (σ_o') (psf)	Stress Reduction Coefficient (r_d)	MSF	Ks	Cyclic Resistance Ratio (M=7.5)	Cyclic Resistance Ratio (M=6.98)	Cyclic Stress Ratio Induced by Design Earthquake	Factor of Safety	Comments
							(1)	(2)	(3)	(4)	(5)	(6)	(7)				(8)	(9)	(10)	(11)	(12)	(13)		
7.5	0	21	10.5		120		1.3	1.05	1.1	1.50	0.75	0.0	0.0	1260	1260	1260	0.97	1.02	1.03	0.06	0.06	N/A	N/A	Above Ground Water
19.5	21	22	21.5	50	120		1.3	1.05	1.3	0.98	0.95	82.9	82.9	2580	2549	2580	0.92	1.22	0.94	2.00	2.00	0.37	5.43	Non-Liquefiable
24.5	22	27	24.5	34	120		1.3	1.05	1.3	0.93	0.95	53.3	53.3	2940	2722	2940	0.91	1.22	0.92	2.00	2.00	0.39	5.18	Non-Liquefiable
29.5	27	32	29.5	42	120		1.3	1.05	1.3	0.92	0.95	65.2	65.2	3540	3010	3509	0.88	1.22	0.89	2.00	2.00	0.41	4.90	Non-Liquefiable
34.5	32	37	34.5	12	120	55	1.3	1.05	1.15	0.77	1	14.5	20.1	4140	3298	3797	0.85	1.09	0.94	0.21	N/A	N/A	N/A	Non-liq: 12<PI<18, w<.8*LL
39.5	37	42	39.5	23	120	37	1.3	1.05	1.3	0.82	1	33.4	38.9	4740	3586	4085	0.82	1.22	0.84	2.00	2.00	0.43	4.65	Non-Liquefiable
44.5	42	47	44.5	17	120	59	1.3	1.05	1.21	0.76	1	21.3	26.9	5340	3874	4373	0.80	1.15	0.89	0.34	N/A	N/A	N/A	Non-Liq: PI>18
49.5	47	50	48.5	8	120	78	1.3	1.05	1.1	0.68	1	8.1	13.7	5820	4104	4603	0.77	1.05	0.93	0.15	0.14	0.43	0.33	**Liquefiable**

Notes:

(1) Energy Correction for N_{90} of automatic hammer to standard N_{60}

(2) Borehole Diameter Correction (Skempton, 1986)

(3) Correction for split-spoon sampler with room for liners, but liners are absent, (Seed et al., 1984, 2001)

(4) Overburden Correction, Caluclated by Eq. 39 (Boulanger and Idriss, 2008)

(5) Rod Length Correction for Samples <10 m in depth

(6) N-value corrected for energy, borehole diameter, sampler with absent liners, rod length, and overburden

(7) N-value corrected for fines content per Eqs. 75 and 76 (Boulanger and Idriss, 2008)

(8) Stress Reduction Coefficient calculated by Eq. 22 (Boulanger and Idriss, 2008)

(9) Magnitude Scaling Factor calculated by Eqns. A.8 & A.10 (Boulanger and Idriss, 2014)

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(13) Calcuated by Eq. 25 (Boulanger and Idriss, 2008)

LIQUEFACTION INDUCED SETTLEMENTS

Project Name	Proposed Comm/Ind Development
Project Location	Norco, CA
Project Number	17G105
Engineer	DWN

Boring No. B-18

Sample Depth (ft)	Depth to Top of Layer (ft)	Depth to Bottom of Layer (ft)	Depth to Midpoint (ft)	$(N_1)_{60}$	DN for fines content	$(N_1)_{60\text{-CS}}$	Liquefaction Factor of Safety	Limiting Shear Strain γ_{min}	Parameter $F\alpha$	Maximum Shear Strain γ_{max}	Height of Layer		Vertical Reconsolidation Strain ε_v		Total Deformation of Layer (in)	Comments
				(1)	(2)	(3)	(4)	(5)	(6)	(7)			(8)			
7.5	0	21	10.5	0.0	0.0	0.0	N/A	0.50	0.95	0.00	21.00		0.000		0.00	Above Ground Water
19.5	21	22	21.5	82.9	0.0	82.9	5.43	0.00	-4.46	0.00	1.00		0.000		0.00	Non-Liquefiable
24.5	22	27	24.5	53.3	0.0	53.3	5.18	0.00	-1.86	0.00	5.00		0.000		0.00	Non-Liquefiable
29.5	27	32	29.5	65.2	0.0	65.2	4.90	0.00	-2.87	0.00	5.00		0.000		0.00	Non-Liquefiable
34.5	32	37	34.5	14.5	5.6	20.1	N/A	0.16	0.51	0.00	5.00		0.000		0.00	Non-liq: 12<PI<18, w<.8*LL
39.5	37	42	39.5	33.4	5.5	38.9	4.65	0.01	-0.72	0.00	5.00		0.000		0.00	Non-Liquefiable
44.5	42	47	44.5	21.3	5.6	26.9	N/A	0.07	0.12	0.00	5.00		0.000		0.00	Non-Liq: PI>18
49.5	47	50	48.5	8.1	5.6	13.7	0.33	0.32	0.81	0.32	3.00		0.031		1.10	**Liquefiable**
											Total Deformation (in)				1.10	

Notes:

(1) $(N_1)_{60}$ calculated previously for the individual layer

(2) Correction for fines content per Equation 76 (Boulanger and Idriss, 2008)

(3) Corrected $(N_1)_{60}$ for fines content

(4) Factor of Safety against Liquefaction, calculated previously for the individual layer

(5) Calcuated by Eq. 86 (Boulanger and Idriss, 2008)

(6) Calcuated by Eq. 89 (Boulanger and Idriss, 2008)

(7) Calcuated by Eqs. 90, 91, and 92 (Boulanger and Idriss, 2008)

(8) Volumetric Strain Induced in a Liquefiable Layer, Calcuated by Eq. 96 (Boulanger and Idriss, 2008)
(Strain N/A if Factor of Safety against Liquefaction > 1.3)

TABLE OF CONTENTS

Southern California Geotechnical

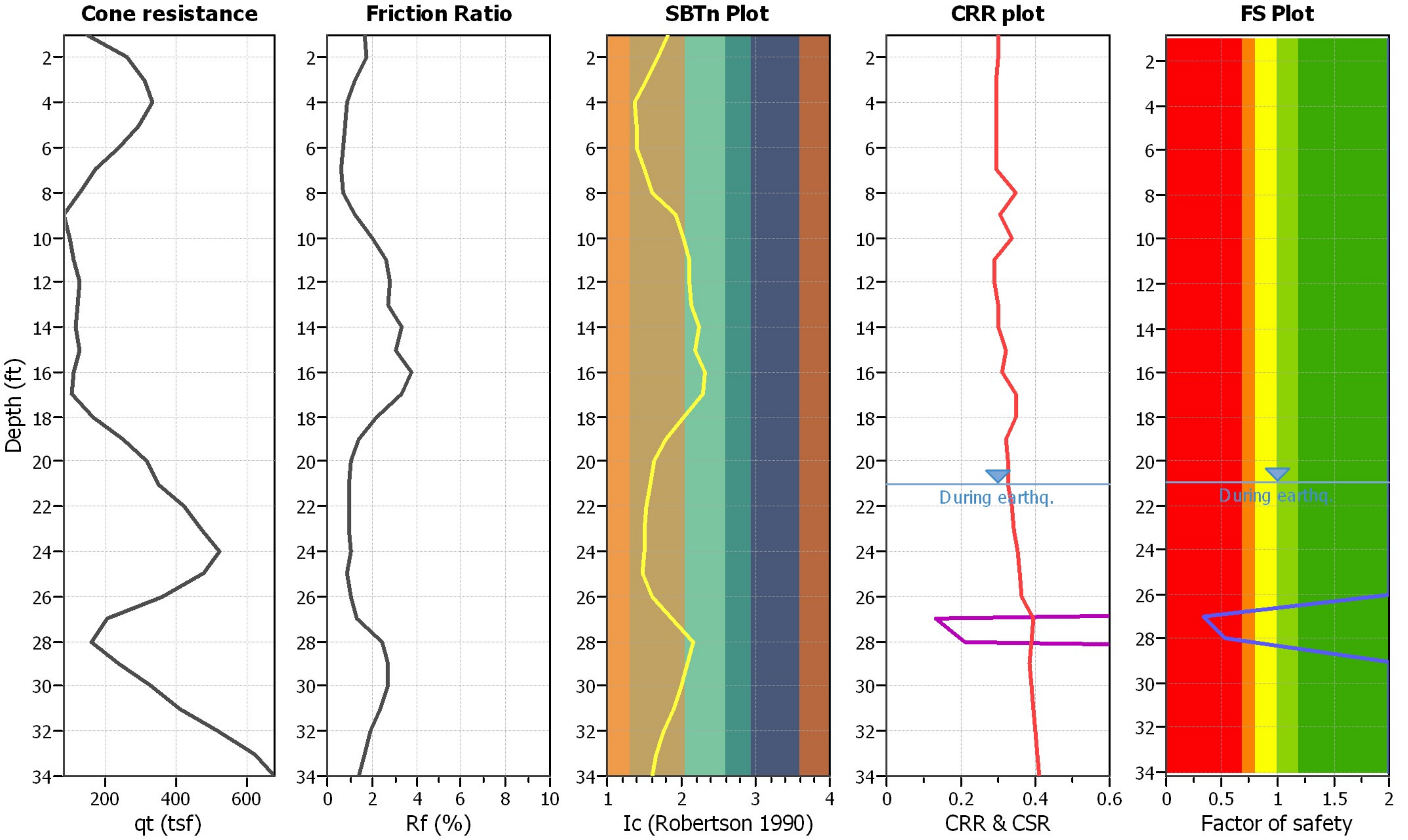
LIQUEFACTION ANALYSIS REPORT

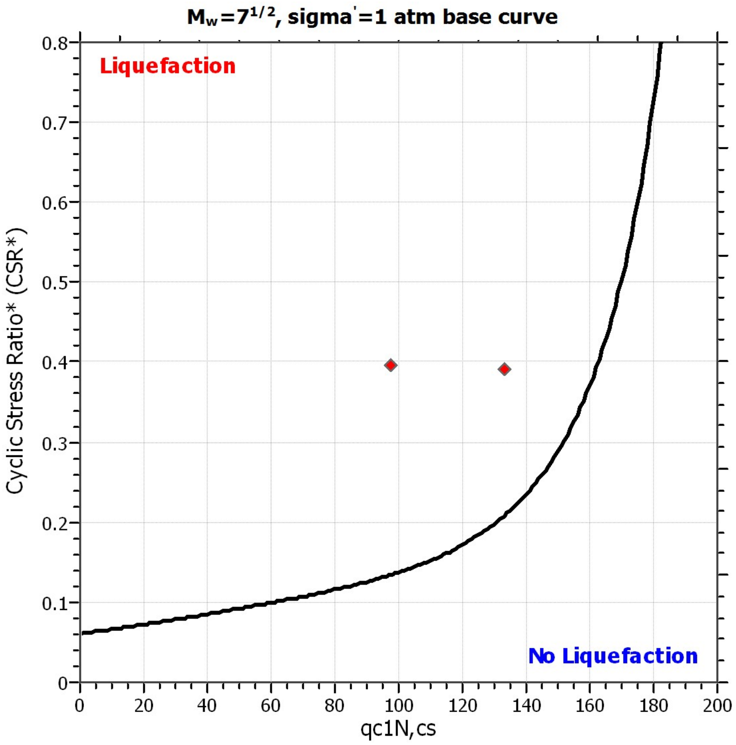
Project title : **Location :**

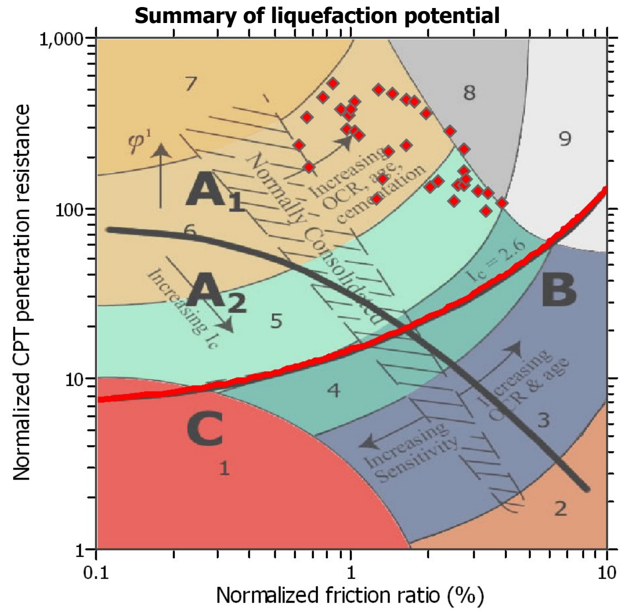
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	21.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	21.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	50.00 ft
Earthquake magnitude M_w:	7.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.61	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

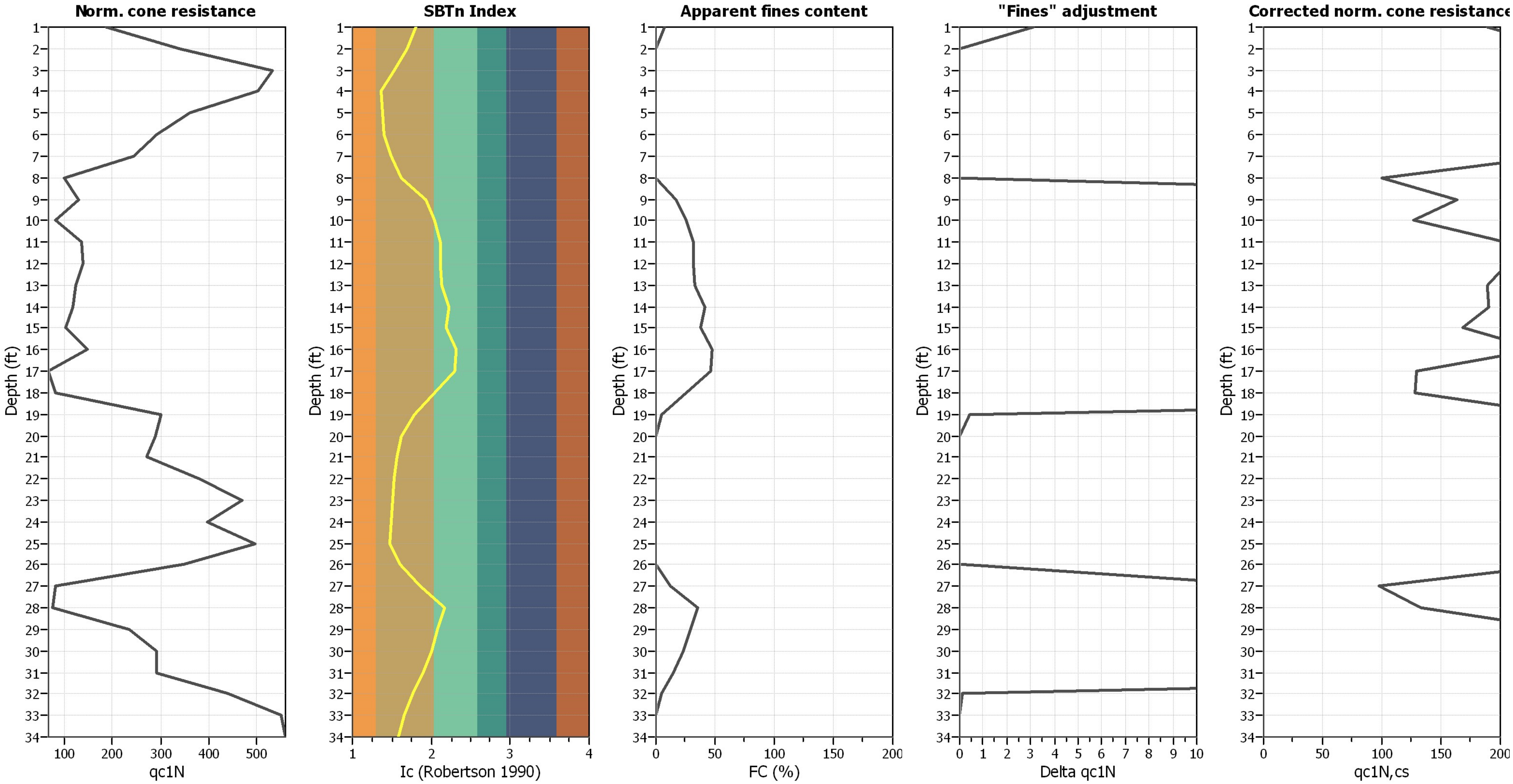






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

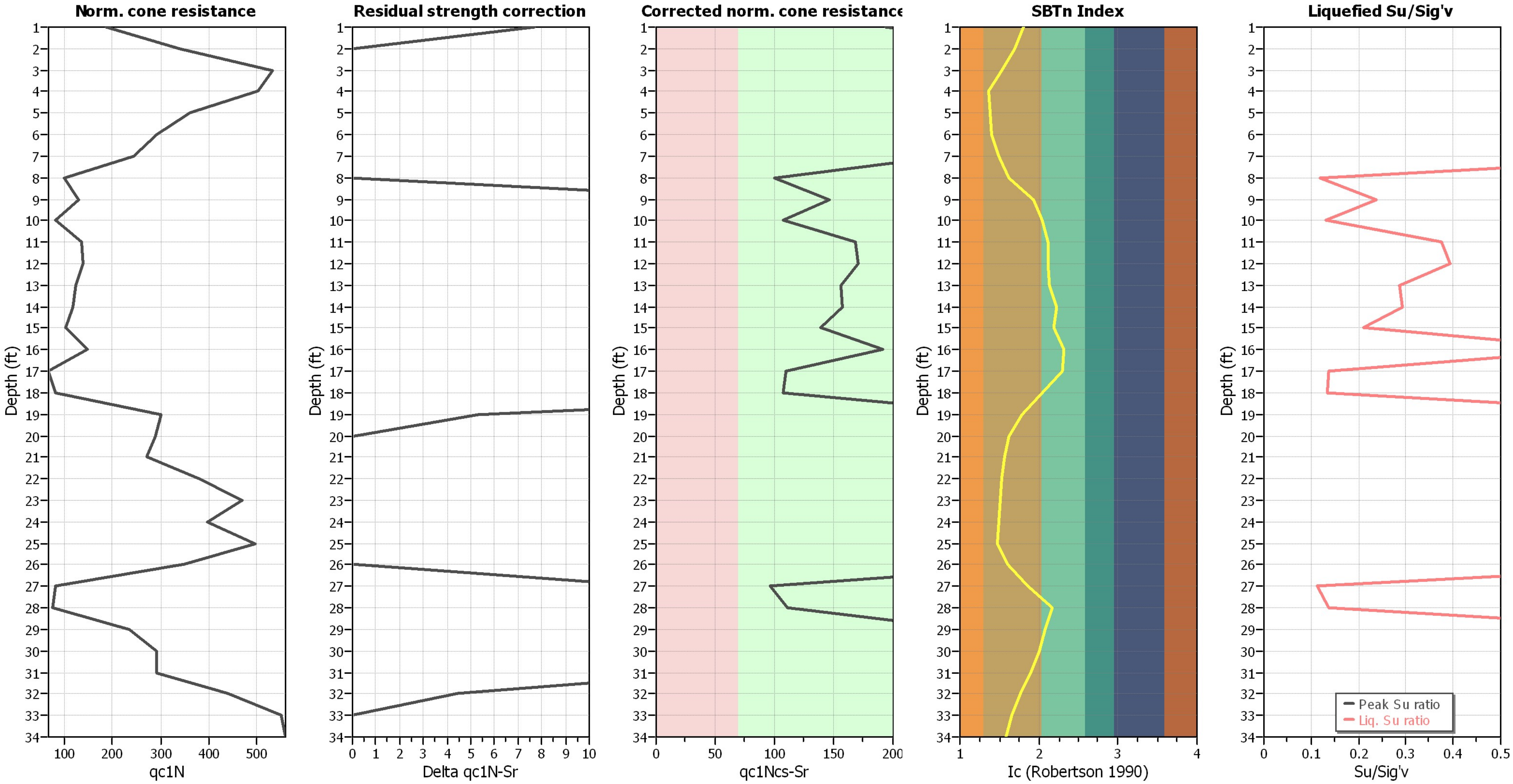
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	21.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.61	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	21.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

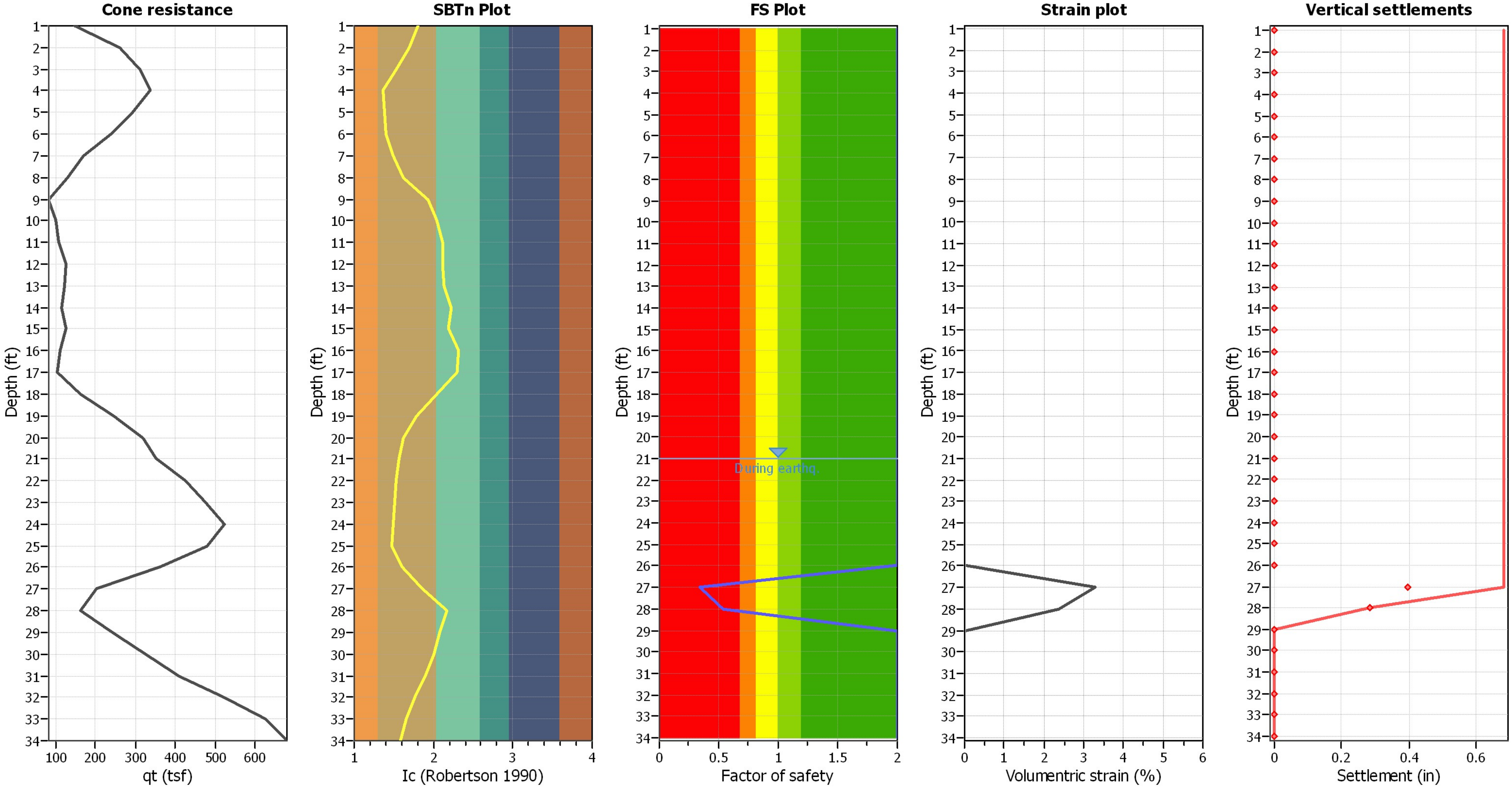
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	21.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.61	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	21.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
21.00	254.00	2.00	0.00	1.00	0.00	22.00	254.00	2.00	0.00	1.00	0.00
23.00	254.00	2.00	0.00	1.00	0.00	24.00	254.00	2.00	0.00	1.00	0.00
25.00	254.00	2.00	0.00	1.00	0.00	26.00	254.00	2.00	0.00	1.00	0.00
27.00	97.34	0.34	3.30	1.00	0.40	28.00	133.22	0.53	2.37	1.00	0.28
29.00	254.00	2.00	0.00	1.00	0.00	30.00	254.00	2.00	0.00	1.00	0.00
31.00	254.00	2.00	0.00	1.00	0.00	32.00	254.00	2.00	0.00	1.00	0.00
33.00	254.00	2.00	0.00	1.00	0.00	34.00	254.00	2.00	0.00	1.00	0.00

Total estimated settlement: 0.68

Abbreviations

$Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
FS: Factor of safety against liquefaction
e_v (%): Post-liquefaction volumentric strain
DF: e_v depth weighting factor
Settlement: Calculated settlement

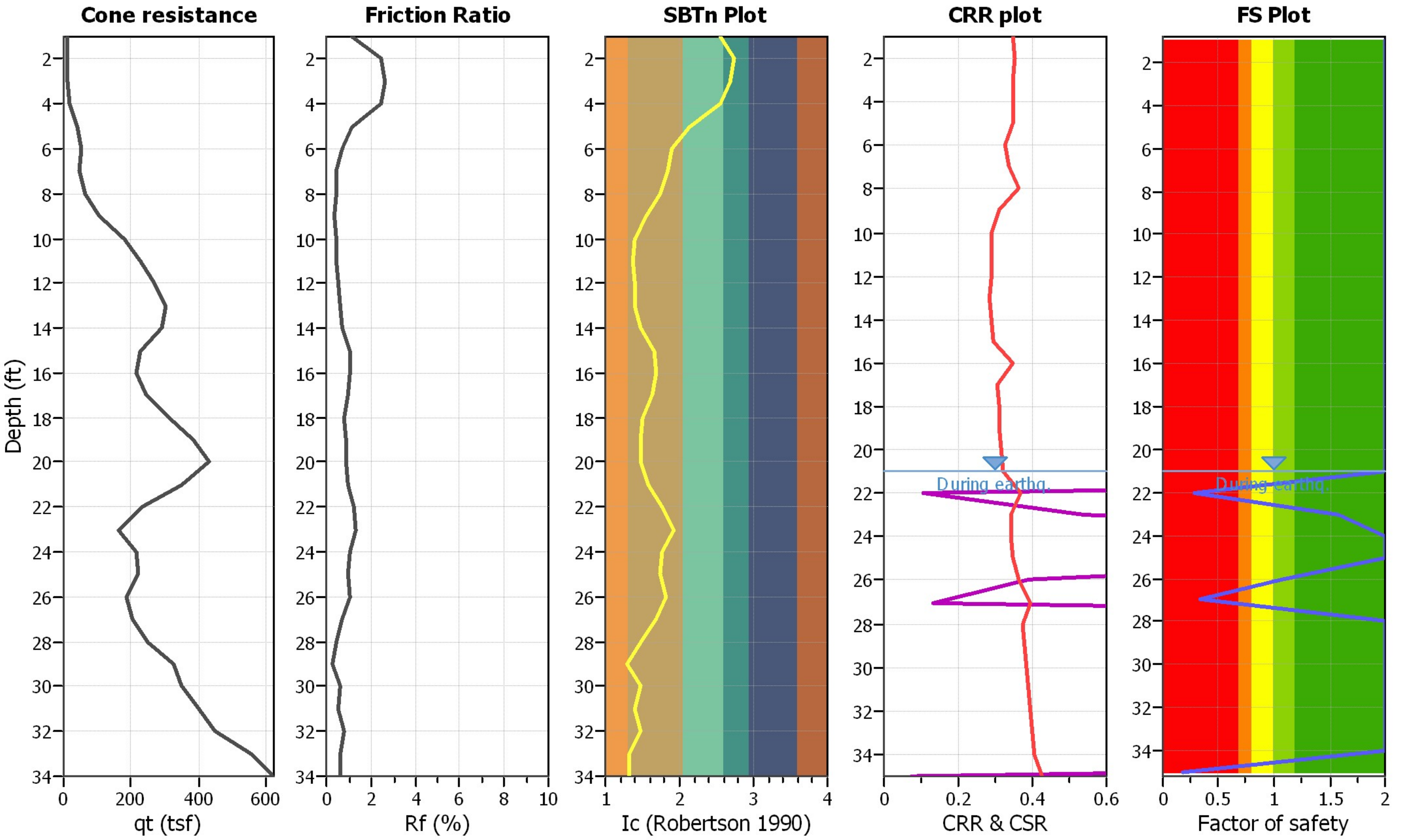
LIQUEFACTION ANALYSIS REPORT

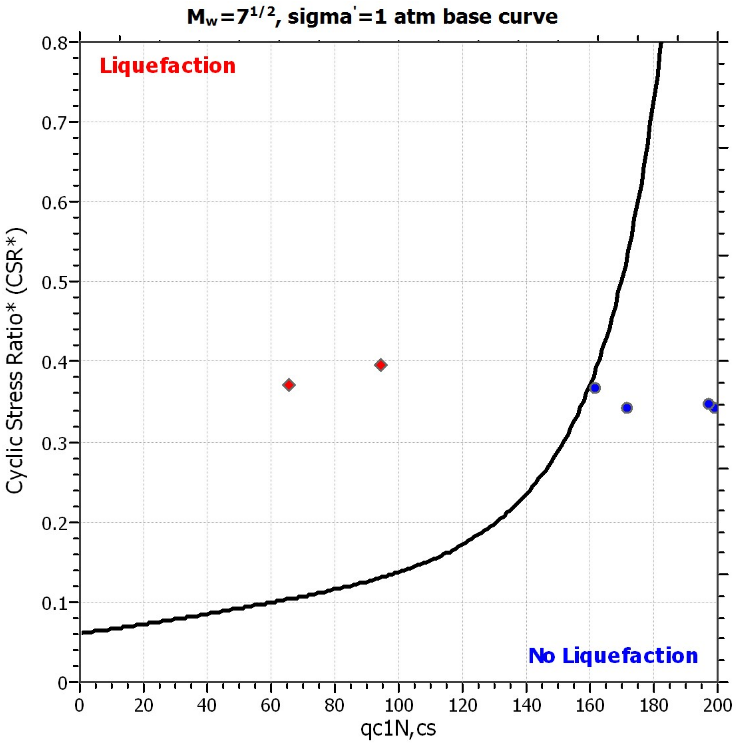
Project title : **Location :**

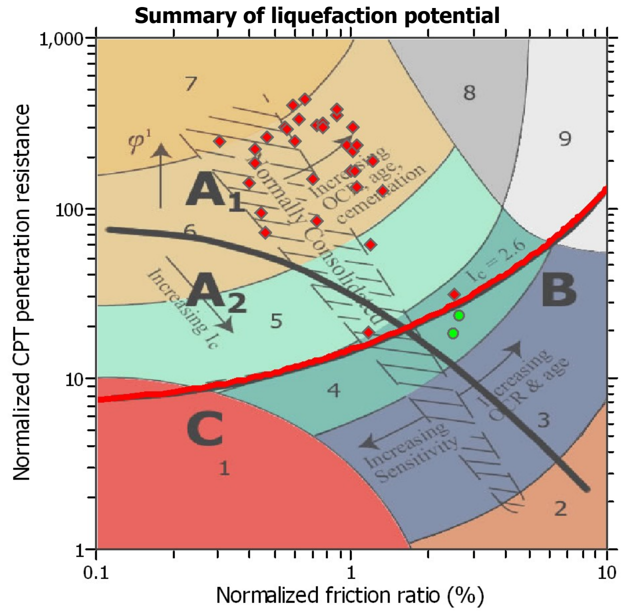
CPT file : CPT-2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	30.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	21.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	50.00 ft
Earthquake magnitude M_w:	7.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.61	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
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Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
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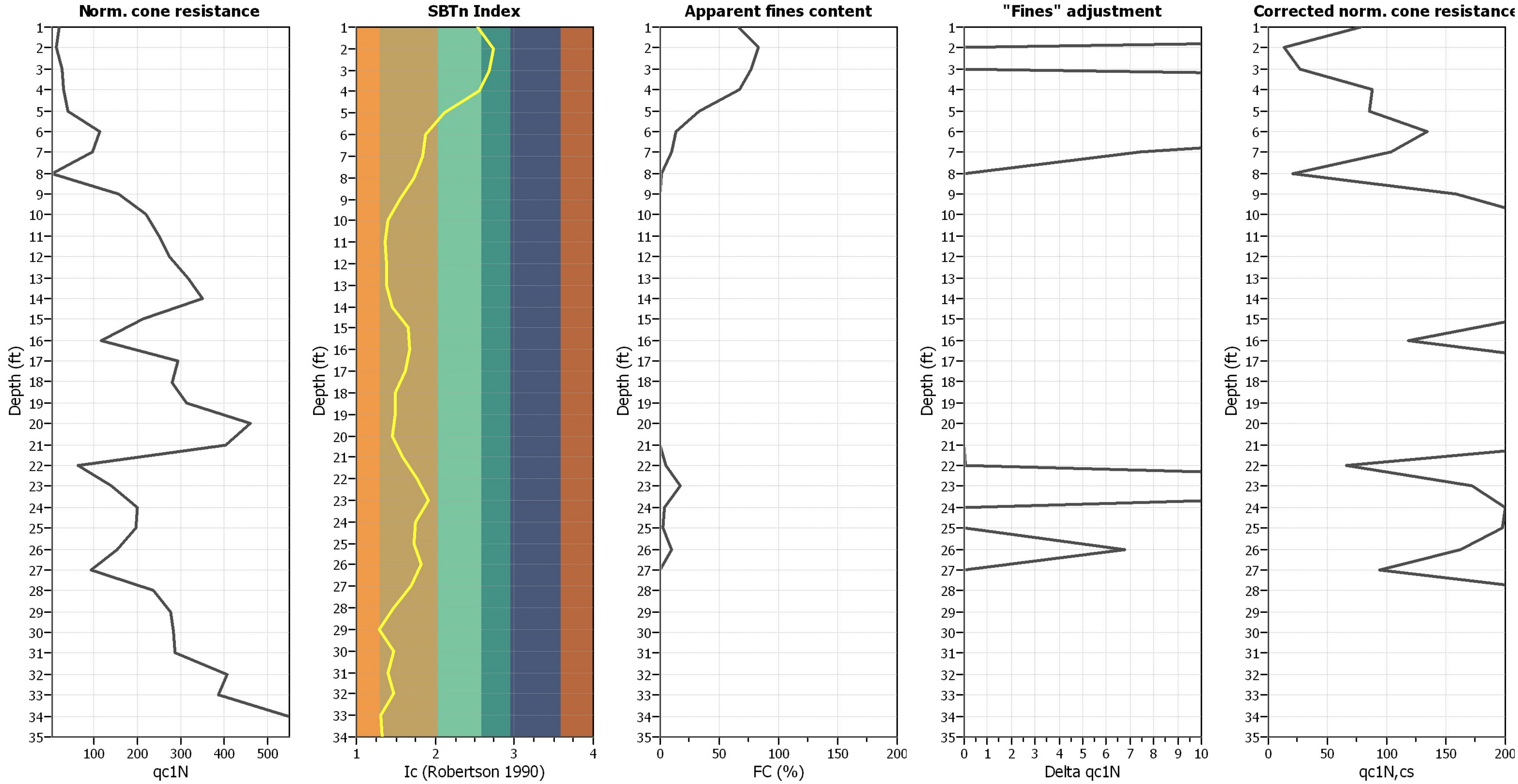
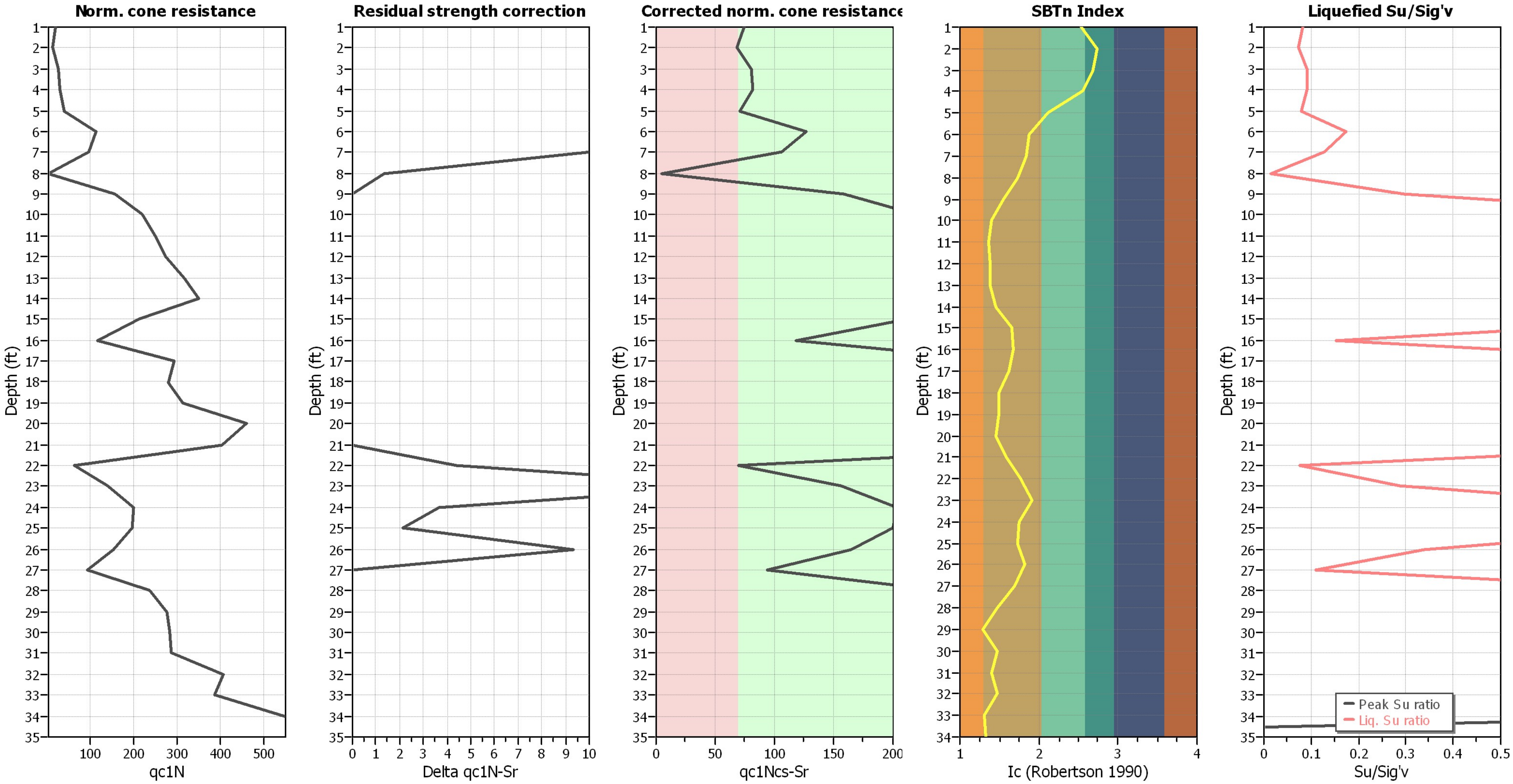
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	21.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.61	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	30.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

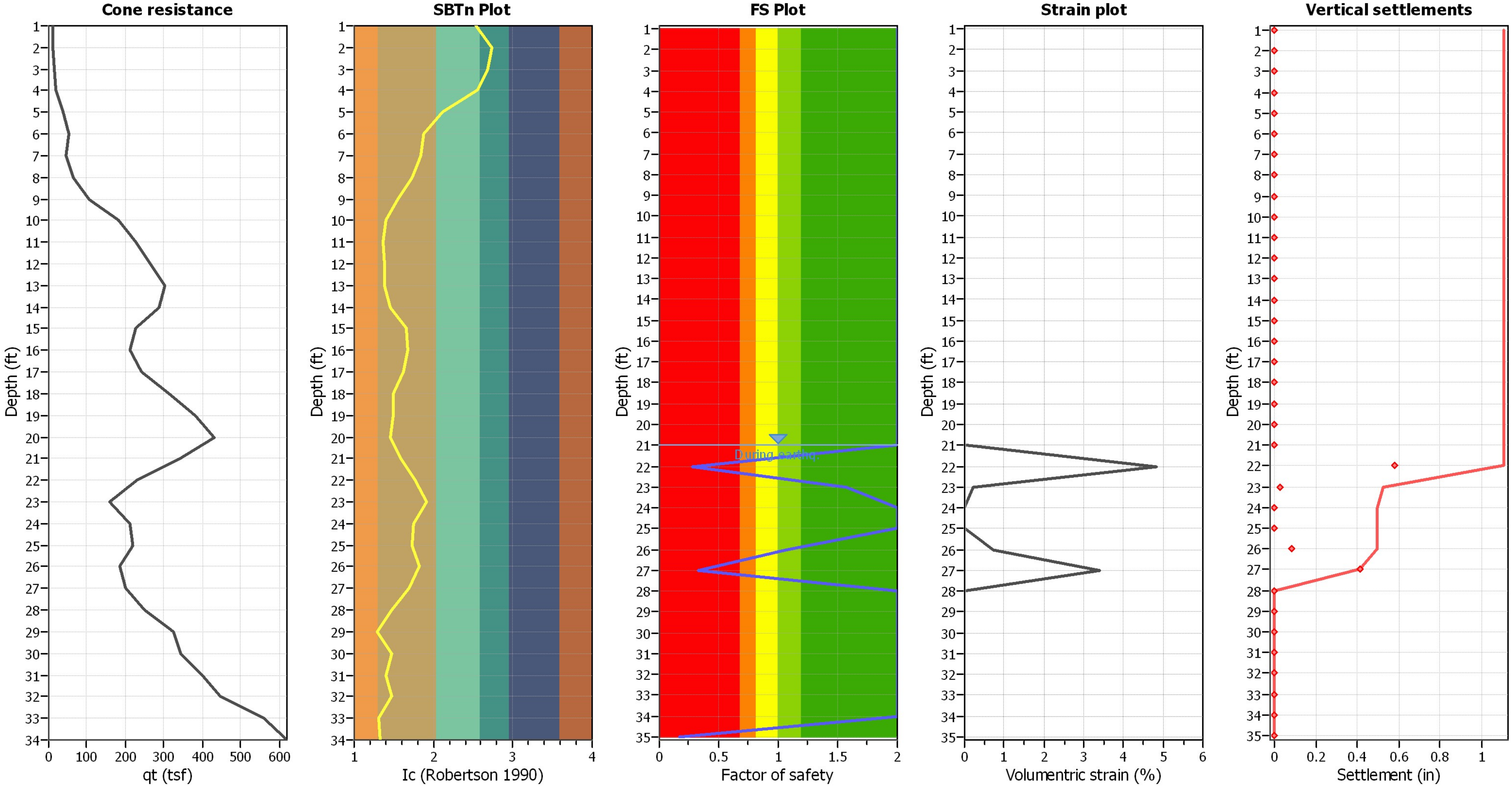
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	21.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.61	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	30.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
21.00	254.00	2.00	0.00	1.00	0.00	22.00	65.35	0.28	4.85	1.00	0.58
23.00	171.79	1.57	0.21	1.00	0.03	24.00	199.53	2.00	0.00	1.00	0.00
25.00	197.65	2.00	0.00	1.00	0.00	26.00	161.64	1.07	0.73	1.00	0.09
27.00	94.09	0.33	3.42	1.00	0.41	28.00	239.03	2.00	0.00	1.00	0.00
29.00	254.00	2.00	0.00	1.00	0.00	30.00	254.00	2.00	0.00	1.00	0.00
31.00	254.00	2.00	0.00	1.00	0.00	32.00	254.00	2.00	0.00	1.00	0.00
33.00	254.00	2.00	0.00	1.00	0.00	34.00	254.00	2.00	0.00	1.00	0.00
35.00	21.00	0.17	0.00	1.00	0.00						

Total estimated settlement: 1.10

Abbreviations

$Q_{tn,cs}$:	Equivalent clean sand normalized cone resistance
FS:	Factor of safety against liquefaction
e_v (%):	Post-liquefaction volumentric strain
DF:	e_v depth weighting factor
Settlement:	Calculated settlement

LIQUEFACTION ANALYSIS REPORT

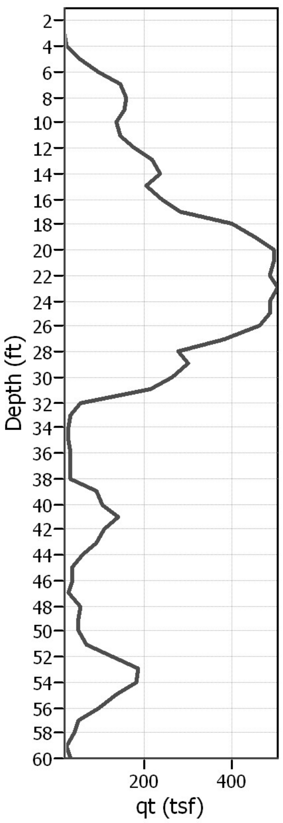
Project title : **Location :**

CPT file : CPT-3

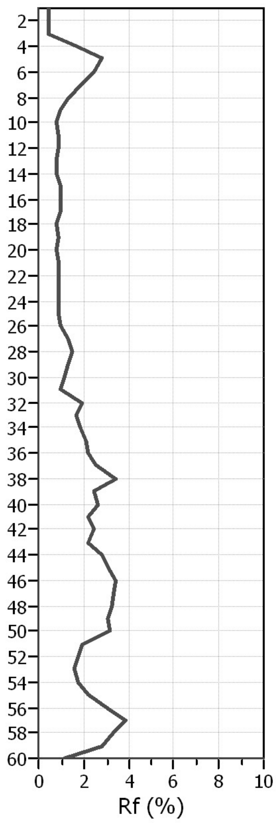
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	30.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	21.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	50.00 ft
Earthquake magnitude M_w:	7.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.61	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

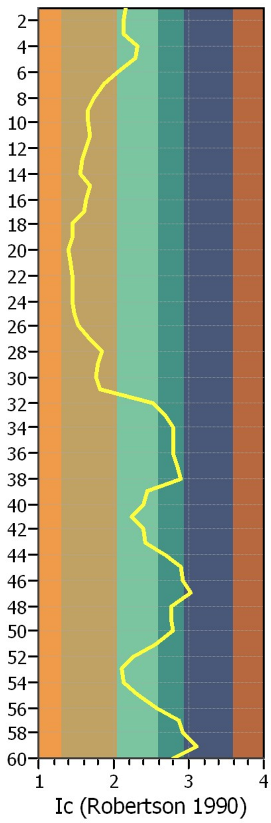
Cone resistance



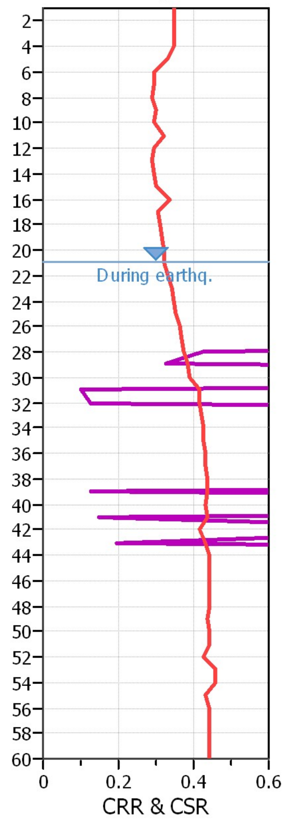
Friction Ratio



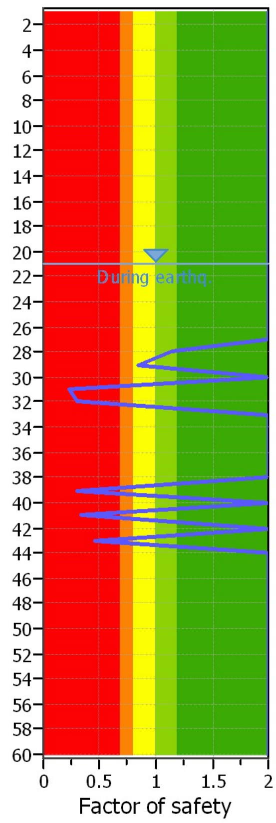
SBTn Plot



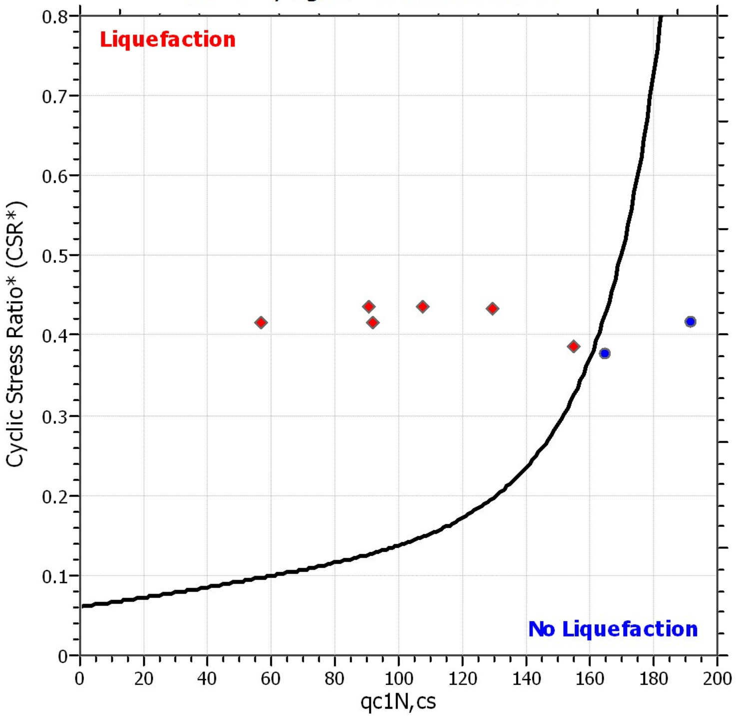
CRR plot



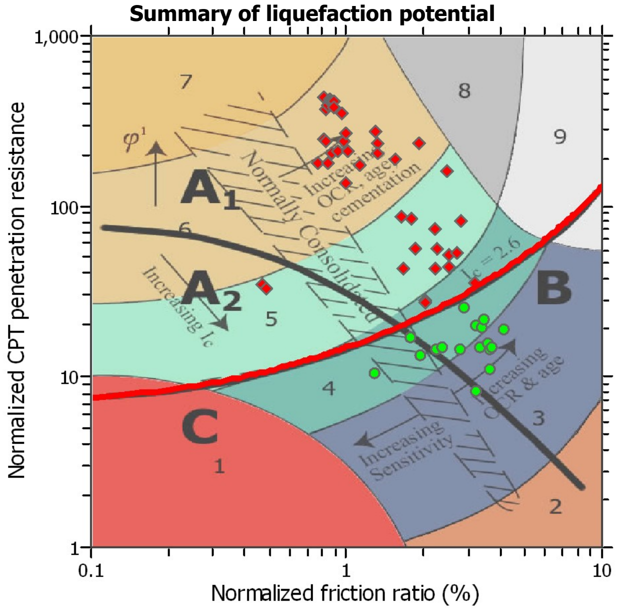
FS Plot



$M_w=7^{1/2}$, sigma'=1 atm base curve

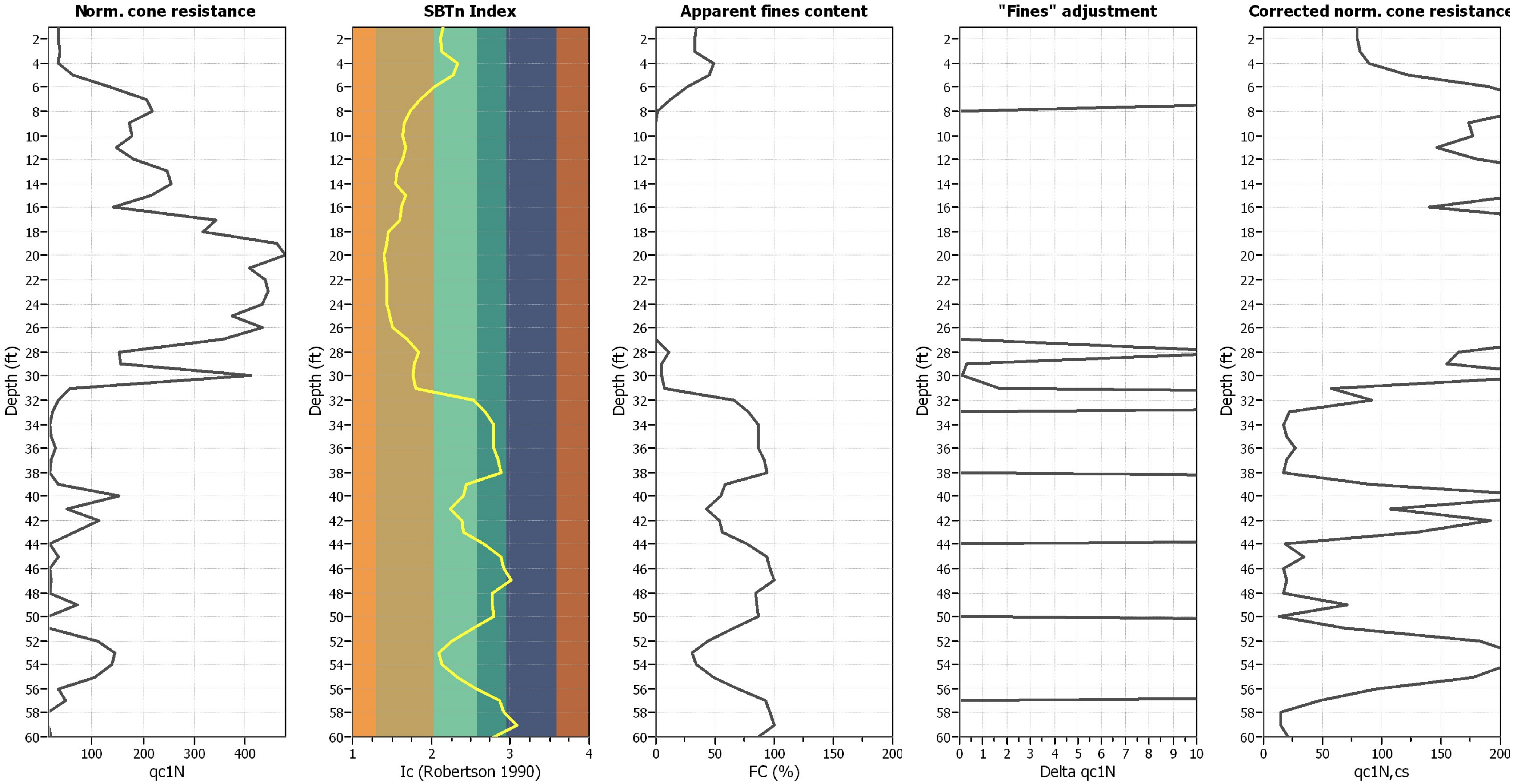


Summary of liquefaction potential



Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

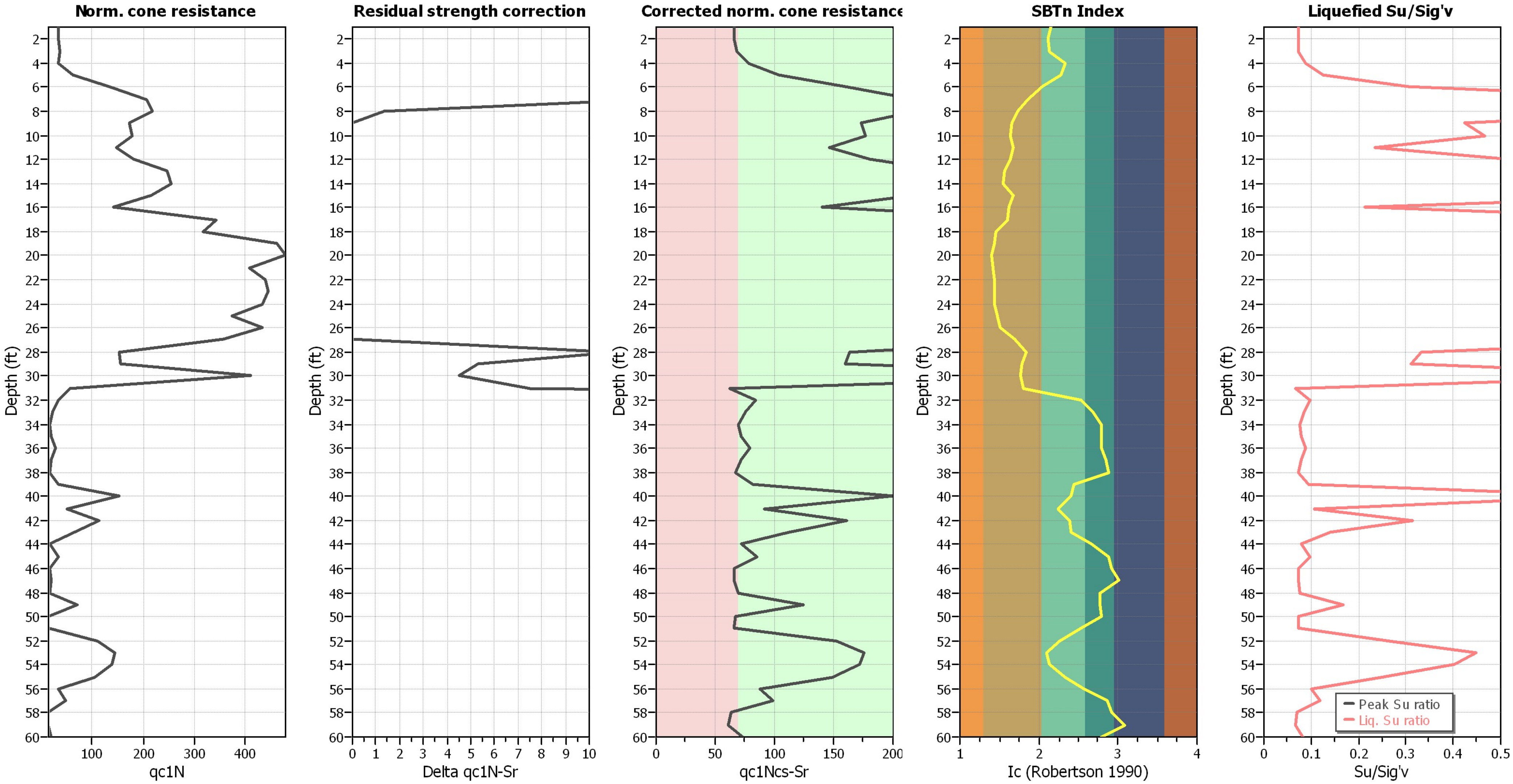
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	21.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.61	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	30.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

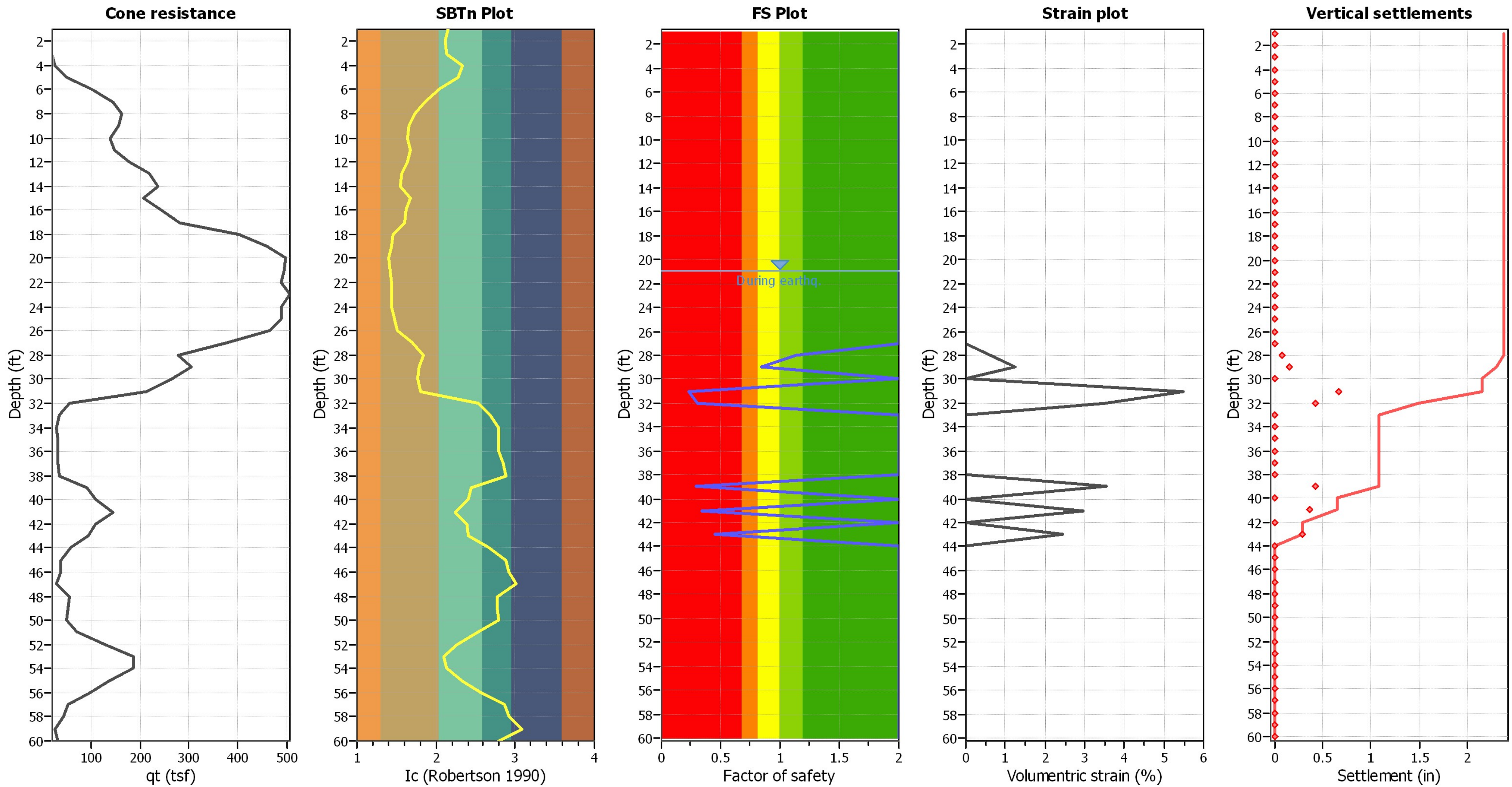
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	21.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.61	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	30.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
21.00	254.00	2.00	0.00	1.00	0.00	22.00	254.00	2.00	0.00	1.00	0.00
23.00	254.00	2.00	0.00	1.00	0.00	24.00	254.00	2.00	0.00	1.00	0.00
25.00	254.00	2.00	0.00	1.00	0.00	26.00	254.00	2.00	0.00	1.00	0.00
27.00	254.00	2.00	0.00	1.00	0.00	28.00	164.75	1.14	0.62	1.00	0.07
29.00	155.09	0.85	1.24	1.00	0.15	30.00	254.00	2.00	0.00	1.00	0.00
31.00	56.99	0.23	5.48	1.00	0.66	32.00	91.79	0.31	3.50	1.00	0.42
33.00	21.52	2.00	0.00	1.00	0.00	34.00	16.79	2.00	0.00	1.00	0.00
35.00	19.16	2.00	0.00	1.00	0.00	36.00	26.45	2.00	0.00	1.00	0.00
37.00	19.81	2.00	0.00	1.00	0.00	38.00	16.93	2.00	0.00	1.00	0.00
39.00	90.59	0.29	3.55	1.00	0.43	40.00	240.77	2.00	0.00	1.00	0.00
41.00	107.73	0.34	2.98	1.00	0.36	42.00	192.03	2.00	0.00	1.00	0.00
43.00	129.66	0.45	2.44	1.00	0.29	44.00	17.74	2.00	0.00	1.00	0.00
45.00	34.65	2.00	0.00	1.00	0.00	46.00	16.92	2.00	0.00	1.00	0.00
47.00	19.12	2.00	0.00	1.00	0.00	48.00	16.56	2.00	0.00	1.00	0.00
49.00	70.70	2.00	0.00	1.00	0.00	50.00	13.48	2.00	0.00	1.00	0.00
51.00	67.97	2.00	0.00	1.00	0.00	52.00	183.28	2.00	0.00	1.00	0.00
53.00	211.87	2.00	0.00	1.00	0.00	54.00	207.73	2.00	0.00	1.00	0.00
55.00	177.30	2.00	0.00	1.00	0.00	56.00	94.98	2.00	0.00	1.00	0.00
57.00	47.90	2.00	0.00	1.00	0.00	58.00	14.47	2.00	0.00	1.00	0.00
59.00	14.22	2.00	0.00	1.00	0.00	60.00	20.46	2.00	0.00	1.00	0.00

Total estimated settlement: 2.38

Abbreviations

$Q_{tn,cs}$:	Equivalent clean sand normalized cone resistance
FS:	Factor of safety against liquefaction
e_v (%):	Post-liquefaction volumentric strain
DF:	e_v depth weighting factor
Settlement:	Calculated settlement

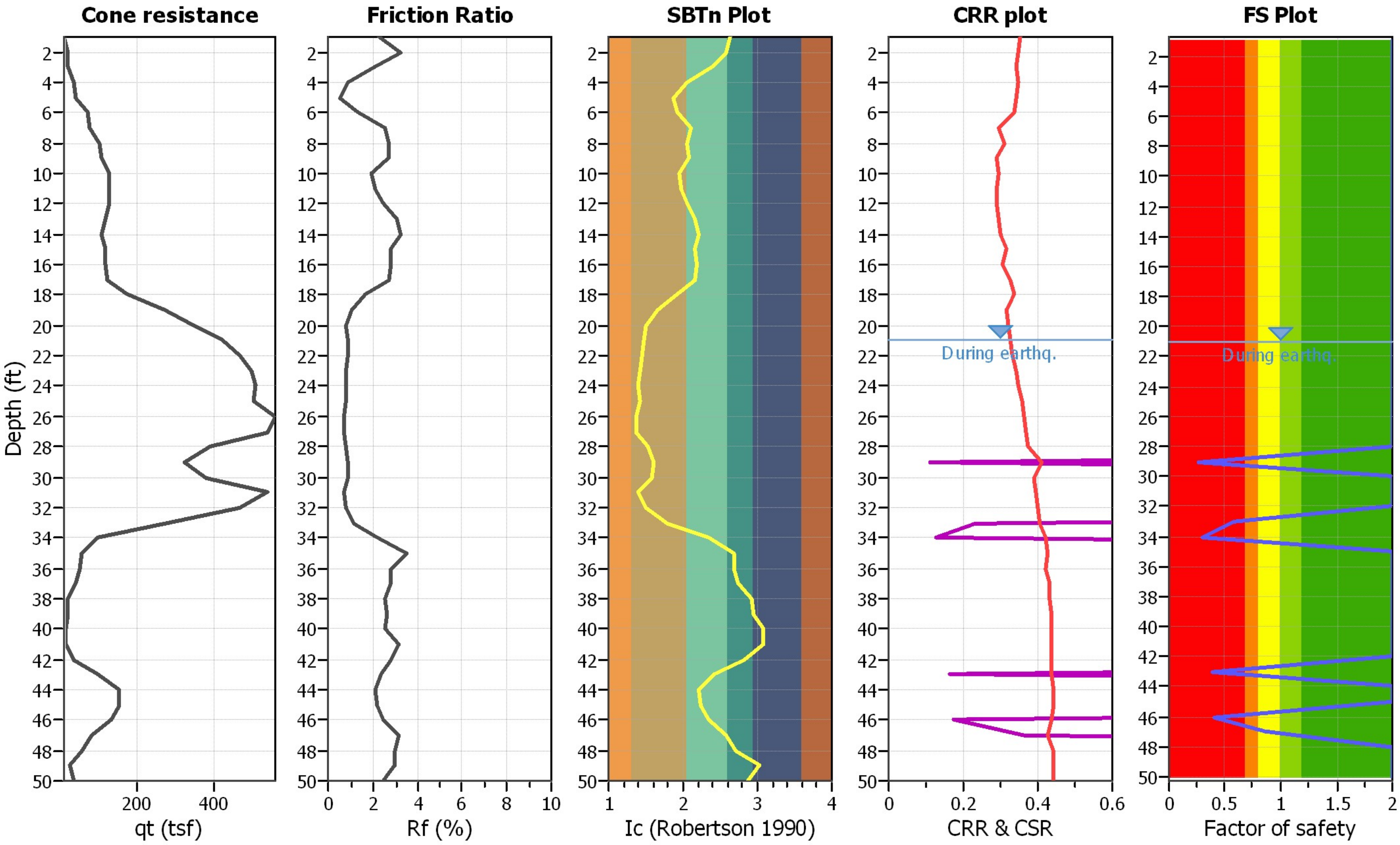
LIQUEFACTION ANALYSIS REPORT

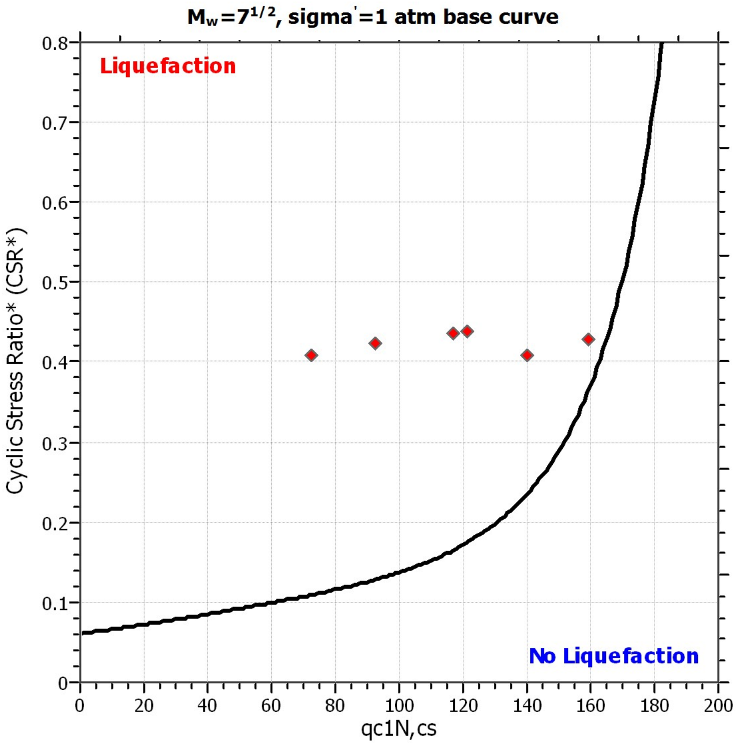
Project title : **Location :**

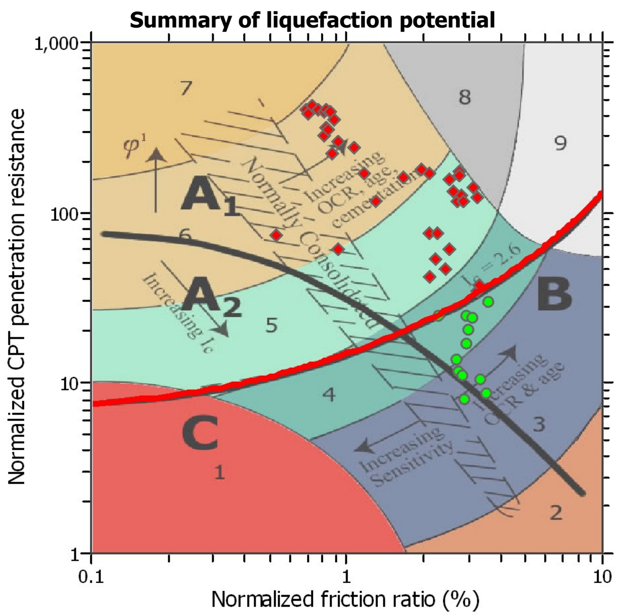
CPT file : CPT-4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	30.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	21.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	50.00 ft
Earthquake magnitude M_w:	7.00	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.61	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

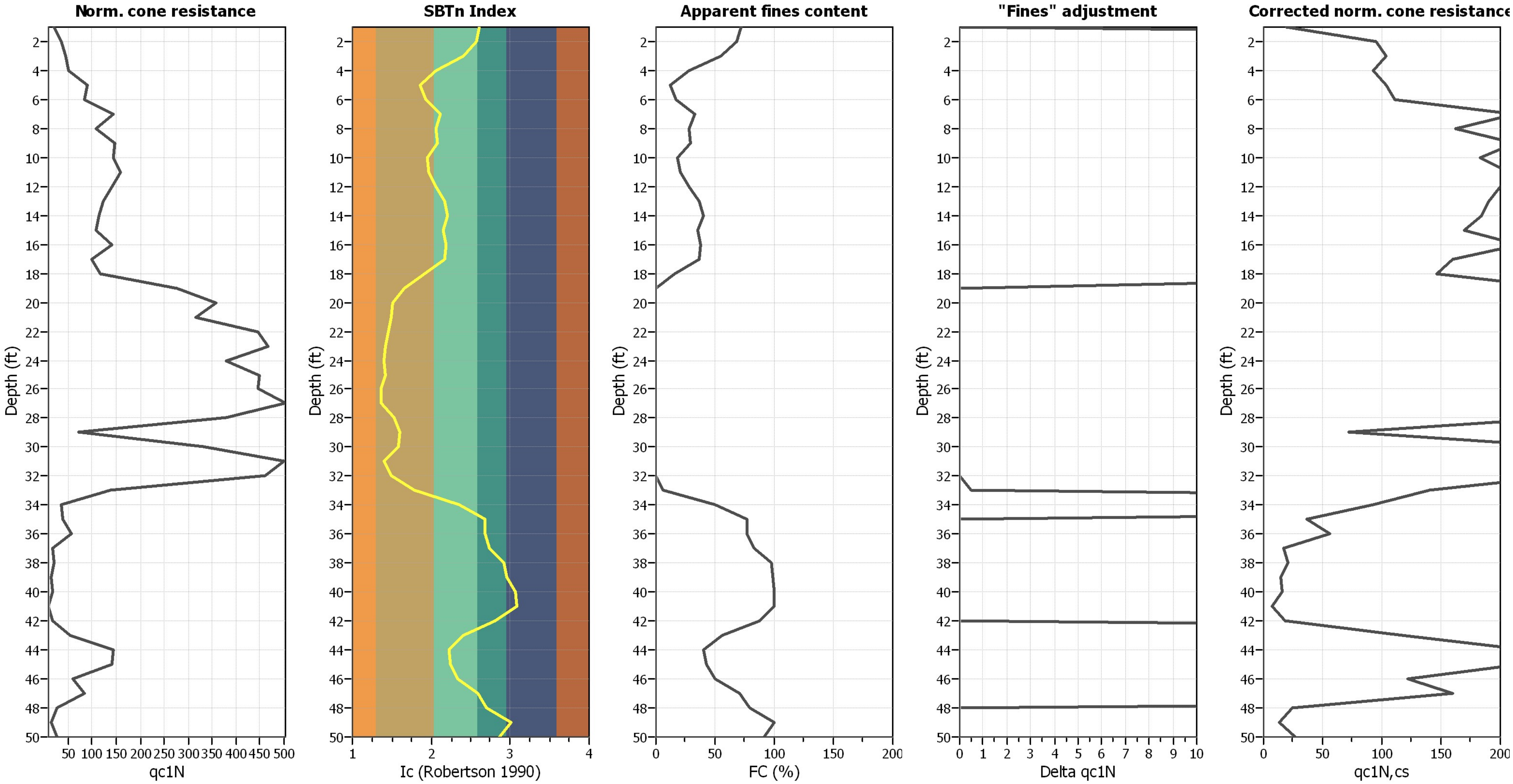






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

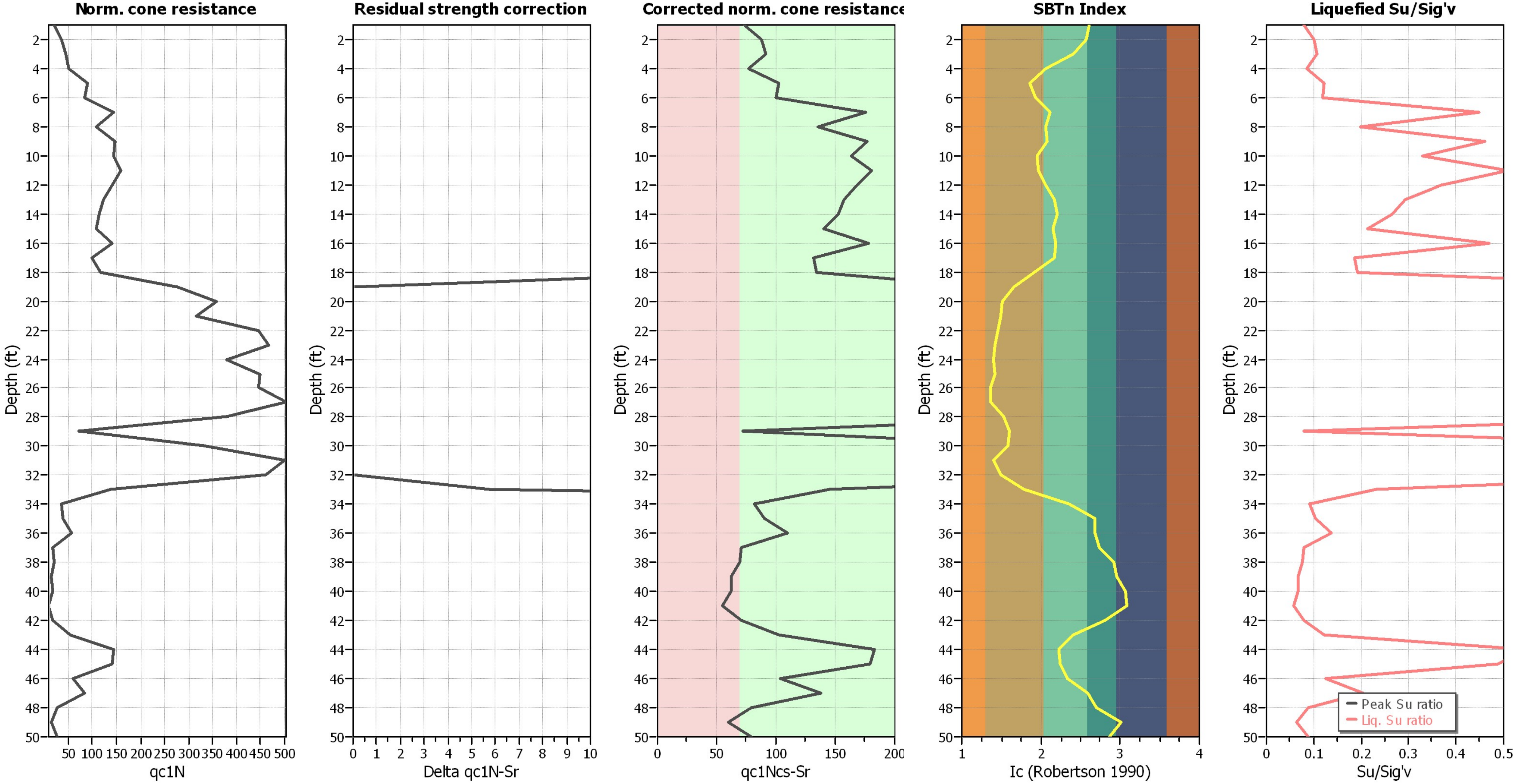
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	21.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.61	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	30.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

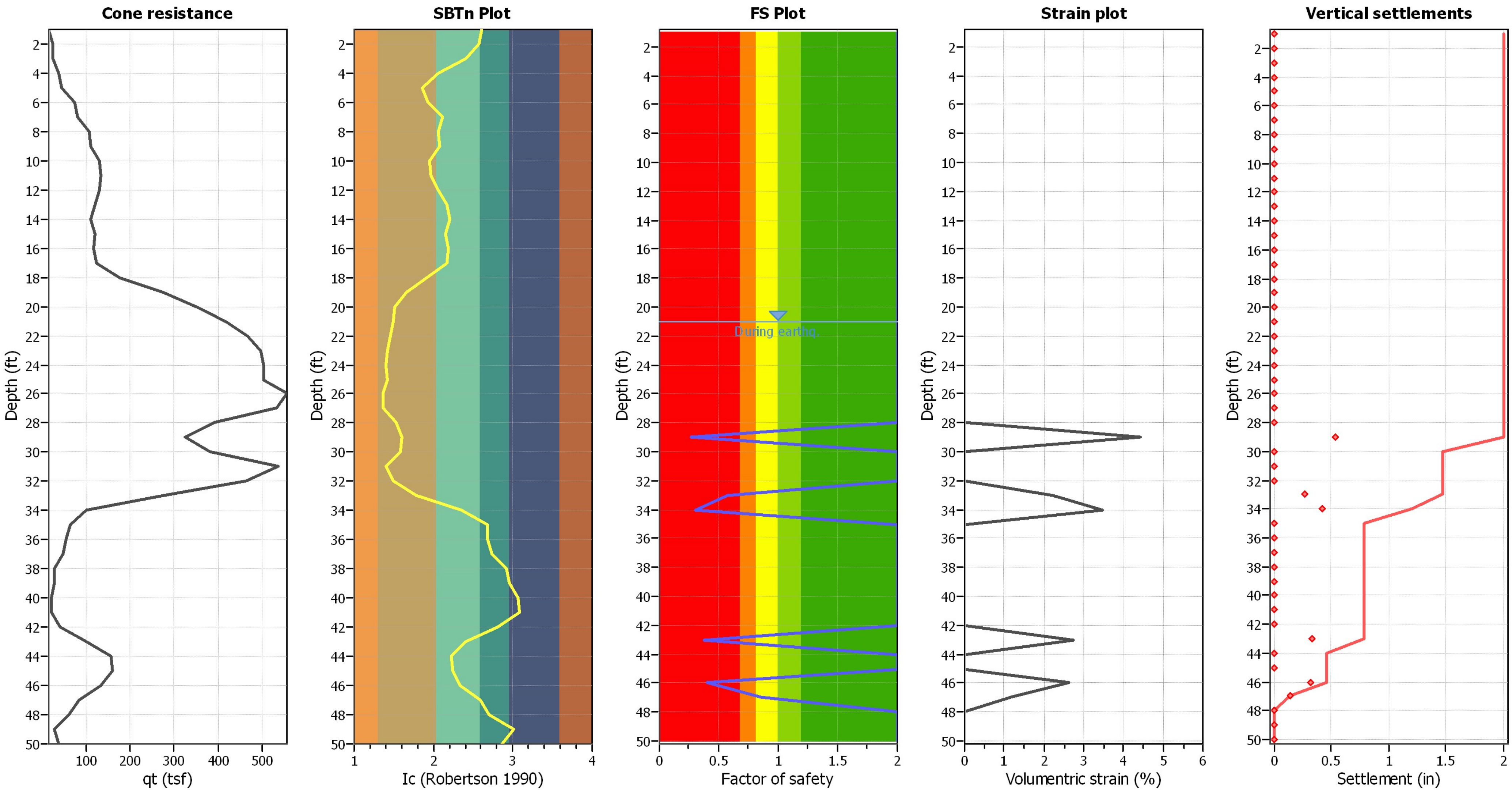
Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	21.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.61	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	30.00 ft	Fill height:	N/A	Limit depth:	50.00 ft

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$q_{c1N,cs}$	FS	e_v (%)	DF	Settlement (in)
21.00	254.00	2.00	0.00	1.00	0.00	22.00	254.00	2.00	0.00	1.00	0.00
23.00	254.00	2.00	0.00	1.00	0.00	24.00	254.00	2.00	0.00	1.00	0.00
25.00	254.00	2.00	0.00	1.00	0.00	26.00	254.00	2.00	0.00	1.00	0.00
27.00	254.00	2.00	0.00	1.00	0.00	28.00	254.00	2.00	0.00	1.00	0.00
29.00	72.28	0.27	4.41	1.00	0.53	30.00	254.00	2.00	0.00	1.00	0.00
31.00	254.00	2.00	0.00	1.00	0.00	32.00	254.00	2.00	0.00	1.00	0.00
33.00	139.74	0.57	2.25	1.00	0.27	34.00	92.19	0.30	3.49	1.00	0.42
35.00	36.57	2.00	0.00	1.00	0.00	36.00	55.71	2.00	0.00	1.00	0.00
37.00	17.14	2.00	0.00	1.00	0.00	38.00	20.33	2.00	0.00	1.00	0.00
39.00	14.98	2.00	0.00	1.00	0.00	40.00	15.56	2.00	0.00	1.00	0.00
41.00	7.68	2.00	0.00	1.00	0.00	42.00	17.91	2.00	0.00	1.00	0.00
43.00	117.02	0.38	2.73	1.00	0.33	44.00	222.10	2.00	0.00	1.00	0.00
45.00	217.05	2.00	0.00	1.00	0.00	46.00	121.42	0.40	2.62	1.00	0.31
47.00	159.34	0.85	1.17	1.00	0.14	48.00	24.96	2.00	0.00	1.00	0.00
49.00	13.05	2.00	0.00	1.00	0.00	50.00	27.28	2.00	0.00	1.00	0.00

Total estimated settlement: 2.00

Abbreviations

$Q_{tn,cs}$:	Equivalent clean sand normalized cone resistance
FS:	Factor of safety against liquefaction
e_v (%):	Post-liquefaction volumentric strain
DF:	e_v depth weighting factor
Settlement:	Calculated settlement

APPENDIX G

SUMMARY

OF

CONE PENETRATION TEST DATA

Project:

Pacific Avenue & 2nd Street
Norco, CA
January 26, 2017

Prepared for:

Mr. Daryl Kas
Southern California Geotechnical, Inc.
22885 E. Savi Ranch Parkway, Ste E
Yorba Linda, CA 92887
Office (714) 685-1115 / Fax (714) 685-1118

Prepared by:

KEHOE TESTING & ENGINEERING
5415 Industrial Drive
Huntington Beach, CA 92649-1518
Office (714) 901-7270 / Fax (714) 901-7289
www.kehoetesting.com

TABLE OF CONTENTS

SUMMARY

OF

CONE PENETRATION TEST DATA

1. INTRODUCTION

This report presents the results of a Cone Penetration Test (CPT) program carried out for the project located at Pacific Avenue & 2nd Street in Norco, California. The work was performed by Kehoe Testing & Engineering (KTE) on January 26, 2017. The scope of work was performed as directed by Southern California Geotechnical, Inc. personnel.

2. SUMMARY OF FIELD WORK

The fieldwork consisted of performing CPT soundings at four locations to determine the soil lithology. Groundwater measurements and hole collapse depths provided in **TABLE 2.1** are for information only. The readings indicate the apparent depth to which the hole is open and the apparent water level (if encountered) in the CPT probe hole at the time of measurement upon completion of the CPT. KTE does not warranty the accuracy of the measurements and the reported water levels may not represent the true or stabilized groundwater levels.

LOCATION	DEPTH OF CPT (ft)	COMMENTS/NOTES:
CPT-1	34	Refusal, hole open to 33 ft (dry)
CPT-2	34	Refusal, groundwater @ 27 ft
CPT-3	60	Groundwater @ 28 ft
CPT-4	50	Groundwater @ 39 ft

TABLE 2.1 - Summary of CPT Soundings

3. FIELD EQUIPMENT & PROCEDURES

The CPT soundings were carried out by **KTE** using an integrated electronic cone system manufactured by Vertek. The CPT soundings were performed in accordance with ASTM standards (D5778). The cone penetrometers were pushed using a 30-ton CPT rig. The cone used during the program was a 15 cm^2 cone and recorded the following parameters at approximately 2.5 cm depth intervals:

- Cone Resistance (qc)
- Sleeve Friction (fs)
- Dynamic Pore Pressure (u)
- Inclination
- Penetration Speed
- Pore Pressure Dissipation (at selected depths)

The above parameters were recorded and viewed in real time using a laptop computer. Data is stored at the KTE office for future analysis and reference. A complete set of baseline readings was taken prior to each sounding to determine temperature shifts and any zero load offsets. Monitoring base line readings ensures that the cone electronics are operating properly.

4. CONE PENETRATION TEST DATA & INTERPRETATION

The Cone Penetration Test data is presented in graphical form in the attached Appendix. These plots were generated using the CPeT-IT program. Penetration depths are referenced to ground surface. The soil classification on the CPT plots is derived from the attached CPT Classification Chart (Robertson) and presents major soil lithologic changes. The stratigraphic interpretation is based on relationships between cone resistance (qc), sleeve friction (fs), and penetration pore pressure (u). The friction ratio (Rf), which is sleeve friction divided by cone resistance, is a calculated parameter that is used along with cone resistance to infer soil behavior type. Generally, cohesive soils (clays) have high friction ratios, low cone resistance and generate excess pore water pressures. Cohesionless soils (sands) have lower friction ratios, high cone bearing and generate little (or negative) excess pore water pressures.

Tables of basic CPT output from the interpretation program CPeT-IT are provided for CPT data averaged over one foot intervals in the Appendix. We recommend a geotechnical engineer review the assumed input parameters and the calculated output from the CPeT-IT program. A summary of the equations used for the tabulated parameters is provided in the Appendix.

It should be noted that it is not always possible to clearly identify a soil type based on qc, fs and u. In these situations, experience, judgement and an assessment of the pore pressure data should be used to infer the soil behavior type.

If you have any questions regarding this information, please do not hesitate to call our office at (714) 901-7270.

Sincerely,

KEHOE TESTING & ENGINEERING

Richard W. Koester, Jr.
General Manager

01/31/17-ms-8016

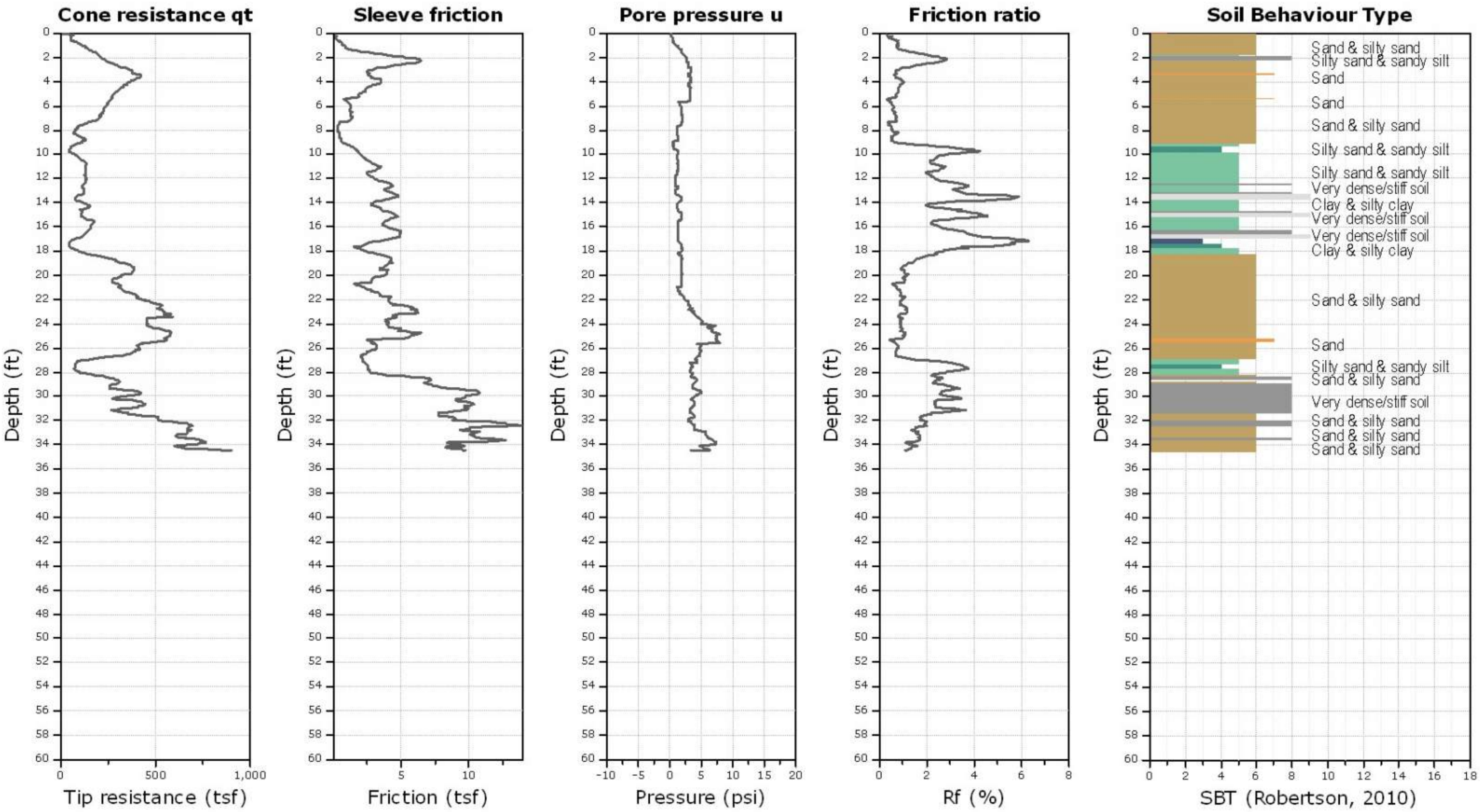
APPENDIX

Kehoe Testing and Engineering
714-901-7270
rich@kehoetesting.com
www.kehoetesting.com

CPT-1

Project: **Southern California Geotechnical, Inc.**
Location: **Pacific Ave & 2nd St Norco, CA**

Total depth: 34.46 ft, Date: 1/26/2017
Cone Type: Vertek



Kehoe Testing and Engineering
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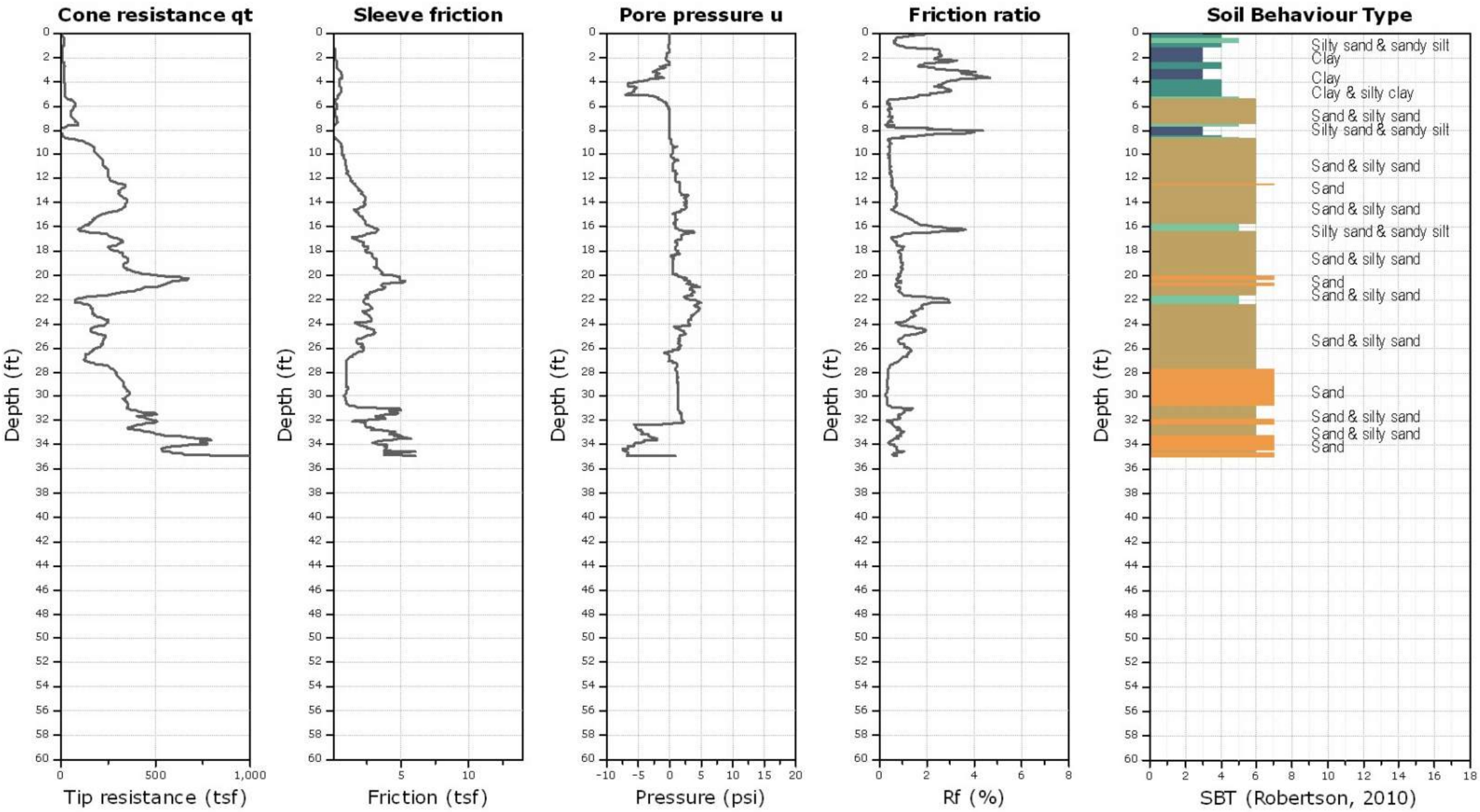
www.kehoetesting.com

CPT-2

Project: **Southern California Geotechnical, Inc.**
Location: **Pacific Ave & 2nd St Norco, CA**

Total depth: 34.94 ft, Date: 1/26/2017
Cone Type: Vertek



Kehoe Testing and Engineering
714-901-7270
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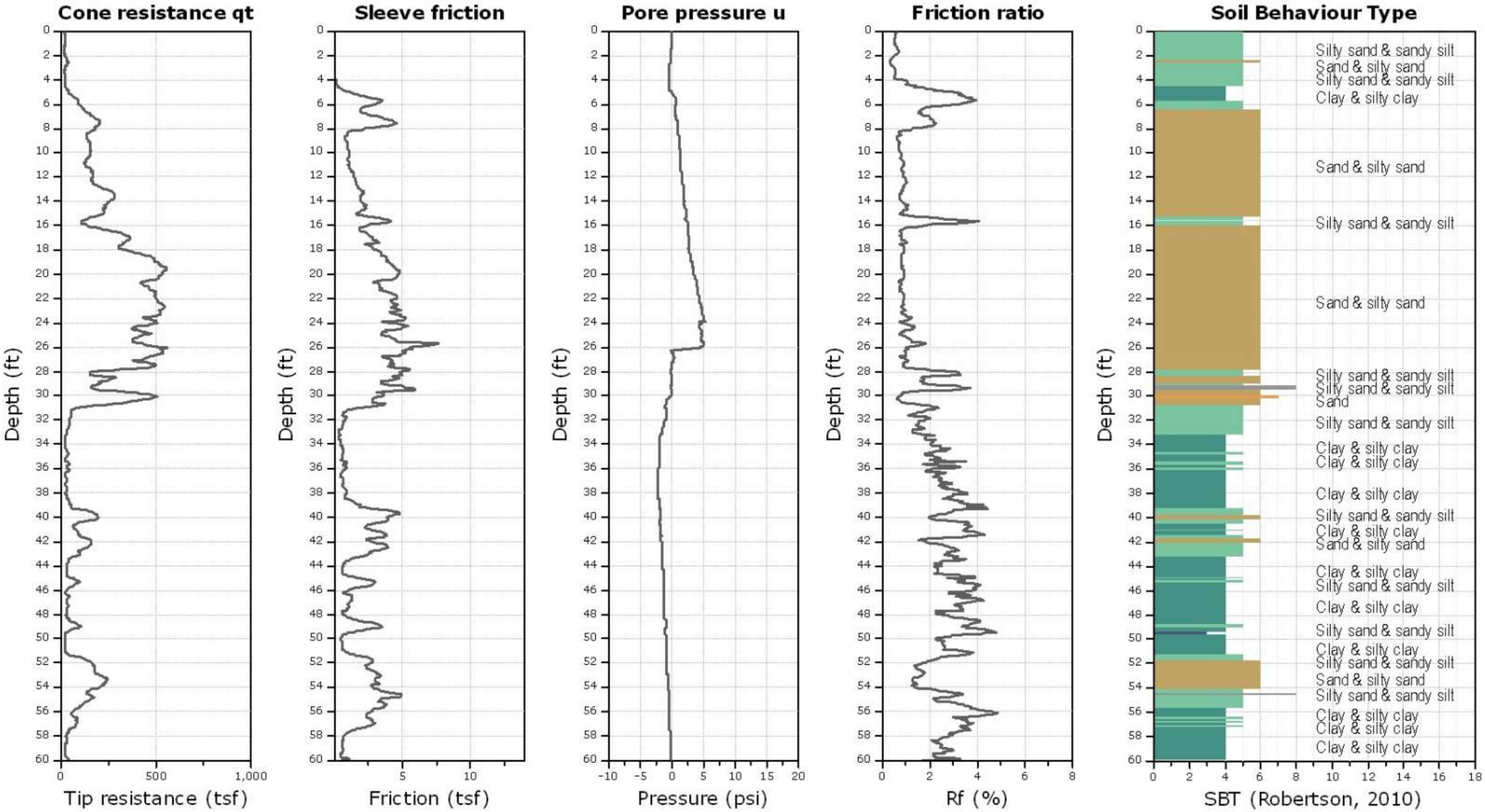
www.kehoetesting.com

CPT-3

Project: **Southern California Geotechnical, Inc.**
Location: **Pacific Ave & 2nd St Norco, CA**

Total depth: 60.31 ft, Date: 1/26/2017
Cone Type: Vertek



Kehoe Testing and Engineering
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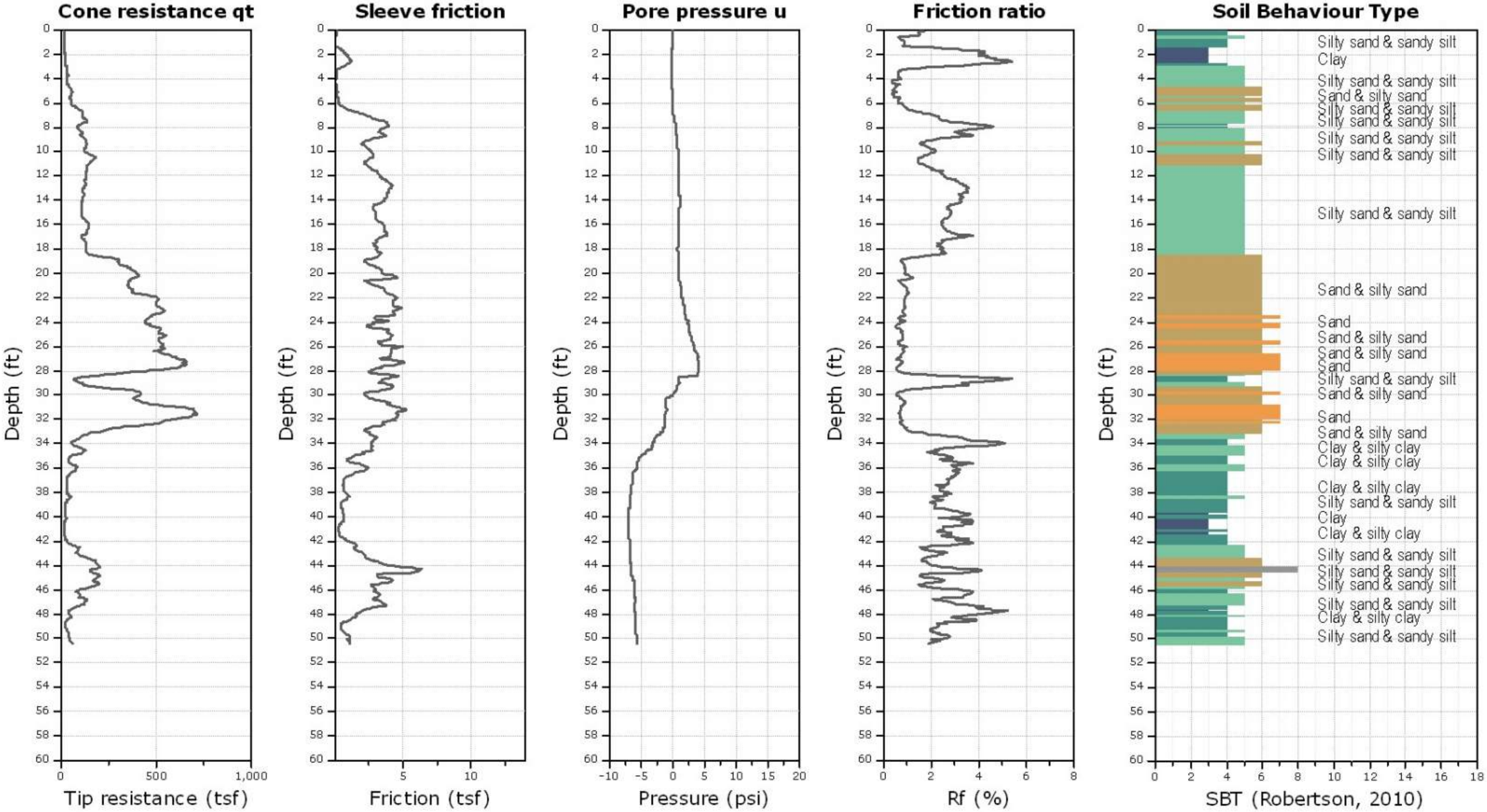
www.kehoetesting.com

CPT-4

Project: **Southern California Geotechnical, Inc.**
Location: **Pacific Ave & 2nd St Norco, CA**

Total depth: 50.36 ft, Date: 1/26/2017
Cone Type: Vertek



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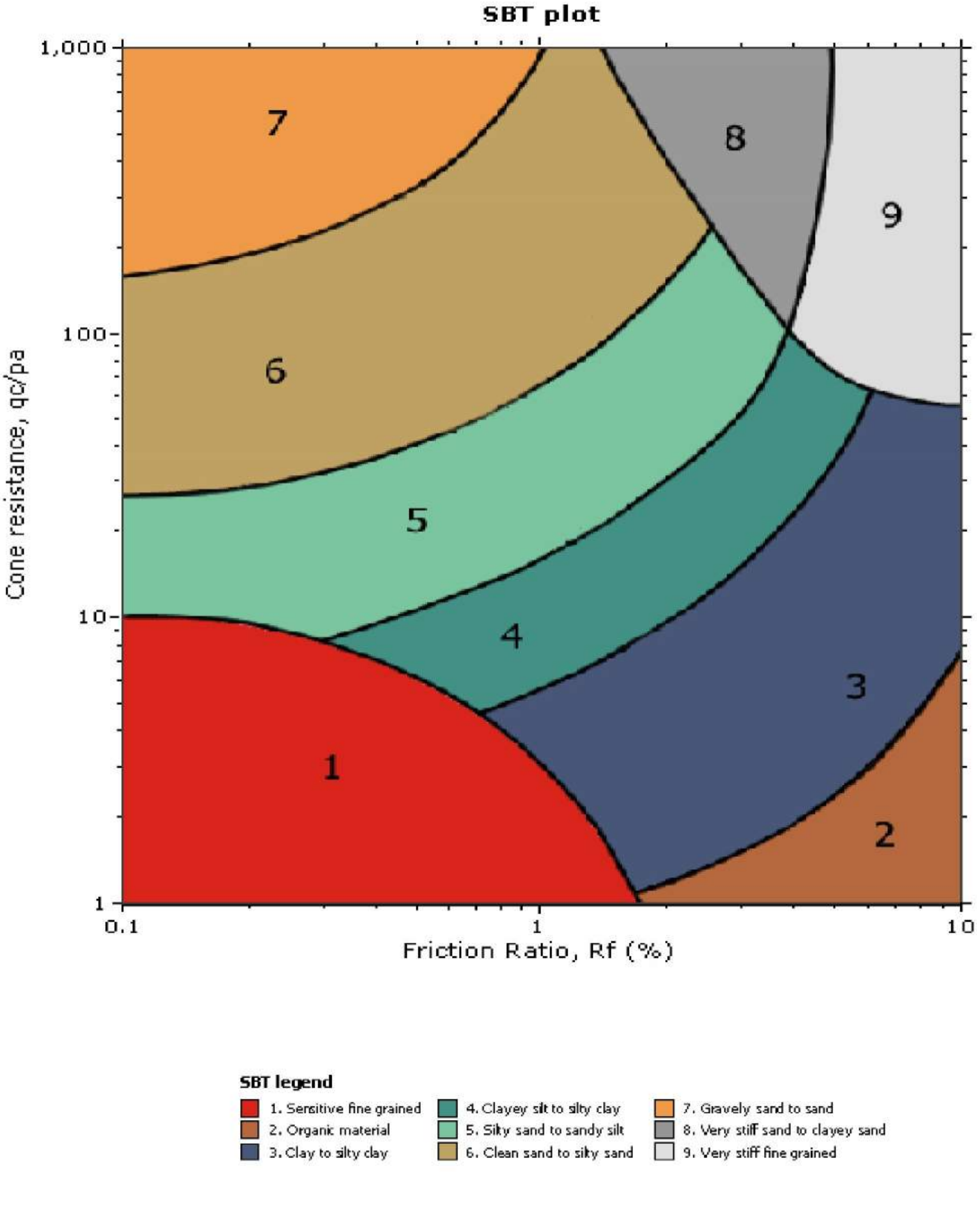


	CPT-1	In situ data										Basic output data											
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	ã (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	116.02	0.94	1.18	0.5	116.03	0.81	6	1.82	121.41	0.06	0	0.06	1909.1	0.81	0	6	0.41	3.2	1.46	351.15	1.39	101.85	7
2	210.94	5.43	2.6	0.5	210.97	2.57	5	2.01	135.7	0.13	0	0.13	1639	2.58	0	8	0.53	3.05	1.77	607.82	1.46	37.78	7
3	361.21	2.92	3.44	0.4	361.26	0.81	6	1.47	132.49	0.19	0	0.19	1854.3	0.81	0	7	0.36	1.84	1.31	627.49	1.27	110.26	7
4	368.84	3.55	3.31	0.2	368.88	0.96	6	1.52	133.96	0.26	0	0.26	1408.4	0.96	0	6	0.39	1.73	1.39	601.01	0.91	94.16	7
5	279.86	1.98	3.22	0.1	279.9	0.71	6	1.5	129.03	0.33	0	0.33	856.84	0.71	0	6	0.39	1.57	1.37	415.88	0.71	116.63	7
6	238.2	1.36	1.68	0.1	238.22	0.57	6	1.48	125.86	0.39	0	0.39	610.98	0.57	0	6	0.39	1.47	1.36	330.85	0.31	131.68	7
7	205.72	1.46	2.02	0	205.75	0.71	6	1.59	126.04	0.45	0	0.45	453.87	0.71	0	6	0.44	1.45	1.48	280.84	0.32	107.72	7
8	73.83	0.42	1.2	0	73.84	0.57	6	1.89	114.38	0.51	0	0.51	143.97	0.57	0	6	0.54	1.49	1.75	102.99	0.17	87.82	7
9	108.29	0.73	0.55	0.2	108.3	0.67	6	1.8	119.4	0.57	0	0.57	189.3	0.68	0	6	0.52	1.38	1.69	140.58	0.07	91.05	7
10	68.71	1.98	1.25	0.2	68.73	2.89	5	2.36	125.6	0.63	0	0.63	107.76	2.91	0	5	0.74	1.46	2.25	94.15	0.14	30.25	5
11	127.3	3.45	1.38	0	127.31	2.71	5	2.16	131.15	0.7	0	0.7	181.51	2.72	0	5	0.68	1.33	2.09	158.7	0.14	33.61	7
12	133.25	3.13	0.97	0	133.26	2.35	5	2.1	130.56	0.76	0	0.76	173.68	2.36	0	5	0.66	1.24	2.04	155.62	0.09	37.82	7
13	121.03	3.97	0.91	0	121.04	3.28	5	2.24	132.05	0.83	0	0.83	145.06	3.3	0	5	0.73	1.19	2.19	135.63	0.08	28.13	5
14	118.52	3.03	1.28	0	118.54	2.55	5	2.16	130.03	0.89	0	0.89	131.63	2.57	0	5	0.7	1.13	2.13	125.22	0.1	34.47	7
15	105.37	4.59	1.75	-0.1	105.39	4.36	9	2.37	132.79	0.96	0	0.96	108.75	4.4	0	9	0.79	1.08	2.36	106.59	0.13	21.63	3
16	155.7	4.07	1.47	-0.2	155.72	2.62	5	2.09	132.86	1.03	0	1.03	150.67	2.63	0	5	0.7	1.02	2.09	149.29	0.1	34.4	7
17	72.68	4.07	1.29	-0.1	72.7	5.6	9	2.56	131	1.09	0	1.09	65.56	5.69	0	9	0.88	0.97	2.57	65.8	0.08	17.06	3
18	90.96	2.4	1.73	-0.1	90.98	2.64	5	2.25	127.68	1.16	0	1.16	77.71	2.67	0	5	0.77	0.93	2.28	79.29	0.11	31.66	5
19	330.83	4.18	1.82	-0.1	330.85	1.26	6	1.64	134.88	1.22	0	1.22	269.43	1.27	0	6	0.54	0.92	1.66	287.94	0.11	68.51	7
20	322.89	3.76	1.84	-0.1	322.91	1.16	6	1.62	134.05	1.29	0	1.29	249.23	1.17	0	6	0.54	0.9	1.65	273.04	0.1	72.73	7
21	305.97	2.3	1.25	-0.3	305.99	0.75	6	1.49	130.32	1.36	0	1.36	224.71	0.75	0	6	0.5	0.88	1.53	254.57	0.07	100.99	7
22	431.39	4.07	2.39	-0.4	431.42	0.94	6	1.47	135.34	1.42	0	1.42	302.09	0.95	0	6	0.49	0.86	1.51	351.07	0.12	89.7	7
23	536.44	6.06	3.76	-0.7	536.49	1.13	6	1.48	137.28	1.49	0	1.49	358.61	1.13	0	6	0.5	0.84	1.53	425.51	0.18	78.94	7
24	457.7	4.07	5.39	-1.7	457.77	0.89	6	1.44	135.49	1.56	0	1.56	292.51	0.89	0	6	0.49	0.83	1.49	356.43	0.25	94.39	7
25	574.56	5.85	7.4	-2.2	574.65	1.02	6	1.43	137.28	1.63	0	1.63	351.91	1.02	0	6	0.49	0.81	1.48	438.13	0.33	86.66	7
26	409.15	3.13	4.87	-2.4	409.21	0.77	6	1.41	133.3	1.7	0	1.7	240.42	0.77	0	6	0.49	0.79	1.48	305.07	0.21	103.46	7
27	108.6	2.19	4.32	-2.5	108.66	2.02	5	2.11	127.45	1.76	0	1.76	60.78	2.05	0	5	0.79	0.67	2.24	67.69	0.18	37.2	7
28	96.91	2.72	3.28	-2.6	96.95	2.8	5	2.25	128.74	1.82	0	1.82	52.18	2.85	0	5	0.85	0.63	2.4	56.59	0.13	28.76	5
29	279.97	7.21	3.58	-2.5	280.01	2.57	8	1.94	137.28	1.89	0	1.89	147.02	2.59	0	5	0.72	0.66	2.05	173.11	0.14	35.32	7
30	349.1	9.82	4.02	-2	349.15	2.81	8	1.92	137.28	1.96	0	1.96	177.11	2.83	0	8	0.71	0.64	2.03	211.18	0.15	33.16	7
31	352.44	9.92	3.43	-2	352.48	2.81	8	1.92	137.28	2.03	0	2.03	172.72	2.83	0	8	0.72	0.63	2.03	207.28	0.12	33.08	7
32	532.89	10.03	3.03	-1.6	532.93	1.88	8	1.68	137.28	2.1	0	2.1	253.05	1.89	0	6	0.63	0.65	1.78	326.96	0.1	49.01	7
33	669.48	10.34	5.77	-1.1	669.55	1.54	6	1.56	137.28	2.17	0	2.17	308.09	1.55	0	6	0.58	0.66	1.65	416.31	0.19	59.63	7
34	684.1	9.5	6.85	-1	684.19	1.39	6	1.51	137.28	2.23	0	2.23	305.14	1.39	0	6	0.57	0.65	1.6	421.78	0.22	65.65	7

	CPT-2	In situ data										Basic output data											
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	ã (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	13.37	0.1	-0.18	0.1	13.36	0.78	4	2.62	100.06	0.05	0	0.05	265.94	0.78	0	6	0.59	6.11	1.94	76.85	-0.26	66.67	7
2	8.67	0.21	-0.64	0.2	8.66	2.41	3	3.02	104.08	0.1	0	0.1	83.78	2.44	-0.01	5	0.77	6.06	2.4	49	-0.45	31.12	5
3	16.6	0.42	-2.01	0.4	16.58	2.52	4	2.79	110.73	0.16	0	0.16	104.36	2.54	-0.01	5	0.74	4.13	2.33	64.1	-0.92	31.8	5
4	18.27	0.52	-4.98	0.4	18.21	2.87	4	2.79	112.6	0.21	0	0.21	84.23	2.9	-0.02	5	0.77	3.43	2.39	58.36	-1.68	28.57	5
5	24.44	0.52	-6.44	0.4	24.36	2.14	4	2.62	113.3	0.27	0	0.27	89.08	2.17	-0.02	5	0.73	2.72	2.29	61.91	-1.71	35.22	7
6	72.16	0.31	-0.37	0.4	72.15	0.43	6	1.85	112.21	0.33	0	0.33	219.98	0.44	0	6	0.49	1.78	1.63	120.52	-0.08	106.49	7
7	61.51	0.31	0.09	0.4	61.51	0.51	6	1.94	111.83	0.38	0	0.38	159.82	0.51	0	6	0.53	1.72	1.74	99.27	0.02	90.4	7
8	2.4	0	0	0.5	2.4	0	0	0	87.36	0.43	0	0.43	4.64	0	0	0	1	2.48	4.06	4.64	0	20.91	0
9	124.48	0.52	0.2	0.5	124.48	0.42	6	1.63	117.28	0.48	0	0.48	255.81	0.42	0	6	0.45	1.42	1.51	166.09	0.03	125.83	7
10	191.62	0.73	0.4	0.4	191.63	0.38	6	1.45	120.8	0.55	0	0.55	350.51	0.38	0	6	0.39	1.3	1.36	234.53	0.05	153.1	7
11	229.11	1.04	0.37	0.4	229.12	0.46	6	1.44	123.84	0.61	0	0.61	376.38	0.46	0	6	0.4	1.25	1.36	269.31	0.04	144.67	7
12	256.79	1.36	1.01	0.4	256.8	0.53	6	1.44	126.04	0.67	0	0.67	382.18	0.53	0	6	0.41	1.2	1.38	291.52	0.11	134.3	7
13	307.64	1.98	1.56	0.4	307.66	0.64	6	1.44	129.26	0.73	0	0.73	417.79	0.65	0	6	0.42	1.16	1.4	337.68	0.15	120.6	7
14	344.61	2.3	2.39	0.3	344.64	0.67	6	1.42	130.61	0.8	0	0.8	429.81	0.67	0	6	0.42	1.12	1.38	364.96	0.22	119.47	7
15	213.45	1.98	0.86	0.3	213.46	0.93	6	1.66	128.37	0.86	0	0.86	246	0.93	0	6	0.51	1.11	1.64	222.95	0.07	83.77	7
16	118.52	2.82	0.92	0.3	118.54	2.38	5	2.14	129.5	0.93	0	0.93	126.59	2.4	0	5	0.7	1.1	2.12	121.75	0.07	36.41	7
17	307.85	1.67	1.74	0.4	307.87	0.54	6	1.39	128	0.99	0	0.99	309.03	0.54	0	6	0.42	1.03	1.38	297.92	0.13	132.61	7
18	299.6	2.4	1.28	0.3	299.62	0.8	6	1.52	130.59	1.06	0	1.06	282.15	0.8	0	6	0.48	1	1.52	282.15	0.09	98.37	7
19	338.55	3.24	0.52	0.2	338.56	0.96	6	1.54	133.07	1.12	0	1.12	300.01	0.96	0	6	0.49	0.97	1.55	309.43	0.03	87.07	7
20	506.37	4.28	1.2	0.2	506.38	0.85	6	1.39	136.1	1.19	0	1.19	423.51	0.85	0	6	0.44	0.95	1.41	452.77	0.07	101.99	7
21	449.45	3.86	3.3	0.1	449.5	0.86	6	1.43	135.06	1.26	0	1.26	355.62	0.86	0	6	0.46	0.92	1.45	390.68	0.19	98.5	7
22	79.26	2.3	3.21	0.2	79.3	2.9	5	2.32	127.02	1.32	0	1.32	58.89	2.95	0	5	0.82	0.83	2.38	61.31	0.17	28.45	5
23	164.06	2.19	4.3	0.4	164.11	1.34	6	1.86	128.46	1.39	0	1.39	117.23	1.35	0	6	0.65	0.84	1.92	129.07	0.22	57.01	7
24	235.07	1.78	3.04	0.4	235.1	0.76	6	1.57	127.79	1.45	0	1.45	160.92	0.76	0	6	0.54	0.84	1.63	186.19	0.15	92.78	7
25	236.42	2.51	1.69	0.4	236.44	1.06	6	1.68	130.32	1.52	0	1.52	154.84	1.07	0	6	0.59	0.81	1.74	179.8	0.08	72.49	7
26	191.83	2.19	1.48	0.6	191.85	1.14	6	1.76	128.84	1.58	0	1.58	120.3	1.15	0	6	0.63	0.78	1.84	139.76	0.07	64.81	7
27	125.21	1.04	0.07	0.6	125.21	0.83	6	1.8	122.37	1.64	0	1.64	75.22	0.85	0	6	0.66	0.75	1.91	87.52	0	67.74	7
28	289.89	1.04	1.19	0.7	289.9	0.36	7	1.29	124.42	1.7	0.03	1.67	172.19	0.36	0	6	0.45	0.81	1.37	221.54	0.03	154.08	7
29	335.73	1.04	1.28	0.8	335.75	0.31	7	1.2	124.77	1.77	0.06	1.7	195.89	0.31	0	7	0.42	0.82	1.28	258.7	0.02	178.08	7
30	348.26	0.84	1.46	0.8	348.28	0.24	7	1.13	123.23	1.83	0.09	1.74	199.64	0.24	0	7	0.39	0.82	1.2	270.02	0.01	207.25	7
31	353.69	4.28	1.37	0.9	353.71	1.21	6	1.61	135.23	1.9	0.12	1.77	198.56	1.22	0	6	0.58	0.74	1.69	246.72	-0.01	69.34	7
32	504.59	1.57	2.11	1.9	504.62	0.31	7	1.06	128.73	1.96	0.16	1.81	278.48	0.31	0	7	0.37	0.82	1.13	390.57	0	208.94	7
33	483.81	4.49	-4.4	2.4	483.76	0.93	6	1.44	136.34	2.03	0.19	1.84	261.54	0.93	0	6	0.51	0.75	1.51	342.47	-0.27	90.56	7
34	689.01	3.86	-5.76	1.5	688.94	0.56	7	1.17	136.1	2.1	0.22	1.88	365.58	0.56	0	7	0.41	0.79	1.23	513.47	-0.34	145.87	7
35	-9999	-9999	-9999	0	0	0	0	0	120.9	2.16	0.25	1.91	0	0	0	0	1	0.55	0	-1.13	0	12.67	0

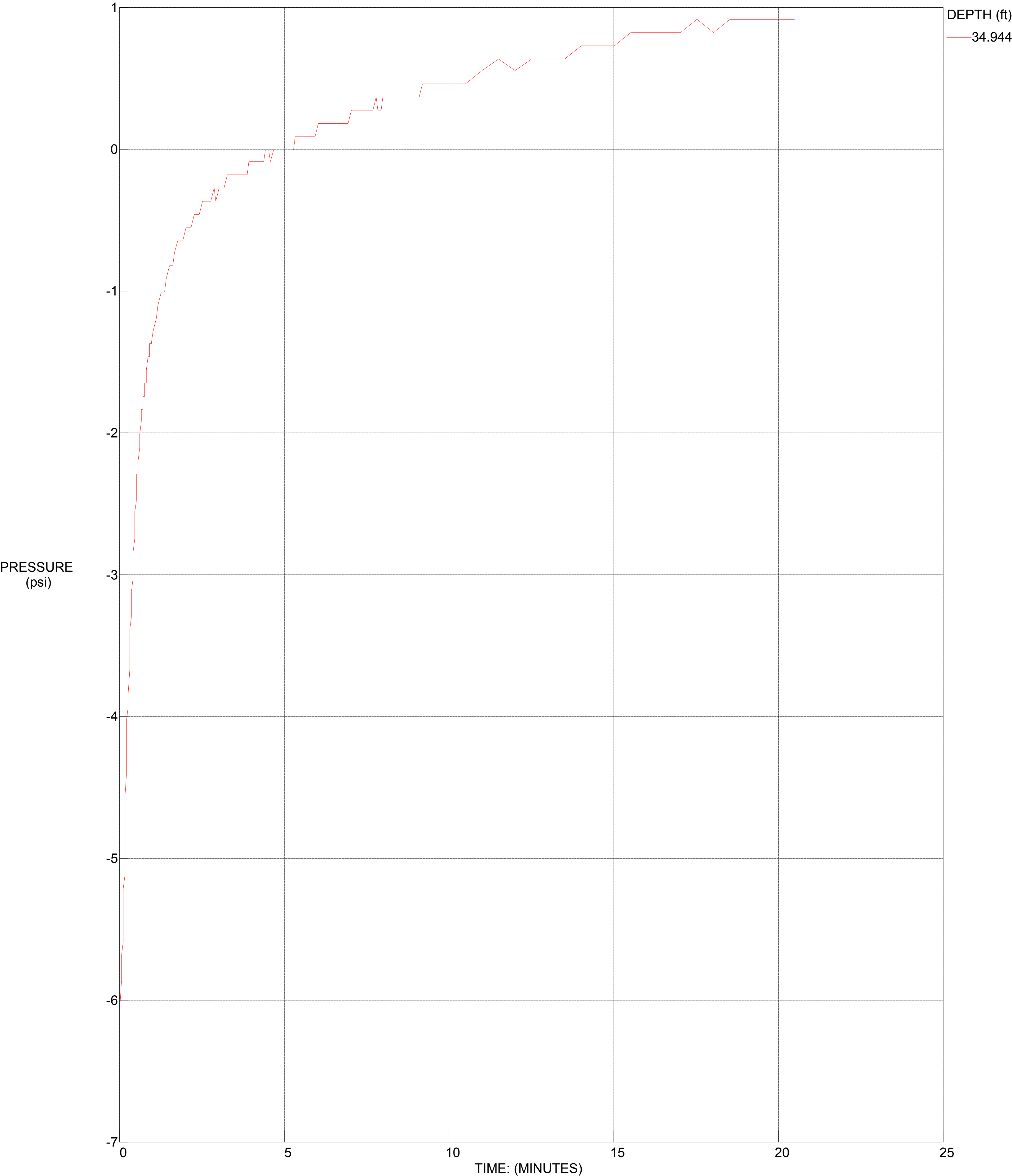
	CPT-3	In situ data										Basic output data											
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	ã (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	20.47	0.1	0	-0.2	20.47	0.51	5	2.37	101.1	0.05	0	0.05	403.62	0.51	0	6	0.53	4.94	1.76	95.34	0	88.7	7
2	21.41	0.1	-0.18	-0.1	21.41	0.49	5	2.35	101.21	0.1	0	0.1	210.46	0.49	0	6	0.55	3.67	1.84	73.91	-0.13	78.99	7
3	22.24	0.1	-0.39	-0.1	22.24	0.47	5	2.33	101.31	0.15	0	0.15	145.55	0.47	0	6	0.58	3.06	1.89	63.91	-0.19	73.75	7
4	21.3	0.1	-0.46	-0.1	21.3	0.49	5	2.35	101.2	0.2	0	0.2	104.24	0.5	0	6	0.61	2.73	1.96	54.5	-0.16	66.51	7
5	38.53	1.15	-0.03	-0.2	38.53	2.98	4	2.55	120.19	0.26	0	0.26	145.79	3	0	5	0.72	2.72	2.25	98.47	-0.01	29.67	5
6	94.82	3.03	0.64	-0.2	94.83	3.19	5	2.3	129.48	0.33	0	0.33	288.73	3.2	0	8	0.66	2.17	2.09	194.18	0.14	29.49	5
7	164.58	3.13	0.64	-0.2	164.59	1.9	6	1.97	131.07	0.39	0	0.39	417.92	1.91	0	6	0.56	1.75	1.82	271.1	0.12	47.87	7
8	179.61	2.3	0.83	-0.1	179.62	1.28	6	1.82	129.02	0.46	0	0.46	391.87	1.28	0	6	0.52	1.54	1.69	261.29	0.13	66.98	7
9	142.02	0.94	1.1	-0.2	142.03	0.66	6	1.7	121.91	0.52	0	0.52	273.09	0.66	0	6	0.48	1.41	1.59	188.18	0.15	101.64	7
10	151.63	1.15	1.29	-0.1	151.64	0.76	6	1.71	123.53	0.58	0	0.58	260.45	0.76	0	6	0.49	1.35	1.62	192.12	0.16	93.54	7
11	126.57	1.15	1.38	0	126.58	0.91	6	1.82	123.09	0.64	0	0.64	196.29	0.91	0	6	0.54	1.31	1.74	156.14	0.15	78.21	7
12	166.04	1.46	1.62	0	166.06	0.88	6	1.73	125.52	0.7	0	0.7	234.74	0.88	0	6	0.52	1.23	1.66	192.84	0.17	84.34	7
13	238.51	1.98	1.84	0	238.53	0.83	6	1.6	128.64	0.77	0	0.77	309.37	0.83	0	6	0.48	1.17	1.55	261.79	0.17	94.22	7
14	255.53	1.98	2.01	0	255.56	0.78	6	1.55	128.81	0.83	0	0.83	305.79	0.78	0	6	0.47	1.12	1.52	269.33	0.17	99.84	7
15	218.46	1.78	2.21	0	218.49	0.81	6	1.62	127.61	0.9	0	0.9	242.62	0.82	0	6	0.5	1.09	1.59	223.35	0.18	92.52	7
16	143.48	2.4	2.48	0	143.51	1.67	6	1.97	128.8	0.96	0	0.96	148.29	1.68	0	6	0.64	1.06	1.95	143.26	0.19	49.22	7
17	361.94	2.82	2.67	-0.1	361.98	0.78	6	1.45	132.23	1.03	0	1.03	351.31	0.78	0	6	0.45	1.01	1.45	345.69	0.19	104.6	7
18	339.49	3.13	2.76	-0.1	339.53	0.92	6	1.53	132.84	1.09	0	1.09	309.44	0.93	0	6	0.49	0.98	1.53	314.75	0.18	89.87	7
19	503.34	3.97	3.13	-0.1	503.38	0.79	6	1.37	135.53	1.16	0	1.16	432.39	0.79	0	6	0.43	0.96	1.38	455.94	0.19	108.29	7
20	529.34	4.7	3.49	-0.2	529.38	0.89	6	1.4	136.89	1.23	0	1.23	429.4	0.89	0	6	0.45	0.93	1.42	466.58	0.2	98.24	7
21	455.82	3.34	3.95	-0.2	455.87	0.73	6	1.37	134.03	1.3	0	1.3	350.47	0.74	0	6	0.44	0.91	1.4	392.56	0.22	112.27	7
22	498.12	4.59	4.38	-0.4	498.17	0.92	6	1.43	136.58	1.37	0	1.37	363.86	0.92	0	6	0.47	0.89	1.46	416.44	0.23	93.69	7
23	512.53	4.8	4.69	-0.6	512.59	0.94	6	1.43	136.97	1.43	0	1.43	356.53	0.94	0	6	0.48	0.87	1.46	418.1	0.24	92.48	7
24	505.53	3.97	4.52	-0.9	505.59	0.78	6	1.37	135.54	1.5	0	1.5	335.72	0.79	0	6	0.46	0.85	1.41	405.82	0.22	106.77	7
25	441.73	3.45	4.69	-1.3	441.78	0.78	6	1.4	134.18	1.57	0	1.57	280.64	0.78	0	6	0.48	0.83	1.45	344.73	0.22	104.37	7
26	517.96	5.53	4.44	-1.2	518.01	1.07	6	1.47	137.28	1.64	0	1.64	315.38	1.07	0	6	0.51	0.8	1.53	390.7	0.2	81.98	7
27	431.18	4.18	0.28	-1	431.18	0.97	6	1.48	135.53	1.71	0	1.71	251.87	0.97	0	6	0.52	0.78	1.55	316.59	0.01	86.42	7
28	196.43	5.12	-0.28	-0.9	196.42	2.61	5	2.03	135.1	1.77	0	1.77	109.82	2.63	0	5	0.75	0.68	2.14	125.02	-0.01	33.87	7
29	204.16	3.45	-0.09	-0.9	204.15	1.69	6	1.87	132.3	1.84	0.03	1.81	111.93	1.7	0	6	0.69	0.69	1.98	132.11	-0.02	48.17	7
30	508.77	3.45	-0.31	-0.4	508.77	0.68	7	1.31	134.52	1.91	0.06	1.84	274.93	0.68	0	6	0.47	0.77	1.39	369.96	-0.05	118.17	7
31	85	1.98	-1.1	-0.3	84.99	2.33	5	2.23	126.12	1.97	0.09	1.88	44.27	2.39	0	5	0.85	0.61	2.4	48.16	-0.09	31.42	5
32	47.62	0.84	-1.2	-0.3	47.6	1.75	5	2.33	118.38	2.03	0.12	1.9	23.94	1.83	0	4	0.91	0.59	2.54	25.24	-0.11	30.31	5
33	32.27	0.42	-1.63	-0.1	32.25	1.3	5	2.39	112.36	2.08	0.16	1.93	15.64	1.38	-0.01	4	0.95	0.57	2.64	16.14	-0.14	28.31	4
34	25.58	0.52	-2.02	0.2	25.56	2.04	4	2.59	113.42	2.14	0.19	1.95	11.99	2.23	-0.01	4	1	0.54	2.86	11.99	-0.17	22.73	4
35	29.24	0.63	-2.11	0.3	29.21	2.14	4	2.55	115.08	2.2	0.22	1.98	13.64	2.32	-0.01	4	1	0.53	2.82	13.64	-0.19	23.26	4
36	40	0.84	-2.17	0.4	39.97	2.09	5	2.44	117.95	2.26	0.25	2.01	18.78	2.22	-0.01	4	0.97	0.54	2.69	19.14	-0.2	25.93	4
37	30.6	0.73	-2.3	0.4	30.57	2.39	4	2.57	116.32	2.32	0.28	2.04	13.88	2.59	-0.02	4	1	0.52	2.84	13.88	-0.22	22.55	4
38	26.52	0.94	-2.21	0.4	26.5	3.55	4	2.72	117.81	2.37	0.31	2.06	11.69	3.9	-0.02	3	1	0.51	3.01	11.69	-0.23	18.77	2
39	50.86	1.98	-2.05	0.5	50.83	3.9	4	2.55	124.87	2.44	0.34	2.09	23.11	4.1	-0.01	3	1	0.51	2.79	23.11	-0.23	20.1	3
40	197.16	3.86	-1.93	0.7	197.13	1.96	6	1.93	133.05	2.5	0.37	2.13	91.41	1.99	0	5	0.75	0.59	2.09	109.2	-0.24	41.56	7
41	78.53	2.72	-1.84	0.8	78.51	3.46	5	2.38	128.22	2.57	0.41	2.16	35.12	3.58	-0.01	4	0.94	0.51	2.6	36.53	-0.25	23.19	5
42	156.33	2.82	-1.7	0.9	156.31	1.8	6	1.97	130.18	2.63	0.44	2.2	69.97	1.83	0	5	0.77	0.57	2.15	82.64	-0.25	41.8	7
43	95.76	2.61	-1.56	1	95.74	2.73	5	2.24	128.42	2.7	0.47	2.23	41.74	2.81	-0.01	4	0.9	0.51	2.47	45.12	-0.26	28.04	5
44	29.24	0.63	-1.56	1.2	29.22	2.14	4	2.55	115.08	2.75	0.5	2.26	11.73	2.37	-0.02	4	1	0.47	2.88	11.73	-0.27	22.23	4
45	54.82	1.78	-1.45	1.2	54.81	3.24	4	2.47	124.24	2.82	0.53	2.29	22.74	3.41	-0.01	4	1	0.46	2.75	22.74	-0.28	22.17	5
46	28.2	1.04	-1.47	1.2	28.18	3.71	4	2.72	118.73	2.88	0.56	2.31	10.93	4.13	-0.03	3	1	0.46	3.05	10.93	-0.29	18.18	2
47	31.85	1.15	-1.38	1.2	31.83	3.61	4	2.67	119.73	2.94	0.59	2.34	12.33	3.98	-0.02	3	1	0.45	2.99	12.33	-0.3	18.76	2
48	28.09	0.73	-1.38	1.3	28.07	2.6	4	2.62	116.11	2.99	0.62	2.37	10.58	2.91	-0.03	3	1	0.45	2.97	10.58	-0.31	20.41	2
49	106.41	3.55	-1.01	1.4	106.4	3.34	5	2.28	130.93	3.06	0.66	2.4	42.98	3.44	-0.01	4	0.93	0.47	2.52	45.71	-0.3	24.54	5
50	23.39	0.52	-1.01	1.5	23.38	2.23	4	2.64	113.2	3.12	0.69	2.43	8.34	2.58	-0.04	3	1	0.44	3.03	8.34	-0.31	20.05	2
51	24.54	0.84	-0.92	1.4	24.53	3.41	4	2.74	116.76	3.17	0.72	2.46	8.69	3.91	-0.04	3	1	0.43	3.11	8.69	-0.32	17.97	2
52	161.03	2.72	-0.83	1.4	161.02	1.69	6	1.94	129.97	3.24	0.75	2.49	63.35	1.72	-0.01	5	0.79	0.51	2.16	75.87	-0.32	42.82	7
53	204.68	3.45	-0.74	1.4	204.67	1.68	6	1.87	132.3	3.31	0.78	2.53	79.73	1.71	0	5	0.76	0.52	2.07	98.31	-0.33	45.46	7
54	197.16	2.92	-0.64	1.5	197.15	1.48	6	1.84	131.01	3.37	0.81	2.56	75.7	1.51	0	5	0.75	0.51	2.05	94.29	-0.33	49.13	7
55	154.13	3.34	-0.46	1.5	154.13	2.17	5	2.03	131.39	3.44	0.84	2.59	58.08	2.22	-0.01	5	0.84	0.47	2.27	67.2	-0.34	35.25	7
56	58.9	2.72	-0.46	1.5	58.89	4.61	4	2.55	127.52	3.5	0.87	2.63	21.09	4.9	-0.02	3	1	0.4	2.87	21.09	-0.35	17.93	3
57	78.95	2.92	-0.37	1.6	78.94	3.7	4	2.4	128.78	3.57	0.9	2.66	28.34	3.88	-0.01	4	1	0.4	2.71	28.34	-0.35	21.31	3
58	26.42	0.73	-0.28	1.6	26.42	2.77	4	2.66	115.96	3.62	0.94	2.69	8.48	3.21	-0.04	3	1	0.39	3.07	8.48	-0.36	19.01	2
59	26.11	0.73	-0.18	1.6	26.1	2.8	4	2.66	115.93	3.68	0.97	2.71	8.26	3.26	-0.04	3	1	0.39	3.09	8.26	-0.36	18.84	2
60	37.07	0.21	-0.18	1.7	37.07	0.56	5	2.16	107.62	3.73	1	2.74	12.18	0.63	-0.03	5	0.96	0.4	2.58	12.63	-0.37	29.04	4

CPT-4 In situ data Basic output data

Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	ã (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	11.9	0.1	-0.09	0	11.9	0.88	4	2.68	99.78	0.05	0	0.05	237.44	0.88	0	6	0.61	6.48	1.99	72.55	-0.13	61.64	7
2	21.51	0.84	-0.18	0.1	21.51	3.88	3	2.82	116.44	0.11	0	0.11	197.83	3.9	0	8	0.74	5.36	2.31	108.46	-0.12	24.01	5
3	27.36	0.63	-0.18	0.2	27.36	2.29	4	2.59	114.92	0.17	0	0.17	164.31	2.3	0	5	0.69	3.6	2.18	92.5	-0.08	36.2	7
4	30.91	0.21	-0.18	0.2	30.91	0.68	5	2.26	107.18	0.22	0	0.22	140.06	0.68	0	6	0.59	2.54	1.92	73.68	-0.06	69.65	7
5	56.29	0.21	-0.09	0.2	56.29	0.37	6	1.91	108.64	0.27	0	0.27	204.82	0.37	0	6	0.5	1.95	1.66	103.43	-0.02	104.48	7
6	51.06	0.31	0	0.1	51.06	0.61	6	2.05	111.37	0.33	0	0.33	154.12	0.62	0	6	0.56	1.92	1.81	91.89	0	80.39	7
7	112.68	2.3	0.12	0.1	112.68	2.04	5	2.1	127.88	0.39	0	0.39	285.58	2.05	0	6	0.61	1.82	1.94	193.25	0.02	43.67	7
8	83.75	3.76	0.48	0.2	83.76	4.49	4	2.44	130.76	0.46	0	0.46	181.72	4.51	0	9	0.74	1.86	2.28	146.4	0.08	21.4	3
9	126.36	2.72	0.74	0.2	126.37	2.15	5	2.09	129.38	0.52	0	0.52	240.56	2.16	0	6	0.62	1.55	1.97	184.53	0.1	41.55	7
10	124.79	2.72	0.83	0.3	124.8	2.18	5	2.09	129.35	0.59	0	0.59	211.3	2.19	0	5	0.64	1.45	1.99	170.64	0.1	40.78	7
11	145.05	2.3	0.92	0.2	145.06	1.58	6	1.95	128.5	0.65	0	0.65	221.44	1.59	0	6	0.59	1.33	1.87	181.77	0.1	53.39	7
12	131.47	3.34	1.01	0.2	131.49	2.54	5	2.13	131	0.72	0	0.72	182.21	2.56	0	5	0.67	1.3	2.06	160.26	0.1	35.51	7
13	117.48	4.18	1.01	0.2	117.49	3.56	5	2.27	132.36	0.78	0	0.78	148.93	3.58	0	8	0.73	1.25	2.22	137.43	0.09	26.24	5
14	112.47	3.65	1.1	0.2	112.48	3.25	5	2.25	131.27	0.85	0	0.85	131.43	3.27	0	5	0.73	1.18	2.21	123.97	0.09	28.15	5
15	107.04	3.03	1.01	0.3	107.05	2.83	5	2.22	129.78	0.91	0	0.91	116.09	2.85	0	5	0.73	1.11	2.2	111.61	0.08	31.31	5
16	146.62	3.55	0.92	0.3	146.63	2.42	5	2.08	131.71	0.98	0	0.98	148.59	2.44	0	5	0.69	1.05	2.07	145.06	0.07	36.6	7
17	102.86	3.55	0.88	0.3	102.87	3.45	5	2.3	130.84	1.05	0	1.05	97.38	3.49	0	5	0.78	1.01	2.3	97.12	0.06	26.21	5
18	126.98	3.03	0.74	0.2	126.99	2.38	5	2.12	130.19	1.11	0	1.11	113.35	2.41	0	5	0.72	0.97	2.13	114.92	0.05	36.06	7
19	301.69	2.19	0.92	0.2	301.7	0.73	6	1.48	129.94	1.18	0	1.18	255.64	0.73	0	6	0.48	0.95	1.5	270.1	0.06	104.87	7
20	396.09	3.55	0.92	0.2	396.1	0.9	6	1.48	134.13	1.24	0	1.24	317.74	0.9	0	6	0.48	0.93	1.5	345.47	0.05	93.39	7
21	354.74	3.03	1.27	0.1	354.75	0.85	6	1.49	132.7	1.31	0	1.31	269.99	0.86	0	6	0.49	0.9	1.52	300.87	0.07	94.84	7
22	506.58	4.49	1.49	0.2	506.59	0.89	6	1.41	136.45	1.38	0	1.38	366.8	0.89	0	6	0.46	0.88	1.44	422.44	0.08	97.08	7
23	538.95	4.49	1.88	0.3	538.97	0.83	6	1.37	136.6	1.45	0	1.45	371.87	0.84	0	6	0.46	0.87	1.41	440.75	0.09	102.87	7
24	443.92	3.24	2.3	0.2	443.95	0.73	6	1.37	133.73	1.51	0	1.51	292.54	0.73	0	6	0.46	0.85	1.42	354.34	0.11	110.65	7
25	529.13	3.97	2.73	0.4	529.17	0.75	6	1.34	135.65	1.58	0	1.58	333.86	0.75	0	6	0.45	0.83	1.39	415.68	0.12	111.24	7
26	532.06	4.91	3.31	0.5	532.1	0.92	6	1.41	137.22	1.65	0	1.65	321.69	0.93	0	6	0.49	0.81	1.47	403.9	0.14	93.28	7
27	607.14	3.34	3.86	0.4	607.19	0.55	7	1.2	134.73	1.72	0	1.72	352.77	0.55	0	7	0.41	0.82	1.25	469.88	0.16	145.71	7
28	461.99	2.72	4.1	0	462.04	0.59	7	1.29	132.54	1.78	0	1.78	258.22	0.59	0	6	0.45	0.79	1.36	343.43	0.17	129.65	7
29	105.26	3.45	1.06	-0.1	105.28	3.27	5	2.28	130.68	1.85	0	1.85	55.97	3.33	0	4	0.86	0.62	2.43	60.44	0.04	25.96	5
30	409.25	2.3	0.09	0	409.25	0.56	7	1.31	131.03	1.91	0	1.91	212.89	0.56	0	6	0.47	0.76	1.4	290.81	0	128.54	7
31	625.73	4.7	-1.2	-0.1	625.71	0.75	7	1.3	137.28	1.98	0	1.98	314.69	0.75	0	6	0.47	0.75	1.37	439.66	-0.04	112.07	7
32	576.44	4.39	-1.47	0	576.42	0.76	6	1.32	136.59	2.05	0	2.05	280.13	0.76	0	6	0.48	0.73	1.41	394.3	-0.05	108.95	7
33	194.03	2.4	-1.56	0.3	194.01	1.24	6	1.78	129.53	2.11	0	2.11	90.73	1.25	0	6	0.69	0.62	1.94	112.64	-0.05	58.13	7
34	54.3	2.72	-3.22	0.3	54.26	5	4	2.6	127.32	2.18	0	2.18	23.91	5.21	0	3	1	0.49	2.85	23.91	-0.11	17.42	3
35	54.51	1.46	-5.01	0.3	54.45	2.69	5	2.41	122.8	2.24	0	2.24	23.31	2.8	-0.01	4	0.98	0.48	2.68	23.73	-0.16	24.72	5
36	80.72	2.4	-5.79	0.5	80.65	2.98	5	2.32	127.39	2.3	0	2.3	34.01	3.07	-0.01	4	0.94	0.48	2.57	35.71	-0.18	25.47	5
37	27.05	0.73	-6.44	0.7	26.97	2.71	4	2.64	116.01	2.36	0	2.36	10.42	2.97	-0.02	3	1	0.45	2.98	10.42	-0.2	20.23	2
38	31.95	0.84	-6.62	0.8	31.87	2.62	4	2.58	117.4	2.42	0	2.42	12.17	2.84	-0.02	3	1	0.44	2.91	12.17	-0.2	21.21	2
39	24.02	0.52	-6.85	1	23.93	2.18	4	2.63	113.26	2.48	0	2.48	8.66	2.43	-0.02	3	1	0.43	3	8.66	-0.2	20.49	2
40	25.06	0.73	-6.99	1.1	24.98	2.93	4	2.69	115.83	2.54	0.03	2.5	8.96	3.26	-0.02	3	1	0.42	3.06	8.96	-0.21	19.12	2
41	12.74	0.31	-7.08	1.1	12.65	2.48	3	2.89	107.97	2.59	0.06	2.53	3.98	3.11	-0.06	3	1	0.42	3.34	3.98	-0.23	16.97	2
42	29.14	1.04	-6.93	1.3	29.05	3.59	4	2.7	118.81	2.65	0.09	2.55	10.33	3.96	-0.02	3	1	0.41	3.05	10.33	-0.23	18.34	2
43	82.81	2.09	-6.8	1.3	82.73	2.52	5	2.26	126.43	2.71	0.12	2.59	30.93	2.61	-0.01	4	0.95	0.43	2.55	32.48	-0.24	27.45	5
44	195.28	4.18	-6.62	1.3	195.2	2.14	6	1.96	133.6	2.78	0.16	2.62	73.37	2.17	0	5	0.81	0.48	2.18	87.57	-0.24	37.51	7
45	189.95	3.45	-6.34	1.4	189.88	1.81	6	1.91	132.12	2.84	0.19	2.66	70.38	1.84	0	5	0.79	0.48	2.14	85.34	-0.24	41.96	7
46	92.21	3.03	-6.16	1.4	92.13	3.29	5	2.31	129.41	2.91	0.22	2.69	33.16	3.39	-0.01	4	0.97	0.4	2.61	34.02	-0.25	23.73	5
47	123.64	3.45	-5.98	1.4	123.57	2.79	5	2.18	131.07	2.97	0.25	2.73	44.25	2.86	-0.01	4	0.91	0.42	2.45	48.02	-0.25	28	5
48	41.77	1.57	-5.96	1.4	41.7	3.76	4	2.6	122.65	3.04	0.28	2.76	14.03	4.05	-0.02	3	1	0.38	2.96	14.03	-0.26	18.94	3
49	22.66	0.52	-5.88	1.5	22.59	2.31	4	2.66	113.12	3.09	0.31	2.78	7.01	2.68	-0.04	3	1	0.38	3.1	7.01	-0.26	19.16	2
50	45.74	1.15	-5.79	1.5	45.67	2.52	5	2.45	120.61	3.15	0.34	2.81	15.13	2.7	-0.02	4	1	0.38	2.82	15.13	-0.27	22.66	4

DISSIPATION

TEST ID: CPT-2
LOCATION: Norco
TEST DATE: Thu 26/Jan/2017
CLIENT: Southern California Geotechnical, Inc



Presented below is a list of formulas used for the estimation of various soil properties. The formulas are presented in SI unit system and assume that all components are expressed in the same units.

:: Unit Weight, g (kN/m³) ::

$$g = g_w \cdot \left(0.27 \cdot \log(R_f) + 0.36 \cdot \log(\frac{q_t}{p_a}) + 1.236 \right)$$

where g_w = water unit weight

:: Permeability, k (m/s) ::

$I_c < 3.27$ and $I_c > 1.00$ then $k = 10^{0.952-3.04 \cdot I_c}$

$I_c \le 4.00$ and $I_c > 3.27$ then $k = 10^{-4.52-1.37 \cdot I_c}$

:: N_{SPT} (blows per 30 cm) ::

$$N_{60} = \left(\frac{q_c}{P_a}\right) \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

$$N_{1(60)} = Q_{tn} \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

:: Young's Modulus, Es (MPa) ::

$$(q_t - \sigma_v) \cdot 0.015 \cdot 10^{0.55 \cdot I_c + 1.68}$$

(applicable only to $I_c < I_{c\_cutoff}$)

:: Relative Density, Dr (%) ::

$$100 \cdot \sqrt{\frac{Q_{tn}}{k_{DR}}}$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: State Parameter, ψ ::

$$\psi = 0.56 - 0.33 \cdot \log(Q_{tn,cs})$$

:: Peak drained friction angle, φ (°) ::

$$\varphi = 17.60 + 11 \cdot \log(Q_{tn})$$

(applicable only to SBT_n: 5, 6, 7 and 8)

:: 1-D constrained modulus, M (MPa) ::

If $I_c > 2.20$

$a = 14$ for $Q_{tn} > 14$

$a = Q_{tn}$ for $Q_{tn} \le 14$

$M_{CPT} = a \cdot (q_t - \sigma_v)$

If $I_c \le 2.20$

$M_{CPT} = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$

:: Small strain shear Modulus, Go (MPa) ::

$$G_0 = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Shear Wave Velocity, Vs (m/s) ::

$$V_s = \left(\frac{G_0}{\rho}\right)^{0.50}$$

:: Undrained peak shear strength, Su (kPa) ::

$N_{kt} = 10.50 + 7 \cdot \log(F_r)$ or user defined

$$S_u = \frac{(q_t - \sigma_v)}{N_{kt}}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Remolded undrained shear strength, Su(rem) (kPa) ::

$S_{u(rem)} = f_s$ (applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Overconsolidation Ratio, OCR ::

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 \cdot +7 \cdot \log(F_r))} \right]^{1.25} \text{ or user defined}$$

$$OCR = k_{OCR} \cdot Q_{tn}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: In situ Stress Ratio, Ko ::

$$K_O = (1 - \sin\varphi') \cdot OCR^{\sin\varphi'}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Soil Sensitivity, S_t ::

$$S_t = \frac{N_S}{F_r}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Effective Stress Friction Angle, φ' (°) ::

$$\varphi' = 29.5° \cdot B_q^{0.121} \cdot (0.256 + 0.336 \cdot B_q + \log Q_t)$$

(applicable for $0.10 < B_q < 1.00$)

References

• Robertson, P.K., Cabal K.L., Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012

• Robertson, P.K., Interpretation of Cone Penetration Tests - a unified approach., Can. Geotech. J. 46(11): 1337–1355 (2009)

APPENDIX H

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-1

JOB NO.: 11G114	DRILLING DATE: 2/24/11	WATER DEPTH: Dry
PROJECT: Norco Ranch Commerce Park	DRILLING METHOD: Hollow Stem Auger	CAVE DEPTH: 17 feet
LOCATION: Norco, California	LOGGED BY: Daryl Kas	READING TAKEN: 8 hours

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					ALLUVIUM: Brown Silty fine Sand, medium dense-damp							
	X	14					5					EI = 2 @ 0 to 5'
					Gray Brown Clayey fine Sand, medium dense-dry to damp							
	X	14					9					
5					Light Gray fine Sandy Clay, trace calcareous nodules, medium stiff to stiff-damp							
	X	7					7					
	X	8					6					
10												
	X	22					7					
15												
					Light Brown to Brown fine to coarse Sand, trace fine Gravel, medium dense to dense-dry to wet							
	X	27					1			4		
20												
	X	38					1					
25												
	X	35					10					
					@ 29 feet, Groundwater encountered during drilling							
30												
	X	38					11					

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

BORING NO. B-1

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/24/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 17 feet
READING TAKEN: 8 hours

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION (Continued)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					@ 35 feet, 2- 1 inch lenses of Gray Silty Clay, soft-wet. Light Brown to Brown fine to coarse Sand, trace fine Gravel, medium dense to dense-dry to wet							
					ALLUVIUM: Brown fine to coarse Sand, fine to coarse Gravel, dense-wet							
	X	57					9					
40												
	X	71					8					
45												
	X	82					10					
50												
					Boring Terminated at 50'							

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

TEST BORING LOG **PLATE B-1b**

BORING NO. B-10

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/25/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 13 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
		20			ALLUVIUM: Gray Brown fine Sandy Silt to Silty fine Sand, trace calcareous veining, medium dense-damp	105	15					
		15			Gray Brown fine Sandy Silt, trace Clay, Iron oxide staining, calcareous nodules and veining, loose to medium dense-damp to moist	107	18					
5		16				101	22					
		18	4.5+		Light Gray Silt, Iron oxide staining, medium dense-damp	95	12					
		30			Light Brown fine Sand, medium dense-dry to damp	103	3					
10												
					Gray Brown Silty fine to medium Sand, medium dense-damp							
		17					7					
15												
					Light Brown fine Sand, trace medium Sand, dense-dry							
		40					2					
20												
					Boring Terminated at 20'							

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

TEST BORING LOG

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-11

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/25/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 22 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
	X	10			ALLUVIUM: Brown Silty fine Sand, slightly porous, loose to medium dense-dry		6					
	X	6			Brown fine Sand, little Silt, loose-damp		9					
5	X	13			Light Gray Silty fine Sand, trace medium Sand, medium dense-damp		13					
	X	16			Light Gray to Gray Brown fine Sandy Silt, trace Clay, Iron oxide staining, medium dense-moist		17					
10												
	X	23					31					
15					Gray Brown Silty fine Sand, trace medium Sand, trace Iron oxide staining, medium dense-damp		10					
	X	20					7			6		
20												
	X	10			Interbedded Silty Clay with Silty fine Sand, Iron oxide staining, stiff to medium dense-very moist		25	29	17	43		
25												
	X	22			Brown fine to coarse Sand, trace Silt, medium dense to dense-wet @ 27 feet, Groundwater encountered during drilling		12			4		
30												
	X	43					11					

BORING NO. B-11

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/25/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 22 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION (Continued)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					Brown fine to coarse Sand, trace Silt, medium dense to dense-wet							
	X	34					15					
40												
	X	44					16					
45												
					Red Brown Clayey fine Sand, medium dense-moist							
	X	27					15			45		
50												
					Boring Terminated at 50'							

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-12

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/25/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 12 feet
READING TAKEN: At Completion

SURFACE ELEVATION: --- MSL

DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					ALLUVIUM: Red Brown Silty fine Sand, trace medium Sand, loose-damp							
	X	9				117	10					
	X	6				104	10					
5	X	6				105	8					
	X	7				103	6					
	X	9				106	7					
10												
					Brown fine to medium Sand, loose-damp to moist							
	X	11				98	4					
15					Light Gray Clayey Silt, trace fine Sand, Iron oxide staining, medium stiff-moist							
					Gray Brown Silty fine Sand, medium dense-wet							
					@ 18 feet, Groundwater encountered during drilling							
	X	20				96	24					
20												

Boring Terminated at 20'

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-13

JOB NO.: 11G114 | DRILLING DATE: 2/25/11 | WATER DEPTH: 22 feet
PROJECT: Norco Ranch Commerce Park | DRILLING METHOD: Hollow Stem Auger | CAVE DEPTH: 24 feet
LOCATION: Norco, California | LOGGED BY: Daryl Kas | READING TAKEN: At Completion

SURFACE ELEVATION: --- MSL

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
	X	4			ALLUVIUM: Orange Brown Silty fine Sand, loose-damp		5					EI = 5 @ 0 to 5'
5	X	8			Red Brown fine Sandy Clay, trace medium Sand, medium stiff-damp to moist		15					
	X	5			Red Brown Silty fine to medium Sand, trace coarse Sand, loose-damp		7					
	X	5			Orange Brown Silty fine Sand, loose-damp		16					
10					Light Gray Brown fine Sandy Silt, trace calcareous veining, loose-moist		8					
15	X	22			Brown fine to coarse Sand, little fine to coarse Gravel, medium dense-dry		2					
20	X	20					2			4		
	X	15			@ 23 feet, Groundwater encountered during drilling		14			5		
25					Gray fine Sandy Silt, medium dense-very moist to wet		24			44		
30	X	28			Gray Brown fine Sand, medium dense-wet		19			9		
	X	8			Gray Silty Clay thinly interbedded with Gray Brown fine Sandy Clay, medium stiff to stiff-very moist		24			59		

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-13

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/25/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: 22 feet
CAVE DEPTH: 24 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION (Continued)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					Gray Silty Clay thinly interbedded with Gray Brown fine Sandy Clay, medium stiff to stiff-very moist							
					Gray Brown fine Sandy Silt, little Clay, loose-moist							
	X	17					18 26			46 76		
40					Gray Silt Clay, Iron oxide staining, very stiff-very moist							
	X	10					21	33	19	74		
45												
					Gray Brown Clayey Silt, trace fine Sand, Iron oxide staining, medium dense-very moist							
	X	13					21	29	17	61		
50												

Boring Terminated at 50'

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

BORING NO. B-2

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/24/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 12 feet
READING TAKEN: At Completion

DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
		10			ALLUVIUM: Red Brown Clayey fine Sand, loose-moist	108	9					
		8			Gray Brown Silty fine Sand, calcareous veining and nodules, loose-moist	103	16					
5		8			Gray Brown Silty fine Sand to fine Sandy Silt, loose-moist	103	16					
		11			Brown Silty fine Sand, loose-moist	110	8					
10		14			Brown fine to coarse Sand, trace fine Gravel, loose to medium dense-dry to damp	110	6					
15		22					2					
20		32					4					
					Boring Terminated at 20'							

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-3

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California
DRILLING DATE: 2/24/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas
WATER DEPTH: Dry
CAVE DEPTH: 14 feet
READING TAKEN: At Completion

SURFACE ELEVATION: --- MSL

DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
	X	8			ALLUVIUM: Gray Brown Silty fine Sand, slightly porous, calcareous veining and nodules, loose-moist	107	15					
	X	11			Light Gray fine Sandy Silt, Iron oxide staining, slightly porous, loose-moist	98	18					
5	X	20				116	11					
	X	30			Gray Brown to Light Gray Brown Silty fine to medium Sand, trace fine Gravel, Iron oxide staining, medium dense-dry	112	2					
10	X	25			Light Brown fine to medium Sand, little fine to coarse Gravel, medium dense-dry	107	2					
15	X	22			Light Brown fine Sand, medium dense-dry	101	2					
20	X	43			Brown fine to coarse Sand, trace fine Gravel, medium dense-moist	112	6					

Boring Terminated at 20'

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-4

JOB NO.: 11G114 | DRILLING DATE: 2/24/11 | WATER DEPTH: Dry
PROJECT: Norco Ranch Commerce Park | DRILLING METHOD: Hollow Stem Auger | CAVE DEPTH: 16.5 feet
LOCATION: Norco, California | LOGGED BY: Daryl Kas | READING TAKEN: 8 hours

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
	X	4			ALLUVIUM: Gray to Brown Clayey fine Sand, calcareous veining and nodules, loose-moist		13					
	X	3			Gray Silty fine Sand to fine Sandy Silt, trace calcareous nodules, loose-moist		15					
5												
	X	21			Light Gray fine Sandy Silt, calcareous nodules and veining, trace Iron oxide staining, medium dense to dense-damp		20					
	X	31					11					
10												
	X	21					19					
15					Light Brown Silty fine Sand, Iron oxide staining, medium dense-dry		3					
					Light Brown to Brown fine to medium Sand, trace coarse Sand, trace fine Gravel, Iron oxide staining, medium dense to dense-dry to wet							
	X	24					2			5		
20												
	X	33					8			5		
25												
					@ 27 feet, Groundwater encountered during drilling							
	X	43					10			5		
30												
	X	33					14			5		

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

TEST BORING LOG **PLATE B-4a**

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/24/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 16.5 feet
READING TAKEN: 8 hours

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION (Continued)	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					Light Brown to Brown fine to medium Sand, trace coarse Sand, trace fine Gravel, Iron oxide staining, medium dense to dense-dry to wet							
					Gray Brown fine Sandy Silt, abundant Iron oxide staining, medium dense-very moist to wet							
	X	18					29			39		
40												
					`Brown fine to coarse Sand, fine to coarse Gravel, medium dense-wet							
	X	13					10			6		
					Gray Brown fine Sandy Clay, trace Silt, stiff-very moist		23			74		
45												
					Gray Brown Silty Clay, Iron oxide staining, stiff-very moist							
	X	22					25	40	19			
					Gray Brown Silty fine Sand, trace fine Sandy Silt, Iron oxide staining, medium dense-very moist		21			19		
50												

Boring Terminated at 50'

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-5

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/24/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 15 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					3± inches Asphaltic concrete, 3½± inches Aggregate base							
		22			FILL: Gray Brown Silty fine Sand, trace medium Sand, medium dense-damp	113	7					
		5			ALLUVIUM: Brown Clayey fine Sand, loose-moist	100	13					
5		6				99	15					
					Gray Brown Clayey Silt, little fine Sand, calcareous veining and nodules, medium stiff-moist							
		20			Gray Brown Silty fine to medium Sand, trace Iron oxide staining, medium dense-moist	118	10					
		13				101	11					
10					Brown to Light Brown fine to coarse Sand, little fine Gravel, loose to dense-damp to moist							
		22					2					
15												
		49					4					
20					Boring Terminated at 20'							

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-6

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/24/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 12 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					ALLUVIUM: Red Brown Silty fine Sand, loose-damp							
		9				103	9					
					Gray Brown Silty fine Sand, trace medium Sand, loose-damp							
		6				107	11					
					Gray Brown fine Sandy Silt, loose-moist							
					Gray Brown Silty fine Sand, trace calcareous nodules/veining, loose-moist							
5		7				93	16					
					Light Gray fine Sandy Silt to Silty fine Sand, trace calcareous nodules and veining, trace Iron oxide staining, medium dense-damp							
		20				103	6					
		16				95	4					
10												
		14					12					
15												
					Light Gray fine Sand, medium dense-dry							
		26					3					
20												
					Boring Terminated at 20'							

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

BORING NO. B-7

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/25/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 13 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					ALLUVIUM: Red Brown Silty fine to medium Sand, medium dense-damp							
		19				120	8					
					Red Brown fine to medium Sandy Clay, stiff-moist							
		20	4.5+		Red Brown Clayey fine to coarse Sand, medium dense-moist	123	11					
5		22			Orange Brown fine to coarse Sand, trace fine Gravel, Iron oxide staining, little fine to coarse Gravel, medium dense-dry to damp	114	5					
		22				109	3					
		18				112	3					
10												
					Gray Brown fine Sandy Silt, trace Clay, Iron oxide staining, loose-moist							
		9					16					
15												
		26					21					
					Gray Brown Silty fine Sand, Iron oxide staining, medium dense-moist		10					
20												
					Boring Terminated at 20'							

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

TEST BORING LOG

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

BORING NO. B-8

JOB NO.: 11G114
PROJECT: Norco Ranch Commerce Park
LOCATION: Norco, California

DRILLING DATE: 2/25/11
DRILLING METHOD: Hollow Stem Auger
LOGGED BY: Daryl Kas

WATER DEPTH: Dry
CAVE DEPTH: 15 feet
READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					ALLUVIUM: Red Brown Clayey fine Sand to fine Sandy Clay, loose to medium stiff-moist							
		12	4.5+			121	16					
					Brown Silty fine Sand, loose-moist							
		9				105	13					
					Gray Brown fine Sandy Silt, loose-moist							
5		9			Gray Clayey Silt, medium stiff to stiff-moist	100	21					
		14	2.0			99	24					
					Gray Brown Silty fine Sand, trace Iron oxide staining, loose-moist							
					Light Brown to Brown fine to coarse Sand, little fine Gravel, Iron oxide staining, medium dense to dense-damp							
		26				108	3					
10												
		33				107	3					
15												
		41				115	4					
20												
					Boring Terminated at 20'							

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

TEST BORING LOG

BORING NO. B-9

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

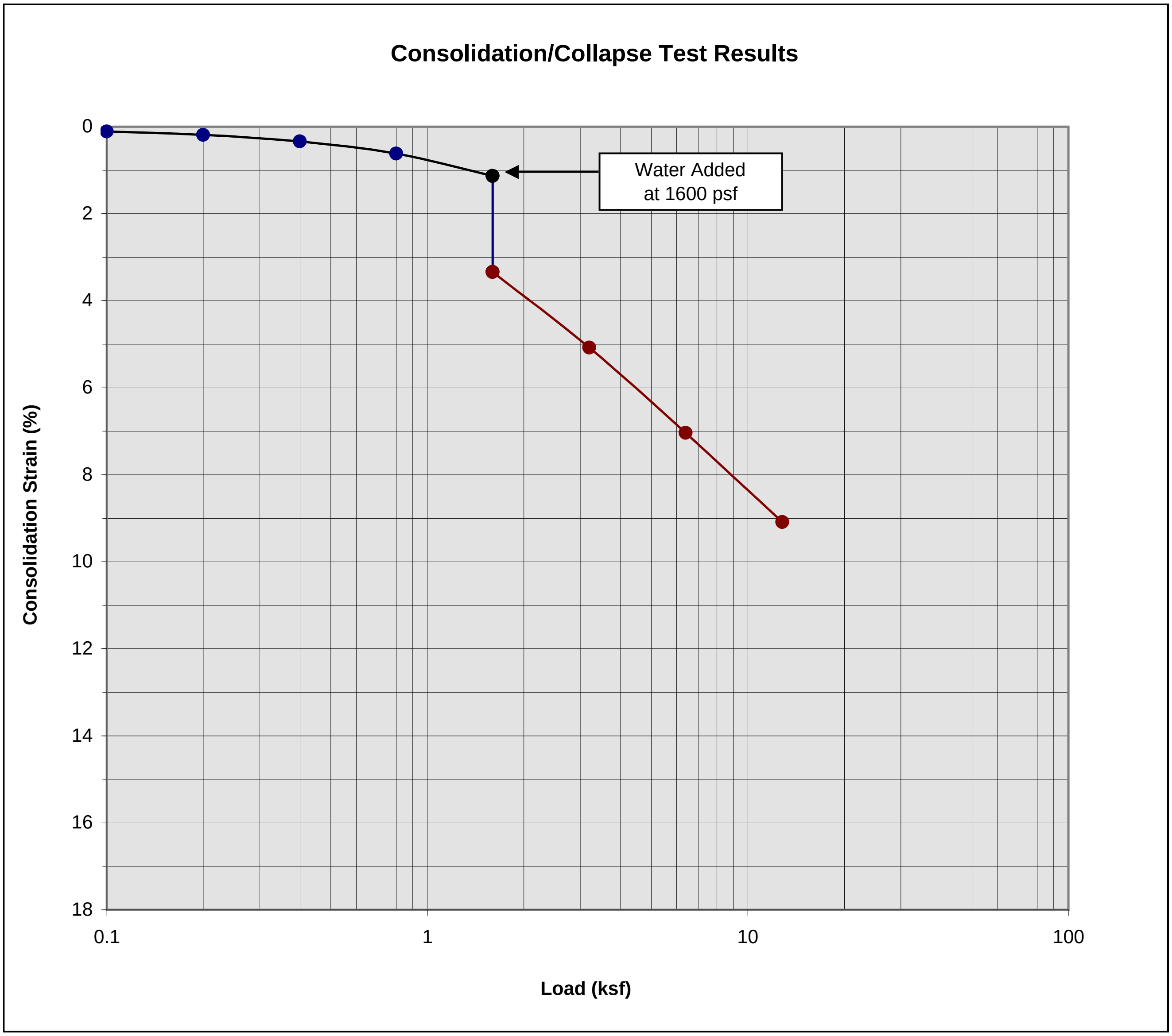
JOB NO.: 11G114 | DRILLING DATE: 2/25/11 | WATER DEPTH: Dry
PROJECT: Norco Ranch Commerce Park | DRILLING METHOD: Hollow Stem Auger | CAVE DEPTH:
LOCATION: Norco, California | LOGGED BY: Daryl Kas | READING TAKEN: At Completion

FIELD RESULTS						LABORATORY RESULTS						
DEPTH (FEET)	SAMPLE	BLOW COUNT	POCKET PEN. (TSF)	GRAPHIC LOG	DESCRIPTION SURFACE ELEVATION: --- MSL	DRY DENSITY (PCF)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PASSING #200 SIEVE (%)	UNCONFINED SHEAR (TSF)	COMMENTS
					ALLUVIUM: Red Brown Clayey fine Sand, loose-moist							
		7				111	12					EI = 51 @ 0 to 5'
		13	3.75			112	18					
					Gray Brown Silty Clay, stiff-moist							
5		14	3.5		Light Gray Brown Clayey Silt, abundant calcareous nodules and veining, very stiff-moist	96	25					
		12			Light Brown Silty fine Sand, loose-damp	102	6					
		13				99	4					
10												
					Brown fine Sand, Iron oxide staining, medium dense-dry to damp							
		10					5					
15												
					Brown fine to coarse Sand, little fine to coarse Gravel, Iron oxide staining, medium dense-dry to damp							
		14					3					
					Gray Silty Clay, medium stiff-moist		20					
20												

Boring Terminated at 20'

TBL 11G114.GPJ SOCALGEO.GDT 3/17/11

TEST BORING LOG

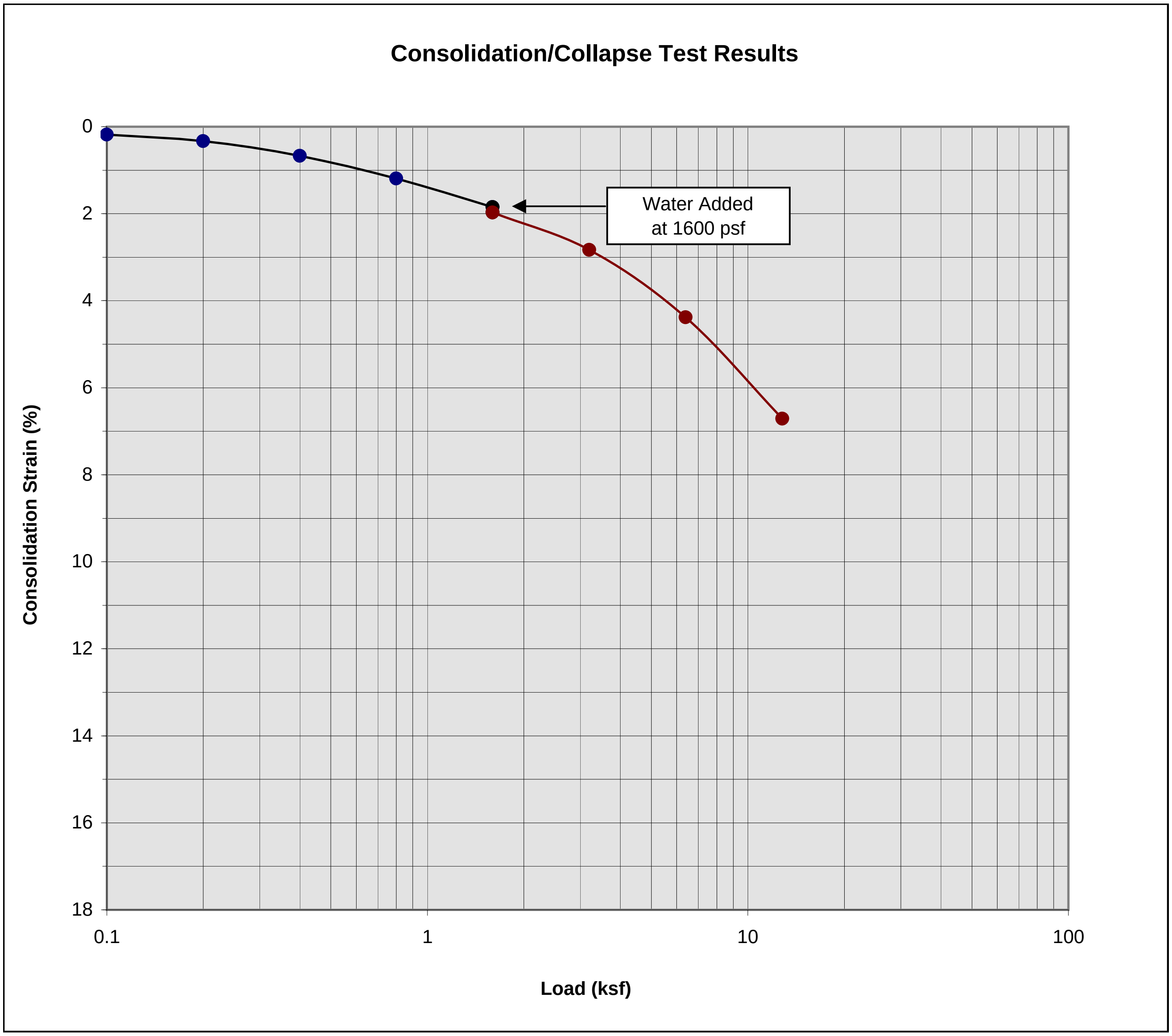


Classification: Red Brown Clayey fine Sand

Boring Number:	B-2	Initial Moisture Content (%)	10
Sample Number:	---	Final Moisture Content (%)	14
Depth (ft)	1 to 2	Initial Dry Density (pcf)	107.2
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	118.2
Specimen Thickness (in)	1.0	Percent Collapse (%)	2.21

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 1

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

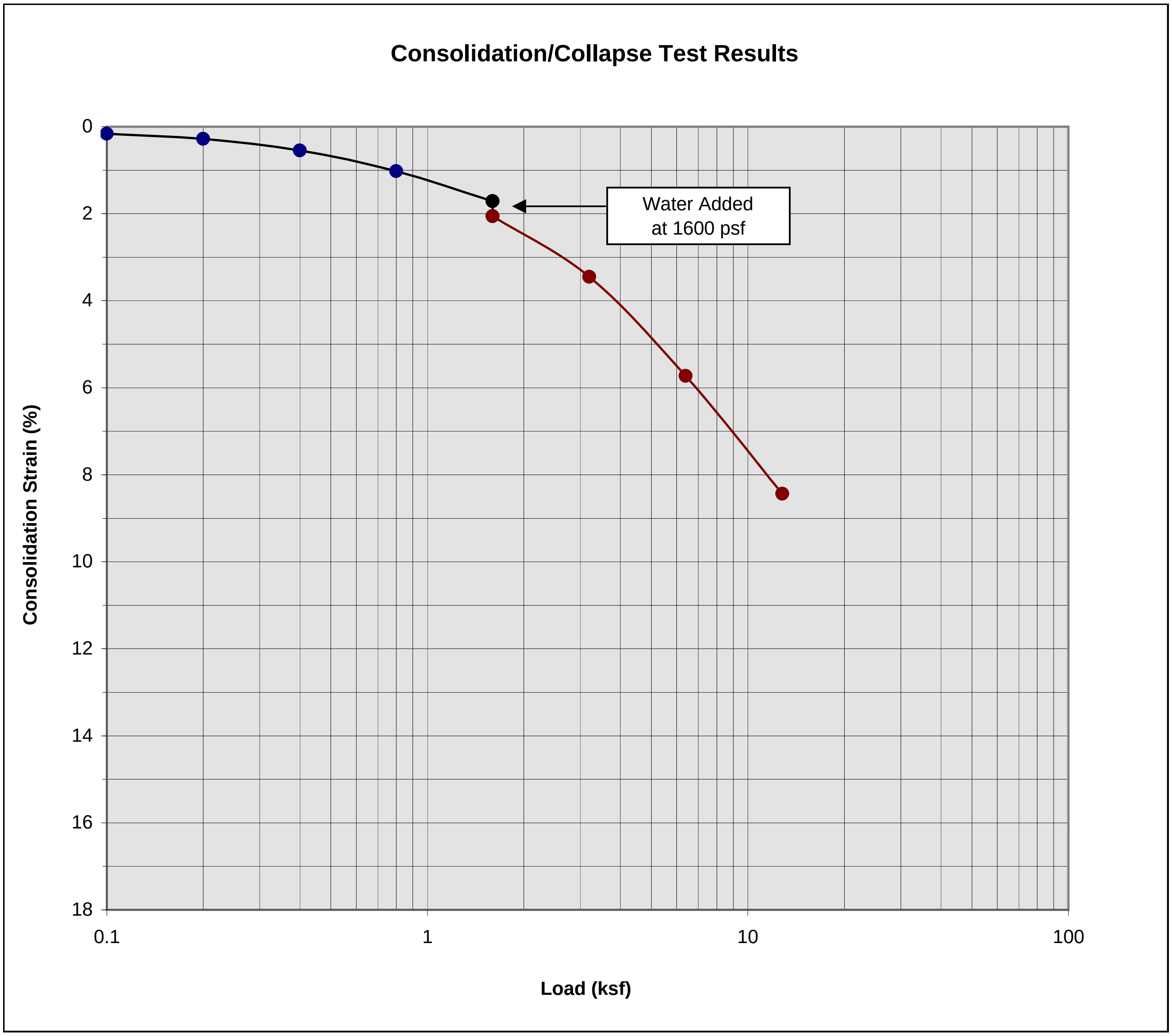


Classification: Gray Brown Silty fine Sand

Boring Number:	B-2	Initial Moisture Content (%)	16
Sample Number:	---	Final Moisture Content (%)	18
Depth (ft)	3 to 4	Initial Dry Density (pcf)	104.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	111.3
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.12

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 2

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



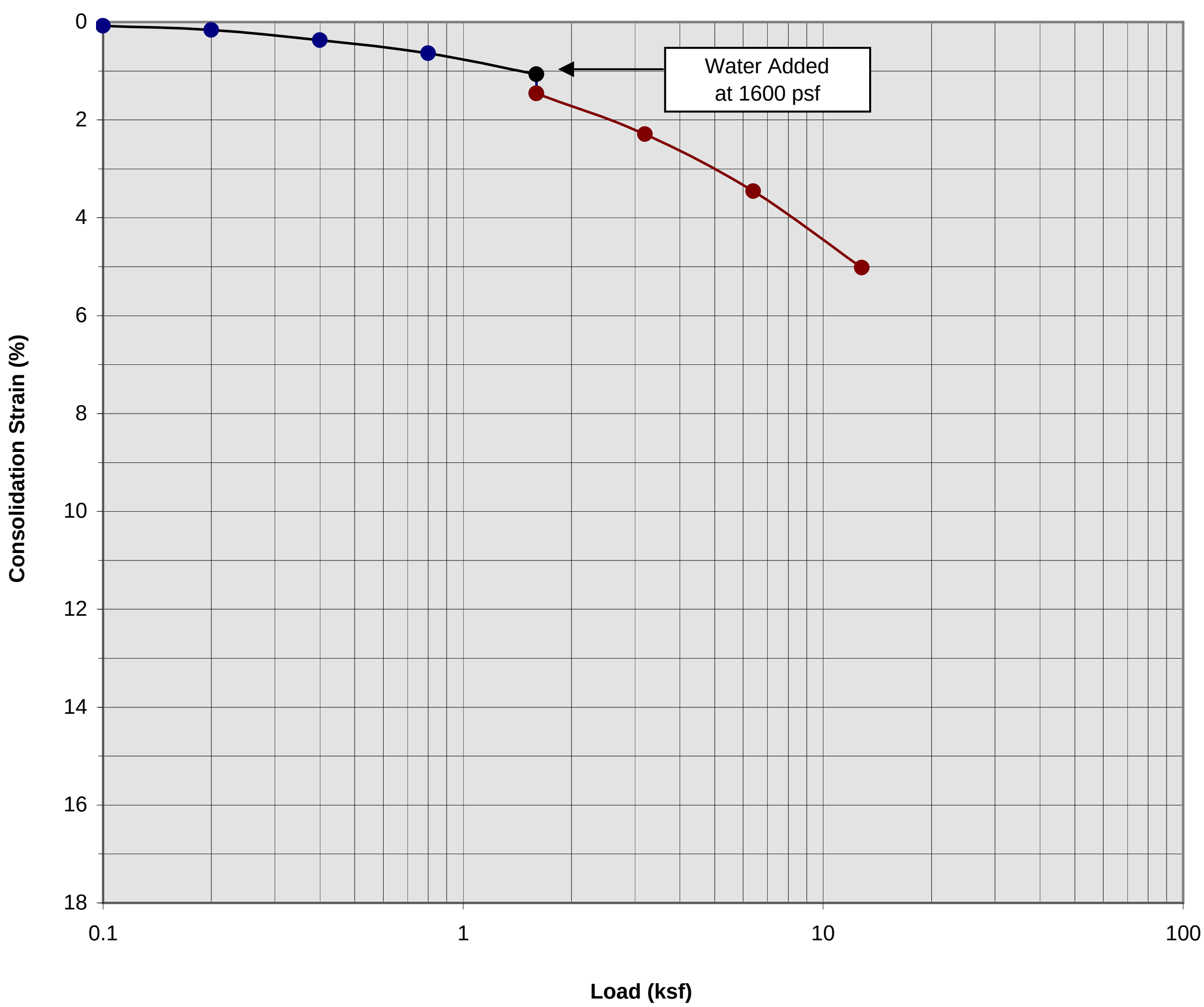
Classification: Gray Brown Silty fine Sand to fine Sandy Silt

Boring Number:	B-2	Initial Moisture Content (%)	16
Sample Number:	---	Final Moisture Content (%)	19
Depth (ft)	5 to 6	Initial Dry Density (pcf)	101.6
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	111.1
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.35

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 3

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results



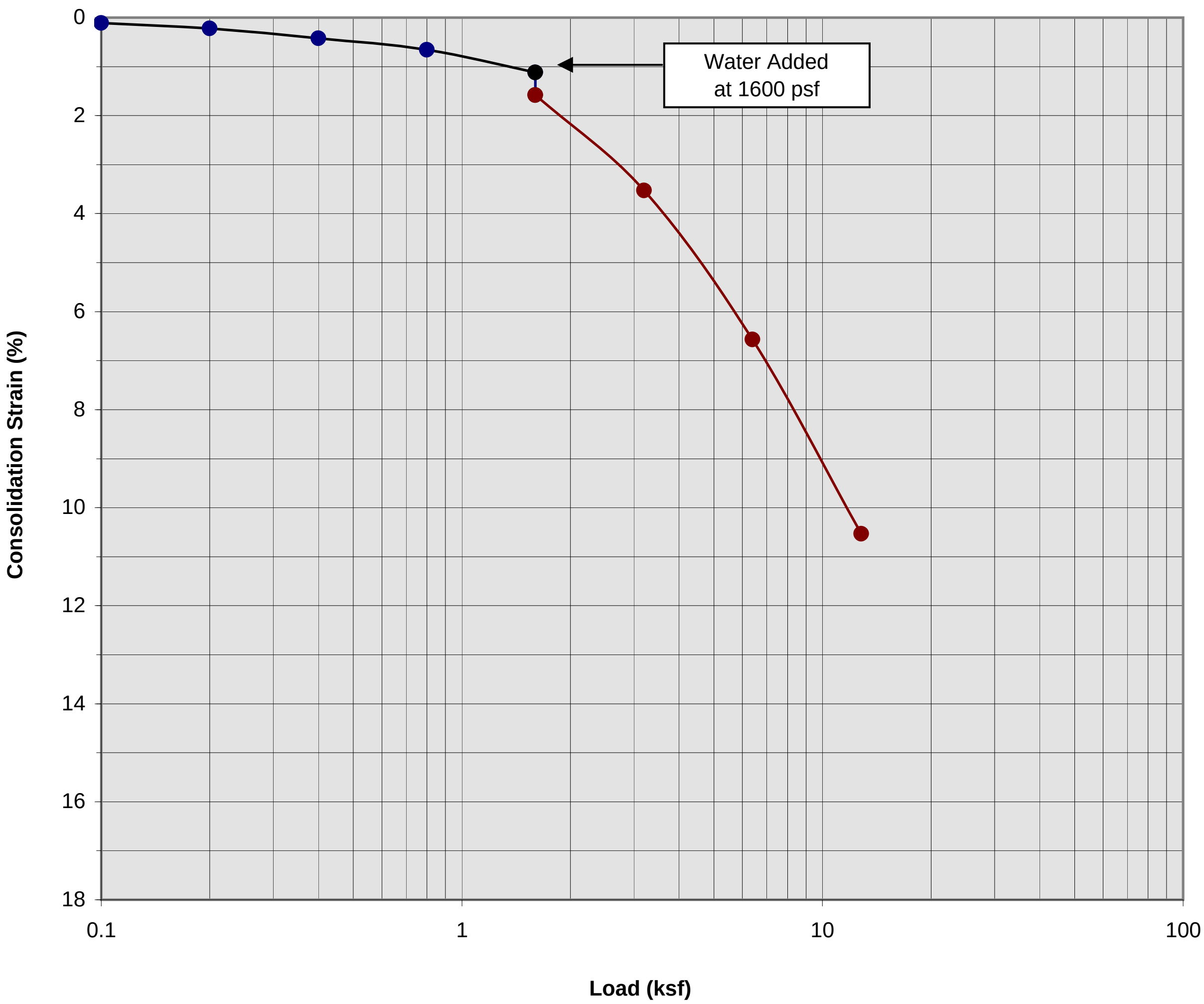
Classification: Brown Silty fine Sand

Boring Number:	B-2	Initial Moisture Content (%)	8
Sample Number:	---	Final Moisture Content (%)	15
Depth (ft)	7 to 8	Initial Dry Density (pcf)	109.2
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	115.4
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.39

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 4

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results

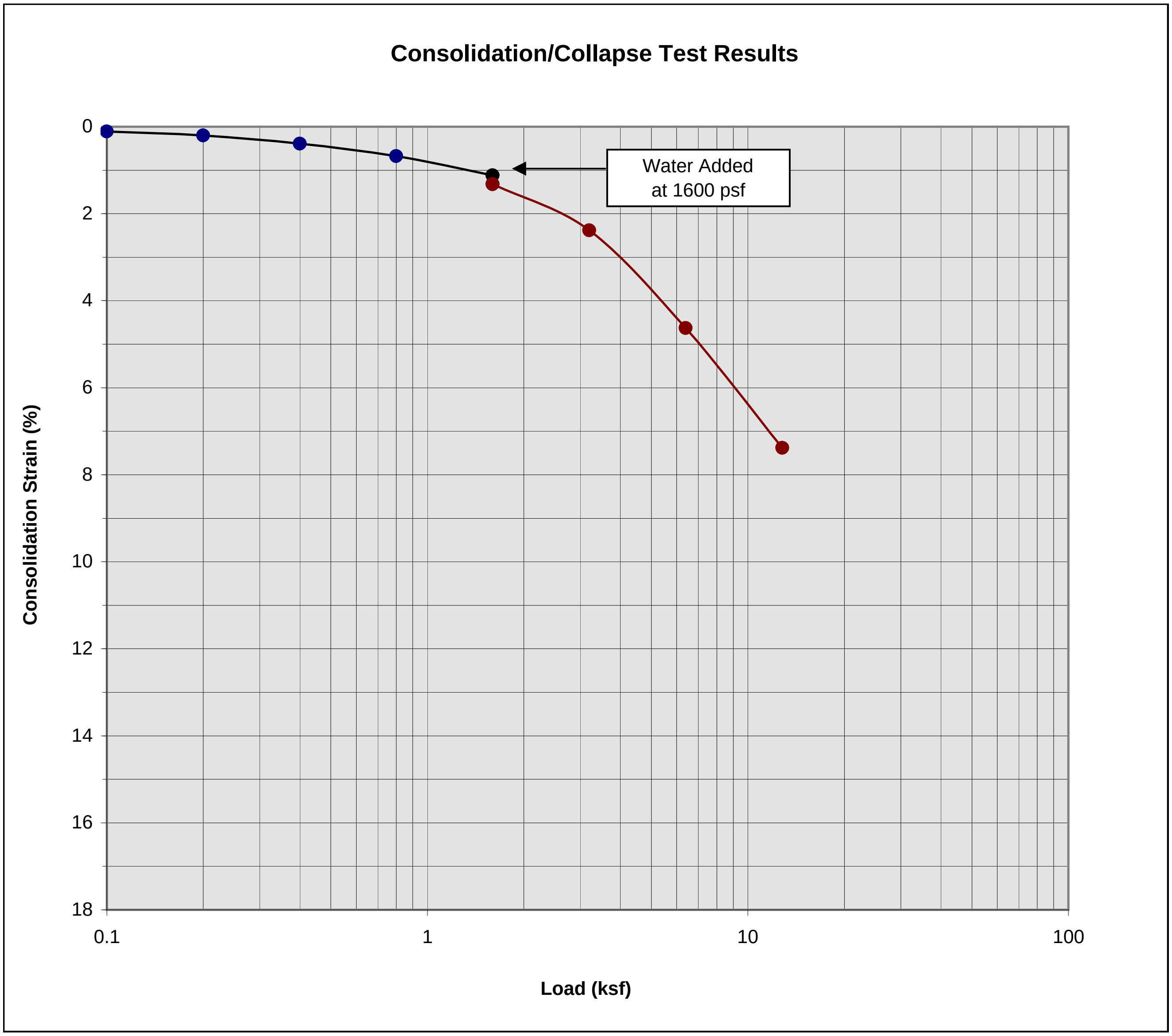


Classification: Red Brown Silty fine Sand

Boring Number:	B-6	Initial Moisture Content (%)	9
Sample Number:	---	Final Moisture Content (%)	16
Depth (ft)	1 to 2	Initial Dry Density (pcf)	104.9
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	117.6
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.46

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 5

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

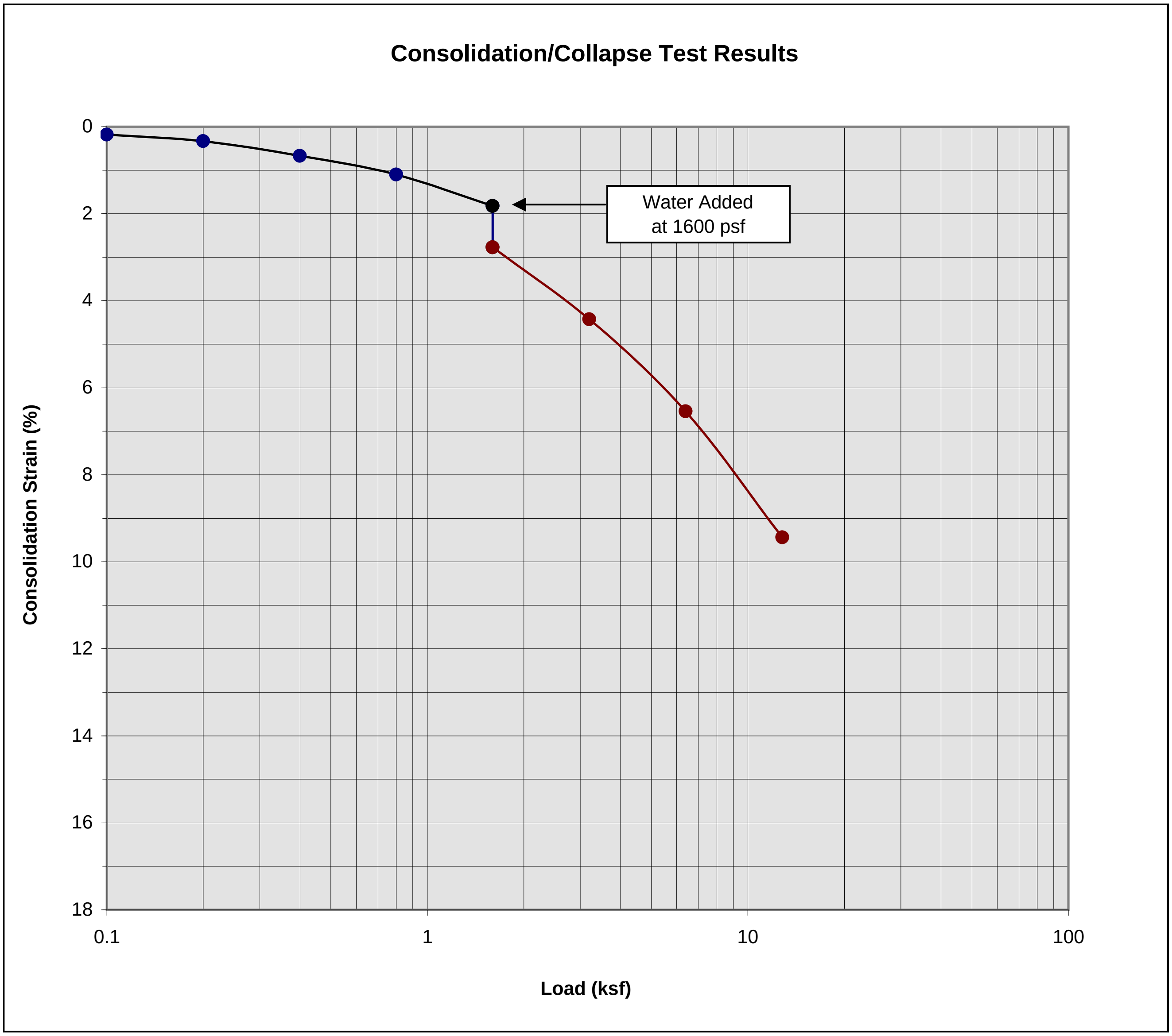


Classification: Gray Brown fine Sandy Silt

Boring Number:	B-6	Initial Moisture Content (%)	12
Sample Number:	---	Final Moisture Content (%)	16
Depth (ft)	3 to 4	Initial Dry Density (pcf)	108.1
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	117.2
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.20

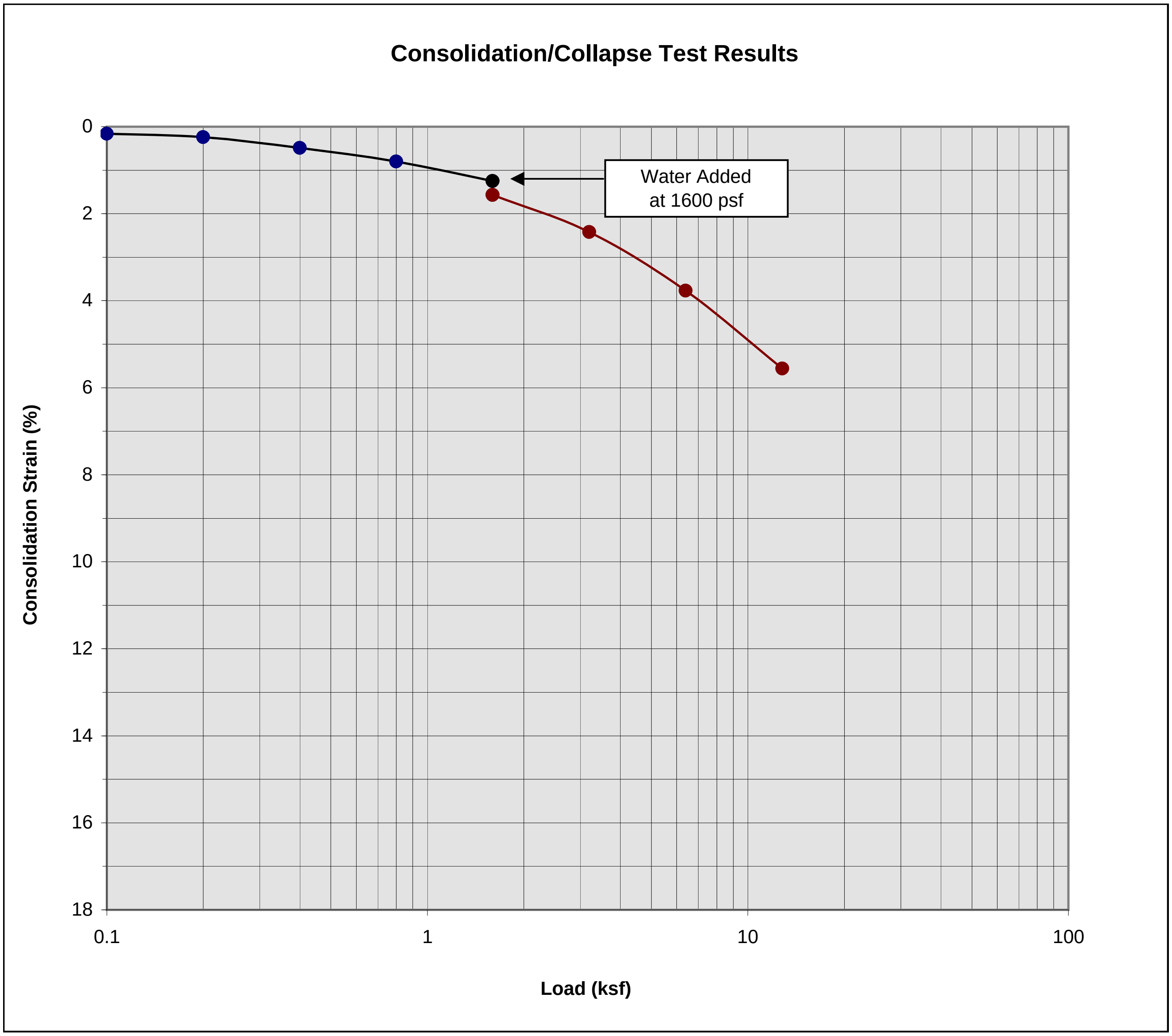
Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 6

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



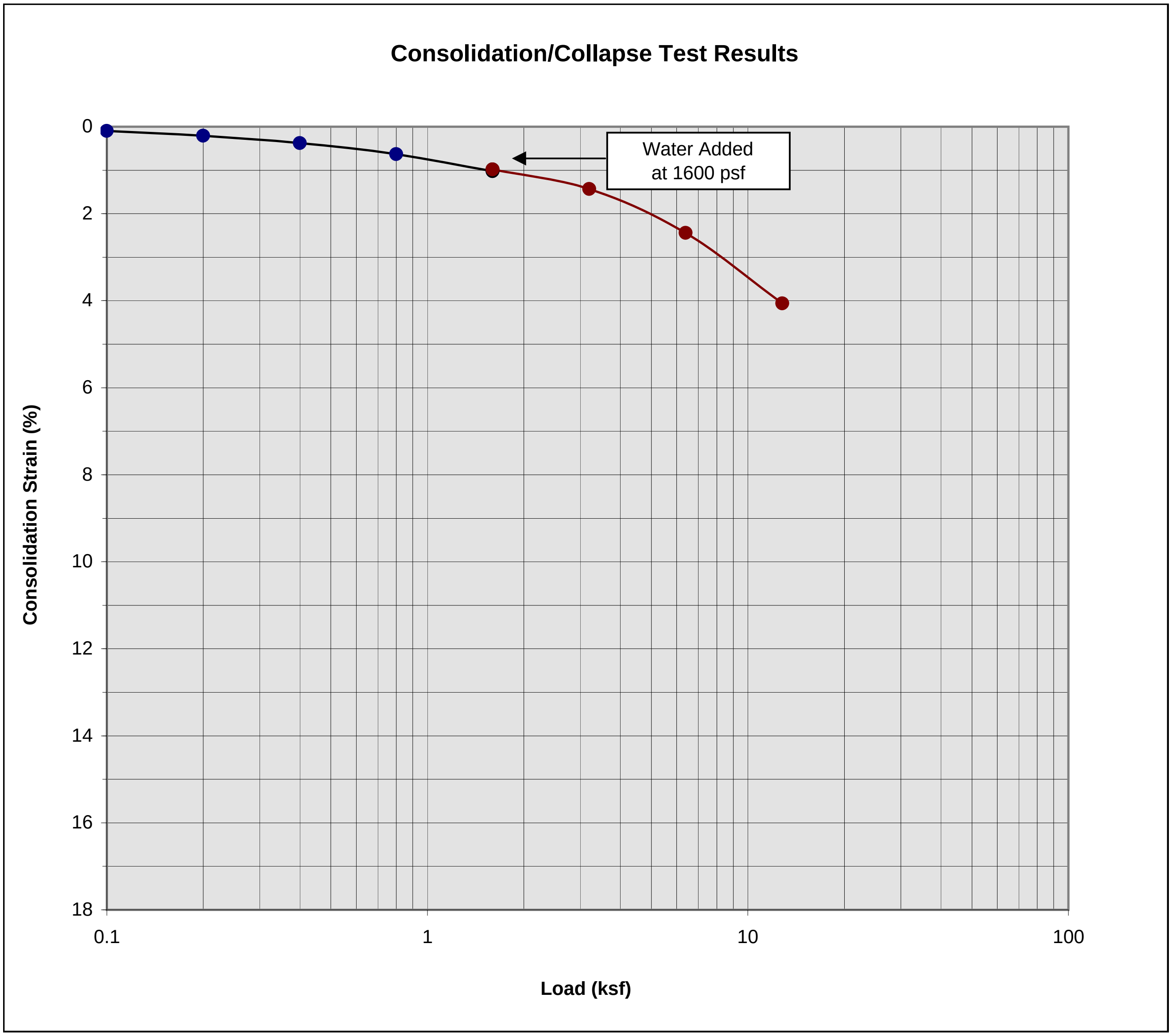
Classification: Gray Brown Silty fine Sand

Boring Number:	B-6	Initial Moisture Content (%)	15
Sample Number:	---	Final Moisture Content (%)	25
Depth (ft)	5 to 6	Initial Dry Density (pcf)	94.9
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	104.4
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.95



Classification: Gray Brown Silty fine Sand

Boring Number:	B-6	Initial Moisture Content (%)	7
Sample Number:	---	Final Moisture Content (%)	26
Depth (ft)	7 to 8	Initial Dry Density (pcf)	99.1
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	104.1
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.32

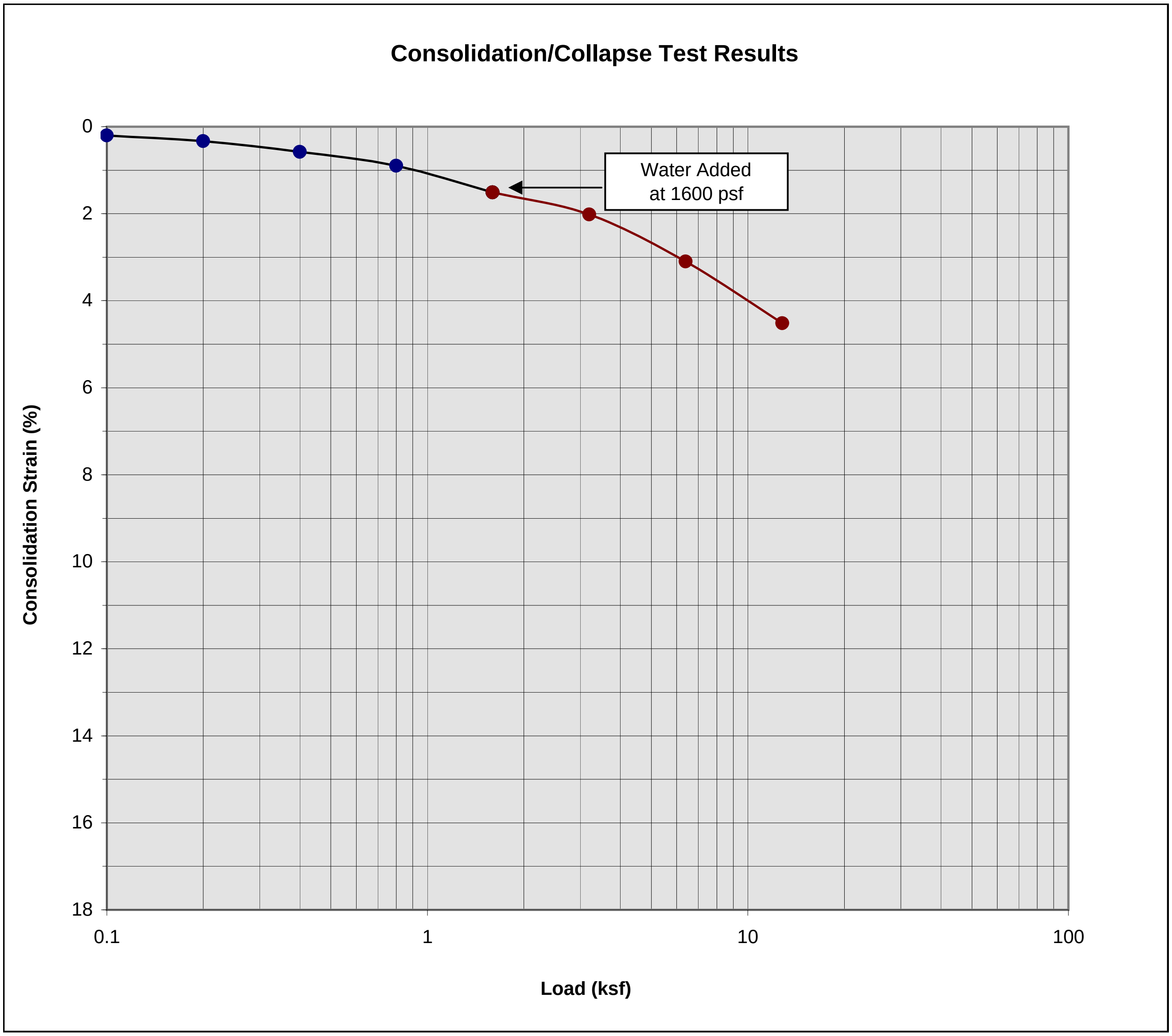


Classification: Gray Brown fine Sandy Silt to Silty fine Sand

Boring Number:	B-10	Initial Moisture Content (%)	16
Sample Number:	---	Final Moisture Content (%)	22
Depth (ft)	1 to 2	Initial Dry Density (pcf)	104.7
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	108.7
Specimen Thickness (in)	1.0	Percent Collapse (%)	-0.04

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 9

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



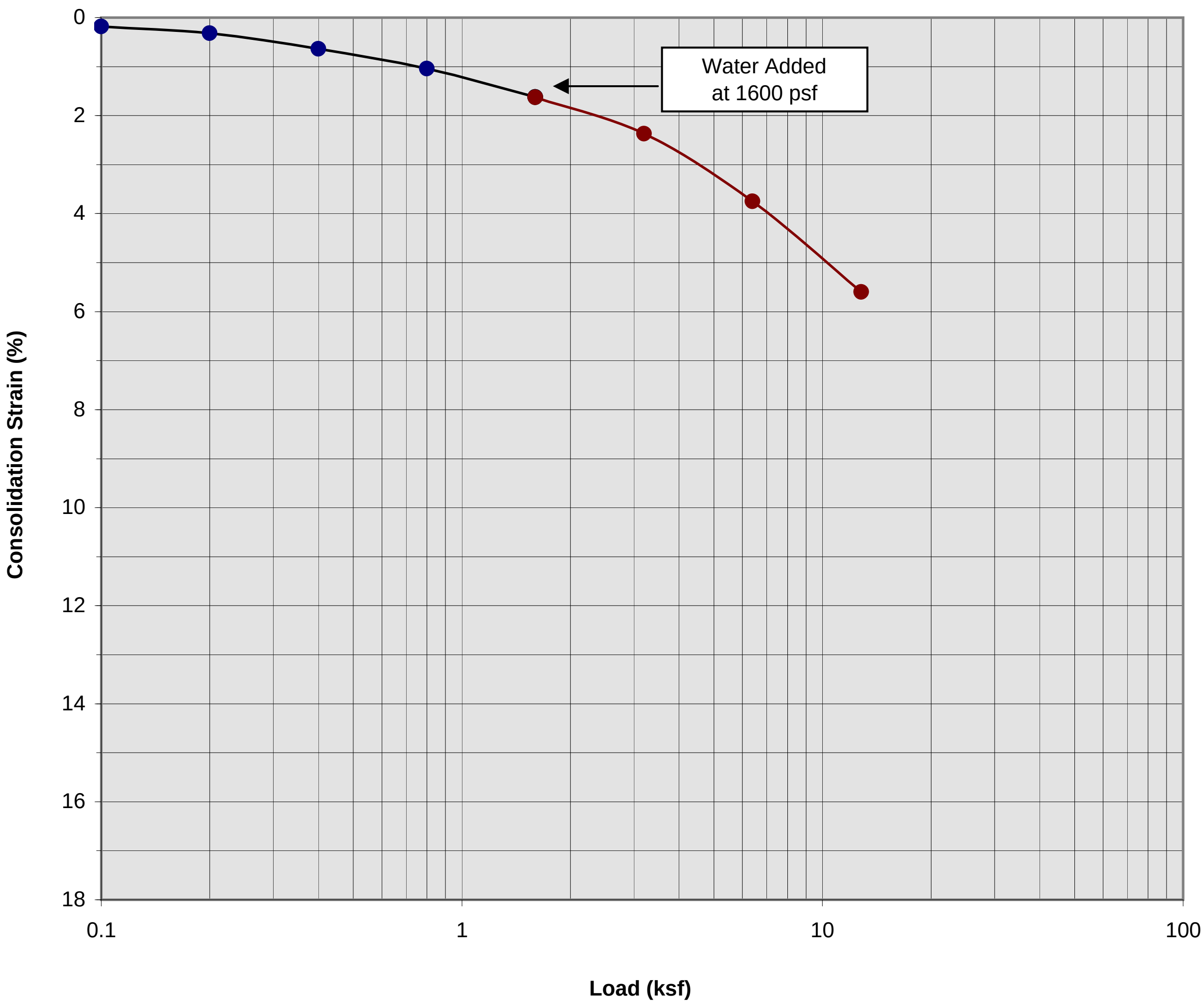
Classification: Gray Brown fine Sandy Silt, trace Clay

Boring Number:	B-10	Initial Moisture Content (%)	18
Sample Number:	---	Final Moisture Content (%)	18
Depth (ft)	3 to 4	Initial Dry Density (pcf)	109.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	114.3
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.00

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 10

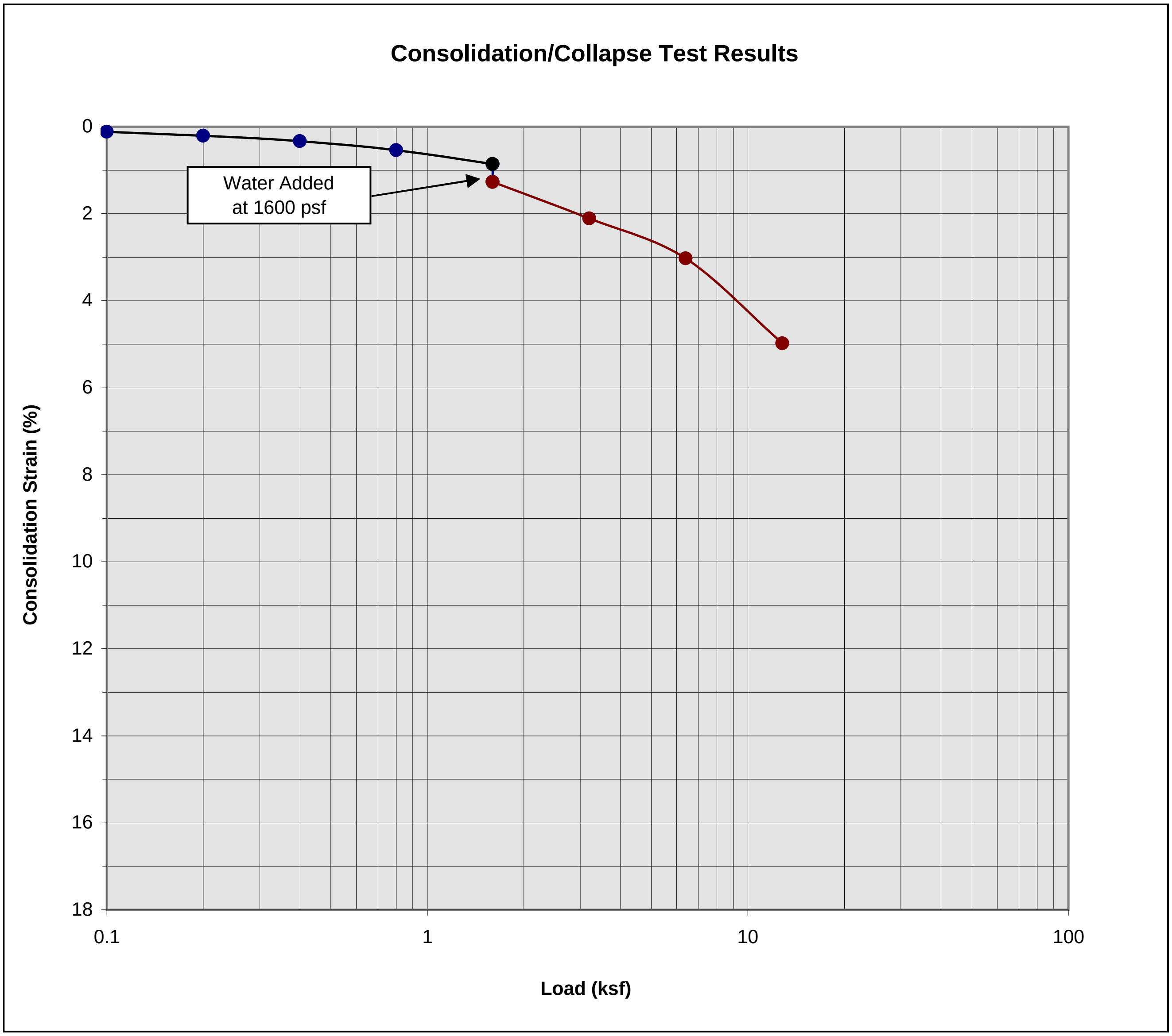
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

Consolidation/Collapse Test Results



Classification: Gray Brown fine Sandy Silt, trace Clay

Boring Number:	B-10	Initial Moisture Content (%)	21
Sample Number:	---	Final Moisture Content (%)	22
Depth (ft)	5 to 6	Initial Dry Density (pcf)	103.6
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	109.7
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.01

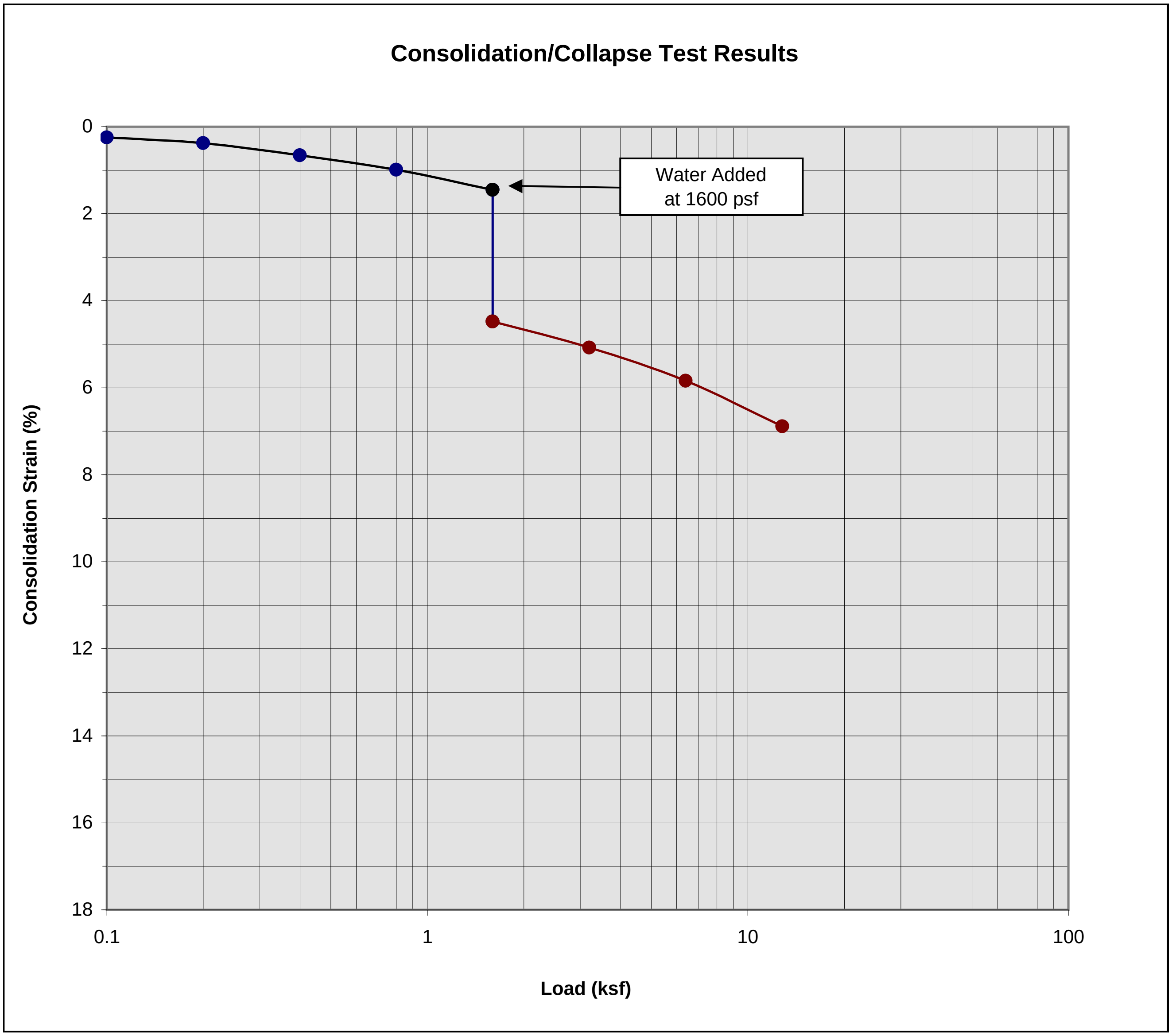


Classification: Light Gray Silt

Boring Number:	B-10	Initial Moisture Content (%)	12
Sample Number:	---	Final Moisture Content (%)	27
Depth (ft)	7 to 8	Initial Dry Density (pcf)	96.5
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	101.3
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.41

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 12

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

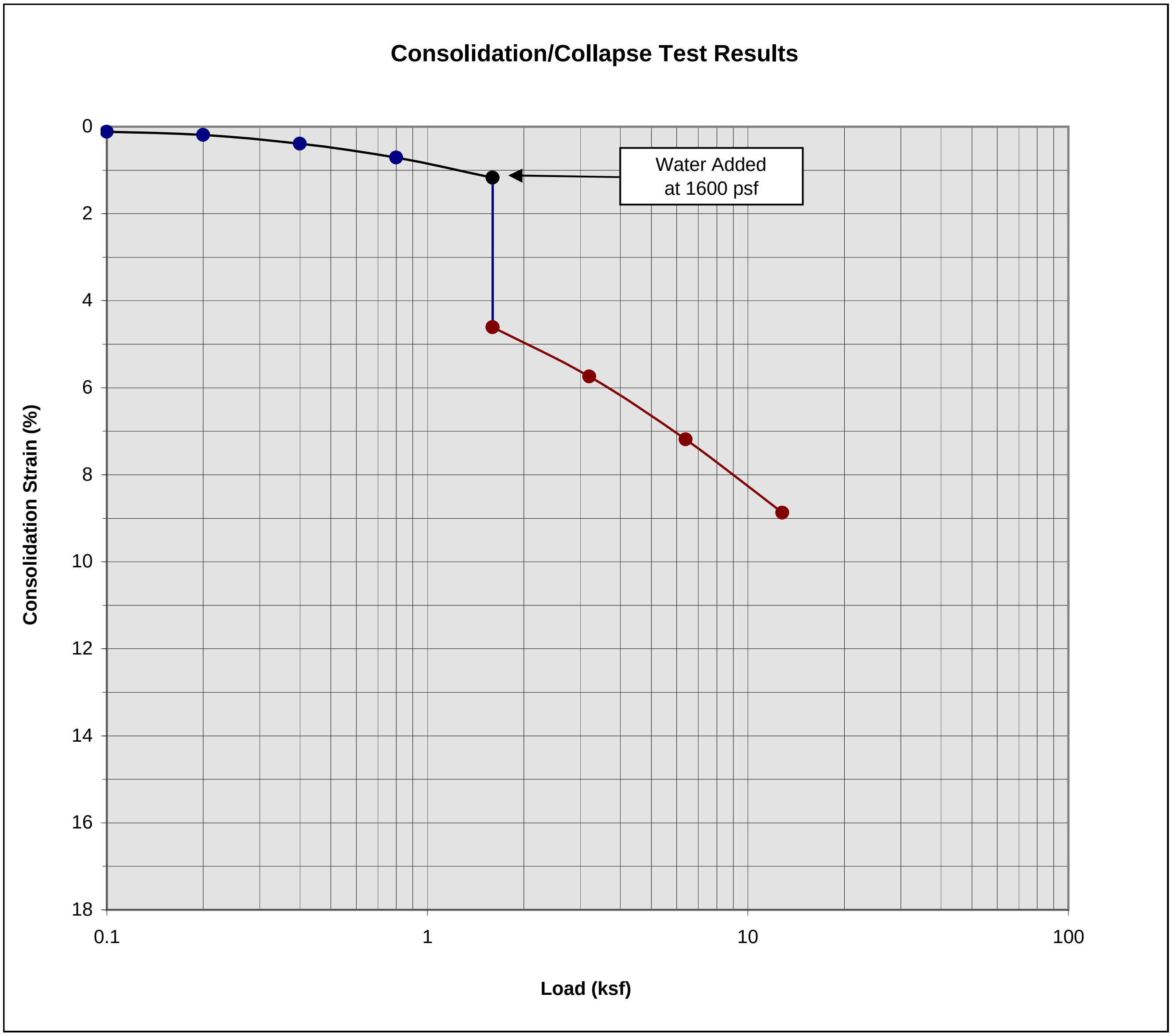


Classification: Red Brown Silty fine Sand

Boring Number:	B-12	Initial Moisture Content (%)	10
Sample Number:	---	Final Moisture Content (%)	11
Depth (ft)	1 to 2	Initial Dry Density (pcf)	119.0
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	128.0
Specimen Thickness (in)	1.0	Percent Collapse (%)	3.03

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 13

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation

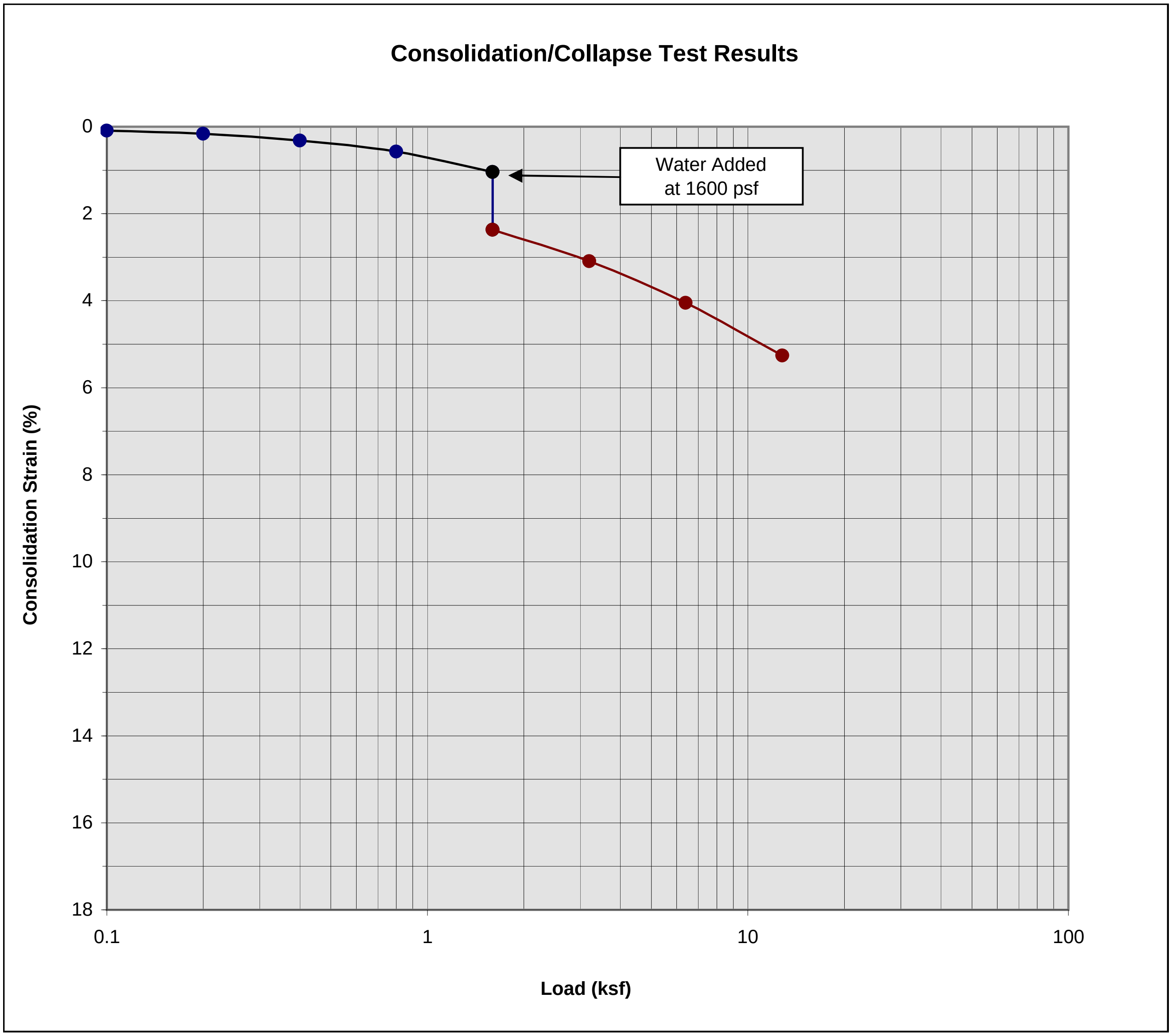


Classification: Red Brown Silty fine Sand

Boring Number:	B-12	Initial Moisture Content (%)	10
Sample Number:	---	Final Moisture Content (%)	15
Depth (ft)	3 to 4	Initial Dry Density (pcf)	105.8
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	116.6
Specimen Thickness (in)	1.0	Percent Collapse (%)	3.44

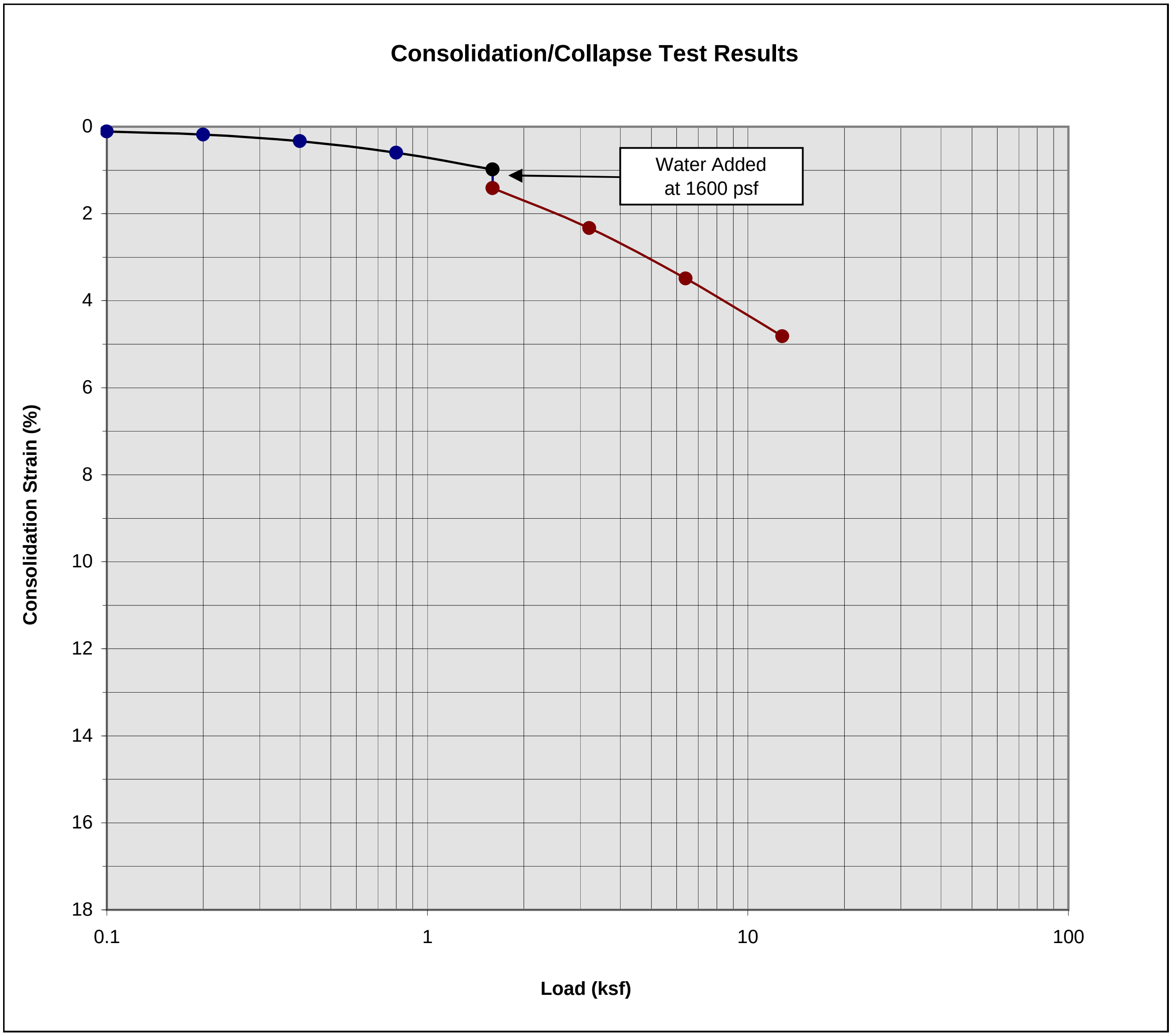
Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 14

SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



Classification: Red Brown Silty fine Sand

Boring Number:	B-12	Initial Moisture Content (%)	8
Sample Number:	---	Final Moisture Content (%)	18
Depth (ft)	5 to 6	Initial Dry Density (pcf)	104.6
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	110.6
Specimen Thickness (in)	1.0	Percent Collapse (%)	1.33

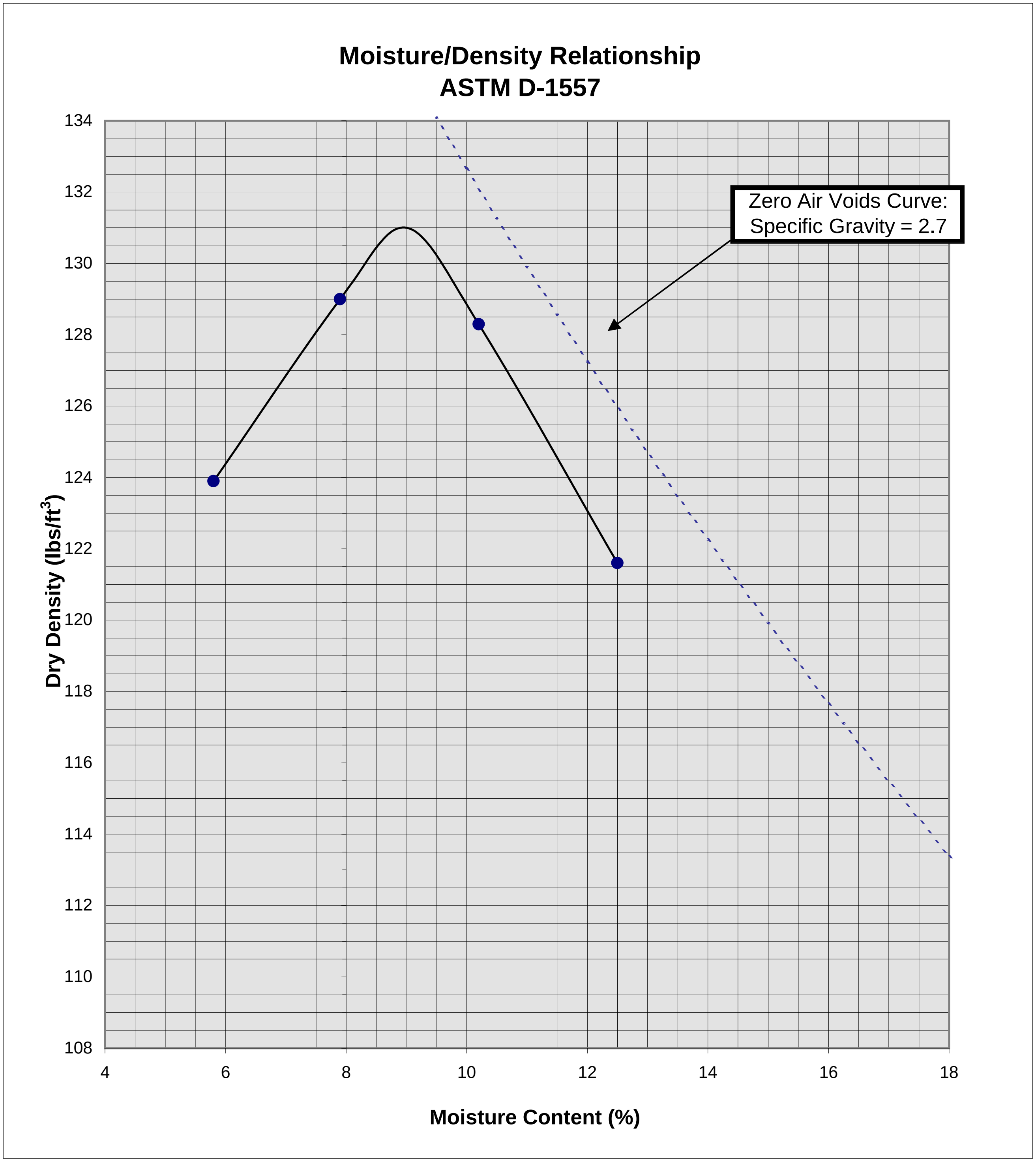


Classification: Red Brown Silty fine Sand

Boring Number:	B-12	Initial Moisture Content (%)	7
Sample Number:	---	Final Moisture Content (%)	18
Depth (ft)	7 to 8	Initial Dry Density (pcf)	101.2
Specimen Diameter (in)	2.4	Final Dry Density (pcf)	106.3
Specimen Thickness (in)	1.0	Percent Collapse (%)	0.43

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C- 16

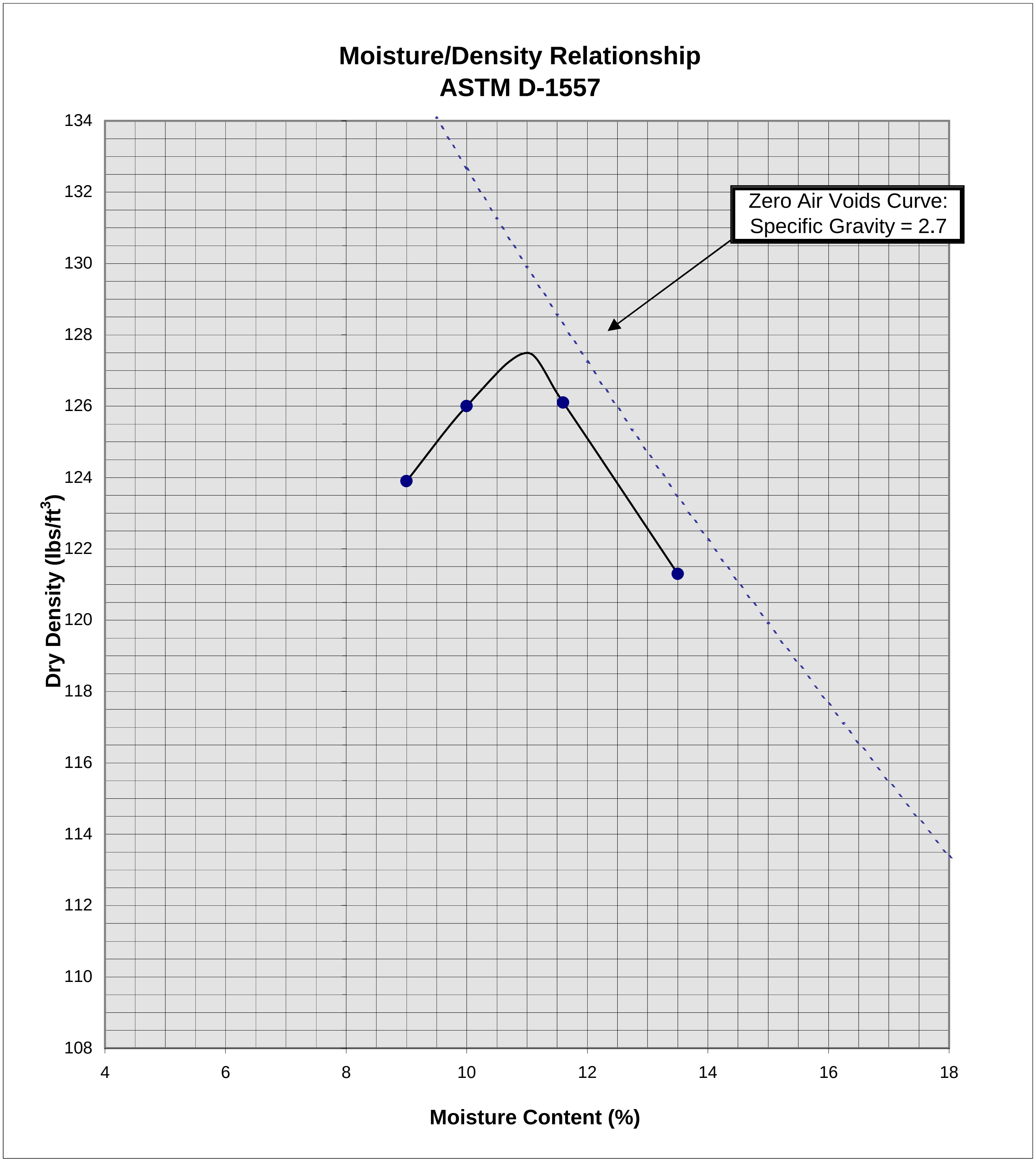
SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



Soil ID Number	B-1 @ 0 to 5'
Optimum Moisture (%)	9
Maximum Dry Density (pcf)	131
Soil Classification	Brown Silty fine Sand

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C-17

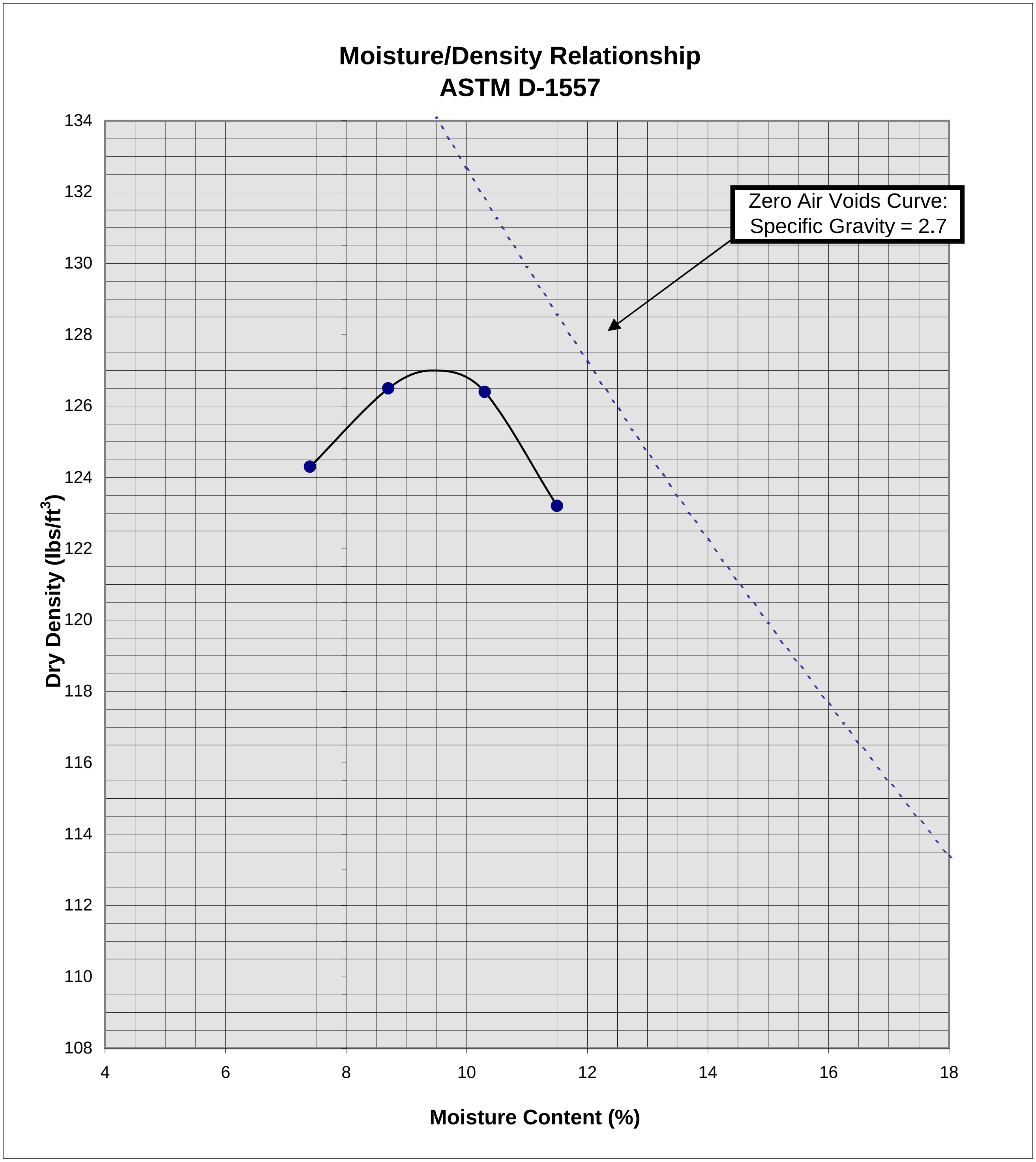
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



Soil ID Number	B-9 @ 0 to 5'
Optimum Moisture (%)	11
Maximum Dry Density (pcf)	127.5
Soil Classification	Red Brown Clayey fine Sand

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C-18

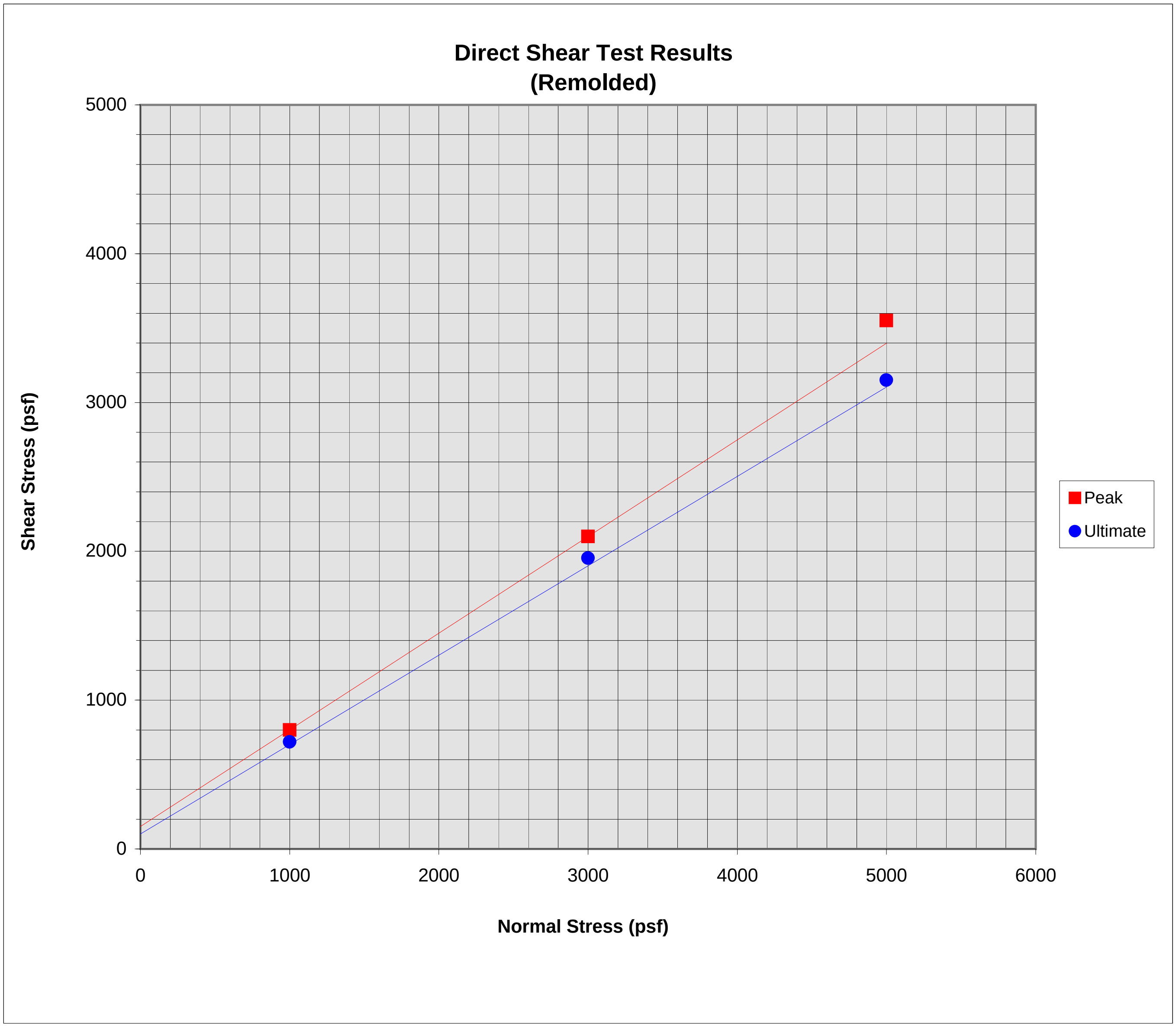
SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



Soil ID Number	B-11 @ 0 to 5'
Optimum Moisture (%)	9.5
Maximum Dry Density (pcf)	127
Soil Classification	Brown Silty fine Sand

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C-19

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



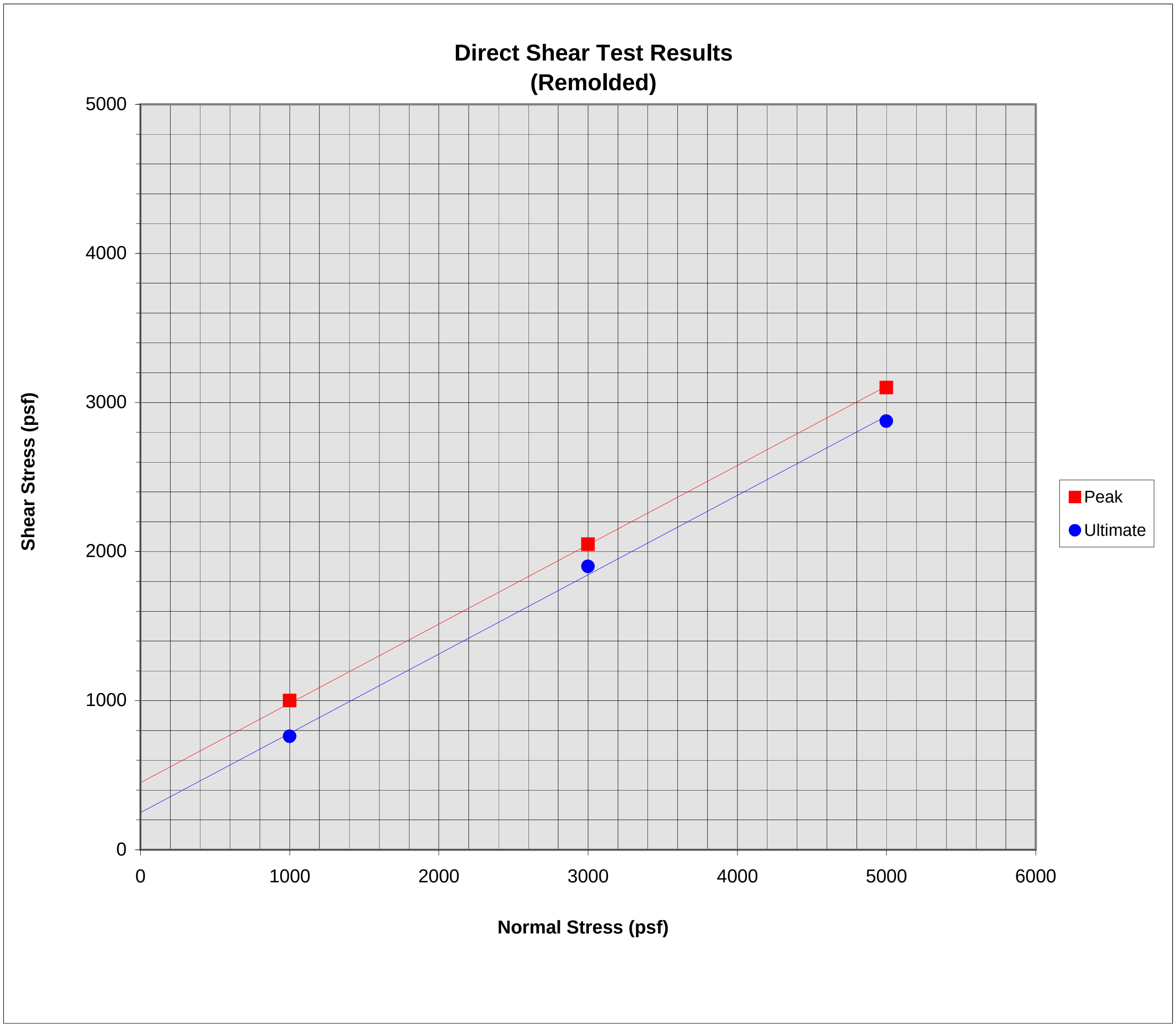
Sample Description: B-1 @ 0 to 5 feet

Classification: Brown Silty fine Sand

Sample Data			Test Results		
Remolded Moisture Content	9.0				
Final Moisture Content	---			Peak	Ultimate
Remolded Dry Density	117.9		ϕ (°)	33.0	31.0
Percent Compaction	90.0		C (psf)	150	100
Final Dry Density	---				
Specimen Diameter (in)	2.4				
Specimen Thickness (in)	1.0				

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C-20

SoCalGeo SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



Sample Description: B-9 @ 0 to 5 feet

Classification: Red Brown Clayey fine Sand

Sample Data

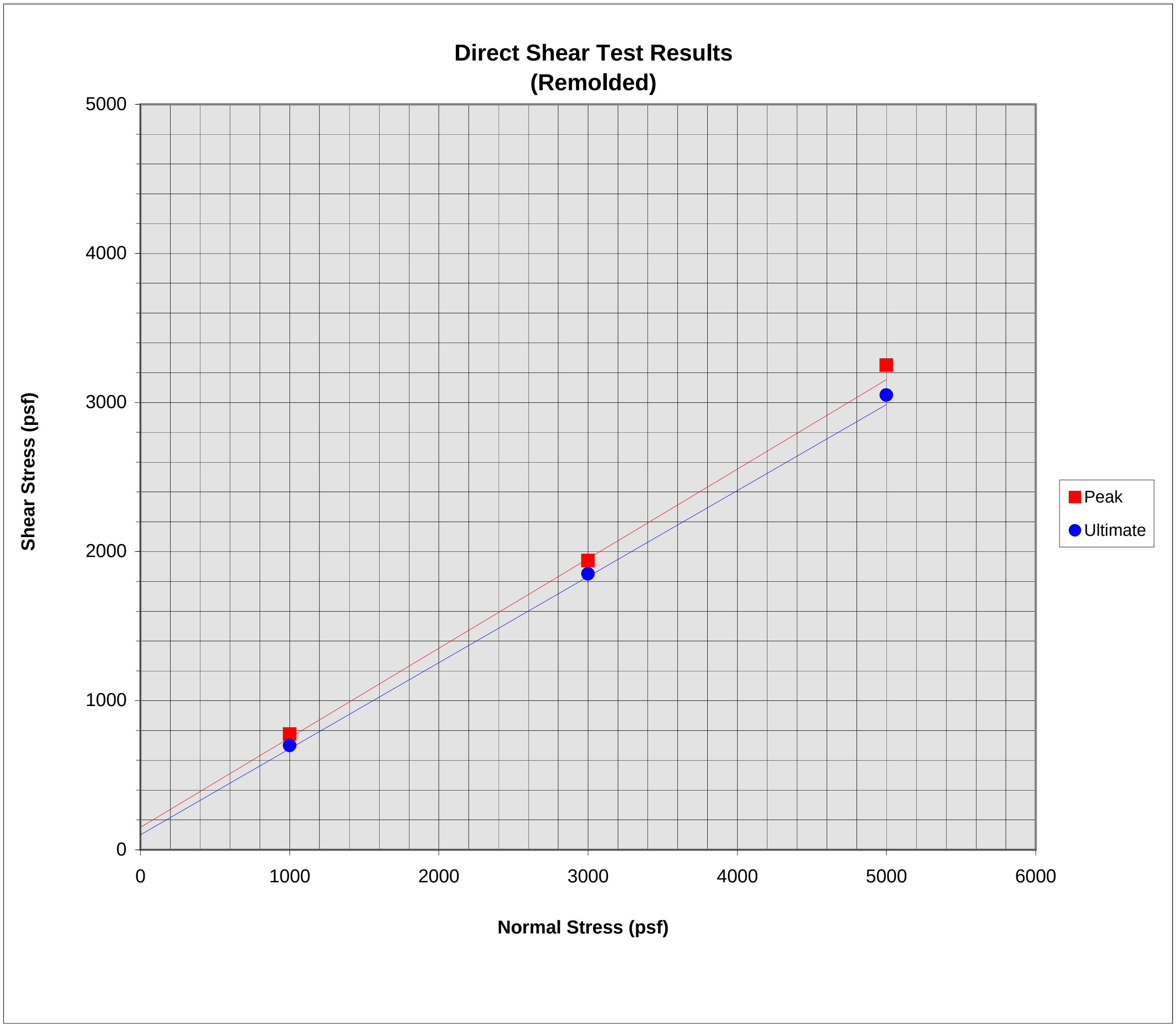
Remolded Moisture Content	9.0
Final Moisture Content	---
Remolded Dry Density	114.7
Percent Compaction	90.0
Final Dry Density	---
Specimen Diameter (in)	2.4
Specimen Thickness (in)	1.0

Test Results

	Peak	Ultimate
ϕ (°)	28.0	28.0
C (psf)	450	250

Norco Ranch Commerce Park
Norco, California
Project No. 11G114
PLATE C-21

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
A California Corporation



Sample Description: B-11 @ 0 to 5 feet

Classification: Brown Silty fine Sand

Sample Data			Test Results	
Remolded Moisture Content	9.0			
Final Moisture Content	---		Peak	Ultimate
Remolded Dry Density	114.3	ϕ (°)	31.0	30.0
Percent Compaction	90.0	C (psf)	150	100
Final Dry Density	---			
Specimen Diameter (in)	2.4			
Specimen Thickness (in)	1.0			

Norco Ranch Commerce Park
Norco, California
Project No. 11G114

PLATE C-22

SoCalGeo
SOUTHERN CALIFORNIA GEOTECHNICAL
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Appendix 4: Historical Site Conditions

Not Applicable

Appendix 5: LID Infeasibility

LID Technical Infeasibility Analysis

Appendix 6: BMP Design Details

BMP Sizing, Design Details and other Supporting Documentation

Infiltration Basin - Design Procedure (Rev. 03-2012)	BMP ID	Legend:	Required Entries
	Basin 1		Calculated Cells

Company Name:	Michael Baker International	Date:	7/30/2019
Designed by:	E Ruedas	County/City Case No.:	1

Design Volume

a) Tributary area (BMP subarea)	A_T =	48.934	acres
b) Enter V_{BMP} determined from Section 2.1 of this Handbook	V_{BMP}=	96,221	ft^3

Maximum Depth

a) Infiltration rate	I =	11.8	in/hr
b) Factor of Safety (See Table 1, Appendix A: "Infiltration Testing" from this BMP Handbook)	FS =	6	
c) Calculate D_1 $\quad D_1 = \dfrac{\text{I (in/hr) x 72 hrs}}{\text{12 (in/ft) x FS}}$	D_1 =	11.8	ft
d) Enter the depth of freeboard (at least 1 ft)		1	ft
e) Enter depth to historic high ground water (measured from **top** of basin)		22	ft
f) Enter depth to top of bedrock or impermeable layer (measured from **top** of basin)		37	ft
g) D_2 is the smaller of: Depth to groundwater - (10 ft + freeboard) and Depth to impermeable layer - (5 ft + freeboard)	D_2 =	11.0	ft
h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet	D_{MAX} =	11.0	ft

Basin Geometry

a) Basin side slopes (no steeper than 4:1)	z =	4	:1
b) Proposed basin depth (excluding freeboard)	d_B =	5	ft
c) Minimum bottom surface area of basin (A_S= V_{BMP}/d_B)	A_S =	19244	ft^2
d) Proposed Design Surface Area	A_D =	20515	ft^2

Forebay

a) Forebay volume (minimum 0.5% V_{BMP})	Volume =	481	ft^3
b) Forebay depth (height of berm/splashwall. 1 foot min.)	Depth =	1	ft
c) Forebay surface area (minimum)	Area =	481	ft^2
d) Full height notch-type weir	Width (W) =	6.0	in

Notes:

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: Michael Baker International — Date: 7/30/2019
Designed by: E Ruedas — Case No: 1
Company Project Number/Name: Palomino Business Park

BMP Identification

BMP NAME / ID: Infiltration Basin 1

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}= 0.78 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)*
DMA A-1								
Bldg. 1	*41600*	*Roofs*	*1*	*0.89*	*37107.2*			
Bldg. 2	*41600*	*Roofs*	*1*	*0.89*	*37107.2*			
Bldg. 5	*117075*	*Roofs*	*1*	*0.89*	*104430.9*			
Bldg. 6	*157275*	*Roofs*	*1*	*0.89*	*140289.3*			
Bldg. 7a	*65350*	*Roofs*	*1*	*0.89*	*58292.2*			
Bldg. 11	*40597*	*Roofs*	*1*	*0.89*	*36212.5*			
Bldg. 12	*16117*	*Roofs*	*1*	*0.89*	*14376.4*			
Bldg. 13	*133480*	*Roofs*	*1*	*0.89*	*119064.2*			
Bldg. 14	*142100*	*Roofs*	*1*	*0.89*	*126753.2*			
DMA B-1								
Bldg. A	*13040*	*Roofs*	*1*	*0.89*	*11631.7*			
Bldg. B	*4095*	*Roofs*	*1*	*0.89*	*3652.7*			
Bldg. C	*4275*	*Roofs*	*1*	*0.89*	*3813.3*			
DMA A-2	*741900*	*Concrete or Asphalt*	*1*	*0.89*	*661774.8*			
DMA B-2	*74332*	*Concrete or Asphalt*	*1*	*0.89*	*66304.1*			
DMA A-3	*245800*	*Ornamental Landscaping*	*0.1*	*0.11*	*27150.6*			
DMA B-3	*59318.44*	*Ornamental Landscaping*	*0.1*	*0.11*	*6552.2*			
DMA AB	*233610*	*Ornamental Landscaping*	*0.1*	*0.11*	*25804.1*			
	2131564.44	***Total***			**1480316.6**	**0.78**	***96220.6***	***131,787***

Notes:

Infiltration Basin - Design Procedure (Rev. 03-2012)	BMP ID	Legend:	Required Entries
	Basin 2		Calculated Cells

Company Name: Michael Baker International — Date: 10/30/2019

Designed by: E Ruedas — County/City Case No.: 1

Design Volume

a) Tributary area (BMP subarea) — A_T = 9.26621 acres

b) Enter V_{BMP} determined from Section 2.1 of this Handbook — V_{BMP}= 18,623 ft^3

Maximum Depth

a) Infiltration rate — I = 11.8 in/hr

b) Factor of Safety (See Table 1, Appendix A: "Infiltration Testing" from this BMP Handbook) — FS = 6

c) Calculate D_1 — $D_1 = \dfrac{I\ (in/hr) \times 72\ hrs}{12\ (in/ft) \times FS}$ — D_1 = 11.8 ft

d) Enter the depth of freeboard (at least 1 ft) — 1 ft

e) Enter depth to historic high ground water (measured from **top** of basin) — 22 ft

f) Enter depth to top of bedrock or impermeable layer (measured from **top** of basin) — 37 ft

g) D_2 is the smaller of:

Depth to groundwater - (10 ft + freeboard) and
Depth to impermeable layer - (5 ft + freeboard) — D_2 = 11.0 ft

h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet — D_{MAX} = 11.0 ft

Basin Geometry

a) Basin side slopes (no steeper than 4:1) — z = 4 :1

b) Proposed basin depth (excluding freeboard) — d_B = 3 ft

c) Minimum bottom surface area of basin (A_S= V_{BMP}/d_B) — A_S = 6208 ft^2

d) Proposed Design Surface Area — A_D = 9230 ft^2

Forebay

a) Forebay volume (minimum 0.5% V_{BMP}) — Volume = 93 ft^3

b) Forebay depth (height of berm/splashwall. 1 foot min.) — Depth = 1 ft

c) Forebay surface area (minimum) — Area = 93 ft^2

d) Full height notch-type weir — Width (W) = 6.0 in

Notes:

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: Michael Baker International | Date: 10/30/2019

Designed by: E Ruedas | Case No: 1

Company Project Number/Name: Palomino Business Park

BMP Identification

BMP NAME / ID: Infiltration Basin 2

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}= 0.78 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)*
DMA A1-1								
Bldg. 3	*41600*	*Roofs*	*1*	*0.89*	*37107.2*			
Bldg. 4	*41600*	*Roofs*	*1*	*0.89*	*37107.2*			
Bldg. 11	*46243*	*Roofs*	*1*	*0.89*	*41248.8*			
Bldg. 12	*73193*	*Roofs*	*1*	*0.89*	*65288.2*			
DMA A1-2	*106900*	*Concrete or Asphalt*	*1*	*0.89*	*95354.8*			
DMA A1-3	*94100*	*Ornamental Landscaping*	*0.1*	*0.11*	*10394.1*			
	403636	***Total***			**286500.3**	**0.78**	***18622.5***	***21,190***

Notes:

Infiltration Basin - Design Procedure (Rev. 03-2012)	BMP ID	Legend:	Required Entries
	Basin 3		Calculated Cells

Company Name:	Michael Baker International	Date:	7/30/2019
Designed by:	E Ruedas	County/City Case No.:	1

Design Volume

a) Tributary area (BMP subarea)	A_T =	23.4537	acres
b) Enter V_{BMP} determined from Section 2.1 of this Handbook	V_{BMP}=	49,349	ft^3

Maximum Depth

a) Infiltration rate	I =	4	in/hr
b) Factor of Safety (See Table 1, Appendix A: "Infiltration Testing" from this BMP Handbook)	FS =	6	
c) Calculate D_1 $D_1 = \dfrac{I\ (in/hr) \times 72\ hrs}{12\ (in/ft) \times FS}$	D_1 =	4.0	ft
d) Enter the depth of freeboard (at least 1 ft)		1	ft
e) Enter depth to historic high ground water (measured from **top** of basin)		22	ft
f) Enter depth to top of bedrock or impermeable layer (measured from **top** of basin)		37	ft
g) D_2 is the smaller of: Depth to groundwater - (10 ft + freeboard) and Depth to impermeable layer - (5 ft + freeboard)	D_2 =	11.0	ft
h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet	D_{MAX} =	4.0	ft

Basin Geometry

a) Basin side slopes (no steeper than 4:1)	z =	4	:1
b) Proposed basin depth (excluding freeboard)	d_B =	4	ft
c) Minimum bottom surface area of basin ($A_S = V_{BMP}/d_B$)	A_S =	12337	ft^2
d) Proposed Design Surface Area	A_D =	16511	ft^2

Forebay

a) Forebay volume (minimum 0.5% V_{BMP})	Volume =	247	ft^3
b) Forebay depth (height of berm/splashwall. 1 foot min.)	Depth =	1.5	ft
c) Forebay surface area (minimum)	Area =	164	ft^2
d) Full height notch-type weir	Width (W) =	6.0	in

Notes:

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: Michael Baker International — Date: 7/30/2019

Designed by: E Ruedas — Case No: 1

Company Project Number/Name: Palomino Business Park

BMP Identification

BMP NAME / ID: Infiltration Basin 3

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}= 0.78 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 Impervious 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)*
DMA C-1								
BLDG 7b	91925	Roofs	1	0.89	81997.1			
BLDG 8	69730	Roofs	1	0.89	62199.2			
BLDG 9	64270	Roofs	1	0.89	57328.8			
BLDG 10	42300	Roofs	1	0.89	37731.6			
BLDG 15	61290	Roofs	1	0.89	54670.7			
BLDG 16	61290	Roofs	1	0.89	54670.7			
BLDG 17	54080	Roofs	1	0.89	48239.4			
BLDG 18	35360	Roofs	1	0.89	31541.1			
DMA C-2	346800	Concrete or Asphalt	1	0.89	309345.6			
DMA C-3	194600	Ornamental Landscaping	0.1	0.11	21495.1			
	1021645	*Total*			759219.3	0.78	49349.3	58293

Notes:

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: Michael Baker International | Date: 8/5/2019

Designed by: E Ruedas | Case No: 1

Company Project Number/Name: Palomino Business Park (Phase II)

BMP Identification

BMP NAME / ID: Underground Infiltration Chamber 1

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}= 0.78 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)*
DMA D-1								
BLDG 19	*44720*	*Roofs*	*1*	*0.89*	*39890.2*			
BLDG 20	*28080*	*Roofs*	*1*	*0.89*	*25047.4*			
BLDG 21	*53070*	*Roofs*	*1*	*0.89*	*47338.4*			
DMA D-2	*143309*	*Concrete or Asphalt*	*1*	*0.89*	*127831.6*			
DMA D-3	*47502*	*Ornamental Landscaping*	*0.1*	*0.11*	*5247*			
	316681	***Total***			**245354.6**	**0.78**	***15948***	***16000***

Notes: For reference only.

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: Michael Baker International — Date: 8/5/2019

Designed by: E Ruedas — Case No: 1

Company Project Number/Name: Palomino Business Park (Phase II)

BMP Identification

BMP NAME / ID: Underground Infiltration Chamber 2

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}= 0.78 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)*
DMA E-1								
BLDG 22	*37440*	*Roofs*	*1*	*0.89*	*33396.5*			
BLDG 23	*30420*	*Roofs*	*1*	*0.89*	*27134.6*			
BLDG 24	*49920*	*Roofs*	*1*	*0.89*	*44528.6*			
BLDG 25	*43680*	*Roofs*	*1*	*0.89*	*38962.6*			
BLDG 26	*57600*	*Roofs*	*1*	*0.89*	*51379.2*			
BLDG 27	*9240*	*Roofs*	*1*	*0.89*	*8242.1*			
BLDG 28	*11040*	*Roofs*	*1*	*0.89*	*9847.7*			
BLDG 29	*12840*	*Roofs*	*1*	*0.89*	*11453.3*			
BLDG 30	*12840*	*Roofs*	*1*	*0.89*	*11453.3*			
BLDG 31	*12840*	*Roofs*	*1*	*0.89*	*11453.3*			
BLDG 32	*12840*	*Roofs*	*1*	*0.89*	*11453.3*			
DMA E-2	*181011*	*Concrete or Asphalt*	*1*	*0.89*	*161461.8*			
DMA E-3	*83243*	*Ornamental Landscaping*	*0.1*	*0.11*	*9194.9*			
	554954	***Total***			**429961.2**	**0.78**	***27947.5***	***28000***

Notes: For reference only.

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: Michael Baker International — Date: 8/5/2019

Designed by: E Ruedas — Case No: 1

Company Project Number/Name: Palomino Business Park (Phase II)

BMP Identification

BMP NAME / ID: Underground Infiltration Chamber 3

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}= 0.78 inches

Drainage Management Area Tabulation

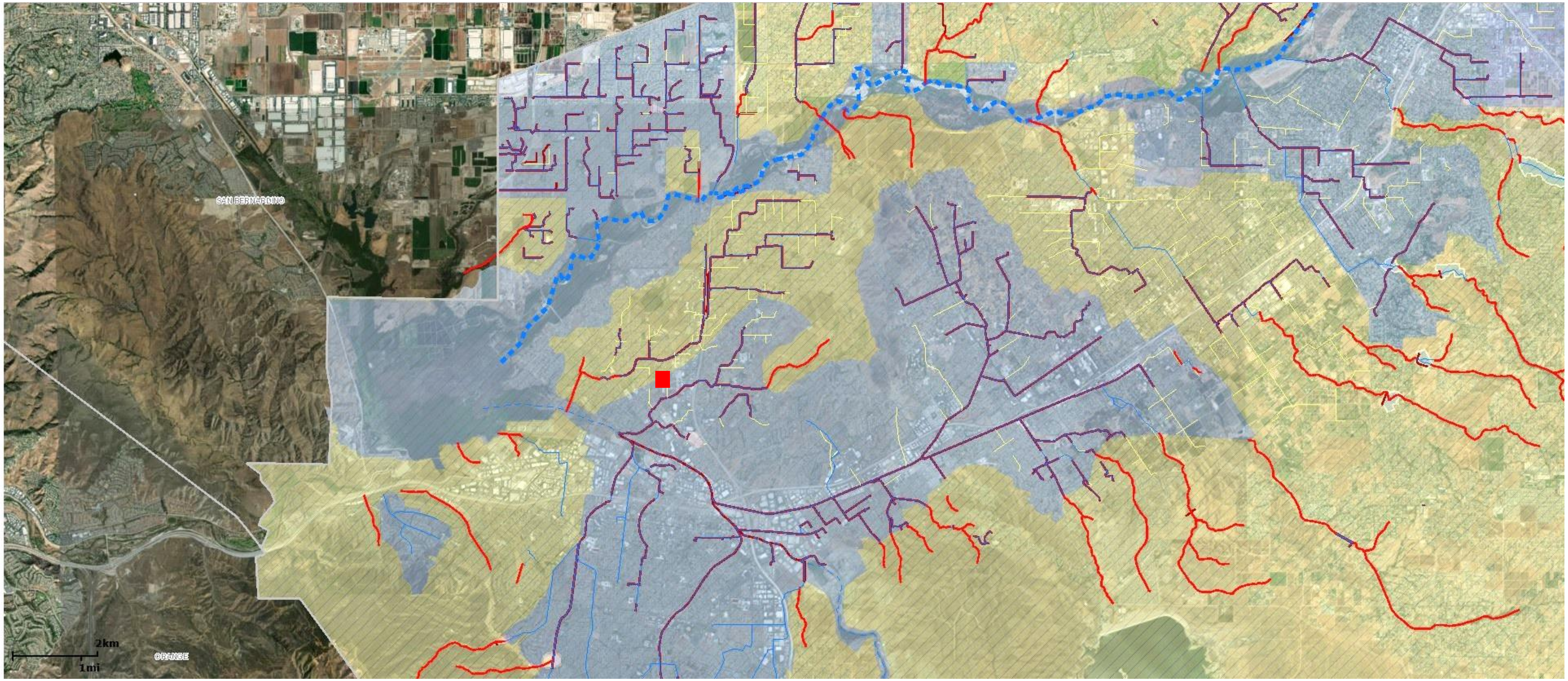
Insert additional rows if needed to accommodate all DMAs draining to the BMP

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)*
DMA F-1								
BLDG 33	*37440*	*Roofs*	*1*	*0.89*	*33396.5*			
BLDG 34	*37440*	*Roofs*	*1*	*0.89*	*33396.5*			
BLDG 35	*51090*	*Roofs*	*1*	*0.89*	*45572.3*			
DMA F-2	*102480*	*Concrete or Asphalt*	*1*	*0.89*	*91412.2*			
DMA F-3	*40315*	*Ornamental Landscaping*	*0.1*	*0.11*	*4453.1*			
	268765	***Total***			**208230.6**	**0.78**	***13535***	***13550***

Notes: For reference only.

Appendix 7: Hydromodification

Supporting Detail Relating to Hydrologic Conditions of Concern



Site Address: rcstormwatertool.org

Legend

	Hydromodification Exemption Area
	Hydromodification Non-Exemption Area
	Project Location

Riverside County
SWCTT

Stormwater Map

U n i t   H y d r o g r a p h   A n a l y s i s

Study date 03/06/19 File: UHEXISTA242.out

++

Riverside County Synthetic Unit Hydrology Method
RCFC & WCD Manual date - April 1978

Program License Serial Number 6388

English (in-lb) Input Units Used
English Rainfall Data (Inches) Input Values Used

English Units used in output format

Drainage Area = 63.19(Ac.) = 0.099 Sq. Mi.
Drainage Area for Depth-Area Areal Adjustment = 63.19(Ac.) = 0.099 Sq. Mi.
Length along longest watercourse = 2958.00(Ft.)
Length along longest watercourse measured to centroid = 2267.00(Ft.)
Length along longest watercourse = 0.560 Mi.
Length along longest watercourse measured to centroid = 0.429 Mi.
Difference in elevation = 30.60(Ft.)
Slope along watercourse = 54.6207 Ft./Mi.
Average Manning's 'N' = 0.025
Lag time = 0.163 Hr.
Lag time = 9.80 Min.
25% of lag time = 2.45 Min.
40% of lag time = 3.92 Min.
Unit time = 5.00 Min.
Duration of storm = 24 Hour(s)
User Entered Base Flow = 0.00(CFS)

2 YEAR Area rainfall data:

Area(Ac.)[1]	Rainfall(In)[2]	Weighting[1*2]
63.19	2.25	142.18

100 YEAR Area rainfall data:

Area(Ac.)[1]	Rainfall(In)[2]	Weighting[1*2]
63.19	7.25	458.13

STORM EVENT (YEAR) = 2.00
Area Averaged 2-Year Rainfall = 2.250(In)
Area Averaged 100-Year Rainfall = 7.250(In)

Point rain (area averaged) = 2.250(In)
Areal adjustment factor = 99.99 %
Adjusted average point rain = 2.250(In)

Sub-Area Data:

Area(Ac.)	Runoff Index	Impervious %
63.190	84.00	0.400

Total Area Entered = 63.19(Ac.)

RI AMC2	RI AMC-1	Infil. Rate (In/Hr)	Impervious (Dec.%)	Adj. Infil. Rate (In/Hr)	Area% (Dec.)	F (In/Hr)
84.0	68.6	0.377	0.400	0.241	1.000	0.241
					Sum (F) =	0.241

Area averaged mean soil loss (F) (In/Hr) = 0.241
Minimum soil loss rate ((In/Hr)) = 0.121
(for 24 hour storm duration)
Soil low loss rate (decimal) = 0.800

U n i t   H y d r o g r a p h
VALLEY S-Curve

Unit Hydrograph Data

Unit time period	(hrs)	Time % of lag	Distribution Graph %	Unit Hydrograph (CFS)
1	0.083	51.041	6.323	4.027
2	0.167	102.081	27.033	17.215
3	0.250	153.122	28.733	18.298
4	0.333	204.163	12.592	8.019
5	0.417	255.203	6.700	4.267
6	0.500	306.244	4.666	2.972
7	0.583	357.285	3.351	2.134
8	0.667	408.325	2.538	1.616
9	0.750	459.366	1.846	1.176
10	0.833	510.407	1.557	0.991
11	0.917	561.447	1.247	0.794
12	1.000	612.488	0.974	0.620

13	1.083	663.529	0.766	0.488
14	1.167	714.569	0.566	0.360
15	1.250	765.610	0.510	0.325
16	1.333	816.651	0.599	0.382
			Sum = 100.000	Sum= 63.684

The following loss rate calculations reflect use of the minimum calculated loss rate subtracted from the Storm Rain to produce the maximum Effective Rain value

Unit	Time (Hr.)	Pattern Percent	Storm Rain (In/Hr)	Loss rate(In./Hr) Max	Low	Effective (In/Hr)
1	0.08	0.07	0.018	(0.428)	0.014	0.004
2	0.17	0.07	0.018	(0.426)	0.014	0.004
3	0.25	0.07	0.018	(0.425)	0.014	0.004
4	0.33	0.10	0.027	(0.423)	0.022	0.005
5	0.42	0.10	0.027	(0.421)	0.022	0.005
6	0.50	0.10	0.027	(0.420)	0.022	0.005
7	0.58	0.10	0.027	(0.418)	0.022	0.005
8	0.67	0.10	0.027	(0.416)	0.022	0.005
9	0.75	0.10	0.027	(0.415)	0.022	0.005
10	0.83	0.13	0.036	(0.413)	0.029	0.007
11	0.92	0.13	0.036	(0.411)	0.029	0.007
12	1.00	0.13	0.036	(0.410)	0.029	0.007
13	1.08	0.10	0.027	(0.408)	0.022	0.005
14	1.17	0.10	0.027	(0.407)	0.022	0.005
15	1.25	0.10	0.027	(0.405)	0.022	0.005
16	1.33	0.10	0.027	(0.403)	0.022	0.005
17	1.42	0.10	0.027	(0.402)	0.022	0.005
18	1.50	0.10	0.027	(0.400)	0.022	0.005
19	1.58	0.10	0.027	(0.399)	0.022	0.005
20	1.67	0.10	0.027	(0.397)	0.022	0.005
21	1.75	0.10	0.027	(0.395)	0.022	0.005
22	1.83	0.13	0.036	(0.394)	0.029	0.007
23	1.92	0.13	0.036	(0.392)	0.029	0.007
24	2.00	0.13	0.036	(0.391)	0.029	0.007
25	2.08	0.13	0.036	(0.389)	0.029	0.007
26	2.17	0.13	0.036	(0.387)	0.029	0.007
27	2.25	0.13	0.036	(0.386)	0.029	0.007
28	2.33	0.13	0.036	(0.384)	0.029	0.007
29	2.42	0.13	0.036	(0.383)	0.029	0.007
30	2.50	0.13	0.036	(0.381)	0.029	0.007
31	2.58	0.17	0.045	(0.380)	0.036	0.009
32	2.67	0.17	0.045	(0.378)	0.036	0.009
33	2.75	0.17	0.045	(0.377)	0.036	0.009
34	2.83	0.17	0.045	(0.375)	0.036	0.009
35	2.92	0.17	0.045	(0.373)	0.036	0.009
36	3.00	0.17	0.045	(0.372)	0.036	0.009
37	3.08	0.17	0.045	(0.370)	0.036	0.009
38	3.17	0.17	0.045	(0.369)	0.036	0.009
39	3.25	0.17	0.045	(0.367)	0.036	0.009
40	3.33	0.17	0.045	(0.366)	0.036	0.009
41	3.42	0.17	0.045	(0.364)	0.036	0.009
42	3.50	0.17	0.045	(0.363)	0.036	0.009
43	3.58	0.17	0.045	(0.361)	0.036	0.009
44	3.67	0.17	0.045	(0.360)	0.036	0.009
45	3.75	0.17	0.045	(0.358)	0.036	0.009
46	3.83	0.20	0.054	(0.357)	0.043	0.011
47	3.92	0.20	0.054	(0.355)	0.043	0.011
48	4.00	0.20	0.054	(0.354)	0.043	0.011
49	4.08	0.20	0.054	(0.352)	0.043	0.011
50	4.17	0.20	0.054	(0.351)	0.043	0.011
51	4.25	0.20	0.054	(0.349)	0.043	0.011
52	4.33	0.23	0.063	(0.348)	0.050	0.013
53	4.42	0.23	0.063	(0.346)	0.050	0.013
54	4.50	0.23	0.063	(0.345)	0.050	0.013
55	4.58	0.23	0.063	(0.343)	0.050	0.013
56	4.67	0.23	0.063	(0.342)	0.050	0.013
57	4.75	0.23	0.063	(0.340)	0.050	0.013
58	4.83	0.27	0.072	(0.339)	0.058	0.014
59	4.92	0.27	0.072	(0.337)	0.058	0.014
60	5.00	0.27	0.072	(0.336)	0.058	0.014
61	5.08	0.20	0.054	(0.334)	0.043	0.011
62	5.17	0.20	0.054	(0.333)	0.043	0.011
63	5.25	0.20	0.054	(0.331)	0.043	0.011
64	5.33	0.23	0.063	(0.330)	0.050	0.013
65	5.42	0.23	0.063	(0.329)	0.050	0.013
66	5.50	0.23	0.063	(0.327)	0.050	0.013
67	5.58	0.27	0.072	(0.326)	0.058	0.014
68	5.67	0.27	0.072	(0.324)	0.058	0.014
69	5.75	0.27	0.072	(0.323)	0.058	0.014
70	5.83	0.27	0.072	(0.321)	0.058	0.014
71	5.92	0.27	0.072	(0.320)	0.058	0.014
72	6.00	0.27	0.072	(0.319)	0.058	0.014
73	6.08	0.30	0.081	(0.317)	0.065	0.016
74	6.17	0.30	0.081	(0.316)	0.065	0.016
75	6.25	0.30	0.081	(0.314)	0.065	0.016
76	6.33	0.30	0.081	(0.313)	0.065	0.016
77	6.42	0.30	0.081	(0.312)	0.065	0.016
78	6.50	0.30	0.081	(0.310)	0.065	0.016
79	6.58	0.33	0.090	(0.309)	0.072	0.018
80	6.67	0.33	0.090	(0.307)	0.072	0.018
81	6.75	0.33	0.090	(0.306)	0.072	0.018
82	6.83	0.33	0.090	(0.305)	0.072	0.018
83	6.92	0.33	0.090	(0.303)	0.072	0.018
84	7.00	0.33	0.090	(0.302)	0.072	0.018
85	7.08	0.33	0.090	(0.300)	0.072	0.018
86	7.17	0.33	0.090	(0.299)	0.072	0.018

87	7.25	0.33	0.090	(0.298)	0.072	0.018
88	7.33	0.37	0.099	(0.296)	0.079	0.020
89	7.42	0.37	0.099	(0.295)	0.079	0.020
90	7.50	0.37	0.099	(0.294)	0.079	0.020
91	7.58	0.40	0.108	(0.292)	0.086	0.022
92	7.67	0.40	0.108	(0.291)	0.086	0.022
93	7.75	0.40	0.108	(0.290)	0.086	0.022
94	7.83	0.43	0.117	(0.288)	0.094	0.023
95	7.92	0.43	0.117	(0.287)	0.094	0.023
96	8.00	0.43	0.117	(0.286)	0.094	0.023
97	8.08	0.50	0.135	(0.284)	0.108	0.027
98	8.17	0.50	0.135	(0.283)	0.108	0.027
99	8.25	0.50	0.135	(0.282)	0.108	0.027
100	8.33	0.50	0.135	(0.280)	0.108	0.027
101	8.42	0.50	0.135	(0.279)	0.108	0.027
102	8.50	0.50	0.135	(0.278)	0.108	0.027
103	8.58	0.53	0.144	(0.276)	0.115	0.029
104	8.67	0.53	0.144	(0.275)	0.115	0.029
105	8.75	0.53	0.144	(0.274)	0.115	0.029
106	8.83	0.57	0.153	(0.273)	0.122	0.031
107	8.92	0.57	0.153	(0.271)	0.122	0.031
108	9.00	0.57	0.153	(0.270)	0.122	0.031
109	9.08	0.63	0.171	(0.269)	0.137	0.034
110	9.17	0.63	0.171	(0.267)	0.137	0.034
111	9.25	0.63	0.171	(0.266)	0.137	0.034
112	9.33	0.67	0.180	(0.265)	0.144	0.036
113	9.42	0.67	0.180	(0.264)	0.144	0.036
114	9.50	0.67	0.180	(0.262)	0.144	0.036
115	9.58	0.70	0.189	(0.261)	0.151	0.038
116	9.67	0.70	0.189	(0.260)	0.151	0.038
117	9.75	0.70	0.189	(0.259)	0.151	0.038
118	9.83	0.73	0.198	(0.257)	0.158	0.040
119	9.92	0.73	0.198	(0.256)	0.158	0.040
120	10.00	0.73	0.198	(0.255)	0.158	0.040
121	10.08	0.50	0.135	(0.254)	0.108	0.027
122	10.17	0.50	0.135	(0.252)	0.108	0.027
123	10.25	0.50	0.135	(0.251)	0.108	0.027
124	10.33	0.50	0.135	(0.250)	0.108	0.027
125	10.42	0.50	0.135	(0.249)	0.108	0.027
126	10.50	0.50	0.135	(0.248)	0.108	0.027
127	10.58	0.67	0.180	(0.246)	0.144	0.036
128	10.67	0.67	0.180	(0.245)	0.144	0.036
129	10.75	0.67	0.180	(0.244)	0.144	0.036
130	10.83	0.67	0.180	(0.243)	0.144	0.036
131	10.92	0.67	0.180	(0.242)	0.144	0.036
132	11.00	0.67	0.180	(0.240)	0.144	0.036
133	11.08	0.63	0.171	(0.239)	0.137	0.034
134	11.17	0.63	0.171	(0.238)	0.137	0.034
135	11.25	0.63	0.171	(0.237)	0.137	0.034
136	11.33	0.63	0.171	(0.236)	0.137	0.034
137	11.42	0.63	0.171	(0.234)	0.137	0.034
138	11.50	0.63	0.171	(0.233)	0.137	0.034
139	11.58	0.57	0.153	(0.232)	0.122	0.031
140	11.67	0.57	0.153	(0.231)	0.122	0.031
141	11.75	0.57	0.153	(0.230)	0.122	0.031
142	11.83	0.60	0.162	(0.229)	0.130	0.032
143	11.92	0.60	0.162	(0.228)	0.130	0.032
144	12.00	0.60	0.162	(0.226)	0.130	0.032
145	12.08	0.83	0.225	(0.225)	0.180	0.045
146	12.17	0.83	0.225	(0.224)	0.180	0.045
147	12.25	0.83	0.225	(0.223)	0.180	0.045
148	12.33	0.87	0.234	(0.222)	0.187	0.047
149	12.42	0.87	0.234	(0.221)	0.187	0.047
150	12.50	0.87	0.234	(0.220)	0.187	0.047
151	12.58	0.93	0.252	(0.219)	0.202	0.050
152	12.67	0.93	0.252	(0.217)	0.202	0.050
153	12.75	0.93	0.252	(0.216)	0.202	0.050
154	12.83	0.97	0.261	(0.215)	0.209	0.052
155	12.92	0.97	0.261	(0.214)	0.209	0.052
156	13.00	0.97	0.261	(0.213)	0.209	0.052
157	13.08	1.13	0.306	0.212	(0.245)	0.094
158	13.17	1.13	0.306	0.211	(0.245)	0.095
159	13.25	1.13	0.306	0.210	(0.245)	0.096
160	13.33	1.13	0.306	0.209	(0.245)	0.097
161	13.42	1.13	0.306	0.208	(0.245)	0.098
162	13.50	1.13	0.306	0.207	(0.245)	0.099
163	13.58	0.77	0.207	(0.206)	0.166	0.041
164	13.67	0.77	0.207	(0.205)	0.166	0.041
165	13.75	0.77	0.207	(0.204)	0.166	0.041
166	13.83	0.77	0.207	(0.203)	0.166	0.041
167	13.92	0.77	0.207	(0.202)	0.166	0.041
168	14.00	0.77	0.207	(0.200)	0.166	0.041
169	14.08	0.90	0.243	(0.199)	0.194	0.049
170	14.17	0.90	0.243	(0.198)	0.194	0.049
171	14.25	0.90	0.243	(0.197)	0.194	0.049
172	14.33	0.87	0.234	(0.196)	0.187	0.047
173	14.42	0.87	0.234	(0.195)	0.187	0.047
174	14.50	0.87	0.234	(0.194)	0.187	0.047
175	14.58	0.87	0.234	(0.193)	0.187	0.047
176	14.67	0.87	0.234	(0.192)	0.187	0.047
177	14.75	0.87	0.234	(0.191)	0.187	0.047
178	14.83	0.83	0.225	(0.190)	0.180	0.045
179	14.92	0.83	0.225	(0.189)	0.180	0.045
180	15.00	0.83	0.225	(0.189)	0.180	0.045
181	15.08	0.80	0.216	(0.188)	0.173	0.043
182	15.17	0.80	0.216	(0.187)	0.173	0.043
183	15.25	0.80	0.216	(0.186)	0.173	0.043
184	15.33	0.77	0.207	(0.185)	0.166	0.041
185	15.42	0.77	0.207	(0.184)	0.166	0.041

186	15.50	0.77	0.207	(0.183)	0.166	0.041
187	15.58	0.63	0.171	(0.182)	0.137	0.034
188	15.67	0.63	0.171	(0.181)	0.137	0.034
189	15.75	0.63	0.171	(0.180)	0.137	0.034
190	15.83	0.63	0.171	(0.179)	0.137	0.034
191	15.92	0.63	0.171	(0.178)	0.137	0.034
192	16.00	0.63	0.171	(0.177)	0.137	0.034
193	16.08	0.13	0.036	(0.176)	0.029	0.007
194	16.17	0.13	0.036	(0.175)	0.029	0.007
195	16.25	0.13	0.036	(0.175)	0.029	0.007
196	16.33	0.13	0.036	(0.174)	0.029	0.007
197	16.42	0.13	0.036	(0.173)	0.029	0.007
198	16.50	0.13	0.036	(0.172)	0.029	0.007
199	16.58	0.10	0.027	(0.171)	0.022	0.005
200	16.67	0.10	0.027	(0.170)	0.022	0.005
201	16.75	0.10	0.027	(0.169)	0.022	0.005
202	16.83	0.10	0.027	(0.168)	0.022	0.005
203	16.92	0.10	0.027	(0.168)	0.022	0.005
204	17.00	0.10	0.027	(0.167)	0.022	0.005
205	17.08	0.17	0.045	(0.166)	0.036	0.009
206	17.17	0.17	0.045	(0.165)	0.036	0.009
207	17.25	0.17	0.045	(0.164)	0.036	0.009
208	17.33	0.17	0.045	(0.163)	0.036	0.009
209	17.42	0.17	0.045	(0.163)	0.036	0.009
210	17.50	0.17	0.045	(0.162)	0.036	0.009
211	17.58	0.17	0.045	(0.161)	0.036	0.009
212	17.67	0.17	0.045	(0.160)	0.036	0.009
213	17.75	0.17	0.045	(0.159)	0.036	0.009
214	17.83	0.13	0.036	(0.159)	0.029	0.007
215	17.92	0.13	0.036	(0.158)	0.029	0.007
216	18.00	0.13	0.036	(0.157)	0.029	0.007
217	18.08	0.13	0.036	(0.156)	0.029	0.007
218	18.17	0.13	0.036	(0.155)	0.029	0.007
219	18.25	0.13	0.036	(0.155)	0.029	0.007
220	18.33	0.13	0.036	(0.154)	0.029	0.007
221	18.42	0.13	0.036	(0.153)	0.029	0.007
222	18.50	0.13	0.036	(0.152)	0.029	0.007
223	18.58	0.10	0.027	(0.152)	0.022	0.005
224	18.67	0.10	0.027	(0.151)	0.022	0.005
225	18.75	0.10	0.027	(0.150)	0.022	0.005
226	18.83	0.07	0.018	(0.150)	0.014	0.004
227	18.92	0.07	0.018	(0.149)	0.014	0.004
228	19.00	0.07	0.018	(0.148)	0.014	0.004
229	19.08	0.10	0.027	(0.147)	0.022	0.005
230	19.17	0.10	0.027	(0.147)	0.022	0.005
231	19.25	0.10	0.027	(0.146)	0.022	0.005
232	19.33	0.13	0.036	(0.145)	0.029	0.007
233	19.42	0.13	0.036	(0.145)	0.029	0.007
234	19.50	0.13	0.036	(0.144)	0.029	0.007
235	19.58	0.10	0.027	(0.143)	0.022	0.005
236	19.67	0.10	0.027	(0.143)	0.022	0.005
237	19.75	0.10	0.027	(0.142)	0.022	0.005
238	19.83	0.07	0.018	(0.141)	0.014	0.004
239	19.92	0.07	0.018	(0.141)	0.014	0.004
240	20.00	0.07	0.018	(0.140)	0.014	0.004
241	20.08	0.10	0.027	(0.140)	0.022	0.005
242	20.17	0.10	0.027	(0.139)	0.022	0.005
243	20.25	0.10	0.027	(0.138)	0.022	0.005
244	20.33	0.10	0.027	(0.138)	0.022	0.005
245	20.42	0.10	0.027	(0.137)	0.022	0.005
246	20.50	0.10	0.027	(0.137)	0.022	0.005
247	20.58	0.10	0.027	(0.136)	0.022	0.005
248	20.67	0.10	0.027	(0.135)	0.022	0.005
249	20.75	0.10	0.027	(0.135)	0.022	0.005
250	20.83	0.07	0.018	(0.134)	0.014	0.004
251	20.92	0.07	0.018	(0.134)	0.014	0.004
252	21.00	0.07	0.018	(0.133)	0.014	0.004
253	21.08	0.10	0.027	(0.133)	0.022	0.005
254	21.17	0.10	0.027	(0.132)	0.022	0.005
255	21.25	0.10	0.027	(0.132)	0.022	0.005
256	21.33	0.07	0.018	(0.131)	0.014	0.004
257	21.42	0.07	0.018	(0.131)	0.014	0.004
258	21.50	0.07	0.018	(0.130)	0.014	0.004
259	21.58	0.10	0.027	(0.130)	0.022	0.005
260	21.67	0.10	0.027	(0.129)	0.022	0.005
261	21.75	0.10	0.027	(0.129)	0.022	0.005
262	21.83	0.07	0.018	(0.128)	0.014	0.004
263	21.92	0.07	0.018	(0.128)	0.014	0.004
264	22.00	0.07	0.018	(0.127)	0.014	0.004
265	22.08	0.10	0.027	(0.127)	0.022	0.005
266	22.17	0.10	0.027	(0.127)	0.022	0.005
267	22.25	0.10	0.027	(0.126)	0.022	0.005
268	22.33	0.07	0.018	(0.126)	0.014	0.004
269	22.42	0.07	0.018	(0.125)	0.014	0.004
270	22.50	0.07	0.018	(0.125)	0.014	0.004
271	22.58	0.07	0.018	(0.125)	0.014	0.004
272	22.67	0.07	0.018	(0.124)	0.014	0.004
273	22.75	0.07	0.018	(0.124)	0.014	0.004
274	22.83	0.07	0.018	(0.124)	0.014	0.004
275	22.92	0.07	0.018	(0.123)	0.014	0.004
276	23.00	0.07	0.018	(0.123)	0.014	0.004
277	23.08	0.07	0.018	(0.123)	0.014	0.004
278	23.17	0.07	0.018	(0.122)	0.014	0.004
279	23.25	0.07	0.018	(0.122)	0.014	0.004
280	23.33	0.07	0.018	(0.122)	0.014	0.004
281	23.42	0.07	0.018	(0.122)	0.014	0.004
282	23.50	0.07	0.018	(0.122)	0.014	0.004
283	23.58	0.07	0.018	(0.121)	0.014	0.004
284	23.67	0.07	0.018	(0.121)	0.014	0.004

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285  23.75     0.07      0.018       (  0.121)       0.014        0.004
286  23.83     0.07      0.018       (  0.121)       0.014        0.004
287  23.92     0.07      0.018       (  0.121)       0.014        0.004
288  24.00     0.07      0.018       (  0.121)       0.014        0.004
                  (Loss Rate Not Used)
    Sum =     100.0                                  Sum =     5.6
        Flood volume = Effective rainfall      0.47(In)
         times area      63.2(Ac.)/[(In)/(Ft.)] =       2.5(Ac.Ft)
        Total soil loss =      1.78(In)
        Total soil loss =     9.384(Ac.Ft)
        Total rainfall =      2.25(In)
        Flood volume =      107266.5 Cubic Feet
        Total soil loss =      408774.1 Cubic Feet
        --------------------------------------------------------------------
         Peak flow rate of this hydrograph =      5.775(CFS)
        --------------------------------------------------------------------
        ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                    24 - H O U R   S T O R M
               R u n o f f     H y d r o g r a p h
        --------------------------------------------------------------------
                Hydrograph in   5   Minute intervals ((CFS))

        --------------------------------------------------------------------
 Time(h+m) Volume Ac.Ft   Q(CFS)  0        2.5       5.0       7.5       10.0
-----------------------------------------------------------------------
  0+ 5       0.0001      0.01  Q         |         |         |         |
  0+10       0.0006      0.08  Q         |         |         |         |
  0+15       0.0016      0.14  Q         |         |         |         |
  0+20       0.0028      0.18  Q         |         |         |         |
  0+25       0.0044      0.22  Q         |         |         |         |
  0+30       0.0062      0.27  VQ        |         |         |         |
  0+35       0.0082      0.29  VQ        |         |         |         |
  0+40       0.0103      0.30  VQ        |         |         |         |
  0+45       0.0125      0.31  VQ        |         |         |         |
  0+50       0.0148      0.33  VQ        |         |         |         |
  0+55       0.0173      0.37  VQ        |         |         |         |
  1+ 0       0.0200      0.40  VQ        |         |         |         |
  1+ 5       0.0229      0.41  VQ        |         |         |         |
  1+10       0.0256      0.39  VQ        |         |         |         |
  1+15       0.0281      0.37  VQ        |         |         |         |
  1+20       0.0306      0.36  VQ        |         |         |         |
  1+25       0.0330      0.35  VQ        |         |         |         |
  1+30       0.0355      0.35  VQ        |         |         |         |
  1+35       0.0379      0.35  VQ        |         |         |         |
  1+40       0.0403      0.35  VQ        |         |         |         |
  1+45       0.0427      0.35  VQ        |         |         |         |
  1+50       0.0451      0.35  VQ        |         |         |         |
  1+55       0.0478      0.38  VQ        |         |         |         |
  2+ 0       0.0507      0.42  VQ        |         |         |         |
  2+ 5       0.0536      0.43  VQ        |         |         |         |
  2+10       0.0566      0.44  VQ        |         |         |         |
  2+15       0.0597      0.44  VQ        |         |         |         |
  2+20       0.0628      0.45  |Q        |         |         |         |
  2+25       0.0659      0.45  |Q        |         |         |         |
  2+30       0.0690      0.45  |Q        |         |         |         |
  2+35       0.0722      0.46  |Q        |         |         |         |
  2+40       0.0755      0.49  |Q        |         |         |         |
  2+45       0.0792      0.53  |VQ       |         |         |         |
  2+50       0.0829      0.54  |VQ       |         |         |         |
  2+55       0.0867      0.55  |VQ       |         |         |         |
  3+ 0       0.0905      0.56  |VQ       |         |         |         |
  3+ 5       0.0944      0.56  |VQ       |         |         |         |
  3+10       0.0983      0.56  |VQ       |         |         |         |
  3+15       0.1022      0.57  |VQ       |         |         |         |
  3+20       0.1061      0.57  |VQ       |         |         |         |
  3+25       0.1100      0.57  |VQ       |         |         |         |
  3+30       0.1140      0.57  |VQ       |         |         |         |
  3+35       0.1179      0.57  |VQ       |         |         |         |
  3+40       0.1218      0.57  |VQ       |         |         |         |
  3+45       0.1258      0.57  | Q       |         |         |         |
  3+50       0.1298      0.58  | Q       |         |         |         |
  3+55       0.1340      0.61  | Q       |         |         |         |
  4+ 0       0.1384      0.64  | Q       |         |         |         |
  4+ 5       0.1430      0.66  | Q       |         |         |         |
  4+10       0.1476      0.67  | Q       |         |         |         |
  4+15       0.1522      0.67  | Q       |         |         |         |
  4+20       0.1569      0.68  | Q       |         |         |         |
  4+25       0.1618      0.72  | Q       |         |         |         |
  4+30       0.1670      0.75  | VQ      |         |         |         |
  4+35       0.1723      0.77  | VQ      |         |         |         |
  4+40       0.1777      0.78  | VQ      |         |         |         |
  4+45       0.1831      0.78  | VQ      |         |         |         |
  4+50       0.1885      0.80  |  Q      |         |         |         |
  4+55       0.1943      0.83  |  Q      |         |         |         |
  5+ 0       0.2002      0.87  |  Q      |         |         |         |
  5+ 5       0.2062      0.87  |  Q      |         |         |         |
  5+10       0.2118      0.82  |  Q      |         |         |         |
  5+15       0.2170      0.76  |  Q      |         |         |         |
  5+20       0.2221      0.74  | QV      |         |         |         |
  5+25       0.2273      0.76  |  Q      |         |         |         |
  5+30       0.2327      0.78  |  Q      |         |         |         |
  5+35       0.2382      0.80  |  Q      |         |         |         |
  5+40       0.2440      0.83  |  Q      |         |         |         |
  5+45       0.2500      0.87  |  QV     |         |         |         |
  5+50       0.2561      0.88  |  QV     |         |         |         |
  5+55       0.2622      0.89  |  QV     |         |         |         |
  6+ 0       0.2684      0.90  |  QV     |         |         |         |
  6+ 5       0.2747      0.91  |  QV     |         |         |         |
  6+10       0.2812      0.95  |  QV     |         |         |         |
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  6+15       0.2880      0.98  |  QV     |         |         |         |
  6+20       0.2948      1.00  |  QV     |         |         |         |
  6+25       0.3017      1.01  |   Q     |         |         |         |
  6+30       0.3087      1.01  |   QV    |         |         |         |
  6+35       0.3158      1.03  |   QV    |         |         |         |
  6+40       0.3231      1.06  |   QV    |         |         |         |
  6+45       0.3306      1.10  |   QV    |         |         |         |
  6+50       0.3383      1.11  |   QV    |         |         |         |
  6+55       0.3460      1.12  |   QV    |         |         |         |
  7+ 0       0.3538      1.13  |   QV    |         |         |         |
  7+ 5       0.3616      1.13  |   QV    |         |         |         |
  7+10       0.3694      1.14  |   Q V   |         |         |         |
  7+15       0.3772      1.14  |   Q V   |         |         |         |
  7+20       0.3851      1.15  |   Q V   |         |         |         |
  7+25       0.3933      1.18  |   Q V   |         |         |         |
  7+30       0.4016      1.22  |   Q V   |         |         |         |
  7+35       0.4102      1.24  |   Q V   |         |         |         |
  7+40       0.4190      1.28  |    QV   |         |         |         |
  7+45       0.4280      1.32  |    QV   |         |         |         |
  7+50       0.4373      1.34  |    Q V  |         |         |         |
  7+55       0.4468      1.38  |    Q V  |         |         |         |
  8+ 0       0.4566      1.42  |    Q V  |         |         |         |
  8+ 5       0.4667      1.46  |    Q V  |         |         |         |
  8+10       0.4772      1.53  |     QV  |         |         |         |
  8+15       0.4883      1.61  |     QV  |         |         |         |
  8+20       0.4996      1.64  |     Q V |         |         |         |
  8+25       0.5111      1.66  |     Q V |         |         |         |
  8+30       0.5226      1.68  |     Q V |         |         |         |
  8+35       0.5343      1.70  |     Q V |         |         |         |
  8+40       0.5462      1.73  |     Q V |         |         |         |
  8+45       0.5584      1.77  |      Q V|         |         |         |
  8+50       0.5708      1.80  |      Q V|         |         |         |
  8+55       0.5835      1.84  |      Q V|         |         |         |
  9+ 0       0.5965      1.88  |      Q V|         |         |         |
  9+ 5       0.6097      1.92  |      Q V|         |         |         |
  9+10       0.6234      1.99  |      Q  V         |         |         |
  9+15       0.6377      2.07  |       Q V         |         |         |
  9+20       0.6522      2.11  |       Q V         |         |         |
  9+25       0.6671      2.16  |       Q V         |         |         |
  9+30       0.6823      2.21  |       Q |V        |         |         |
  9+35       0.6977      2.24  |       Q |V        |         |         |
  9+40       0.7135      2.29  |        Q|V        |         |         |
  9+45       0.7295      2.33  |        Q|V        |         |         |
  9+50       0.7458      2.36  |        Q| V       |         |         |
  9+55       0.7624      2.41  |        Q| V       |         |         |
 10+ 0       0.7793      2.45  |        Q| V       |         |         |
 10+ 5       0.7959      2.42  |        Q| V       |         |         |
 10+10       0.8112      2.22  |       Q |  V      |         |         |
 10+15       0.8250      2.00  |      Q  |  V      |         |         |
 10+20       0.8381      1.90  |      Q  |  V      |         |         |
 10+25       0.8509      1.86  |      Q  |  V      |         |         |
 10+30       0.8634      1.82  |      Q  |   V     |         |         |
 10+35       0.8760      1.83  |      Q  |   V     |         |         |
 10+40       0.8896      1.97  |      Q  |   V     |         |         |
 10+45       0.9042      2.12  |       Q |   V     |         |         |
 10+50       0.9193      2.18  |       Q |   V     |         |         |
 10+55       0.9345      2.21  |       Q |    V    |         |         |
 11+ 0       0.9499      2.23  |       Q |    V    |         |         |
 11+ 5       0.9653      2.24  |       Q |    V    |         |         |
 11+10       0.9806      2.22  |       Q |    V    |         |         |
 11+15       0.9957      2.19  |       Q |     V   |         |         |
 11+20       1.0107      2.18  |       Q |     V   |         |         |
 11+25       1.0257      2.18  |       Q |     V   |         |         |
 11+30       1.0407      2.18  |       Q |     V   |         |         |
 11+35       1.0557      2.17  |       Q |      V  |         |         |
 11+40       1.0701      2.11  |       Q |      V  |         |         |
 11+45       1.0842      2.04  |       Q |      V  |         |         |
 11+50       1.0981      2.02  |       Q |      V  |         |         |
 11+55       1.1121      2.03  |       Q |       V |         |         |
 12+ 0       1.1263      2.06  |       Q |       V |         |         |
 12+ 5       1.1408      2.11  |       Q |       V |         |         |
 12+10       1.1569      2.33  |        Q|       V |         |         |
 12+15       1.1745      2.56  |         Q        V|         |         |
 12+20       1.1929      2.67  |         Q        V|         |         |
 12+25       1.2119      2.75  |         |Q       V|         |         |
 12+30       1.2313      2.82  |         |Q        V         |         |
 12+35       1.2512      2.88  |         |Q        V         |         |
 12+40       1.2716      2.97  |         |Q        V         |         |
 12+45       1.2927      3.06  |         | Q       V         |         |
 12+50       1.3141      3.11  |         | Q       |V        |         |
 12+55       1.3359      3.17  |         | Q       |V        |         |
 13+ 0       1.3581      3.22  |         | Q       | V       |         |
 13+ 5       1.3817      3.42  |         |  Q      | V       |         |
 13+10       1.4103      4.16  |         |     Q   | V       |         |
 13+15       1.4445      4.97  |         |        Q|  V      |         |
 13+20       1.4814      5.36  |         |         |Q  V     |         |
 13+25       1.5199      5.59  |         |         | Q V     |         |
 13+30       1.5597      5.77  |         |         |  Q V    |         |
 13+35       1.5989      5.69  |         |         | Q  V    |         |
 13+40       1.6319      4.80  |         |        Q|     V   |         |
 13+45       1.6582      3.81  |         |    Q    |     V   |         |
 13+50       1.6816      3.41  |         |  Q      |      V  |         |
 13+55       1.7037      3.20  |         | Q       |      V  |         |
 14+ 0       1.7248      3.06  |         | Q       |       V |         |
 14+ 5       1.7454      3.00  |         |Q        |       V |         |
 14+10       1.7664      3.05  |         | Q       |       V |         |
 14+15       1.7879      3.13  |         | Q       |        V|         |
 14+20       1.8096      3.14  |         | Q       |        V|         |
 14+25       1.8309      3.09  |         | Q       |        V|         |
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14+30       1.8519      3.05  |         | Q       |         V         |
14+35       1.8727      3.02  |         | Q       |         V         |
14+40       1.8934      3.01  |         | Q       |         V         |
14+45       1.9140      2.99  |         |Q        |         |V        |
14+50       1.9344      2.97  |         |Q        |         |V        |
14+55       1.9546      2.94  |         |Q        |         |V        |
15+ 0       1.9747      2.91  |         |Q        |         | V       |
15+ 5       1.9945      2.89  |         |Q        |         | V       |
15+10       2.0142      2.85  |         |Q        |         | V       |
15+15       2.0335      2.81  |         |Q        |         |  V      |
15+20       2.0527      2.79  |         |Q        |         |  V      |
15+25       2.0716      2.75  |         Q         |         |  V      |
15+30       2.0903      2.70  |         Q         |         |  V      |
15+35       2.1085      2.66  |         Q         |         |   V     |
15+40       2.1259      2.52  |         Q         |         |   V     |
15+45       2.1423      2.38  |        Q|         |         |   V     |
15+50       2.1582      2.31  |        Q|         |         |    V    |
15+55       2.1739      2.28  |        Q|         |         |    V    |
16+ 0       2.1894      2.25  |        Q|         |         |    V    |
16+ 5       2.2041      2.13  |       Q |         |         |    V    |
16+10       2.2154      1.65  |     Q   |         |         |    V    |
16+15       2.2233      1.14  |   Q     |         |         |     V   |
16+20       2.2296      0.92  |  Q      |         |         |     V   |
16+25       2.2351      0.80  |  Q      |         |         |     V   |
16+30       2.2400      0.71  | Q       |         |         |     V   |
16+35       2.2444      0.64  | Q       |         |         |     V   |
16+40       2.2483      0.56  | Q       |         |         |     V   |
16+45       2.2517      0.50  |Q        |         |         |     V   |
16+50       2.2548      0.45  |Q        |         |         |     V   |
16+55       2.2578      0.42  |Q        |         |         |     V   |
17+ 0       2.2605      0.40  |Q        |         |         |     V   |
17+ 5       2.2633      0.40  |Q        |         |         |     V   |
17+10       2.2664      0.45  |Q        |         |         |     V   |
17+15       2.2698      0.50  | Q       |         |         |     V   |
17+20       2.2734      0.52  | Q       |         |         |     V   |
17+25       2.2771      0.53  | Q       |         |         |     V   |
17+30       2.2808      0.54  | Q       |         |         |      V  |
17+35       2.2846      0.55  | Q       |         |         |      V  |
17+40       2.2885      0.56  | Q       |         |         |      V  |
17+45       2.2923      0.56  | Q       |         |         |      V  |
17+50       2.2962      0.56  | Q       |         |         |      V  |
17+55       2.2998      0.53  | Q       |         |         |      V  |
18+ 0       2.3032      0.50  |Q        |         |         |      V  |
18+ 5       2.3065      0.48  |Q        |         |         |      V  |
18+10       2.3098      0.48  |Q        |         |         |      V  |
18+15       2.3131      0.47  |Q        |         |         |      V  |
18+20       2.3163      0.47  |Q        |         |         |      V  |
18+25       2.3196      0.47  |Q        |         |         |      V  |
18+30       2.3228      0.47  |Q        |         |         |      V  |
18+35       2.3259      0.46  |Q        |         |         |      V  |
18+40       2.3288      0.42  |Q        |         |         |      V  |
18+45       2.3315      0.39  |Q        |         |         |      V  |
18+50       2.3340      0.37  |Q        |         |         |      V  |
18+55       2.3363      0.33  |Q        |         |         |      V  |
19+ 0       2.3383      0.29  |Q        |         |         |      V  |
19+ 5       2.3402      0.28  |Q        |         |         |       V |
19+10       2.3423      0.30  |Q        |         |         |       V |
19+15       2.3445      0.32  |Q        |         |         |       V |
19+20       2.3468      0.34  |Q        |         |         |       V |
19+25       2.3494      0.37  |Q        |         |         |       V |
19+30       2.3522      0.41  |Q        |         |         |       V |
19+35       2.3551      0.42  |Q        |         |         |       V |
19+40       2.3578      0.40  |Q        |         |         |       V |
19+45       2.3604      0.37  |Q        |         |         |       V |
19+50       2.3628      0.35  |Q        |         |         |       V |
19+55       2.3649      0.32  |Q        |         |         |       V |
20+ 0       2.3669      0.28  |Q        |         |         |       V |
20+ 5       2.3687      0.27  |Q        |         |         |       V |
20+10       2.3708      0.29  |Q        |         |         |       V |
20+15       2.3730      0.32  |Q        |         |         |       V |
20+20       2.3752      0.33  |Q        |         |         |       V |
20+25       2.3775      0.33  |Q        |         |         |       V |
20+30       2.3799      0.34  |Q        |         |         |       V |
20+35       2.3822      0.34  |Q        |         |         |       V |
20+40       2.3845      0.34  |Q        |         |         |       V |
20+45       2.3869      0.34  |Q        |         |         |       V |
20+50       2.3892      0.33  |Q        |         |         |       V |
20+55       2.3913      0.30  |Q        |         |         |       V |
21+ 0       2.3931      0.27  |Q        |         |         |       V |
21+ 5       2.3949      0.26  |Q        |         |         |       V |
21+10       2.3969      0.29  |Q        |         |         |       V |
21+15       2.3991      0.32  |Q        |         |         |       V |
21+20       2.4013      0.32  |Q        |         |         |        V|
21+25       2.4033      0.29  |Q        |         |         |        V|
21+30       2.4051      0.26  |Q        |         |         |        V|
21+35       2.4069      0.26  |Q        |         |         |        V|
21+40       2.4089      0.28  |Q        |         |         |        V|
21+45       2.4110      0.31  |Q        |         |         |        V|
21+50       2.4132      0.32  |Q        |         |         |        V|
21+55       2.4152      0.29  |Q        |         |         |        V|
22+ 0       2.4170      0.26  |Q        |         |         |        V|
22+ 5       2.4188      0.26  |Q        |         |         |        V|
22+10       2.4207      0.28  |Q        |         |         |        V|
22+15       2.4229      0.31  |Q        |         |         |        V|
22+20       2.4251      0.32  |Q        |         |         |        V|
22+25       2.4271      0.29  |Q        |         |         |        V|
22+30       2.4289      0.26  |Q        |         |         |        V|
22+35       2.4306      0.25  Q         |         |         |        V|
22+40       2.4323      0.24  Q         |         |         |        V|
```



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22+45       2.4339      0.24  Q         |         |         |        V|
22+50       2.4356      0.24  Q         |         |         |        V|
22+55       2.4372      0.24  Q         |         |         |        V|
23+ 0       2.4388      0.23  Q         |         |         |        V|
23+ 5       2.4404      0.23  Q         |         |         |        V|
23+10       2.4420      0.23  Q         |         |         |        V|
23+15       2.4436      0.23  Q         |         |         |        V|
23+20       2.4452      0.23  Q         |         |         |        V|
23+25       2.4468      0.23  Q         |         |         |        V|
23+30       2.4484      0.23  Q         |         |         |        V|
23+35       2.4499      0.23  Q         |         |         |        V|
23+40       2.4515      0.23  Q         |         |         |        V|
23+45       2.4531      0.23  Q         |         |         |        V|
23+50       2.4547      0.23  Q         |         |         |        V|
23+55       2.4563      0.23  Q         |         |         |        V|
24+ 0       2.4578      0.23  Q         |         |         |        V|
24+ 5       2.4593      0.21  Q         |         |         |        V|
24+10       2.4604      0.15  Q         |         |         |        V|
24+15       2.4610      0.09  Q         |         |         |        V|
24+20       2.4614      0.06  Q         |         |         |        V|
24+25       2.4617      0.04  Q         |         |         |        V|
24+30       2.4619      0.03  Q         |         |         |        V|
24+35       2.4621      0.02  Q         |         |         |        V|
24+40       2.4622      0.02  Q         |         |         |        V|
24+45       2.4623      0.01  Q         |         |         |        V|
24+50       2.4624      0.01  Q         |         |         |        V|
24+55       2.4624      0.01  Q         |         |         |        V|
25+ 0       2.4624      0.01  Q         |         |         |        V|
25+ 5       2.4625      0.00  Q         |         |         |        V|
25+10       2.4625      0.00  Q         |         |         |        V|
25+15       2.4625      0.00  Q         |         |         |        V|
-----------------------------------------------------------------------
```

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                 FLOOD HYDROGRAPH ROUTING PROGRAM
          Copyright (c) CIVILCADD/CIVILDESIGN, 1989 - 2014
                     Study date: 10/22/19

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Program License Serial Number 6388

---------------------------------------------------------------------
********************* HYDROGRAPH INFORMATION **********************

                  From study/file name: UHPROPA242.rte
****************************HYDROGRAPH DATA****************************
                  Number of intervals =   298
                  Time interval =    5.0 (Min.)
                  Maximum/Peak flow rate =       11.244 (CFS)
                  Total volume =       3.970 (Ac.Ft)
         Status of hydrographs being held in storage
                    Stream 1  Stream 2  Stream 3  Stream 4  Stream 5
         Peak (CFS)      0.000     0.000     0.000     0.000     0.000
         Vol (Ac.Ft)      0.000     0.000     0.000     0.000     0.000
***********************************************************************



++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
Process from Point/Station        1.000 to Point/Station        1.000
**** PRINT CURRENT HYDROGRAPH ****
______________________________________________________________________
++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                  P R I N T   O F   S T O R M
               R u n o f f     H y d r o g r a p h
---------------------------------------------------------------------
            Hydrograph in   5   Minute intervals (CFS)

---------------------------------------------------------------------
Time(h+m) Volume(Ac.Ft)   Q(CFS)  0         2.8       5.6       8.4      11.2
-----------------------------------------------------------------------
  0+ 5       0.0002      0.02  Q         |         |         |         |
  0+10       0.0009      0.11  Q         |         |         |         |
  0+15       0.0020      0.15  Q         |         |         |         |
  0+20       0.0032      0.18  Q         |         |         |         |
  0+25       0.0048      0.23  Q         |         |         |         |
  0+30       0.0066      0.26  Q         |         |         |         |
  0+35       0.0085      0.27  Q         |         |         |         |
  0+40       0.0104      0.28  VQ        |         |         |         |
  0+45       0.0124      0.29  VQ        |         |         |         |
  0+50       0.0145      0.30  VQ        |         |         |         |
  0+55       0.0169      0.35  VQ        |         |         |         |
  1+ 0       0.0195      0.37  VQ        |         |         |         |
  1+ 5       0.0220      0.37  VQ        |         |         |         |
  1+10       0.0243      0.33  VQ        |         |         |         |
  1+15       0.0264      0.31  VQ        |         |         |         |
  1+20       0.0285      0.31  VQ        |         |         |         |
  1+25       0.0306      0.30  VQ        |         |         |         |
  1+30       0.0327      0.30  VQ        |         |         |         |
  1+35       0.0348      0.30  VQ        |         |         |         |
  1+40       0.0368      0.30  VQ        |         |         |         |
  1+45       0.0389      0.30  VQ        |         |         |         |
  1+50       0.0410      0.31  VQ        |         |         |         |
  1+55       0.0434      0.35  VQ        |         |         |         |
  2+ 0       0.0460      0.37  VQ        |         |         |         |
  2+ 5       0.0486      0.38  VQ        |         |         |         |
  2+10       0.0512      0.39  VQ        |         |         |         |
  2+15       0.0539      0.39  VQ        |         |         |         |
  2+20       0.0566      0.39  VQ        |         |         |         |
  2+25       0.0593      0.39  VQ        |         |         |         |
  2+30       0.0620      0.39  VQ        |         |         |         |
  2+35       0.0648      0.41  VQ        |         |         |         |
  2+40       0.0679      0.45  VQ        |         |         |         |
  2+45       0.0712      0.47  VQ        |         |         |         |
  2+50       0.0745      0.48  VQ        |         |         |         |
  2+55       0.0778      0.48  VQ        |         |         |         |
  3+ 0       0.0811      0.49  VQ        |         |         |         |
  3+ 5       0.0845      0.49  VQ        |         |         |         |
  3+10       0.0879      0.49  VQ        |         |         |         |
  3+15       0.0913      0.49  VQ        |         |         |         |
  3+20       0.0947      0.49  VQ        |         |         |         |
  3+25       0.0981      0.49  VQ        |         |         |         |
  3+30       0.1015      0.49   Q        |         |         |         |
  3+35       0.1049      0.49  |Q        |         |         |         |
  3+40       0.1083      0.49  |Q        |         |         |         |
  3+45       0.1117      0.49  |Q        |         |         |         |
  3+50       0.1151      0.51  |Q        |         |         |         |
  3+55       0.1189      0.55  |Q        |         |         |         |
  4+ 0       0.1228      0.57  |VQ       |         |         |         |
  4+ 5       0.1268      0.58  |VQ       |         |         |         |
  4+10       0.1308      0.58  |VQ       |         |         |         |
  4+15       0.1349      0.59  |VQ       |         |         |         |
  4+20       0.1390      0.60  |VQ       |         |         |         |
  4+25       0.1434      0.65  |VQ       |         |         |         |
  4+30       0.1480      0.67  |VQ       |         |         |         |
  4+35       0.1527      0.68  |VQ       |         |         |         |
  4+40       0.1574      0.68  |VQ       |         |         |         |
```



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  4+45       0.1621      0.68  |VQ       |         |         |         |
  4+50       0.1669      0.70  |VQ       |         |         |         |
  4+55       0.1720      0.74  |VQ       |         |         |         |
  5+ 0       0.1773      0.77  |VQ       |         |         |         |
  5+ 5       0.1825      0.75  |VQ       |         |         |         |
  5+10       0.1871      0.67  |VQ       |         |         |         |
  5+15       0.1914      0.63  |VQ       |         |         |         |
  5+20       0.1958      0.63  |VQ       |         |         |         |
  5+25       0.2003      0.66  | Q       |         |         |         |
  5+30       0.2050      0.68  | Q       |         |         |         |
  5+35       0.2098      0.70  | Q       |         |         |         |
  5+40       0.2149      0.74  | Q       |         |         |         |
  5+45       0.2202      0.76  | Q       |         |         |         |
  5+50       0.2255      0.77  | Q       |         |         |         |
  5+55       0.2308      0.78  | Q       |         |         |         |
  6+ 0       0.2362      0.78  | Q       |         |         |         |
  6+ 5       0.2417      0.80  | Q       |         |         |         |
  6+10       0.2475      0.84  | Q       |         |         |         |
  6+15       0.2535      0.86  | VQ      |         |         |         |
  6+20       0.2595      0.87  | VQ      |         |         |         |
  6+25       0.2655      0.88  | VQ      |         |         |         |
  6+30       0.2716      0.88  | VQ      |         |         |         |
  6+35       0.2778      0.90  | VQ      |         |         |         |
  6+40       0.2843      0.94  | VQ      |         |         |         |
  6+45       0.2909      0.96  | VQ      |         |         |         |
  6+50       0.2976      0.97  | VQ      |         |         |         |
  6+55       0.3043      0.98  |  Q      |         |         |         |
  7+ 0       0.3111      0.98  |  Q      |         |         |         |
  7+ 5       0.3178      0.98  |  Q      |         |         |         |
  7+10       0.3246      0.98  |  Q      |         |         |         |
  7+15       0.3314      0.99  |  Q      |         |         |         |
  7+20       0.3383      1.00  |  Q      |         |         |         |
  7+25       0.3455      1.04  |  Q      |         |         |         |
  7+30       0.3528      1.06  |  Q      |         |         |         |
  7+35       0.3602      1.08  |  Q      |         |         |         |
  7+40       0.3680      1.13  |  VQ     |         |         |         |
  7+45       0.3760      1.15  |  VQ     |         |         |         |
  7+50       0.3841      1.18  |  VQ     |         |         |         |
  7+55       0.3926      1.23  |  VQ     |         |         |         |
  8+ 0       0.4012      1.25  |   Q     |         |         |         |
  8+ 5       0.4101      1.29  |   Q     |         |         |         |
  8+10       0.4196      1.38  |   Q     |         |         |         |
  8+15       0.4294      1.43  |   VQ    |         |         |         |
  8+20       0.4394      1.45  |   VQ    |         |         |         |
  8+25       0.4494      1.46  |   VQ    |         |         |         |
  8+30       0.4595      1.47  |   VQ    |         |         |         |
  8+35       0.4697      1.48  |   VQ    |         |         |         |
  8+40       0.4803      1.53  |   VQ    |         |         |         |
  8+45       0.4910      1.55  |   VQ    |         |         |         |
  8+50       0.5018      1.58  |    Q    |         |         |         |
  8+55       0.5130      1.62  |    Q    |         |         |         |
  9+ 0       0.5244      1.65  |    Q    |         |         |         |
  9+ 5       0.5365      1.76  |    VQ   |         |         |         |
  9+10       0.5510      2.11  |    V Q  |         |         |         |
  9+15       0.5669      2.30  |    V  Q |         |         |         |
  9+20       0.5838      2.46  |    V  Q |         |         |         |
  9+25       0.6027      2.74  |     V  Q|         |         |         |
  9+30       0.6227      2.90  |     V   Q         |         |         |
  9+35       0.6437      3.05  |     V   Q         |         |         |
  9+40       0.6667      3.34  |     V   |Q        |         |         |
  9+45       0.6907      3.50  |     V   | Q       |         |         |
  9+50       0.7159      3.65  |      V  | Q       |         |         |
  9+55       0.7430      3.93  |      V  |  Q      |         |         |
 10+ 0       0.7711      4.09  |      V  |   Q     |         |         |
 10+ 5       0.7974      3.82  |       V |  Q      |         |         |
 10+10       0.8156      2.64  |       VQ|         |         |         |
 10+15       0.8300      2.08  |      QV |         |         |         |
 10+20       0.8428      1.87  |     Q V |         |         |         |
 10+25       0.8548      1.74  |     Q V |         |         |         |
 10+30       0.8662      1.65  |    Q  V |         |         |         |
 10+35       0.8789      1.85  |     Q V |         |         |         |
 10+40       0.8976      2.71  |        Q|         |         |         |
 10+45       0.9191      3.12  |        V|Q        |         |         |
 10+50       0.9418      3.30  |        V|Q        |         |         |
 10+55       0.9653      3.41  |        V| Q       |         |         |
 11+ 0       0.9894      3.50  |        V| Q       |         |         |
 11+ 5       1.0136      3.52  |         V Q       |         |         |
 11+10       1.0368      3.36  |         VQ        |         |         |
 11+15       1.0596      3.32  |         VQ        |         |         |
 11+20       1.0825      3.32  |         VQ        |         |         |
 11+25       1.1055      3.34  |          Q        |         |         |
 11+30       1.1286      3.35  |         |Q        |         |         |
 11+35       1.1509      3.25  |         |Q        |         |         |
 11+40       1.1705      2.84  |         QV        |         |         |
 11+45       1.1888      2.66  |        Q|V        |         |         |
 11+50       1.2071      2.66  |        Q| V       |         |         |
 11+55       1.2268      2.85  |         Q V       |         |         |
 12+ 0       1.2471      2.95  |         Q V       |         |         |
 12+ 5       1.2708      3.44  |         | Q       |         |         |
 12+10       1.3051      4.98  |         |  V    Q |         |         |
 12+15       1.3446      5.73  |         |  V      Q         |         |
 12+20       1.3867      6.11  |         |  V      |Q        |         |
 12+25       1.4317      6.53  |         |   V     |  Q      |         |
 12+30       1.4784      6.78  |         |   V     |   Q     |         |
 12+35       1.5270      7.06  |         |    V    |    Q    |         |
 12+40       1.5793      7.60  |         |    V    |      Q  |         |
 12+45       1.6337      7.89  |         |     V   |       Q |         |
 12+50       1.6895      8.10  |         |      V  |       Q |         |
 12+55       1.7475      8.42  |         |      V  |        Q|         |
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  13+ 0      1.8067      8.59  |         |       V |         Q         |
  13+ 5      1.8686      9.00  |         |       V |         | Q       |
  13+10      1.9385     10.14  |         |        V|         |     Q   |
  13+15      2.0123     10.71  |         |         V         |       Q |
  13+20      2.0878     10.96  |         |          V        |        Q|
  13+25      2.1644     11.13  |         |         |V        |        Q|
  13+30      2.2419     11.24  |         |         | V       |         Q
  13+35      2.3152     10.65  |         |         |  V      |      Q  |
  13+40      2.3727      8.36  |         |         |  V     Q|         |
  13+45      2.4229      7.29  |         |         |   VQ    |         |
  13+50      2.4703      6.88  |         |         |   Q     |         |
  13+55      2.5161      6.65  |         |         |  Q V    |         |
  14+ 0      2.5608      6.50  |         |         |  Q V    |         |
  14+ 5      2.6066      6.65  |         |         |  Q  V   |         |
  14+10      2.6578      7.44  |         |         |     Q   |         |
  14+15      2.7117      7.82  |         |         |      Q  |         |
  14+20      2.7661      7.90  |         |         |      VQ |         |
  14+25      2.8197      7.78  |         |         |      QV |         |
  14+30      2.8732      7.77  |         |         |      QV |         |
  14+35      2.9269      7.80  |         |         |      Q V|         |
  14+40      2.9809      7.83  |         |         |      Q  V         |
  14+45      3.0350      7.86  |         |         |      Q  V         |
  14+50      3.0889      7.83  |         |         |      Q   V        |
  14+55      3.1416      7.65  |         |         |      Q  |V        |
  15+ 0      3.1937      7.56  |         |         |     Q   | V       |
  15+ 5      3.2452      7.48  |         |         |     Q   | V       |
  15+10      3.2952      7.26  |         |         |    Q    |  V      |
  15+15      3.3446      7.17  |         |         |    Q    |  V      |
  15+20      3.3934      7.08  |         |         |    Q    |   V     |
  15+25      3.4406      6.86  |         |         |   Q     |   V     |
  15+30      3.4871      6.76  |         |         |   Q     |    V    |
  15+35      3.5317      6.48  |         |         |  Q      |    V    |
  15+40      3.5703      5.60  |         |        Q|         |    V    |
  15+45      3.6061      5.20  |         |       Q |         |     V   |
  15+50      3.6409      5.04  |         |      Q  |         |     V   |
  15+55      3.6750      4.95  |         |      Q  |         |      V  |
  16+ 0      3.7088      4.91  |         |      Q  |         |      V  |
  16+ 5      3.7386      4.32  |         |    Q    |         |      V  |
  16+10      3.7549      2.37  |       Q |         |         |      V  |
  16+15      3.7648      1.44  |    Q    |         |         |      V  |
  16+20      3.7721      1.06  |  Q      |         |         |       V |
  16+25      3.7777      0.82  | Q       |         |         |       V |
  16+30      3.7824      0.68  | Q       |         |         |       V |
  16+35      3.7863      0.57  | Q       |         |         |       V |
  16+40      3.7894      0.45  |Q        |         |         |       V |
  16+45      3.7921      0.38  |Q        |         |         |       V |
  16+50      3.7944      0.34  |Q        |         |         |       V |
  16+55      3.7965      0.31  |Q        |         |         |       V |
  17+ 0      3.7986      0.30  |Q        |         |         |       V |
  17+ 5      3.8008      0.33  |Q        |         |         |       V |
  17+10      3.8036      0.41  |Q        |         |         |       V |
  17+15      3.8067      0.45  |Q        |         |         |       V |
  17+20      3.8099      0.46  |Q        |         |         |       V |
  17+25      3.8132      0.47  |Q        |         |         |       V |
  17+30      3.8165      0.48  |Q        |         |         |       V |
  17+35      3.8199      0.49  |Q        |         |         |       V |
  17+40      3.8232      0.49  |Q        |         |         |       V |
  17+45      3.8266      0.49  |Q        |         |         |       V |
  17+50      3.8299      0.48  |Q        |         |         |       V |
  17+55      3.8329      0.44  |Q        |         |         |       V |
  18+ 0      3.8358      0.42  |Q        |         |         |       V |
  18+ 5      3.8386      0.41  |Q        |         |         |       V |
  18+10      3.8414      0.40  |Q        |         |         |       V |
  18+15      3.8442      0.40  |Q        |         |         |       V |
  18+20      3.8469      0.40  |Q        |         |         |       V |
  18+25      3.8496      0.40  |Q        |         |         |       V |
  18+30      3.8524      0.40  |Q        |         |         |       V |
  18+35      3.8550      0.38  |Q        |         |         |       V |
  18+40      3.8573      0.34  |Q        |         |         |       V |
  18+45      3.8595      0.32  |Q        |         |         |       V |
  18+50      3.8616      0.30  |Q        |         |         |       V |
  18+55      3.8633      0.25  Q         |         |         |       V |
  19+ 0      3.8649      0.23  Q         |         |         |       V |
  19+ 5      3.8665      0.23  Q         |         |         |       V |
  19+10      3.8683      0.26  Q         |         |         |       V |
  19+15      3.8702      0.28  Q         |         |         |       V |
  19+20      3.8723      0.30  |Q        |         |         |        V|
  19+25      3.8746      0.34  |Q        |         |         |        V|
  19+30      3.8772      0.37  |Q        |         |         |        V|
  19+35      3.8797      0.36  |Q        |         |         |        V|
  19+40      3.8819      0.33  |Q        |         |         |        V|
  19+45      3.8841      0.31  |Q        |         |         |        V|
  19+50      3.8861      0.29  |Q        |         |         |        V|
  19+55      3.8878      0.25  Q         |         |         |        V|
  20+ 0      3.8894      0.23  Q         |         |         |        V|
  20+ 5      3.8909      0.23  Q         |         |         |        V|
  20+10      3.8927      0.26  Q         |         |         |        V|
  20+15      3.8947      0.28  Q         |         |         |        V|
  20+20      3.8967      0.29  |Q        |         |         |        V|
  20+25      3.8986      0.29  |Q        |         |         |        V|
  20+30      3.9006      0.29  |Q        |         |         |        V|
  20+35      3.9027      0.29  |Q        |         |         |        V|
  20+40      3.9047      0.29  |Q        |         |         |        V|
  20+45      3.9067      0.29  |Q        |         |         |        V|
  20+50      3.9087      0.28  |Q        |         |         |        V|
  20+55      3.9103      0.24  Q         |         |         |        V|
  21+ 0      3.9118      0.22  Q         |         |         |        V|
  21+ 5      3.9134      0.22  Q         |         |         |        V|
  21+10      3.9152      0.26  Q         |         |         |        V|
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  21+15      3.9171      0.28  Q         |         |         |        V|
  21+20      3.9190      0.27  Q         |         |         |        V|
  21+25      3.9206      0.23  Q         |         |         |        V|
  21+30      3.9221      0.22  Q         |         |         |        V|
  21+35      3.9236      0.22  Q         |         |         |        V|
  21+40      3.9254      0.26  Q         |         |         |        V|
  21+45      3.9273      0.28  Q         |         |         |        V|
  21+50      3.9292      0.27  Q         |         |         |        V|
  21+55      3.9308      0.23  Q         |         |         |        V|
  22+ 0      3.9323      0.22  Q         |         |         |        V|
  22+ 5      3.9338      0.22  Q         |         |         |        V|
  22+10      3.9356      0.26  Q         |         |         |        V|
  22+15      3.9375      0.28  Q         |         |         |        V|
  22+20      3.9394      0.27  Q         |         |         |        V|
  22+25      3.9410      0.23  Q         |         |         |        V|
  22+30      3.9425      0.22  Q         |         |         |        V|
  22+35      3.9439      0.21  Q         |         |         |        V|
  22+40      3.9453      0.20  Q         |         |         |        V|
  22+45      3.9467      0.20  Q         |         |         |        V|
  22+50      3.9481      0.20  Q         |         |         |        V|
  22+55      3.9495      0.20  Q         |         |         |        V|
  23+ 0      3.9508      0.20  Q         |         |         |        V|
  23+ 5      3.9522      0.20  Q         |         |         |        V|
  23+10      3.9536      0.20  Q         |         |         |        V|
  23+15      3.9549      0.20  Q         |         |         |        V|
  23+20      3.9563      0.20  Q         |         |         |        V|
  23+25      3.9576      0.20  Q         |         |         |        V|
  23+30      3.9590      0.20  Q         |         |         |        V|
  23+35      3.9604      0.20  Q         |         |         |        V|
  23+40      3.9617      0.20  Q         |         |         |        V|
  23+45      3.9631      0.20  Q         |         |         |        V|
  23+50      3.9644      0.20  Q         |         |         |        V|
  23+55      3.9658      0.20  Q         |         |         |        V|
  24+ 0      3.9672      0.20  Q         |         |         |        V|
-----------------------------------------------------------------------
         ****************************HYDROGRAPH DATA****************************
                           Number of intervals =   298
                           Time interval =    5.0 (Min.)
                           Maximum/Peak flow rate =       11.244 (CFS)
                           Total volume =       3.970 (Ac.Ft)
                  Status of hydrographs being held in storage
                             Stream 1  Stream 2  Stream 3  Stream 4  Stream 5
                  Peak (CFS)      0.000     0.000     0.000     0.000     0.000
                  Vol (Ac.Ft)      0.000     0.000     0.000     0.000     0.000
         ***********************************************************************

         --------------------------------------------------------------------


         ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
         Process from Point/Station        1.000 to Point/Station        2.000
         **** ADD/COMBINE/RECOVER HYDROGRAPHS ****
         ______________________________________________________________________
         ******************** HYDROGRAPH INFORMATION *********************

                           From study/file name: UHPROPG242.rte
         ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                            P R I N T  O F  S T O R M
                         R u n o f f     H y d r o g r a p h
         --------------------------------------------------------------------
                      Hydrograph in   5   Minute intervals (CFS)

         --------------------------------------------------------------------
 Time(h+m) Add q(CFS)  Tot. Q   0        2.9       5.8       8.7      11.6
 -----------------------------------------------------------------------
    0+ 5      0.0060      0.03  Q         |         |         |         |
    0+10      0.0157      0.13  Q         |         |         |         |
    0+15      0.0181      0.17  Q         |         |         |         |
    0+20      0.0222      0.20  Q         |         |         |         |
    0+25      0.0277      0.26  Q         |         |         |         |
    0+30      0.0293      0.29  qQ        |         |         |         |
    0+35      0.0299      0.30  qQ        |         |         |         |
    0+40      0.0302      0.31  qQ        |         |         |         |
    0+45      0.0304      0.32  qQ        |         |         |         |
    0+50      0.0334      0.34  qQ        |         |         |         |
    0+55      0.0382      0.39  qQ        |         |         |         |
    1+ 0      0.0395      0.41  qQ        |         |         |         |
    1+ 5      0.0370      0.40  qQ        |         |         |         |
    1+10      0.0325      0.36  qQ        |         |         |         |
    1+15      0.0314      0.34  qQ        |         |         |         |
    1+20      0.0309      0.34  qQ        |         |         |         |
    1+25      0.0306      0.33  qQ        |         |         |         |
    1+30      0.0304      0.33  qQ        |         |         |         |
    1+35      0.0304      0.33  qQ        |         |         |         |
    1+40      0.0304      0.33  qQ        |         |         |         |
    1+45      0.0304      0.33  qQ        |         |         |         |
    1+50      0.0334      0.34  qQ        |         |         |         |
    1+55      0.0382      0.39  qQ        |         |         |         |
    2+ 0      0.0395      0.41  qQ        |         |         |         |
    2+ 5      0.0400      0.42  qQ        |         |         |         |
    2+10      0.0403      0.43  qQ        |         |         |         |
    2+15      0.0405      0.43  qQ        |         |         |         |
    2+20      0.0405      0.43  qQ        |         |         |         |
    2+25      0.0405      0.43  qQ        |         |         |         |
    2+30      0.0405      0.43  qQ        |         |         |         |
    2+35      0.0435      0.45  qQ        |         |         |         |
    2+40      0.0484      0.50  qQ        |         |         |         |
    2+45      0.0496      0.52  qQ        |         |         |         |
    2+50      0.0501      0.53  qQ        |         |         |         |
```

2+55	0.0504	0.53
3+ 0	0.0506	0.54
3+ 5	0.0506	0.54
3+10	0.0506	0.54
3+15	0.0506	0.54
3+20	0.0506	0.54
3+25	0.0506	0.54
3+30	0.0506	0.54
3+35	0.0506	0.54
3+40	0.0506	0.54
3+45	0.0506	0.54
3+50	0.0536	0.56
3+55	0.0585	0.61
4+ 0	0.0597	0.63
4+ 5	0.0603	0.64
4+10	0.0605	0.64
4+15	0.0608	0.65
4+20	0.0637	0.66
4+25	0.0686	0.71
4+30	0.0698	0.74
4+35	0.0704	0.75
4+40	0.0707	0.75
4+45	0.0709	0.76
4+50	0.0739	0.77
4+55	0.0787	0.82
5+ 0	0.0800	0.85
5+ 5	0.0745	0.82
5+10	0.0651	0.73
5+15	0.0629	0.69
5+20	0.0648	0.69
5+25	0.0690	0.73
5+30	0.0698	0.75
5+35	0.0734	0.77
5+40	0.0785	0.82
5+45	0.0800	0.84
5+50	0.0805	0.85
5+55	0.0808	0.86
6+ 0	0.0810	0.86
6+ 5	0.0840	0.88
6+10	0.0889	0.93
6+15	0.0901	0.95
6+20	0.0906	0.96
6+25	0.0909	0.97
6+30	0.0911	0.97
6+35	0.0941	0.99
6+40	0.0990	1.04
6+45	0.1002	1.06
6+50	0.1008	1.07
6+55	0.1011	1.08
7+ 0	0.1013	1.08
7+ 5	0.1013	1.08
7+10	0.1013	1.09
7+15	0.1013	1.09
7+20	0.1043	1.10
7+25	0.1091	1.15
7+30	0.1103	1.17
7+35	0.1139	1.20
7+40	0.1190	1.25
7+45	0.1205	1.28
7+50	0.1240	1.30
7+55	0.1292	1.36
8+ 0	0.1306	1.38
8+ 5	0.1371	1.43
8+10	0.1471	1.53
8+15	0.1498	1.58
8+20	0.1509	1.60
8+25	0.1515	1.61
8+30	0.1519	1.62
8+35	0.1549	1.64
8+40	0.1598	1.69
8+45	0.1610	1.71
8+50	0.1645	1.74
8+55	0.1697	1.79
9+ 0	0.1711	1.82
9+ 5	0.1776	1.94
9+10	0.1876	2.30
9+15	0.1903	2.49
9+20	0.1944	2.65
9+25	0.1998	2.94
9+30	0.2015	3.10
9+35	0.2050	3.26
9+40	0.2102	3.55
9+45	0.2116	3.71
9+50	0.2151	3.86
9+55	0.2203	4.15
10+ 0	0.2218	4.31
10+ 5	0.2014	4.02
10+10	0.1677	2.81
10+15	0.1593	2.24
10+20	0.1555	2.02
10+25	0.1534	1.89
10+30	0.1519	1.81
10+35	0.1668	2.02
10+40	0.1911	2.90
10+45	0.1973	3.32
10+50	0.2000	3.50
10+55	0.2015	3.61
11+ 0	0.2026	3.71
11+ 5	0.1996	3.72

11+10	0.1947	3.56
11+15	0.1935	3.51
11+20	0.1929	3.51
11+25	0.1926	3.53
11+30	0.1924	3.54
11+35	0.1865	3.43
11+40	0.1767	3.02
11+45	0.1743	2.83
11+50	0.1762	2.84
11+55	0.1804	3.04
12+ 0	0.1812	3.14
12+ 5	0.2027	3.64
12+10	0.2370	5.22
12+15	0.2458	5.97
12+20	0.2526	6.37
12+25	0.2595	6.79
12+30	0.2623	7.04
12+35	0.2688	7.33
12+40	0.2788	7.88
12+45	0.2815	8.17
12+50	0.2855	8.39
12+55	0.2910	8.72
13+ 0	0.2926	8.88
13+ 5	0.3081	9.31
13+10	0.3327	10.48
13+15	0.3391	11.05
13+20	0.3418	11.31
13+25	0.3433	11.47
13+30	0.3443	11.59
13+35	0.3115	10.96
13+40	0.2581	8.61
13+45	0.2446	7.53
13+50	0.2386	7.12
13+55	0.2353	6.88
14+ 0	0.2329	6.73
14+ 5	0.2449	6.89
14+10	0.2643	7.71
14+15	0.2692	8.09
14+20	0.2684	8.17
14+25	0.2647	8.05
14+30	0.2644	8.03
14+35	0.2638	8.06
14+40	0.2635	8.10
14+45	0.2633	8.13
14+50	0.2603	8.09
14+55	0.2555	7.90
15+ 0	0.2542	7.82
15+ 5	0.2507	7.73
15+10	0.2456	7.51
15+15	0.2441	7.41
15+20	0.2406	7.32
15+25	0.2354	7.09
15+30	0.2340	6.99
15+35	0.2215	6.70
15+40	0.2018	5.81
15+45	0.1967	5.40
15+50	0.1945	5.24
15+55	0.1933	5.15
16+ 0	0.1924	5.10
16+ 5	0.1477	4.47
16+10	0.0748	2.45
16+15	0.0564	1.50
16+20	0.0482	1.10
16+25	0.0438	0.86
16+30	0.0405	0.72
16+35	0.0375	0.60
16+40	0.0327	0.48
16+45	0.0314	0.41
16+50	0.0309	0.37
16+55	0.0306	0.34
17+ 0	0.0304	0.33
17+ 5	0.0363	0.36
17+10	0.0461	0.46
17+15	0.0485	0.50
17+20	0.0496	0.51
17+25	0.0502	0.52
17+30	0.0506	0.53
17+35	0.0506	0.54
17+40	0.0506	0.54
17+45	0.0506	0.54
17+50	0.0477	0.53
17+55	0.0428	0.48
18+ 0	0.0416	0.46
18+ 5	0.0410	0.45
18+10	0.0407	0.45
18+15	0.0405	0.44
18+20	0.0405	0.44
18+25	0.0405	0.44
18+30	0.0405	0.44
18+35	0.0375	0.42
18+40	0.0327	0.37
18+45	0.0314	0.35
18+50	0.0279	0.33
18+55	0.0228	0.27
19+ 0	0.0213	0.25
19+ 5	0.0237	0.25
19+10	0.0283	0.29
19+15	0.0293	0.31
19+20	0.0329	0.33

```
  19+25       0.0380      0.38  qQ       |         |         |         |
  19+30       0.0395      0.41  qQ       |         |         |         |
  19+35       0.0370      0.40  qQ       |         |         |         |
  19+40       0.0325      0.36  qQ       |         |         |         |
  19+45       0.0314      0.34  qQ       |         |         |         |
  19+50       0.0279      0.32  qQ       |         |         |         |
  19+55       0.0228      0.27  Q        |         |         |         |
  20+ 0       0.0213      0.25  Q        |         |         |         |
  20+ 5       0.0237      0.25  Q        |         |         |         |
  20+10       0.0283      0.29  qQ       |         |         |         |
  20+15       0.0293      0.31  qQ       |         |         |         |
  20+20       0.0299      0.32  qQ       |         |         |         |
  20+25       0.0302      0.32  qQ       |         |         |         |
  20+30       0.0304      0.32  qQ       |         |         |         |
  20+35       0.0304      0.32  qQ       |         |         |         |
  20+40       0.0304      0.32  qQ       |         |         |         |
  20+45       0.0304      0.33  qQ       |         |         |         |
  20+50       0.0274      0.31  qQ       |         |         |         |
  20+55       0.0225      0.26  Q        |         |         |         |
  21+ 0       0.0213      0.24  Q        |         |         |         |
  21+ 5       0.0237      0.25  Q        |         |         |         |
  21+10       0.0283      0.29  qQ       |         |         |         |
  21+15       0.0293      0.31  qQ       |         |         |         |
  21+20       0.0269      0.30  qQ       |         |         |         |
  21+25       0.0223      0.26  Q        |         |         |         |
  21+30       0.0213      0.24  Q        |         |         |         |
  21+35       0.0237      0.24  Q        |         |         |         |
  21+40       0.0283      0.29  Q        |         |         |         |
  21+45       0.0293      0.31  qQ       |         |         |         |
  21+50       0.0269      0.30  qQ       |         |         |         |
  21+55       0.0223      0.26  Q        |         |         |         |
  22+ 0       0.0213      0.24  Q        |         |         |         |
  22+ 5       0.0237      0.24  Q        |         |         |         |
  22+10       0.0283      0.29  Q        |         |         |         |
  22+15       0.0293      0.31  qQ       |         |         |         |
  22+20       0.0269      0.30  qQ       |         |         |         |
  22+25       0.0223      0.26  Q        |         |         |         |
  22+30       0.0213      0.24  Q        |         |         |         |
  22+35       0.0208      0.23  Q        |         |         |         |
  22+40       0.0205      0.22  Q        |         |         |         |
  22+45       0.0203      0.22  Q        |         |         |         |
  22+50       0.0203      0.22  Q        |         |         |         |
  22+55       0.0203      0.22  Q        |         |         |         |
  23+ 0       0.0203      0.22  Q        |         |         |         |
  23+ 5       0.0203      0.22  Q        |         |         |         |
  23+10       0.0203      0.22  Q        |         |         |         |
  23+15       0.0203      0.22  Q        |         |         |         |
  23+20       0.0203      0.22  Q        |         |         |         |
  23+25       0.0203      0.22  Q        |         |         |         |
  23+30       0.0203      0.22  Q        |         |         |         |
  23+35       0.0203      0.22  Q        |         |         |         |
  23+40       0.0203      0.22  Q        |         |         |         |
  23+45       0.0203      0.22  Q        |         |         |         |
  23+50       0.0203      0.22  Q        |         |         |         |
  23+55       0.0203      0.22  Q        |         |         |         |
  24+ 0       0.0203      0.22  Q        |         |         |         |
  24+ 5       0.0143      0.19  Q        |         |         |         |
  24+10       0.0046      0.09  Q        |         |         |         |
  24+15       0.0021      0.05  Q        |         |         |         |
  24+20       0.0010      0.03  Q        |         |         |         |
  24+25       0.0004      0.02  Q        |         |         |         |
  24+30       0.0000      0.01  Q        |         |         |         |
  24+35       0.0000      0.01  Q        |         |         |         |
  24+40       0.0000      0.01  Q        |         |         |         |
  24+45       0.0000      0.00  Q        |         |         |         |
  24+50       0.0000      0.00  Q        |         |         |         |
-----------------------------------------------------------------------
         ****************************HYDROGRAPH DATA****************************
                           Number of intervals =   298
                           Time interval =    5.0 (Min.)
                           Maximum/Peak flow rate =       11.588 (CFS)
                           Total volume =       4.179 (Ac.Ft)
                  Status of hydrographs being held in storage
                             Stream 1  Stream 2  Stream 3  Stream 4  Stream 5
                  Peak (CFS)      0.000     0.000     0.000     0.000     0.000
                  Vol (Ac.Ft)      0.000     0.000     0.000     0.000     0.000
         ***********************************************************************

         --------------------------------------------------------------------


         ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
         Process from Point/Station        2.000 to Point/Station        2.000
         **** FLOWBY BASIN ROUTING OR SPLIT FLOW ****
         ______________________________________________________________________
         A constant split flow fraction of 0.2500 is
         being diverted from the main stream into stream number 3
         Total volume of excess flow diverted into flowby
         basin (stream number 3 ) is       1.04(Ac.Ft)
         ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                           P R I N T  O F  S T O R M
                        R u n o f f     H y d r o g r a p h
         --------------------------------------------------------------------
                     Hydrograph in   5   Minute intervals (CFS)

         --------------------------------------------------------------------
 Time(h+m) Volume(Ac.Ft)    Q(CFS)  0        2.2       4.3       6.5       8.7
 --------------------------------------------------------------------
   0+ 5       0.0002      0.02  Q        |         |         |         |
```



```
  0+10        0.0008      0.09  Q        |         |         |         |
  0+15        0.0017      0.13  Q        |         |         |         |
  0+20        0.0027      0.15  Q        |         |         |         |
  0+25        0.0041      0.20  Q        |         |         |         |
  0+30        0.0056      0.22  VQ       |         |         |         |
  0+35        0.0071      0.23  VQ       |         |         |         |
  0+40        0.0088      0.23  VQ       |         |         |         |
  0+45        0.0104      0.24  VQ       |         |         |         |
  0+50        0.0121      0.25  VQ       |         |         |         |
  0+55        0.0141      0.29  VQ       |         |         |         |
  1+ 0        0.0163      0.31  VQ       |         |         |         |
  1+ 5        0.0183      0.30  VQ       |         |         |         |
  1+10        0.0202      0.27  VQ       |         |         |         |
  1+15        0.0220      0.26  VQ       |         |         |         |
  1+20        0.0237      0.25  VQ       |         |         |         |
  1+25        0.0255      0.25  VQ       |         |         |         |
  1+30        0.0272      0.25  VQ       |         |         |         |
  1+35        0.0289      0.25  VQ       |         |         |         |
  1+40        0.0306      0.25  VQ       |         |         |         |
  1+45        0.0323      0.25  VQ       |         |         |         |
  1+50        0.0340      0.26  VQ       |         |         |         |
  1+55        0.0360      0.29  VQ       |         |         |         |
  2+ 0        0.0382      0.31  VQ       |         |         |         |
  2+ 5        0.0403      0.32  VQ       |         |         |         |
  2+10        0.0425      0.32  VQ       |         |         |         |
  2+15        0.0448      0.32  VQ       |         |         |         |
  2+20        0.0470      0.32  VQ       |         |         |         |
  2+25        0.0492      0.32  VQ       |         |         |         |
  2+30        0.0515      0.33  VQ       |         |         |         |
  2+35        0.0538      0.34  VQ       |         |         |         |
  2+40        0.0564      0.37  VQ       |         |         |         |
  2+45        0.0590      0.39  VQ       |         |         |         |
  2+50        0.0618      0.40  VQ       |         |         |         |
  2+55        0.0645      0.40  VQ       |         |         |         |
  3+ 0        0.0673      0.40  VQ       |         |         |         |
  3+ 5        0.0701      0.40  VQ       |         |         |         |
  3+10        0.0729      0.41  VQ       |         |         |         |
  3+15        0.0757      0.41  VQ       |         |         |         |
  3+20        0.0785      0.41   Q       |         |         |         |
  3+25        0.0813      0.41  |Q       |         |         |         |
  3+30        0.0841      0.41  |Q       |         |         |         |
  3+35        0.0869      0.41  |Q       |         |         |         |
  3+40        0.0898      0.41  |Q       |         |         |         |
  3+45        0.0926      0.41  |Q       |         |         |         |
  3+50        0.0955      0.42  |Q       |         |         |         |
  3+55        0.0986      0.46  |VQ      |         |         |         |
  4+ 0        0.1018      0.47  |VQ      |         |         |         |
  4+ 5        0.1051      0.48  |VQ      |         |         |         |
  4+10        0.1085      0.48  |VQ      |         |         |         |
  4+15        0.1118      0.48  |VQ      |         |         |         |
  4+20        0.1152      0.50  |VQ      |         |         |         |
  4+25        0.1189      0.54  |VQ      |         |         |         |
  4+30        0.1227      0.55  |VQ      |         |         |         |
  4+35        0.1266      0.56  |VQ      |         |         |         |
  4+40        0.1304      0.56  |VQ      |         |         |         |
  4+45        0.1344      0.57  |VQ      |         |         |         |
  4+50        0.1383      0.58  |VQ      |         |         |         |
  4+55        0.1426      0.62  |VQ      |         |         |         |
  5+ 0        0.1470      0.63  |VQ      |         |         |         |
  5+ 5        0.1512      0.62  |VQ      |         |         |         |
  5+10        0.1550      0.55  |VQ      |         |         |         |
  5+15        0.1586      0.52  | Q      |         |         |         |
  5+20        0.1622      0.52  | Q      |         |         |         |
  5+25        0.1660      0.55  | Q      |         |         |         |
  5+30        0.1698      0.56  | Q      |         |         |         |
  5+35        0.1738      0.58  | Q      |         |         |         |
  5+40        0.1780      0.62  | Q      |         |         |         |
  5+45        0.1824      0.63  | Q      |         |         |         |
  5+50        0.1868      0.64  | Q      |         |         |         |
  5+55        0.1912      0.64  | Q      |         |         |         |
  6+ 0        0.1957      0.65  | Q      |         |         |         |
  6+ 5        0.2002      0.66  | VQ     |         |         |         |
  6+10        0.2051      0.70  | VQ     |         |         |         |
  6+15        0.2100      0.72  | VQ     |         |         |         |
  6+20        0.2150      0.72  | VQ     |         |         |         |
  6+25        0.2200      0.73  | VQ     |         |         |         |
  6+30        0.2250      0.73  | VQ     |         |         |         |
  6+35        0.2301      0.74  | VQ     |         |         |         |
  6+40        0.2355      0.78  |  Q     |         |         |         |
  6+45        0.2410      0.80  |  Q     |         |         |         |
  6+50        0.2465      0.80  |  Q     |         |         |         |
  6+55        0.2521      0.81  |  Q     |         |         |         |
  7+ 0        0.2577      0.81  |  Q     |         |         |         |
  7+ 5        0.2633      0.81  |  Q     |         |         |         |
  7+10        0.2689      0.81  |  Q     |         |         |         |
  7+15        0.2745      0.82  |  Q     |         |         |         |
  7+20        0.2802      0.83  |  Q     |         |         |         |
  7+25        0.2861      0.86  |  Q     |         |         |         |
  7+30        0.2922      0.88  |  VQ    |         |         |         |
  7+35        0.2984      0.90  |  VQ    |         |         |         |
  7+40        0.3048      0.94  |  VQ    |         |         |         |
  7+45        0.3114      0.96  |  VQ    |         |         |         |
  7+50        0.3182      0.98  |   Q    |         |         |         |
  7+55        0.3252      1.02  |   Q    |         |         |         |
  8+ 0        0.3323      1.04  |   Q    |         |         |         |
  8+ 5        0.3397      1.07  |   Q    |         |         |         |
  8+10        0.3476      1.15  |   VQ   |         |         |         |
  8+15        0.3557      1.18  |   VQ   |         |         |         |
  8+20        0.3640      1.20  |   VQ   |         |         |         |
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8+25	0.3723	1.21
8+30	0.3806	1.21
8+35	0.3891	1.23
8+40	0.3978	1.27
8+45	0.4067	1.29
8+50	0.4157	1.31
8+55	0.4249	1.35
9+ 0	0.4343	1.36
9+ 5	0.4443	1.45
9+10	0.4562	1.73
9+15	0.4691	1.87
9+20	0.4828	1.99
9+25	0.4980	2.21
9+30	0.5140	2.33
9+35	0.5308	2.44
9+40	0.5492	2.66
9+45	0.5683	2.78
9+50	0.5883	2.90
9+55	0.6097	3.12
10+ 0	0.6320	3.23
10+ 5	0.6528	3.01
10+10	0.6673	2.10
10+15	0.6789	1.68
10+20	0.6893	1.52
10+25	0.6991	1.42
10+30	0.7084	1.35
10+35	0.7188	1.52
10+40	0.7338	2.18
10+45	0.7509	2.49
10+50	0.7690	2.62
10+55	0.7877	2.71
11+ 0	0.8068	2.78
11+ 5	0.8260	2.79
11+10	0.8444	2.67
11+15	0.8625	2.63
11+20	0.8806	2.63
11+25	0.8989	2.65
11+30	0.9172	2.66
11+35	0.9349	2.57
11+40	0.9505	2.26
11+45	0.9651	2.12
11+50	0.9798	2.13
11+55	0.9955	2.28
12+ 0	1.0117	2.35
12+ 5	1.0305	2.73
12+10	1.0574	3.91
12+15	1.0883	4.48
12+20	1.1212	4.77
12+25	1.1563	5.09
12+30	1.1926	5.28
12+35	1.2305	5.50
12+40	1.2712	5.91
12+45	1.3134	6.13
12+50	1.3567	6.29
12+55	1.4017	6.54
13+ 0	1.4476	6.66
13+ 5	1.4957	6.98
13+10	1.5498	7.86
13+15	1.6069	8.29
13+20	1.6653	8.48
13+25	1.7246	8.61
13+30	1.7844	8.69
13+35	1.8410	8.22
13+40	1.8855	6.46
13+45	1.9244	5.65
13+50	1.9612	5.34
13+55	1.9967	5.16
14+ 0	2.0315	5.05
14+ 5	2.0671	5.17
14+10	2.1069	5.78
14+15	2.1487	6.07
14+20	2.1909	6.13
14+25	2.2324	6.03
14+30	2.2739	6.03
14+35	2.3156	6.05
14+40	2.3574	6.07
14+45	2.3994	6.09
14+50	2.4412	6.07
14+55	2.4820	5.93
15+ 0	2.5224	5.86
15+ 5	2.5623	5.80
15+10	2.6011	5.63
15+15	2.6394	5.56
15+20	2.6772	5.49
15+25	2.7138	5.32
15+30	2.7499	5.24
15+35	2.7845	5.02
15+40	2.8145	4.36
15+45	2.8424	4.05
15+50	2.8694	3.93
15+55	2.8960	3.86
16+ 0	2.9224	3.83
16+ 5	2.9455	3.35
16+10	2.9581	1.83
16+15	2.9658	1.12
16+20	2.9715	0.83
16+25	2.9760	0.65
16+30	2.9797	0.54
16+35	2.9828	0.45

16+40	2.9853	0.36
16+45	2.9875	0.31
16+50	2.9894	0.28
16+55	2.9911	0.25
17+ 0	2.9928	0.25
17+ 5	2.9947	0.27
17+10	2.9970	0.34
17+15	2.9996	0.37
17+20	3.0023	0.39
17+25	3.0050	0.39
17+30	3.0077	0.40
17+35	3.0105	0.40
17+40	3.0133	0.40
17+45	3.0161	0.41
17+50	3.0188	0.40
17+55	3.0213	0.36
18+ 0	3.0237	0.34
18+ 5	3.0260	0.34
18+10	3.0283	0.33
18+15	3.0306	0.33
18+20	3.0328	0.33
18+25	3.0351	0.33
18+30	3.0373	0.33
18+35	3.0395	0.32
18+40	3.0414	0.28
18+45	3.0433	0.26
18+50	3.0449	0.24
18+55	3.0463	0.20
19+ 0	3.0476	0.19
19+ 5	3.0489	0.19
19+10	3.0504	0.22
19+15	3.0520	0.23
19+20	3.0538	0.25
19+25	3.0557	0.29
19+30	3.0578	0.30
19+35	3.0599	0.30
19+40	3.0618	0.27
19+45	3.0635	0.26
19+50	3.0652	0.24
19+55	3.0666	0.20
20+ 0	3.0679	0.18
20+ 5	3.0692	0.19
20+10	3.0707	0.22
20+15	3.0723	0.23
20+20	3.0739	0.24
20+25	3.0756	0.24
20+30	3.0772	0.24
20+35	3.0789	0.24
20+40	3.0806	0.24
20+45	3.0822	0.24
20+50	3.0838	0.23
20+55	3.0852	0.20
21+ 0	3.0865	0.18
21+ 5	3.0877	0.19
21+10	3.0892	0.22
21+15	3.0908	0.23
21+20	3.0924	0.23
21+25	3.0937	0.19
21+30	3.0949	0.18
21+35	3.0962	0.18
21+40	3.0977	0.22
21+45	3.0993	0.23
21+50	3.1008	0.22
21+55	3.1021	0.19
22+ 0	3.1034	0.18
22+ 5	3.1046	0.18
22+10	3.1061	0.22
22+15	3.1077	0.23
22+20	3.1092	0.22
22+25	3.1106	0.19
22+30	3.1118	0.18
22+35	3.1130	0.17
22+40	3.1141	0.17
22+45	3.1153	0.17
22+50	3.1164	0.17
22+55	3.1176	0.17
23+ 0	3.1187	0.16
23+ 5	3.1198	0.16
23+10	3.1209	0.16
23+15	3.1221	0.16
23+20	3.1232	0.16
23+25	3.1243	0.16
23+30	3.1254	0.16
23+35	3.1266	0.16
23+40	3.1277	0.16
23+45	3.1288	0.16
23+50	3.1299	0.16
23+55	3.1311	0.16
24+ 0	3.1322	0.16
24+ 5	3.1332	0.14
24+10	3.1336	0.07
24+15	3.1339	0.04
24+20	3.1340	0.02
24+25	3.1341	0.01
24+30	3.1342	0.01
24+35	3.1342	0.01
24+40	3.1343	0.00
24+45	3.1343	0.00
24+50	3.1343	0.00

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 ----------------------------------------------------------------------
         ****************************HYDROGRAPH DATA****************************
                   Number of intervals =   298
                   Time interval =    5.0 (Min.)
                   Maximum/Peak flow rate =        8.691 (CFS)
                   Total volume =       3.134 (Ac.Ft)
          Status of hydrographs being held in storage
                     Stream 1  Stream 2  Stream 3  Stream 4  Stream 5
          Peak (CFS)      0.000     0.000     2.897     0.000     0.000
          Vol (Ac.Ft)      0.000     0.000     1.045     0.000     0.000
         ***********************************************************************

         --------------------------------------------------------------------


         ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
         Process from Point/Station        2.000 to Point/Station        2.000
         **** RETARDING BASIN ROUTING ****
         ______________________________________________________________________

         User entry of depth-outflow-storage data
         --------------------------------------------------------------------
         Total number of inflow hydrograph intervals = 298
         Hydrograph time unit =  5.000 (Min.)
         Initial depth in storage basin =   0.00(Ft.)
         --------------------------------------------------------------------
         --------------------------------------------------------------------
         Initial basin depth =   0.00 (Ft.)
         Initial basin storage =      0.00 (Ac.Ft)
         Initial basin outflow =   0.00 (CFS)
         ---------------------------------------------------------------------
         --------------------------------------------------------------------
         Depth vs. Storage and Depth vs. Discharge data:
          Basin Depth  Storage    Outflow   (S-O*dt/2)   (S+O*dt/2)
              (Ft.)    (Ac.Ft)     (CFS)     (Ac.Ft)    (Ac.Ft)
         ---------------------------------------------------------------------
          0.000      0.000      0.000      0.000        0.000
          2.000      1.400      3.640      1.387        1.413
          4.000      3.200      7.500      3.174        3.226
          6.000      5.100      9.840      5.066        5.134
          8.000      7.600     11.710      7.560        7.640
         10.000     10.300     13.330     10.254       10.346
         12.000     13.300     14.780     13.249       13.351
         14.000     16.500     16.040     16.445       16.555
         16.000     19.900     17.020     19.841       19.959
         18.000     23.600     28.820     23.501       23.699
         20.000     27.300     36.360     27.175       27.425
         --------------------------------------------------------------------
                           Hydrograph Detention Basin Routing
         ---------------------------------------------------------------------

         Graph values: 'I'= unit inflow; 'O'=outflow at time shown
         ---------------------------------------------------------------------
  Time   Inflow  Outflow     Storage                                     Depth
 (Hours)  (CFS)   (CFS)     (Ac.Ft) .0       2.2     4.35    6.52    8.69 (Ft.)
  0.083    0.02    0.00      0.000  O       |       |       |       |      0.00
  0.167    0.09    0.00      0.000  O       |       |       |       |      0.00
  0.250    0.13    0.00      0.001  O       |       |       |       |      0.00
  0.333    0.15    0.01      0.002  O       |       |       |       |      0.00
  0.417    0.20    0.01      0.003  O       |       |       |       |      0.00
  0.500    0.22    0.01      0.005  O       |       |       |       |      0.01
  0.583    0.23    0.02      0.006  O       |       |       |       |      0.01
  0.667    0.23    0.02      0.008  O       |       |       |       |      0.01
  0.750    0.24    0.02      0.009  O       |       |       |       |      0.01
  0.833    0.25    0.03      0.011  O       |       |       |       |      0.02
  0.917    0.29    0.03      0.012  OI      |       |       |       |      0.02
  1.000    0.31    0.04      0.014  OI      |       |       |       |      0.02
  1.083    0.30    0.04      0.016  OI      |       |       |       |      0.02
  1.167    0.27    0.05      0.018  OI      |       |       |       |      0.03
  1.250    0.26    0.05      0.019  O       |       |       |       |      0.03
  1.333    0.25    0.05      0.020  O       |       |       |       |      0.03
  1.417    0.25    0.06      0.022  O       |       |       |       |      0.03
  1.500    0.25    0.06      0.023  O       |       |       |       |      0.03
  1.583    0.25    0.06      0.024  O       |       |       |       |      0.03
  1.667    0.25    0.07      0.026  O       |       |       |       |      0.04
  1.750    0.25    0.07      0.027  O       |       |       |       |      0.04
  1.833    0.26    0.07      0.028  O       |       |       |       |      0.04
  1.917    0.29    0.08      0.030  OI      |       |       |       |      0.04
  2.000    0.31    0.08      0.031  OI      |       |       |       |      0.04
  2.083    0.32    0.08      0.033  OI      |       |       |       |      0.05
  2.167    0.32    0.09      0.034  OI      |       |       |       |      0.05
  2.250    0.32    0.09      0.036  OI      |       |       |       |      0.05
  2.333    0.32    0.10      0.037  OI      |       |       |       |      0.05
  2.417    0.32    0.10      0.039  OI      |       |       |       |      0.06
  2.500    0.33    0.11      0.040  OI      |       |       |       |      0.06
  2.583    0.34    0.11      0.042  OI      |       |       |       |      0.06
  2.667    0.37    0.11      0.044  OI      |       |       |       |      0.06
  2.750    0.39    0.12      0.045  OI      |       |       |       |      0.06
  2.833    0.40    0.12      0.047  OI      |       |       |       |      0.07
  2.917    0.40    0.13      0.049  OI      |       |       |       |      0.07
  3.000    0.40    0.13      0.051  OI      |       |       |       |      0.07
  3.083    0.40    0.14      0.053  OI      |       |       |       |      0.08
  3.167    0.41    0.14      0.055  OI      |       |       |       |      0.08
  3.250    0.41    0.15      0.057  OI      |       |       |       |      0.08
  3.333    0.41    0.15      0.058  OI      |       |       |       |      0.08
  3.417    0.41    0.16      0.060  OI      |       |       |       |      0.09
  3.500    0.41    0.16      0.062  OI      |       |       |       |      0.09
  3.583    0.41    0.17      0.064  OI      |       |       |       |      0.09
  3.667    0.41    0.17      0.065  OI      |       |       |       |      0.09
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  3.750    0.41    0.17      0.067  OI      |       |       |       |      0.10
  3.833    0.42    0.18      0.068  OI      |       |       |       |      0.10
  3.917    0.46    0.18      0.070  OI      |       |       |       |      0.10
  4.000    0.47    0.19      0.072  OI      |       |       |       |      0.10
  4.083    0.48    0.19      0.074  OI      |       |       |       |      0.11
  4.167    0.48    0.20      0.076  OI      |       |       |       |      0.11
  4.250    0.48    0.20      0.078  OI      |       |       |       |      0.11
  4.333    0.50    0.21      0.080  OI      |       |       |       |      0.11
  4.417    0.54    0.21      0.082  OI      |       |       |       |      0.12
  4.500    0.55    0.22      0.084  O I     |       |       |       |      0.12
  4.583    0.56    0.23      0.087  O I     |       |       |       |      0.12
  4.667    0.56    0.23      0.089  O I     |       |       |       |      0.13
  4.750    0.57    0.24      0.091  O I     |       |       |       |      0.13
  4.833    0.58    0.24      0.094  O I     |       |       |       |      0.13
  4.917    0.62    0.25      0.096  O I     |       |       |       |      0.14
  5.000    0.63    0.26      0.099  O I     |       |       |       |      0.14
  5.083    0.62    0.26      0.101  O I     |       |       |       |      0.14
  5.167    0.55    0.27      0.103  O I     |       |       |       |      0.15
  5.250    0.52    0.27      0.105  |O      |       |       |       |      0.15
  5.333    0.52    0.28      0.107  |O      |       |       |       |      0.15
  5.417    0.55    0.28      0.108  |OI     |       |       |       |      0.15
  5.500    0.56    0.29      0.110  |OI     |       |       |       |      0.16
  5.583    0.58    0.29      0.112  |OI     |       |       |       |      0.16
  5.667    0.62    0.30      0.114  |OI     |       |       |       |      0.16
  5.750    0.63    0.30      0.117  |OI     |       |       |       |      0.17
  5.833    0.64    0.31      0.119  |OI     |       |       |       |      0.17
  5.917    0.64    0.31      0.121  |OI     |       |       |       |      0.17
  6.000    0.65    0.32      0.123  |OI     |       |       |       |      0.18
  6.083    0.66    0.33      0.126  |OI     |       |       |       |      0.18
  6.167    0.70    0.33      0.128  |OI     |       |       |       |      0.18
  6.250    0.72    0.34      0.131  |OI     |       |       |       |      0.19
  6.333    0.72    0.35      0.133  |OI     |       |       |       |      0.19
  6.417    0.73    0.35      0.136  |OI     |       |       |       |      0.19
  6.500    0.73    0.36      0.138  |OI     |       |       |       |      0.20
  6.583    0.74    0.37      0.141  |OI     |       |       |       |      0.20
  6.667    0.78    0.37      0.144  |OI     |       |       |       |      0.21
  6.750    0.80    0.38      0.146  |OI     |       |       |       |      0.21
  6.833    0.80    0.39      0.149  |OI     |       |       |       |      0.21
  6.917    0.81    0.40      0.152  |OI     |       |       |       |      0.22
  7.000    0.81    0.40      0.155  |OI     |       |       |       |      0.22
  7.083    0.81    0.41      0.158  |OI     |       |       |       |      0.23
  7.167    0.81    0.42      0.161  |OI     |       |       |       |      0.23
  7.250    0.82    0.42      0.163  |O I    |       |       |       |      0.23
  7.333    0.83    0.43      0.166  |O I    |       |       |       |      0.24
  7.417    0.86    0.44      0.169  |O I    |       |       |       |      0.24
  7.500    0.88    0.45      0.172  |O I    |       |       |       |      0.25
  7.583    0.90    0.45      0.175  |O I    |       |       |       |      0.25
  7.667    0.94    0.46      0.178  |O I    |       |       |       |      0.25
  7.750    0.96    0.47      0.181  |O I    |       |       |       |      0.26
  7.833    0.98    0.48      0.185  |O I    |       |       |       |      0.26
  7.917    1.02    0.49      0.188  |O I    |       |       |       |      0.27
  8.000    1.04    0.50      0.192  |O I    |       |       |       |      0.27
  8.083    1.07    0.51      0.196  |O I    |       |       |       |      0.28
  8.167    1.15    0.52      0.200  |O  I   |       |       |       |      0.29
  8.250    1.18    0.53      0.204  |O  I   |       |       |       |      0.29
  8.333    1.20    0.54      0.209  |O  I   |       |       |       |      0.30
  8.417    1.21    0.55      0.213  | O I   |       |       |       |      0.30
  8.500    1.21    0.57      0.218  | O I   |       |       |       |      0.31
  8.583    1.23    0.58      0.222  | O I   |       |       |       |      0.32
  8.667    1.27    0.59      0.227  | O I   |       |       |       |      0.32
  8.750    1.29    0.60      0.231  | O I   |       |       |       |      0.33
  8.833    1.31    0.61      0.236  | O I   |       |       |       |      0.34
  8.917    1.35    0.63      0.241  | O I   |       |       |       |      0.34
  9.000    1.36    0.64      0.246  | O  I  |       |       |       |      0.35
  9.083    1.45    0.65      0.251  | O  I  |       |       |       |      0.36
  9.167    1.73    0.67      0.258  | O   I |       |       |       |      0.37
  9.250    1.87    0.69      0.265  | O   I |       |       |       |      0.38
  9.333    1.99    0.71      0.274  | O    I|       |       |       |      0.39
  9.417    2.21    0.74      0.283  | O     I       |       |       |      0.40
  9.500    2.33    0.76      0.294  | O     I       |       |       |      0.42
  9.583    2.44    0.79      0.305  | O     I       |       |       |      0.44
  9.667    2.66    0.82      0.317  |  O    |I      |       |       |      0.45
  9.750    2.78    0.86      0.330  |  O    | I     |       |       |      0.47
  9.833    2.90    0.89      0.343  |  O    | I     |       |       |      0.49
  9.917    3.12    0.93      0.358  |  O    |  I    |       |       |      0.51
 10.000    3.23    0.97      0.373  |  O    |  I    |       |       |      0.53
 10.083    3.01    1.01      0.388  |  O    |  I    |       |       |      0.55
 10.167    2.10    1.04      0.398  |  O   I|       |       |       |      0.57
 10.250    1.68    1.05      0.404  |  O  I |       |       |       |      0.58
 10.333    1.52    1.06      0.408  |  O I  |       |       |       |      0.58
 10.417    1.42    1.07      0.411  |  O I  |       |       |       |      0.59
 10.500    1.35    1.07      0.413  |  OI   |       |       |       |      0.59
 10.583    1.52    1.08      0.415  |  O I  |       |       |       |      0.59
 10.667    2.18    1.09      0.420  |   O   I       |       |       |      0.60
 10.750    2.49    1.12      0.429  |   O   |I      |       |       |      0.61
 10.833    2.62    1.14      0.439  |   O   |I      |       |       |      0.63
 10.917    2.71    1.17      0.449  |   O   |I      |       |       |      0.64
 11.000    2.78    1.20      0.460  |   O   | I     |       |       |      0.66
 11.083    2.79    1.22      0.471  |   O   | I     |       |       |      0.67
 11.167    2.67    1.25      0.481  |   O   |I      |       |       |      0.69
 11.250    2.63    1.28      0.491  |   O   |I      |       |       |      0.70
 11.333    2.63    1.30      0.500  |   O   |I      |       |       |      0.71
 11.417    2.65    1.32      0.509  |   O   |I      |       |       |      0.73
 11.500    2.66    1.35      0.518  |   O   |I      |       |       |      0.74
 11.583    2.57    1.37      0.527  |    O  |I      |       |       |      0.75
 11.667    2.26    1.39      0.534  |    O  I       |       |       |      0.76
 11.750    2.12    1.40      0.539  |    O I|       |       |       |      0.77
 11.833    2.13    1.42      0.544  |    O I|       |       |       |      0.78
 11.917    2.28    1.43      0.550  |    O  I       |       |       |      0.79
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12.000    2.35    1.45      0.556  |    O  I       |       |       |     0.79
12.083    2.73    1.46      0.563  |    O  | I     |       |       |     0.80
12.167    3.91    1.50      0.576  |    O  |     I |       |       |     0.82
12.250    4.48    1.55      0.594  |    O  |       I       |       |     0.85
12.333    4.77    1.60      0.615  |    O  |       |I      |       |     0.88
12.417    5.09    1.66      0.638  |     O |       | I     |       |     0.91
12.500    5.28    1.72      0.662  |     O |       |  I    |       |     0.95
12.583    5.50    1.79      0.687  |     O |       |   I   |       |     0.98
12.667    5.91    1.86      0.714  |     O |       |    I  |       |     1.02
12.750    6.13    1.93      0.742  |      O|       |     I |       |     1.06
12.833    6.29    2.01      0.772  |      O|       |      I|       |     1.10
12.917    6.54    2.08      0.802  |      O|       |       I       |     1.15
13.000    6.66    2.16      0.833  |      O|       |       I       |     1.19
13.083    6.98    2.25      0.864  |       O       |       |I      |     1.23
13.167    7.86    2.34      0.900  |       O       |       |   I   |     1.29
13.250    8.29    2.44      0.939  |       O       |       |     I |     1.34
13.333    8.48    2.55      0.979  |       |O      |       |      I|     1.40
13.417    8.61    2.65      1.020  |       |O      |       |      I|     1.46
13.500    8.69    2.76      1.061  |       | O     |       |       I     1.52
13.583    8.22    2.86      1.100  |       | O     |       |     I |     1.57
13.667    6.46    2.94      1.131  |       | O     |      I|       |     1.62
13.750    5.65    2.99      1.152  |       |  O    |   I   |       |     1.65
13.833    5.34    3.04      1.169  |       |  O    |  I    |       |     1.67
13.917    5.16    3.08      1.184  |       |  O    |  I    |       |     1.69
14.000    5.05    3.11      1.198  |       |  O    | I     |       |     1.71
14.083    5.17    3.15      1.211  |       |  O    |  I    |       |     1.73
14.167    5.78    3.19      1.227  |       |  O    |    I  |       |     1.75
14.250    6.07    3.24      1.246  |       |  O    |     I |       |     1.78
14.333    6.13    3.29      1.266  |       |   O   |     I |       |     1.81
14.417    6.03    3.34      1.285  |       |   O   |     I |       |     1.84
14.500    6.03    3.39      1.303  |       |   O   |     I |       |     1.86
14.583    6.05    3.43      1.321  |       |   O   |     I |       |     1.89
14.667    6.07    3.48      1.339  |       |   O   |     I |       |     1.91
14.750    6.09    3.53      1.357  |       |   O   |     I |       |     1.94
14.833    6.07    3.57      1.374  |       |    O  |     I |       |     1.96
14.917    5.93    3.62      1.391  |       |    O  |    I  |       |     1.99
15.000    5.86    3.65      1.406  |       |    O  |    I  |       |     2.01
15.083    5.80    3.69      1.421  |       |    O  |    I  |       |     2.02
15.167    5.63    3.72      1.435  |       |    O  |   I   |       |     2.04
15.250    5.56    3.74      1.448  |       |    O  |   I   |       |     2.05
15.333    5.49    3.77      1.460  |       |    O  |   I   |       |     2.07
15.417    5.32    3.79      1.471  |       |    O  |  I    |       |     2.08
15.500    5.24    3.81      1.481  |       |     O |  I    |       |     2.09
15.583    5.02    3.83      1.490  |       |     O | I     |       |     2.10
15.667    4.36    3.85      1.496  |       |     O I       |       |     2.11
15.750    4.05    3.85      1.499  |       |     O |       |       |     2.11
15.833    3.93    3.85      1.500  |       |     O |       |       |     2.11
15.917    3.86    3.85      1.500  |       |     O |       |       |     2.11
16.000    3.83    3.85      1.500  |       |     O |       |       |     2.11
16.083    3.35    3.85      1.498  |       |   I O |       |       |     2.11
16.167    1.83    3.83      1.489  |     I |     O |       |       |     2.10
16.250    1.12    3.80      1.473  |   I   |    O  |       |       |     2.08
16.333    0.83    3.76      1.454  |  I    |    O  |       |       |     2.06
16.417    0.65    3.71      1.433  | I     |    O  |       |       |     2.04
16.500    0.54    3.67      1.412  |I      |    O  |       |       |     2.01
16.583    0.45    3.62      1.390  |I      |    O  |       |       |     1.99
16.667    0.36    3.56      1.369  |I      |    O  |       |       |     1.96
16.750    0.31    3.50      1.347  |I      |   O   |       |       |     1.92
16.833    0.28    3.44      1.325  |I      |   O   |       |       |     1.89
16.917    0.25    3.39      1.303  I       |   O   |       |       |     1.86
17.000    0.25    3.33      1.282  I       |   O   |       |       |     1.83
17.083    0.27    3.28      1.261  I       |   O   |       |       |     1.80
17.167    0.34    3.22      1.240  |I      |  O    |       |       |     1.77
17.250    0.37    3.17      1.221  |I      |  O    |       |       |     1.74
17.333    0.39    3.12      1.202  |I      |  O    |       |       |     1.72
17.417    0.39    3.08      1.183  |I      |  O    |       |       |     1.69
17.500    0.40    3.03      1.165  |I      |  O    |       |       |     1.66
17.583    0.40    2.98      1.147  |I      | O     |       |       |     1.64
17.667    0.40    2.94      1.129  |I      | O     |       |       |     1.61
17.750    0.41    2.89      1.112  |I      | O     |       |       |     1.59
17.833    0.40    2.85      1.095  |I      | O     |       |       |     1.56
17.917    0.36    2.80      1.078  |I      | O     |       |       |     1.54
18.000    0.34    2.76      1.061  |I      | O     |       |       |     1.52
18.083    0.34    2.72      1.045  |I      | O     |       |       |     1.49
18.167    0.33    2.67      1.029  |I      |O      |       |       |     1.47
18.250    0.33    2.63      1.013  |I      |O      |       |       |     1.45
18.333    0.33    2.59      0.997  |I      |O      |       |       |     1.42
18.417    0.33    2.55      0.981  |I      |O      |       |       |     1.40
18.500    0.33    2.51      0.966  |I      |O      |       |       |     1.38
18.583    0.32    2.47      0.951  |I      |O      |       |       |     1.36
18.667    0.28    2.43      0.936  |I      O       |       |       |     1.34
18.750    0.26    2.40      0.922  I       O       |       |       |     1.32
18.833    0.24    2.36      0.907  I       O       |       |       |     1.30
18.917    0.20    2.32      0.892  I       O       |       |       |     1.27
19.000    0.19    2.28      0.878  I       O       |       |       |     1.25
19.083    0.19    2.25      0.864  I       O       |       |       |     1.23
19.167    0.22    2.21      0.850  I       O       |       |       |     1.21
19.250    0.23    2.17      0.836  I       O       |       |       |     1.19
19.333    0.25    2.14      0.823  I      O|       |       |       |     1.18
19.417    0.29    2.11      0.810  |I     O|       |       |       |     1.16
19.500    0.30    2.07      0.798  |I     O|       |       |       |     1.14
19.583    0.30    2.04      0.786  |I     O|       |       |       |     1.12
19.667    0.27    2.01      0.774  I      O|       |       |       |     1.11
19.750    0.26    1.98      0.762  I      O|       |       |       |     1.09
19.833    0.24    1.95      0.750  I      O|       |       |       |     1.07
19.917    0.20    1.92      0.738  I      O|       |       |       |     1.05
20.000    0.18    1.89      0.726  I     O |       |       |       |     1.04
20.083    0.19    1.86      0.715  I     O |       |       |       |     1.02
20.167    0.22    1.83      0.704  I     O |       |       |       |     1.01
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20.250    0.23    1.80      0.693  I     O |       |       |       |     0.99
20.333    0.24    1.77      0.682  I     O |       |       |       |     0.97
20.417    0.24    1.75      0.671  I     O |       |       |       |     0.96
20.500    0.24    1.72      0.661  I     O |       |       |       |     0.94
20.583    0.24    1.69      0.651  I     O |       |       |       |     0.93
20.667    0.24    1.67      0.641  I     O |       |       |       |     0.92
20.750    0.24    1.64      0.631  I     O |       |       |       |     0.90
20.833    0.23    1.62      0.622  I    O  |       |       |       |     0.89
20.917    0.20    1.59      0.612  I    O  |       |       |       |     0.87
21.000    0.18    1.57      0.603  I    O  |       |       |       |     0.86
21.083    0.19    1.54      0.593  I    O  |       |       |       |     0.85
21.167    0.22    1.52      0.584  I    O  |       |       |       |     0.83
21.250    0.23    1.50      0.575  I    O  |       |       |       |     0.82
21.333    0.23    1.47      0.567  I    O  |       |       |       |     0.81
21.417    0.19    1.45      0.558  I    O  |       |       |       |     0.80
21.500    0.18    1.43      0.549  I    O  |       |       |       |     0.78
21.583    0.18    1.41      0.541  I    O  |       |       |       |     0.77
21.667    0.22    1.38      0.533  I    O  |       |       |       |     0.76
21.750    0.23    1.36      0.525  I    O  |       |       |       |     0.75
21.833    0.22    1.34      0.517  I   O   |       |       |       |     0.74
21.917    0.19    1.32      0.509  I   O   |       |       |       |     0.73
22.000    0.18    1.30      0.501  I   O   |       |       |       |     0.72
22.083    0.18    1.28      0.494  I   O   |       |       |       |     0.71
22.167    0.22    1.26      0.486  I   O   |       |       |       |     0.69
22.250    0.23    1.25      0.479  I   O   |       |       |       |     0.68
22.333    0.22    1.23      0.472  I   O   |       |       |       |     0.67
22.417    0.19    1.21      0.465  I   O   |       |       |       |     0.66
22.500    0.18    1.19      0.458  I   O   |       |       |       |     0.65
22.583    0.17    1.17      0.451  I   O   |       |       |       |     0.64
22.667    0.17    1.16      0.445  I   O   |       |       |       |     0.64
22.750    0.17    1.14      0.438  I   O   |       |       |       |     0.63
22.833    0.17    1.12      0.431  I   O   |       |       |       |     0.62
22.917    0.17    1.10      0.425  I   O   |       |       |       |     0.61
23.000    0.16    1.09      0.418  I   O   |       |       |       |     0.60
23.083    0.16    1.07      0.412  I  O    |       |       |       |     0.59
23.167    0.16    1.05      0.406  I  O    |       |       |       |     0.58
23.250    0.16    1.04      0.400  I  O    |       |       |       |     0.57
23.333    0.16    1.02      0.394  I  O    |       |       |       |     0.56
23.417    0.16    1.01      0.388  I  O    |       |       |       |     0.55
23.500    0.16    0.99      0.382  I  O    |       |       |       |     0.55
23.583    0.16    0.98      0.376  I  O    |       |       |       |     0.54
23.667    0.16    0.96      0.371  I  O    |       |       |       |     0.53
23.750    0.16    0.95      0.365  I  O    |       |       |       |     0.52
23.833    0.16    0.94      0.360  I  O    |       |       |       |     0.51
23.917    0.16    0.92      0.355  I  O    |       |       |       |     0.51
24.000    0.16    0.91      0.349  I  O    |       |       |       |     0.50
24.083    0.14    0.90      0.344  I  O    |       |       |       |     0.49
24.167    0.07    0.88      0.339  I  O    |       |       |       |     0.48
24.250    0.04    0.87      0.333  I  O    |       |       |       |     0.48
24.333    0.02    0.85      0.328  I  O    |       |       |       |     0.47
24.417    0.01    0.84      0.322  I  O    |       |       |       |     0.46
24.500    0.01    0.82      0.316  I  O    |       |       |       |     0.45
24.583    0.01    0.81      0.311  I O     |       |       |       |     0.44
24.667    0.00    0.79      0.305  I O     |       |       |       |     0.44
24.750    0.00    0.78      0.300  I O     |       |       |       |     0.43
24.833    0.00    0.77      0.294  I O     |       |       |       |     0.42
24.917    0.00    0.75      0.289  I O     |       |       |       |     0.41
25.000    0.00    0.74      0.284  I O     |       |       |       |     0.41
25.083    0.00    0.73      0.279  I O     |       |       |       |     0.40
25.167    0.00    0.71      0.274  I O     |       |       |       |     0.39
25.250    0.00    0.70      0.269  I O     |       |       |       |     0.38
25.333    0.00    0.69      0.264  I O     |       |       |       |     0.38
25.417    0.00    0.68      0.260  I O     |       |       |       |     0.37
25.500    0.00    0.66      0.255  I O     |       |       |       |     0.36
25.583    0.00    0.65      0.251  I O     |       |       |       |     0.36
25.667    0.00    0.64      0.246  I O     |       |       |       |     0.35
25.750    0.00    0.63      0.242  I O     |       |       |       |     0.35
25.833    0.00    0.62      0.238  I O     |       |       |       |     0.34
25.917    0.00    0.61      0.233  I O     |       |       |       |     0.33
26.000    0.00    0.60      0.229  I O     |       |       |       |     0.33
26.083    0.00    0.59      0.225  I O     |       |       |       |     0.32
26.167    0.00    0.57      0.221  I O     |       |       |       |     0.32
26.250    0.00    0.56      0.217  I O     |       |       |       |     0.31
26.333    0.00    0.55      0.213  I O     |       |       |       |     0.30
26.417    0.00    0.54      0.210  I O     |       |       |       |     0.30
26.500    0.00    0.54      0.206  IO      |       |       |       |     0.29
26.583    0.00    0.53      0.202  IO      |       |       |       |     0.29
26.667    0.00    0.52      0.199  IO      |       |       |       |     0.28
26.750    0.00    0.51      0.195  IO      |       |       |       |     0.28
26.833    0.00    0.50      0.192  IO      |       |       |       |     0.27
26.917    0.00    0.49      0.188  IO      |       |       |       |     0.27
27.000    0.00    0.48      0.185  IO      |       |       |       |     0.26
27.083    0.00    0.47      0.182  IO      |       |       |       |     0.26
27.167    0.00    0.46      0.178  IO      |       |       |       |     0.25
27.250    0.00    0.46      0.175  IO      |       |       |       |     0.25
27.333    0.00    0.45      0.172  IO      |       |       |       |     0.25
27.417    0.00    0.44      0.169  IO      |       |       |       |     0.24
27.500    0.00    0.43      0.166  IO      |       |       |       |     0.24
27.583    0.00    0.42      0.163  IO      |       |       |       |     0.23
27.667    0.00    0.42      0.160  IO      |       |       |       |     0.23
27.750    0.00    0.41      0.157  IO      |       |       |       |     0.22
27.833    0.00    0.40      0.155  IO      |       |       |       |     0.22
27.917    0.00    0.39      0.152  IO      |       |       |       |     0.22
28.000    0.00    0.39      0.149  IO      |       |       |       |     0.21
28.083    0.00    0.38      0.146  IO      |       |       |       |     0.21
28.167    0.00    0.37      0.144  IO      |       |       |       |     0.21
28.250    0.00    0.37      0.141  IO      |       |       |       |     0.20
28.333    0.00    0.36      0.139  IO      |       |       |       |     0.20
28.417    0.00    0.35      0.136  IO      |       |       |       |     0.19
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28.500	0.00	0.35	0.134 IO	|	|	|	|	0.19
28.583	0.00	0.34	0.132 IO	|	|	|	|	0.19
28.667	0.00	0.34	0.129 IO	|	|	|	|	0.18
28.750	0.00	0.33	0.127 IO	|	|	|	|	0.18
28.833	0.00	0.32	0.125 IO	|	|	|	|	0.18
28.917	0.00	0.32	0.122 IO	|	|	|	|	0.17
29.000	0.00	0.31	0.120 IO	|	|	|	|	0.17
29.083	0.00	0.31	0.118 IO	|	|	|	|	0.17
29.167	0.00	0.30	0.116 IO	|	|	|	|	0.17
29.250	0.00	0.30	0.114 IO	|	|	|	|	0.16
29.333	0.00	0.29	0.112 IO	|	|	|	|	0.16
29.417	0.00	0.29	0.110 IO	|	|	|	|	0.16
29.500	0.00	0.28	0.108 IO	|	|	|	|	0.15
29.583	0.00	0.28	0.106 IO	|	|	|	|	0.15
29.667	0.00	0.27	0.104 O	|	|	|	|	0.15
29.750	0.00	0.27	0.102 O	|	|	|	|	0.15
29.833	0.00	0.26	0.101 O	|	|	|	|	0.14
29.917	0.00	0.26	0.099 O	|	|	|	|	0.14
30.000	0.00	0.25	0.097 O	|	|	|	|	0.14
30.083	0.00	0.25	0.095 O	|	|	|	|	0.14
30.167	0.00	0.24	0.094 O	|	|	|	|	0.13
30.250	0.00	0.24	0.092 O	|	|	|	|	0.13
30.333	0.00	0.23	0.090 O	|	|	|	|	0.13
30.417	0.00	0.23	0.089 O	|	|	|	|	0.13
30.500	0.00	0.23	0.087 O	|	|	|	|	0.12
30.583	0.00	0.22	0.086 O	|	|	|	|	0.12
30.667	0.00	0.22	0.084 O	|	|	|	|	0.12
30.750	0.00	0.21	0.083 O	|	|	|	|	0.12
30.833	0.00	0.21	0.081 O	|	|	|	|	0.12
30.917	0.00	0.21	0.080 O	|	|	|	|	0.11
31.000	0.00	0.20	0.078 O	|	|	|	|	0.11
31.083	0.00	0.20	0.077 O	|	|	|	|	0.11
31.167	0.00	0.20	0.076 O	|	|	|	|	0.11
31.250	0.00	0.19	0.074 O	|	|	|	|	0.11
31.333	0.00	0.19	0.073 O	|	|	|	|	0.10
31.417	0.00	0.19	0.072 O	|	|	|	|	0.10
31.500	0.00	0.18	0.070 O	|	|	|	|	0.10
31.583	0.00	0.18	0.069 O	|	|	|	|	0.10
31.667	0.00	0.18	0.068 O	|	|	|	|	0.10
31.750	0.00	0.17	0.067 O	|	|	|	|	0.10
31.833	0.00	0.17	0.065 O	|	|	|	|	0.09
31.917	0.00	0.17	0.064 O	|	|	|	|	0.09
32.000	0.00	0.16	0.063 O	|	|	|	|	0.09
32.083	0.00	0.16	0.062 O	|	|	|	|	0.09
32.167	0.00	0.16	0.061 O	|	|	|	|	0.09
32.250	0.00	0.16	0.060 O	|	|	|	|	0.09
32.333	0.00	0.15	0.059 O	|	|	|	|	0.08
32.417	0.00	0.15	0.058 O	|	|	|	|	0.08
32.500	0.00	0.15	0.057 O	|	|	|	|	0.08
32.583	0.00	0.14	0.056 O	|	|	|	|	0.08
32.667	0.00	0.14	0.055 O	|	|	|	|	0.08
32.750	0.00	0.14	0.054 O	|	|	|	|	0.08
32.833	0.00	0.14	0.053 O	|	|	|	|	0.08
32.917	0.00	0.13	0.052 O	|	|	|	|	0.07
33.000	0.00	0.13	0.051 O	|	|	|	|	0.07
33.083	0.00	0.13	0.050 O	|	|	|	|	0.07
33.167	0.00	0.13	0.049 O	|	|	|	|	0.07
33.250	0.00	0.13	0.048 O	|	|	|	|	0.07
33.333	0.00	0.12	0.047 O	|	|	|	|	0.07
33.417	0.00	0.12	0.047 O	|	|	|	|	0.07
33.500	0.00	0.12	0.046 O	|	|	|	|	0.07
33.583	0.00	0.12	0.045 O	|	|	|	|	0.06
33.667	0.00	0.11	0.044 O	|	|	|	|	0.06
33.750	0.00	0.11	0.043 O	|	|	|	|	0.06
33.833	0.00	0.11	0.043 O	|	|	|	|	0.06
33.917	0.00	0.11	0.042 O	|	|	|	|	0.06
34.000	0.00	0.11	0.041 O	|	|	|	|	0.06
34.083	0.00	0.10	0.040 O	|	|	|	|	0.06
34.167	0.00	0.10	0.040 O	|	|	|	|	0.06
34.250	0.00	0.10	0.039 O	|	|	|	|	0.06
34.333	0.00	0.10	0.038 O	|	|	|	|	0.05
34.417	0.00	0.10	0.038 O	|	|	|	|	0.05
34.500	0.00	0.10	0.037 O	|	|	|	|	0.05
34.583	0.00	0.09	0.036 O	|	|	|	|	0.05
34.667	0.00	0.09	0.036 O	|	|	|	|	0.05
34.750	0.00	0.09	0.035 O	|	|	|	|	0.05
34.833	0.00	0.09	0.034 O	|	|	|	|	0.05
34.917	0.00	0.09	0.034 O	|	|	|	|	0.05
35.000	0.00	0.09	0.033 O	|	|	|	|	0.05
35.083	0.00	0.08	0.033 O	|	|	|	|	0.05
35.167	0.00	0.08	0.032 O	|	|	|	|	0.05
35.250	0.00	0.08	0.031 O	|	|	|	|	0.04
35.333	0.00	0.08	0.031 O	|	|	|	|	0.04
35.417	0.00	0.08	0.030 O	|	|	|	|	0.04
35.500	0.00	0.08	0.030 O	|	|	|	|	0.04
35.583	0.00	0.08	0.029 O	|	|	|	|	0.04
35.667	0.00	0.07	0.029 O	|	|	|	|	0.04
35.750	0.00	0.07	0.028 O	|	|	|	|	0.04
35.833	0.00	0.07	0.028 O	|	|	|	|	0.04
35.917	0.00	0.07	0.027 O	|	|	|	|	0.04
36.000	0.00	0.07	0.027 O	|	|	|	|	0.04
36.083	0.00	0.07	0.026 O	|	|	|	|	0.04
36.167	0.00	0.07	0.026 O	|	|	|	|	0.04
36.250	0.00	0.07	0.025 O	|	|	|	|	0.04
36.333	0.00	0.06	0.025 O	|	|	|	|	0.04
36.417	0.00	0.06	0.024 O	|	|	|	|	0.03
36.500	0.00	0.06	0.024 O	|	|	|	|	0.03
36.583	0.00	0.06	0.024 O	|	|	|	|	0.03
36.667	0.00	0.06	0.023 O	|	|	|	|	0.03

36.750	0.00	0.06	0.023 O	|	|	|	|	0.03
36.833	0.00	0.06	0.022 O	|	|	|	|	0.03
36.917	0.00	0.06	0.022 O	|	|	|	|	0.03
37.000	0.00	0.06	0.022 O	|	|	|	|	0.03
37.083	0.00	0.06	0.021 O	|	|	|	|	0.03
37.167	0.00	0.05	0.021 O	|	|	|	|	0.03
37.250	0.00	0.05	0.020 O	|	|	|	|	0.03
37.333	0.00	0.05	0.020 O	|	|	|	|	0.03
37.417	0.00	0.05	0.020 O	|	|	|	|	0.03
37.500	0.00	0.05	0.019 O	|	|	|	|	0.03
37.583	0.00	0.05	0.019 O	|	|	|	|	0.03
37.667	0.00	0.05	0.019 O	|	|	|	|	0.03
37.750	0.00	0.05	0.018 O	|	|	|	|	0.03
37.833	0.00	0.05	0.018 O	|	|	|	|	0.03
37.917	0.00	0.05	0.018 O	|	|	|	|	0.03
38.000	0.00	0.05	0.017 O	|	|	|	|	0.02
38.083	0.00	0.04	0.017 O	|	|	|	|	0.02
38.167	0.00	0.04	0.017 O	|	|	|	|	0.02
38.250	0.00	0.04	0.016 O	|	|	|	|	0.02
38.333	0.00	0.04	0.016 O	|	|	|	|	0.02
38.417	0.00	0.04	0.016 O	|	|	|	|	0.02
38.500	0.00	0.04	0.016 O	|	|	|	|	0.02
38.583	0.00	0.04	0.015 O	|	|	|	|	0.02
38.667	0.00	0.04	0.015 O	|	|	|	|	0.02
38.750	0.00	0.04	0.015 O	|	|	|	|	0.02
38.833	0.00	0.04	0.015 O	|	|	|	|	0.02
38.917	0.00	0.04	0.014 O	|	|	|	|	0.02
39.000	0.00	0.04	0.014 O	|	|	|	|	0.02
39.083	0.00	0.04	0.014 O	|	|	|	|	0.02
39.167	0.00	0.04	0.014 O	|	|	|	|	0.02
39.250	0.00	0.03	0.013 O	|	|	|	|	0.02
39.333	0.00	0.03	0.013 O	|	|	|	|	0.02
39.417	0.00	0.03	0.013 O	|	|	|	|	0.02
39.500	0.00	0.03	0.013 O	|	|	|	|	0.02
39.583	0.00	0.03	0.012 O	|	|	|	|	0.02
39.667	0.00	0.03	0.012 O	|	|	|	|	0.02
39.750	0.00	0.03	0.012 O	|	|	|	|	0.02
39.833	0.00	0.03	0.012 O	|	|	|	|	0.02
39.917	0.00	0.03	0.012 O	|	|	|	|	0.02
40.000	0.00	0.03	0.011 O	|	|	|	|	0.02
40.083	0.00	0.03	0.011 O	|	|	|	|	0.02
40.167	0.00	0.03	0.011 O	|	|	|	|	0.02
40.250	0.00	0.03	0.011 O	|	|	|	|	0.02
40.333	0.00	0.03	0.011 O	|	|	|	|	0.02
40.417	0.00	0.03	0.010 O	|	|	|	|	0.01
40.500	0.00	0.03	0.010 O	|	|	|	|	0.01
40.583	0.00	0.03	0.010 O	|	|	|	|	0.01
40.667	0.00	0.03	0.010 O	|	|	|	|	0.01
40.750	0.00	0.03	0.010 O	|	|	|	|	0.01
40.833	0.00	0.02	0.009 O	|	|	|	|	0.01
40.917	0.00	0.02	0.009 O	|	|	|	|	0.01
41.000	0.00	0.02	0.009 O	|	|	|	|	0.01
41.083	0.00	0.02	0.009 O	|	|	|	|	0.01
41.167	0.00	0.02	0.009 O	|	|	|	|	0.01
41.250	0.00	0.02	0.009 O	|	|	|	|	0.01
41.333	0.00	0.02	0.008 O	|	|	|	|	0.01
41.417	0.00	0.02	0.008 O	|	|	|	|	0.01
41.500	0.00	0.02	0.008 O	|	|	|	|	0.01
41.583	0.00	0.02	0.008 O	|	|	|	|	0.01
41.667	0.00	0.02	0.008 O	|	|	|	|	0.01
41.750	0.00	0.02	0.008 O	|	|	|	|	0.01
41.833	0.00	0.02	0.008 O	|	|	|	|	0.01
41.917	0.00	0.02	0.007 O	|	|	|	|	0.01
42.000	0.00	0.02	0.007 O	|	|	|	|	0.01
42.083	0.00	0.02	0.007 O	|	|	|	|	0.01
42.167	0.00	0.02	0.007 O	|	|	|	|	0.01
42.250	0.00	0.02	0.007 O	|	|	|	|	0.01
42.333	0.00	0.02	0.007 O	|	|	|	|	0.01
42.417	0.00	0.02	0.007 O	|	|	|	|	0.01
42.500	0.00	0.02	0.007 O	|	|	|	|	0.01
42.583	0.00	0.02	0.006 O	|	|	|	|	0.01
42.667	0.00	0.02	0.006 O	|	|	|	|	0.01
42.750	0.00	0.02	0.006 O	|	|	|	|	0.01
42.833	0.00	0.02	0.006 O	|	|	|	|	0.01
42.917	0.00	0.02	0.006 O	|	|	|	|	0.01
43.000	0.00	0.02	0.006 O	|	|	|	|	0.01
43.083	0.00	0.02	0.006 O	|	|	|	|	0.01
43.167	0.00	0.01	0.006 O	|	|	|	|	0.01
43.250	0.00	0.01	0.006 O	|	|	|	|	0.01
43.333	0.00	0.01	0.006 O	|	|	|	|	0.01
43.417	0.00	0.01	0.005 O	|	|	|	|	0.01
43.500	0.00	0.01	0.005 O	|	|	|	|	0.01
43.583	0.00	0.01	0.005 O	|	|	|	|	0.01
43.667	0.00	0.01	0.005 O	|	|	|	|	0.01
43.750	0.00	0.01	0.005 O	|	|	|	|	0.01
43.833	0.00	0.01	0.005 O	|	|	|	|	0.01
43.917	0.00	0.01	0.005 O	|	|	|	|	0.01
44.000	0.00	0.01	0.005 O	|	|	|	|	0.01
44.083	0.00	0.01	0.005 O	|	|	|	|	0.01
44.167	0.00	0.01	0.005 O	|	|	|	|	0.01
44.250	0.00	0.01	0.005 O	|	|	|	|	0.01
44.333	0.00	0.01	0.004 O	|	|	|	|	0.01
44.417	0.00	0.01	0.004 O	|	|	|	|	0.01
44.500	0.00	0.01	0.004 O	|	|	|	|	0.01
44.583	0.00	0.01	0.004 O	|	|	|	|	0.01
44.667	0.00	0.01	0.004 O	|	|	|	|	0.01
44.750	0.00	0.01	0.004 O	|	|	|	|	0.01
44.833	0.00	0.01	0.004 O	|	|	|	|	0.01
44.917	0.00	0.01	0.004 O	|	|	|	|	0.01

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45.000    0.00    0.01     0.004  O      |       |       |       |      0.01
45.083    0.00    0.01     0.004  O      |       |       |       |      0.01
45.167    0.00    0.01     0.004  O      |       |       |       |      0.01
45.250    0.00    0.01     0.004  O      |       |       |       |      0.01
45.333    0.00    0.01     0.004  O      |       |       |       |      0.01
45.417    0.00    0.01     0.004  O      |       |       |       |      0.01
45.500    0.00    0.01     0.003  O      |       |       |       |      0.00
45.583    0.00    0.01     0.003  O      |       |       |       |      0.00
45.667    0.00    0.01     0.003  O      |       |       |       |      0.00
45.750    0.00    0.01     0.003  O      |       |       |       |      0.00
45.833    0.00    0.01     0.003  O      |       |       |       |      0.00
45.917    0.00    0.01     0.003  O      |       |       |       |      0.00
46.000    0.00    0.01     0.003  O      |       |       |       |      0.00
46.083    0.00    0.01     0.003  O      |       |       |       |      0.00
46.167    0.00    0.01     0.003  O      |       |       |       |      0.00
46.250    0.00    0.01     0.003  O      |       |       |       |      0.00
46.333    0.00    0.01     0.003  O      |       |       |       |      0.00
46.417    0.00    0.01     0.003  O      |       |       |       |      0.00
46.500    0.00    0.01     0.003  O      |       |       |       |      0.00
46.583    0.00    0.01     0.003  O      |       |       |       |      0.00
46.667    0.00    0.01     0.003  O      |       |       |       |      0.00
46.750    0.00    0.01     0.003  O      |       |       |       |      0.00
46.833    0.00    0.01     0.003  O      |       |       |       |      0.00
46.917    0.00    0.01     0.003  O      |       |       |       |      0.00
47.000    0.00    0.01     0.003  O      |       |       |       |      0.00
47.083    0.00    0.01     0.002  O      |       |       |       |      0.00
47.167    0.00    0.01     0.002  O      |       |       |       |      0.00
47.250    0.00    0.01     0.002  O      |       |       |       |      0.00
47.333    0.00    0.01     0.002  O      |       |       |       |      0.00
47.417    0.00    0.01     0.002  O      |       |       |       |      0.00
47.500    0.00    0.01     0.002  O      |       |       |       |      0.00
47.583    0.00    0.01     0.002  O      |       |       |       |      0.00
47.667    0.00    0.01     0.002  O      |       |       |       |      0.00
47.750    0.00    0.01     0.002  O      |       |       |       |      0.00
47.833    0.00    0.01     0.002  O      |       |       |       |      0.00
47.917    0.00    0.01     0.002  O      |       |       |       |      0.00
48.000    0.00    0.01     0.002  O      |       |       |       |      0.00
48.083    0.00    0.01     0.002  O      |       |       |       |      0.00
48.167    0.00    0.01     0.002  O      |       |       |       |      0.00
48.250    0.00    0.00     0.002  O      |       |       |       |      0.00
48.333    0.00    0.00     0.002  O      |       |       |       |      0.00
48.417    0.00    0.00     0.002  O      |       |       |       |      0.00
48.500    0.00    0.00     0.002  O      |       |       |       |      0.00
48.583    0.00    0.00     0.002  O      |       |       |       |      0.00
48.667    0.00    0.00     0.002  O      |       |       |       |      0.00
48.750    0.00    0.00     0.002  O      |       |       |       |      0.00
48.833    0.00    0.00     0.002  O      |       |       |       |      0.00
48.917    0.00    0.00     0.002  O      |       |       |       |      0.00
49.000    0.00    0.00     0.002  O      |       |       |       |      0.00
49.083    0.00    0.00     0.002  O      |       |       |       |      0.00
49.167    0.00    0.00     0.002  O      |       |       |       |      0.00
49.250    0.00    0.00     0.002  O      |       |       |       |      0.00
49.333    0.00    0.00     0.002  O      |       |       |       |      0.00
49.417    0.00    0.00     0.001  O      |       |       |       |      0.00
49.500    0.00    0.00     0.001  O      |       |       |       |      0.00
49.583    0.00    0.00     0.001  O      |       |       |       |      0.00
49.667    0.00    0.00     0.001  O      |       |       |       |      0.00
49.750    0.00    0.00     0.001  O      |       |       |       |      0.00
49.833    0.00    0.00     0.001  O      |       |       |       |      0.00
49.917    0.00    0.00     0.001  O      |       |       |       |      0.00
50.000    0.00    0.00     0.001  O      |       |       |       |      0.00
50.083    0.00    0.00     0.001  O      |       |       |       |      0.00
50.167    0.00    0.00     0.001  O      |       |       |       |      0.00
50.250    0.00    0.00     0.001  O      |       |       |       |      0.00
50.333    0.00    0.00     0.001  O      |       |       |       |      0.00
50.417    0.00    0.00     0.001  O      |       |       |       |      0.00
50.500    0.00    0.00     0.001  O      |       |       |       |      0.00
50.583    0.00    0.00     0.001  O      |       |       |       |      0.00
50.667    0.00    0.00     0.001  O      |       |       |       |      0.00
50.750    0.00    0.00     0.001  O      |       |       |       |      0.00
50.833    0.00    0.00     0.001  O      |       |       |       |      0.00
50.917    0.00    0.00     0.001  O      |       |       |       |      0.00
51.000    0.00    0.00     0.001  O      |       |       |       |      0.00
51.083    0.00    0.00     0.001  O      |       |       |       |      0.00
51.167    0.00    0.00     0.001  O      |       |       |       |      0.00
51.250    0.00    0.00     0.001  O      |       |       |       |      0.00
51.333    0.00    0.00     0.001  O      |       |       |       |      0.00
51.417    0.00    0.00     0.001  O      |       |       |       |      0.00
51.500    0.00    0.00     0.001  O      |       |       |       |      0.00
51.583    0.00    0.00     0.001  O      |       |       |       |      0.00
51.667    0.00    0.00     0.001  O      |       |       |       |      0.00
51.750    0.00    0.00     0.001  O      |       |       |       |      0.00
51.833    0.00    0.00     0.001  O      |       |       |       |      0.00
51.917    0.00    0.00     0.001  O      |       |       |       |      0.00
52.000    0.00    0.00     0.001  O      |       |       |       |      0.00
52.083    0.00    0.00     0.001  O      |       |       |       |      0.00
52.167    0.00    0.00     0.001  O      |       |       |       |      0.00
52.250    0.00    0.00     0.001  O      |       |       |       |      0.00
52.333    0.00    0.00     0.001  O      |       |       |       |      0.00
52.417    0.00    0.00     0.001  O      |       |       |       |      0.00
52.500    0.00    0.00     0.001  O      |       |       |       |      0.00
52.583    0.00    0.00     0.001  O      |       |       |       |      0.00
52.667    0.00    0.00     0.001  O      |       |       |       |      0.00
52.750    0.00    0.00     0.001  O      |       |       |       |      0.00
52.833    0.00    0.00     0.001  O      |       |       |       |      0.00
52.917    0.00    0.00     0.001  O      |       |       |       |      0.00
53.000    0.00    0.00     0.001  O      |       |       |       |      0.00

        ***************************HYDROGRAPH DATA****************************
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                   Number of intervals =   636
                   Time interval =    5.0 (Min.)
                   Maximum/Peak flow rate =        3.854 (CFS)
                   Total volume =       3.134 (Ac.Ft)
          Status of hydrographs being held in storage
                    Stream 1  Stream 2  Stream 3  Stream 4  Stream 5
          Peak (CFS)      0.000     0.000     2.897     0.000     0.000
          Vol (Ac.Ft)      0.000     0.000     1.045     0.000     0.000
 ***********************************************************************

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 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 Process from Point/Station        4.000 to Point/Station        4.000
 **** PRINT CURRENT HYDROGRAPH ****

 ______________________________________________________________________
 ++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
                  P R I N T  O F  S T O R M
               R u n o f f     H y d r o g r a p h
 --------------------------------------------------------------------
            Hydrograph in   5   Minute intervals (CFS)

 --------------------------------------------------------------------
Time(h+m) Volume(Ac.Ft)   Q(CFS)  0        1.0       1.9       2.9       3.9
-----------------------------------------------------------------------
  0+ 5      0.0000      0.00  Q         |         |         |         |
  0+10      0.0000      0.00  Q         |         |         |         |
  0+15      0.0000      0.00  Q         |         |         |         |
  0+20      0.0001      0.01  Q         |         |         |         |
  0+25      0.0001      0.01  Q         |         |         |         |
  0+30      0.0002      0.01  Q         |         |         |         |
  0+35      0.0003      0.02  Q         |         |         |         |
  0+40      0.0005      0.02  Q         |         |         |         |
  0+45      0.0006      0.02  Q         |         |         |         |
  0+50      0.0008      0.03  Q         |         |         |         |
  0+55      0.0010      0.03  Q         |         |         |         |
  1+ 0      0.0013      0.04  Q         |         |         |         |
  1+ 5      0.0016      0.04  Q         |         |         |         |
  1+10      0.0019      0.05  Q         |         |         |         |
  1+15      0.0022      0.05  Q         |         |         |         |
  1+20      0.0026      0.05  Q         |         |         |         |
  1+25      0.0030      0.06  Q         |         |         |         |
  1+30      0.0034      0.06  Q         |         |         |         |
  1+35      0.0038      0.06  Q         |         |         |         |
  1+40      0.0043      0.07  Q         |         |         |         |
  1+45      0.0048      0.07  Q         |         |         |         |
  1+50      0.0053      0.07  Q         |         |         |         |
  1+55      0.0058      0.08  Q         |         |         |         |
  2+ 0      0.0064      0.08  Q         |         |         |         |
  2+ 5      0.0069      0.08  Q         |         |         |         |
  2+10      0.0076      0.09  Q         |         |         |         |
  2+15      0.0082      0.09  Q         |         |         |         |
  2+20      0.0089      0.10  VQ        |         |         |         |
  2+25      0.0096      0.10  VQ        |         |         |         |
  2+30      0.0103      0.11  VQ        |         |         |         |
  2+35      0.0110      0.11  VQ        |         |         |         |
  2+40      0.0118      0.11  VQ        |         |         |         |
  2+45      0.0126      0.12  VQ        |         |         |         |
  2+50      0.0135      0.12  VQ        |         |         |         |
  2+55      0.0144      0.13  VQ        |         |         |         |
  3+ 0      0.0153      0.13  VQ        |         |         |         |
  3+ 5      0.0162      0.14  VQ        |         |         |         |
  3+10      0.0172      0.14  VQ        |         |         |         |
  3+15      0.0182      0.15  VQ        |         |         |         |
  3+20      0.0193      0.15  VQ        |         |         |         |
  3+25      0.0203      0.16  VQ        |         |         |         |
  3+30      0.0214      0.16  VQ        |         |         |         |
  3+35      0.0226      0.17  VQ        |         |         |         |
  3+40      0.0237      0.17  VQ        |         |         |         |
  3+45      0.0249      0.17  VQ        |         |         |         |
  3+50      0.0262      0.18  VQ        |         |         |         |
  3+55      0.0274      0.18  VQ        |         |         |         |
  4+ 0      0.0287      0.19  VQ        |         |         |         |
  4+ 5      0.0300      0.19  VQ        |         |         |         |
  4+10      0.0314      0.20  V Q       |         |         |         |
  4+15      0.0328      0.20  V Q       |         |         |         |
  4+20      0.0342      0.21  V Q       |         |         |         |
  4+25      0.0357      0.21  V Q       |         |         |         |
  4+30      0.0372      0.22  V Q       |         |         |         |
  4+35      0.0388      0.23  V Q       |         |         |         |
  4+40      0.0404      0.23  V Q       |         |         |         |
  4+45      0.0420      0.24  V Q       |         |         |         |
  4+50      0.0437      0.24  V Q       |         |         |         |
  4+55      0.0454      0.25  V Q       |         |         |         |
  5+ 0      0.0472      0.26  V Q       |         |         |         |
  5+ 5      0.0490      0.26  V Q       |         |         |         |
  5+10      0.0508      0.27  V Q       |         |         |         |
  5+15      0.0527      0.27  V Q       |         |         |         |
  5+20      0.0546      0.28  V Q       |         |         |         |
  5+25      0.0565      0.28  V Q       |         |         |         |
  5+30      0.0585      0.29  V Q       |         |         |         |
  5+35      0.0605      0.29  V  Q      |         |         |         |
  5+40      0.0626      0.30  V  Q      |         |         |         |
  5+45      0.0647      0.30  V  Q      |         |         |         |
  5+50      0.0668      0.31  V  Q      |         |         |         |
  5+55      0.0690      0.31  V  Q      |         |         |         |
  6+ 0      0.0712      0.32  V  Q      |         |         |         |
  6+ 5      0.0734      0.33  V  Q      |         |         |         |
```

6+10	0.0757	0.33
6+15	0.0781	0.34
6+20	0.0804	0.35
6+25	0.0829	0.35
6+30	0.0854	0.36
6+35	0.0879	0.37
6+40	0.0904	0.37
6+45	0.0931	0.38
6+50	0.0957	0.39
6+55	0.0985	0.40
7+ 0	0.1012	0.40
7+ 5	0.1041	0.41
7+10	0.1069	0.42
7+15	0.1099	0.42
7+20	0.1128	0.43
7+25	0.1159	0.44
7+30	0.1189	0.45
7+35	0.1221	0.45
7+40	0.1253	0.46
7+45	0.1285	0.47
7+50	0.1318	0.48
7+55	0.1352	0.49
8+ 0	0.1386	0.50
8+ 5	0.1421	0.51
8+10	0.1457	0.52
8+15	0.1493	0.53
8+20	0.1531	0.54
8+25	0.1569	0.55
8+30	0.1608	0.57
8+35	0.1648	0.58
8+40	0.1688	0.59
8+45	0.1730	0.60
8+50	0.1772	0.61
8+55	0.1815	0.63
9+ 0	0.1859	0.64
9+ 5	0.1904	0.65
9+10	0.1950	0.67
9+15	0.1998	0.69
9+20	0.2047	0.71
9+25	0.2098	0.74
9+30	0.2150	0.76
9+35	0.2205	0.79
9+40	0.2261	0.82
9+45	0.2320	0.86
9+50	0.2382	0.89
9+55	0.2446	0.93
10+ 0	0.2513	0.97
10+ 5	0.2582	1.01
10+10	0.2653	1.04
10+15	0.2726	1.05
10+20	0.2799	1.06
10+25	0.2872	1.07
10+30	0.2946	1.07
10+35	0.3021	1.08
10+40	0.3096	1.09
10+45	0.3173	1.12
10+50	0.3251	1.14
10+55	0.3332	1.17
11+ 0	0.3414	1.20
11+ 5	0.3498	1.22
11+10	0.3584	1.25
11+15	0.3672	1.28
11+20	0.3762	1.30
11+25	0.3853	1.32
11+30	0.3946	1.35
11+35	0.4040	1.37
11+40	0.4136	1.39
11+45	0.4232	1.40
11+50	0.4330	1.42
11+55	0.4428	1.43
12+ 0	0.4528	1.45
12+ 5	0.4629	1.46
12+10	0.4732	1.50
12+15	0.4838	1.55
12+20	0.4948	1.60
12+25	0.5063	1.66
12+30	0.5181	1.72
12+35	0.5304	1.79
12+40	0.5432	1.86
12+45	0.5565	1.93
12+50	0.5703	2.01
12+55	0.5847	2.08
13+ 0	0.5996	2.16
13+ 5	0.6151	2.25
13+10	0.6312	2.34
13+15	0.6480	2.44
13+20	0.6655	2.55
13+25	0.6838	2.65
13+30	0.7028	2.76
13+35	0.7225	2.86
13+40	0.7427	2.94
13+45	0.7634	2.99
13+50	0.7843	3.04
13+55	0.8055	3.08
14+ 0	0.8269	3.11
14+ 5	0.8486	3.15
14+10	0.8706	3.19
14+15	0.8929	3.24
14+20	0.9156	3.29

14+25	0.9386	3.34
14+30	0.9619	3.39
14+35	0.9856	3.43
14+40	1.0096	3.48
14+45	1.0338	3.53
14+50	1.0585	3.57
14+55	1.0834	3.62
15+ 0	1.1085	3.65
15+ 5	1.1339	3.69
15+10	1.1595	3.72
15+15	1.1853	3.74
15+20	1.2112	3.77
15+25	1.2373	3.79
15+30	1.2636	3.81
15+35	1.2900	3.83
15+40	1.3165	3.85
15+45	1.3430	3.85
15+50	1.3696	3.85
15+55	1.3961	3.85
16+ 0	1.4227	3.85
16+ 5	1.4492	3.85
16+10	1.4756	3.83
16+15	1.5017	3.80
16+20	1.5276	3.76
16+25	1.5531	3.71
16+30	1.5784	3.67
16+35	1.6033	3.62
16+40	1.6278	3.56
16+45	1.6519	3.50
16+50	1.6756	3.44
16+55	1.6990	3.39
17+ 0	1.7219	3.33
17+ 5	1.7445	3.28
17+10	1.7667	3.22
17+15	1.7885	3.17
17+20	1.8101	3.12
17+25	1.8312	3.08
17+30	1.8521	3.03
17+35	1.8726	2.98
17+40	1.8928	2.94
17+45	1.9128	2.89
17+50	1.9324	2.85
17+55	1.9517	2.80
18+ 0	1.9707	2.76
18+ 5	1.9894	2.72
18+10	2.0078	2.67
18+15	2.0259	2.63
18+20	2.0438	2.59
18+25	2.0613	2.55
18+30	2.0787	2.51
18+35	2.0957	2.47
18+40	2.1125	2.43
18+45	2.1290	2.40
18+50	2.1452	2.36
18+55	2.1612	2.32
19+ 0	2.1769	2.28
19+ 5	2.1924	2.25
19+10	2.2076	2.21
19+15	2.2226	2.17
19+20	2.2373	2.14
19+25	2.2518	2.11
19+30	2.2661	2.07
19+35	2.2802	2.04
19+40	2.2940	2.01
19+45	2.3076	1.98
19+50	2.3211	1.95
19+55	2.3343	1.92
20+ 0	2.3473	1.89
20+ 5	2.3601	1.86
20+10	2.3727	1.83
20+15	2.3851	1.80
20+20	2.3973	1.77
20+25	2.4093	1.75
20+30	2.4212	1.72
20+35	2.4328	1.69
20+40	2.4443	1.67
20+45	2.4556	1.64
20+50	2.4668	1.62
20+55	2.4777	1.59
21+ 0	2.4885	1.57
21+ 5	2.4991	1.54
21+10	2.5096	1.52
21+15	2.5199	1.50
21+20	2.5300	1.47
21+25	2.5400	1.45
21+30	2.5499	1.43
21+35	2.5596	1.41
21+40	2.5691	1.38
21+45	2.5785	1.36
21+50	2.5877	1.34
21+55	2.5969	1.32
22+ 0	2.6058	1.30
22+ 5	2.6147	1.28
22+10	2.6234	1.26
22+15	2.6320	1.25
22+20	2.6404	1.23
22+25	2.6488	1.21
22+30	2.6570	1.19
22+35	2.6650	1.17

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   22+40       2.6730      1.16  |         |Q        |         |   V     |
   22+45       2.6808      1.14  |         |Q        |         |   V     |
   22+50       2.6886      1.12  |         |Q        |         |   V     |
   22+55       2.6962      1.10  |         |Q        |         |   V     |
   23+ 0       2.7037      1.09  |         |Q        |         |   V     |
   23+ 5       2.7110      1.07  |         |Q        |         |   V     |
   23+10       2.7183      1.05  |         Q         |         |   V     |
   23+15       2.7255      1.04  |         Q         |         |   V     |
   23+20       2.7325      1.02  |         Q         |         |   V     |
   23+25       2.7395      1.01  |         Q         |         |   V     |
   23+30       2.7463      0.99  |         Q         |         |    V    |
   23+35       2.7530      0.98  |         Q         |         |    V    |
   23+40       2.7597      0.96  |         Q         |         |    V    |
   23+45       2.7662      0.95  |        Q|         |         |    V    |
   23+50       2.7727      0.94  |        Q|         |         |    V    |
   23+55       2.7790      0.92  |        Q|         |         |    V    |
   24+ 0       2.7853      0.91  |        Q|         |         |    V    |
-----------------------------------------------------------------------
         ****************************HYDROGRAPH DATA****************************
                           Number of intervals =   636
                           Time interval =    5.0 (Min.)
                           Maximum/Peak flow rate =        3.854 (CFS)
                           Total volume =       3.134 (Ac.Ft)
                  Status of hydrographs being held in storage
                             Stream 1  Stream 2  Stream 3  Stream 4  Stream 5
                  Peak (CFS)      0.000     0.000     2.897     0.000     0.000
                  Vol (Ac.Ft)      0.000     0.000     1.045     0.000     0.000
         ***********************************************************************

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Appendix 8: Source Control

Pollutant Sources/Source Control Checklist

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

How to use this worksheet (also see instructions in Section G of the WQMP Template):

1. Review Column 1 and identify which of these potential sources of stormwater pollutants apply to your site. Check each box that applies.
2. Review Column 2 and incorporate all of the corresponding applicable BMPs in your WQMP Exhibit.
3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in your WQMP. Use the format shown in Table G.1on page 23 of this WQMP Template. Describe your specific BMPs in an accompanying narrative, and explain any special conditions or situations that required omitting BMPs or substituting alternative BMPs for those shown here.

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
☒ A. **On-site storm drain inlets**	☒ **Locations of inlets.**	☒ **Mark all inlets with the words "Only Rain Down the Storm Drain" or similar. Catch Basin Markers 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."**
❑ B. **Interior floor drains and elevator shaft sump pumps**		❑ **State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.**	❑ **Inspect and maintain drains to prevent blockages and overflow.**
❑ C. **Interior parking garages**		❑ **State that parking garage floor drains will be plumbed to the sanitary sewer.**	❑ **Inspect and maintain drains to prevent blockages and overflow.**

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
❑ D1. **Need for future indoor & structural pest control**		❑ **Note building design features that discourage entry of pests.**	❑ **Provide Integrated Pest Management information to owners, lessees, and operators.**
☒ D2. **Landscape/ Outdoor Pesticide Use**	❑ **Show locations of native trees or areas of shrubs and ground cover to be undisturbed and retained.** ❑ **Show self-retaining landscape areas, if any.** ☒ **Show stormwater treatment and hydrograph modification management BMPs. (See instructions in Chapter 3, Step 5 and guidance in Chapter 5.)**	**State that final landscape plans will accomplish all of the following.** ☒ **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 landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions.** ☒ **Consider using pest-resistant plants, especially adjacent 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 operational BMPs in "What you should know for…..Landscape and Gardening"** at http://rcflood.org/stormwater/**Error! Hyperlink reference not valid.** ☒ **Provide IPM information to new owners, lessees and operators.**

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
☐ E. **Pools, spas, ponds, decorative fountains, and other water features.**	☐ **Show location of water feature and a sanitary sewer cleanout in an accessible area within 10 feet. (Exception: Public pools must be plumbed according to County Department of Environmental Health Guidelines.)**	**If the Co-Permittee requires pools to be plumbed to the sanitary sewer, place a note on the plans and state in the narrative that this connection will be made according to local requirements.**	☐ **See applicable operational BMPs in** "Guidelines for Maintaining Your Swimming Pool, Jacuzzi and Garden Fountain" at http://rcflood.org/stormwater/
☐ F. **Food service**	☐ **For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment.** ☐ **On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.**	☐ **Describe the location and features of the designated cleaning area.** ☐ **Describe the items to be cleaned in this facility and how it has been sized to insure that the largest items can be accommodated.**	☐ **See the brochure, "**The Food Service Industry Best Management Practices for: Restaurants, Grocery Stores, Delicatessens and Bakeries" at http://rcflood.org/stormwater/ **Provide this brochure to new site owners, lessees, and operators.**
☒ G. **Refuse areas**	☒ **Show where site refuse and recycled materials will be handled and stored for pickup. See local municipal requirements for sizes and other details of refuse areas.** ☒ **If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run-on and show locations of berms to prevent runoff from the area.** ☒ **Any drains from dumpsters, compactors, and tallow bin areas shall be connected to a grease removal device before discharge to sanitary sewer.**	☒ **State how site refuse will be handled and provide supporting detail to what is shown on plans.** ☒ **State that signs will be posted on or near dumpsters with the words "Do not dump hazardous materials here" or similar.**	☒ **State how the following will be implemented:** **Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post "no hazardous materials" signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on-site. See Fact Sheet SC-34, "Waste Handling and Disposal" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
☒ H. **Industrial processes.**	☒ **Show process area.**	☒ **If industrial processes are to be located on site, state: "All process activities to be performed indoors. No processes to drain to exterior or to storm drain system."**	☒ **See Fact Sheet SC-10, "Non-Stormwater Discharges" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com** See the brochure "Industrial & Commercial Facilities Best Management Practices for: Industrial, Commercial Facilities" at http://rcflood.org/stormwater/

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
❑ I. **Outdoor storage of equipment or materials. (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.)**	❑ **Show any outdoor storage areas, including how materials will be covered. Show how areas will be graded and bermed to prevent run-on or run-off from area.** ❑ **Storage of non-hazardous liquids shall be covered by a roof and/or drain to the sanitary sewer system, and be contained by berms, dikes, liners, or vaults.** ❑ **Storage of hazardous materials and wastes must be in compliance with the local hazardous materials ordinance and a Hazardous Materials Management Plan for the site.**	**Include a detailed description of materials to be stored, storage areas, and structural features to prevent pollutants from entering storm drains.** **Where appropriate, reference documentation of compliance with the requirements of Hazardous Materials Programs for:** ▪ **Hazardous Waste Generation** ▪ **Hazardous Materials Release Response and Inventory** ▪ **California Accidental Release (CalARP)** ▪ **Aboveground Storage Tank** ▪ **Uniform Fire Code Article 80 Section 103(b) & (c) 1991** ▪ **Underground Storage Tank** **www.cchealth.org/groups/hazmat/**	❑ **See the Fact Sheets SC-31, "Outdoor Liquid Container Storage" and SC-33, "Outdoor Storage of Raw Materials " in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
❑ J. **Vehicle and Equipment Cleaning**	❑ **Show on drawings as appropriate:** **(1) Commercial/industrial facilities having vehicle/equipment cleaning needs shall either provide a covered, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses.** **(2) Multi-dwelling complexes shall have a paved, bermed, and covered car wash area (unless car washing is prohibited on-site and hoses are provided with an automatic shut-off to discourage such use).** **(3) Washing areas for cars, vehicles, and equipment shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer.** **(4) Commercial car wash facilities shall be designed such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility shall discharge to the sanitary sewer, or a wastewater reclamation system shall be installed.**	❑ **If a car wash area is not provided, describe any measures taken to discourage on-site car washing and explain how these will be enforced.**	**Describe operational measures to implement the following (if applicable):** ❑ **Washwater from vehicle and equipment washing operations shall not be discharged to the storm drain system.** Refer to "Outdoor Cleaning Activities and Professional Mobile Service Providers" for many of the Potential Sources of Runoff Pollutants categories below. Brochure can be found at http://rcflood.org/stormwater/ ❑**Car dealerships and similar may rinse cars with water only.**

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
❑ K. **Vehicle/Equipment Repair and Maintenance**	❑ **Accommodate all vehicle equipment repair and maintenance indoors. Or designate an outdoor work area and design the area to prevent run-on and runoff of stormwater.** ❑ **Show secondary containment for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas.** ❑ **Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer and an industrial waste discharge permit will be obtained.**	❑ **State that no vehicle repair or maintenance will be done outdoors, or else describe the required features of the outdoor work area.** ❑ **State that there are no floor drains or if there are floor drains, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.** ❑ **State that there are no tanks, containers or sinks to be used for parts cleaning or rinsing or, if there are, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.**	**In the Stormwater Control Plan, note that all of the following restrictions apply to use the site:** ❑ **No person shall dispose of, nor permit the disposal, directly or indirectly of vehicle fluids, hazardous materials, or rinsewater from parts cleaning into storm drains.** ❑ **No vehicle fluid removal shall be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids shall be contained or drained from the vehicle immediately.** ❑ **No person shall leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment.** Refer to "Automotive Maintenance & Car Care Best Management Practices for Auto Body Shops, Auto Repair Shops, Car Dealerships, Gas Stations and Fleet Service Operations". Brochure can be found at http://rcflood.org/stormwater/ Refer to Outdoor Cleaning Activities and Professional Mobile Service Providers for many of the Potential Sources of Runoff Pollutants categories below. Brochure can be found at http://rcflood.org/stormwater/

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
❑ L. **Fuel Dispensing Areas**	❑ **Fueling areas[6] shall have impermeable floors (i.e., portland cement concrete or equivalent smooth impervious surface) that are: a) graded at the minimum slope necessary to prevent ponding; and b) separated from the rest of the site by a grade break that prevents run-on of stormwater to the maximum extent practicable.** ❑ **Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area[1].] The canopy [or cover] shall not drain onto the fueling area.**		❑ **The property owner shall dry sweep the fueling area routinely.** ❑ **See the Fact Sheet SD-30 , "Fueling Areas" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

[6] **The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.**

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
☒ M. **Loading Docks**	☒ **Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks shall be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts shall be positioned to direct stormwater away from the loading area. Water from loading dock areas shall be drained to the sanitary sewer, or diverted and collected for ultimate discharge to the sanitary sewer.** ❑ **Loading dock areas draining directly to the sanitary sewer shall be equipped with a spill control valve or equivalent device, which shall be kept closed during periods of operation.** ☒ **Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.**		☒ **Move loaded and unloaded items indoors as soon as possible.** ☒ **See Fact Sheet SC-30, "Outdoor Loading and Unloading," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
☒ N. **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**
O. **Miscellaneous Drain or Wash Water or Other Sources** ☐ **Boiler drain lines** ☐ **Condensate drain lines** ☒ **Rooftop equipment** ☐ **Drainage sumps** ☐ **Roofing, gutters, and trim.** ☒ **Other sources**		☐ **Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system.** ☐ **Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system.** ☒ **Rooftop equipment with potential to produce pollutants shall be roofed and/or have secondary containment.** ☐ **Any drainage sumps on-site shall feature a sediment sump to reduce the quantity of sediment in pumped water.** ☒ **Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff.** ☐ **Include controls for other sources as specified by local reviewer.**	

STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR WQMP SHOULD INCLUDE THESE SOURCE CONTROL BMPs, AS APPLICABLE		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on WQMP Drawings	3 Permanent Controls—List in WQMP Table and Narrative	4 Operational BMPs—Include in WQMP Table and Narrative
☒ P. **Plazas, sidewalks, and parking lots.**			☒ **Sweep plazas, sidewalks, and parking lots regularly to prevent accumulation of litter and debris. Collect debris from pressure washing to prevent entry into the storm drain system. Collect washwater containing any cleaning agent or degreaser and discharge to the sanitary sewer not to a storm drain.**

Appendix 9: O&M

Operation and Maintenance Plan and Documentation of Finance, Maintenance and Recording Mechanisms

Operation and Maintenance Plan and Documentation of Finance, Maintenance and Recording Mechanisms for Palomino Business Park

Riverside County, California

I. Inspection and Maintenance Log

See Appendix A for Inspection and Maintenance Log Records.

II. Updates, Revisions and Errata

See Appendix B for Updates, Revisions and Errata.

III. Introduction

Palomino Business Park is within the City of Norco and is a proposed commercial and industrial development consisting of approximately 81.65 acres. There are 5 drainage management areas (DMAs) for the project site.

The southern portion of the site, DMA A, B and AB, are tributary to Infiltration Basin 1.

DMA A1 is tributary to Infiltration Basin 2.

DMA C is tributary to Infiltration Basin 3.

IV. Responsibility for Maintenance

a. General

Property Owner:
Contact Info:

The "Storm Water Quality Management Plan and Storm Water BMP Transfer, Access and Maintenance Agreement" executed between the City of Norco and the property owner requires that the property owner will install, implement and maintain the Infiltration Basins and on-site FlexStorm Inlet Filters. Any major maintenance to these systems should be performed by a professional contractor.

The FlexStorm Inlet Filters installed at off-site storm drain inlets shall be maintained by the City of Norco.

Operation and Maintenance Agreement will be provided in the O&M Plan in the Final WQMP.

The annual anticipated cost of maintenance is $XXXX.

b. Staff Training Program
Staff and professional contractors will be trained annually.

c. Records
Maintenance/inspection records should be kept for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection upon request at any time.

d. Safety
Staff and professional contractors will have safety training annually.

V. Summary of Drainage Management Areas and Stormwater BMPs

a. Drainage Areas
DMAs details can be found in Section III. Introduction.

The WQMP Exhibit, which outlines the DMA pervious and impervious areas, can be found in Appendix 1 of the WQMP.

b. Structural Post-Construction BMPs
Infiltration Basin 1 is a volume-based infiltration BMP that treats runoff from DMAs A, B and AB.

Infiltration Basin 2 is a volume-based infiltration BMP that treats runoff from DMA A-1.

Infiltration Basin 3 is a volume-based infiltration BMP that treats runoff from DMA C.

The WQMP Exhibit, which outlines post-construction BMPs, can be found in Appendix 1 of the WQMP.

c. Self-Treating Areas

The following DMAs are self-treating and does not require specialized maintenance beyond that of typical landscape maintenance: N/A

VI. Stormwater BMP Design Documentation

See Appendix 9 of the WQMP for product brochures and maintenance manuals for the BMPs included above, as well as the Flexstorm Inlet Filters.

VII. Maintenance Matrix

<table>
<tr><th>System</th><th>Maintenance Activity</th><th>Frequency</th></tr>
<tr><td rowspan="8">Infiltration Basins</td><td>Maintain vegetation as needed. Use of fertilizers, pesticides and herbicides should be strenuously avoided to ensure they don’t contribute to water pollution. If appropriate native plant selections and other IPM methods are used, such products shouldn’t be needed. If such projects are used,
Products shall be applied in accordance with their labeling, especially in relation to application to water, and in areas subjected to flooding.
Fertilizers should not be applied within 15 days before, after, or during the rain season.</td><td rowspan="5">Ongoing including just before annual storm seasons and following rainfall events.</td></tr>
<tr><td>Remove debris and litter from the entire basin to minimize clogging and improve aesthetics.</td></tr>
<tr><td>Check for obvious problems and repair as needed. Address odor, insects, and overgrowth issues associated with stagnant or standing water in the basin bottom. There should be no long-term ponding water.</td></tr>
<tr><td>Check for erosion and sediment laden areas in the basin. Repair as needed. Clean forebay if needed.</td></tr>
<tr><td>Revegetate side slopes where needed.</td></tr>
<tr><td>Inspection of hydraulic and structural facilities. Examine the inlet for blockage, the embankment and spillway integrity, as well as damage to any structural element.</td><td rowspan="3">Annually. If possible, schedule these inspections within 72 hours after a significant rainfall.</td></tr>
<tr><td>Check for erosion, slumping and overgrowth. Repair as needed.</td></tr>
<tr><td>Check basin depth for sediment build up and reduced total capacity. Scrape bottom as needed and remove sediment. Restore to original cross-section and infiltration rate. Replant basin vegetation.</td></tr>
</table>

	Verify the basin bottom is allowing acceptable infiltration. Use a disc or other method to aerate basin bottom only if there is actual significant loss of infiltrative capacity, rather than on a routine basis.	
	No water should be present 72 hours after an event. No long term standing water should be present at all. No algae formation should be visible. Correct problem as needed.	
FlexStorm Inlet Filters	Inspect/Remove debris from inlet filter	Before the rainy season and after storm events/when more than half filled

Appendix 10: Educational Materials

BMP Fact Sheets, Maintenance Guidelines and Other End-User BMP Information

FLEXSTORM™ Inlet Filter Specifications and Work Instructions

Product: **FLEXSTORM Inlet Filters**

Manufacturer: **Inlet & Pipe Protection, Inc** www.inletfilters.com

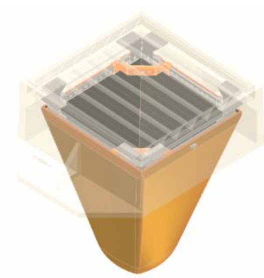
***A subsidiary of* Advanced Drainage Systems (ADS)** www.ads-pipe.com

1.0 Description of Work:

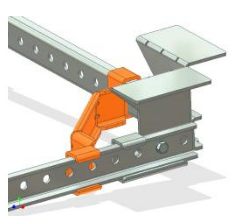
1.1 The work covered shall consist of supplying, installing, and maintaining/cleaning of the FLEXSTORM Inlet Filter assembly. The purpose of the FLEXSTORM Inlet Filter system is to collect silt and sediment from surface storm water runoff at drainage locations shown on the plans or as directed by the Engineer. FLEXSTORM PURE, permanent filters, are capable of removing small particles, hydrocarbons, and other contaminants from drainage "hot spots".

2.0 Material:

2.1 The FLEXSTORM Inlet Filter system is comprised of a corrosion resistant steel frame and a replaceable geotextile sediment bag attached to the frame with a stainless steel locking band. The sediment bag hangs suspended from the rigid frame at a distance below the grate that shall allow full water flow into the drainage structure if the bag is completely filled with sediment.

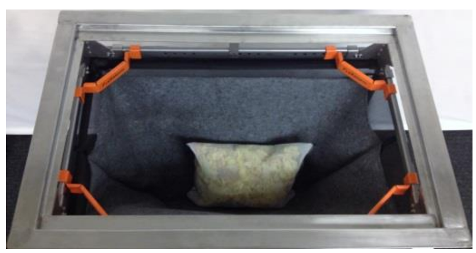



2.2 The FLEXSTORM Inlet Filter frame includes lifting handles in addition to the standard overflow feature. A FLEXSTORM Removal Tool engages the lifting bars or handles to allow manual removal of the assembly without machine assistance. The frame suspension system on most rectangular designs is adjustable in ½" increments up to 5" per side should the casting or drainage structure have imperfections.


2.3 **FLEXSTORM CATCH-IT** Inlet Filters for temporary inlet protection: The FLEXSTORM CATCH-IT framing is galvanized or zinc plated for corrosion resistance. The **“FX”** Woven Polypropylene filter bag is the design standard, although the **“IL”** Nonwoven geotextile is also available if preferred by the engineer. These products are typically used for temporary inlet protection lasting 3 months (short term road work) to 5 years (residential developments).


2.4 **FLEXSTORM PURE** Inlet Filters for permanent inlet protection: The FLEXSTORM PURE framing is comprised of 304 stainless steel with a 25 year life rating. Multiple filter bags are available: **FX, FX+, PC, PC+, LL** and others. The Post Construction **“PC+”** is the design standard consisting of the **“FX”** Woven Polypropylene sediment bag lined with Adsorb-it filter fabric, which is made from recycled polyester fibers. The **“PC+”** includes a replaceable hydrocarbon skimmer pouch strapped to the bottom of the bag for advanced TPH removal.



3.0 Filter Bag Specifications and Capabilities:

3.1 Material Properties (taken from manufacturers average roll value):

FLEXSTORM FILTER BAGS	(22” depth) STD Bag P/N	(12” depth) Short Bag P/N	Clean Water Flow Rate (GPM/SqFt)	Min A.O.S. (US Sieve)
FX: Standard Woven Bag	FX	FX-S	200	40
FX+: Woven w/ Oil Skimmer	FXP	FXP-S	200	40
FXO: Woven w/ Oil Boom	FXO	FXO-S	200	40
PC: Post Construction Bag	PC	PC-S	137	140
PC+: PC w/ Oil Skimmer	PCP	PCP-S	137	140
LL: Litter and Leaf Bag	LL	LL-S	High	3.5
IL: IDOT Non-Woven Bag	IL	IL-S	145	70

3.2 Standard Bag Sizes and Capabilities: Bag Sizes are determined by clear opening dimensions of the drainage structure. Once frame design size is confirmed, Small - XL bag ratings can be confirmed to meet design criteria. Ratings below are for standard 22” deep bags.

Standard Bag Size§	Solids Storage Capacity (CuFt)	Filtered Flow Rate at 50% Max (CFS)			Oil Retention (Oz)	
		FX	PC	IL	PC*	PCP**
Small	1.6	1.2	0.8	0.9	66	155
Medium	2.1	1.8	1.2	1.3	96	185
Large	3.8	2.2	1.5	1.6	120	209
XL	4.2	3.6	2.4	2.6	192	370

4.0 Tested Filtration Efficiency and Removal Rates: Filtration Efficiency, TSS, and TPH testing performed under large scale, real world conditions at accredited third party erosion and sediment control testing laboratory. (See Full Test Reports at www.inletfilters.com)

Inside View of Hopper Agitator

Hopper With Outlet Pipe Leading To Area Inlet

Area Inlet Simulated Showing Influent Discharge From Pipe

4.1 **FLEXSTORM “FX” Filtration Efficiency Test Results:** All testing performed in general accordance with the ASTM D 7351, *Standard Test Method For Determination of Sediment Retention Device Effectiveness in Sheet Flow Application,* with flow diverted into an area inlet. Test Soil used as sediment had the following characteristics with a nominal 7% sediment to water concentration mix. This is representative of a heavy sediment load running off of a construction site.

Soil Characteristics	Test Method	Value		Filtration Efficiency of “FX” FLEXSTORM Bag
% Gravel	ASTM D 422	2		**82%**
% Sand		60		
% Silt		24		
% Clay		14		
Liquid Limit, %	ASTM D 4318	34		
Plasticity Index, %		9		
Soil Classification	USDA	Sandy Loam		
Soil Classification	USCS	Silty Sand (SM)		

4.2 **FLEXSTORM "PC" and "PC+" Test Results:** TSS measured on effluent samples in accordance with SM 2540D and TPH in accordance with EPA 1664A.

Product Tested	110 micron Sediment Load	Ave Flow Rate GPM	% TSS Removal	Soil Retention Efficiency
FLEXSTORM PC Sediment Bag	1750 mg/L using OK-110 Silica Sand and Clean Water	23	**99.28%**	98.96%
		48	**99.32%**	99.25%
		70	**98.89%**	98.80%

Product Tested	Street Sweep Sediment Load	Particle Size of Sediment Load	% TSS Removal	Soil Retention Efficiency
FLEXSTORM PC Sediment Bag	2.5% = 100 lbs Sed / 4000 lbs water	.001 mm – 10.0 mm (median 200 micron)	**99.68%**	95.61%

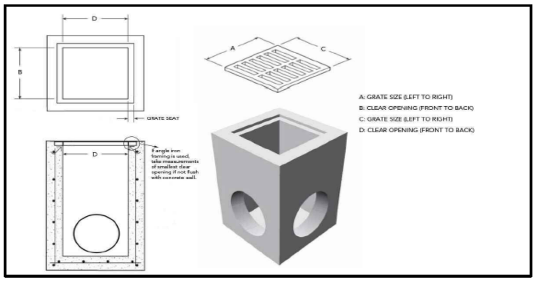
Product Tested	Hydrocarbon Load	Ave Flow Rate GPM	% TPH Removal	Oil Retention Efficiency
FLEXSTORM PC+	243 mg/L using 750 mL (1.45 lb) used motor oil + lube oil and clean water	19	**99.04%**	97.22%
FLEXSTORM PC		20	**97.67%**	91.61%
FLEXSTORM PC+		92	**96.88%**	99.11%

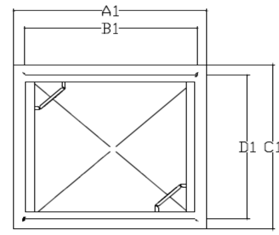
5.0 Identification of Drainage Structures to Determine FLEXSTORM Item Codes:

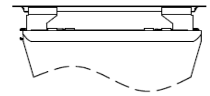
5.1 The Installer (Contactor) shall inspect the plans and/or worksite to determine the quantity of each drainage structure casting type. The foundry casting number or the exact grate size and clear opening size will provide the information necessary to identify the required FLEXSTORM Inlet Filter part number. Inlet Filters are supplied to the field pre-configured to fit the specified drainage structure. Item Codes can be built using the FLEXSTORM Product Configurator at www.inletfilters.com. Detailed Submittal / Specification drawings are linked to each Item Code and available for download by engineers and contractors to include on plans and/or verify field inlet requirements. An example of a typical drawing is shown below.

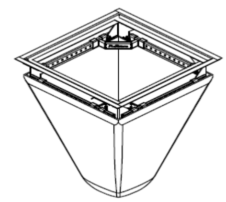
FLEXSTORM P/Ns 62SHDFX & 62SHDFXP

HD4 INLET TYPE: SQUARE/RECT PRECAST OPENING WITH 4 SEAT GRATE SUPPORT









Pure Frame with FX Bag		Field Inlet Dimensions		Flexstorm Framing Dims				Flexstorm Ratings (Flow at 50% Max)			Pure Frame with FX+ Bag	
		Grate Size (A x C)	Clear Opening (B x D)					Bag Capacity (ft^3)	PC/PC+ Flow Rate (CFS)	Bypass (CFS)		
ADS P/N	Flexstorm Item Code			B1	D1	A1	C1				ADS P/N	Flexstorm Item Code
62SHDFX	P-HD4-95-95-80-80-FX	9 1/2 X 9 1/2	8 X 8	6.0	5.0	9.5	9.3	0.2	0.5	1.2	62SHDFXP	P-HD4-95-95-80-80-FXP
62SHDFX	P-HD4-115-115-105-105-FX	11.5 x 11.5	10.5 x 10.5	8.0	7.5	11.5	11.3	0.4	0.7	1.7	62SHDFXP	P-HD4-115-115-105-105-FXP
62SHDFX	P-HD4-118-118-105-105-FX	11.75 x 11.75	10.5 x 10.5	8.0	7.5	11.5	11.5	0.4	0.7	1.7	62SHDFXP	P-HD4-118-118-105-105-FXP
62SHDFX	P-HD4-120-120-105-105-FX	12 X 12	10.5 X 10.5	8.5	7.5	12.0	11.8	0.4	0.7	1.7	62SHDFXP	P-HD4-120-120-105-105-FXP
62SHDFX	P-HD4-134-134-116-116-FX	13.375 X 13.375	11 5/8 X 11 5/8	9.5	8.5	13.0	13.1	0.5	0.8	1.9	62SHDFXP	P-HD4-134-134-116-116-FXP
62SHDFX	P-HD4-130-130-120-120-FX	13 x 13	12 x 12	9.5	9.0	13.0	12.8	0.5	0.8	2.0	62SHDFXP	P-HD4-130-130-120-120-FXP
62SHDFX	P-HD4-144-144-133-133-FX	14.375 x 14.375	13.25 x 13.25	10.5	10.5	14.0	14.1	0.7	0.9	2.3	62SHDFXP	P-HD4-144-144-133-133-FXP
62SHDFX	P-HD4-145-145-133-133-FX	14.5 X 14.5	13.25X 13.25	11.0	10.5	14.5	14.3	0.7	0.9	2.3	62SHDFXP	P-HD4-145-145-133-133-FXP
62SHDFX	P-HD4-159-159-143-143-FX	15.87 X 15.87	14.25 X 14.25	12.0	11.5	15.5	15.6	0.9	1.0	2.5	62SHDFXP	P-HD4-159-159-143-143-FXP
62SHDFX	P-HD4-178-178-160-160-FX	17.75 x 17.75	16 x 16	14.0	13.0	17.5	17.5	1.2	1.1	2.9	62SHDFXP	P-HD4-178-178-160-160-FXP

NOTES:

1. RATINGS SHOWN ARE FOR STANDARD 22" BAG DEPTH; "SHORT" 12" DEPTH BAGS ARE AVAILABLE WITH -S SUFFIX; RATINGS REDUCED BY ~50%.

2. THE FOLLOWING REQUIRES ADDITIONAL REVIEW

-GRATES WITH EXTENDED BOTTOMS

-ANY OBSTRUCTED INLET OPENINGS

FLEXSTORM INLET FILTERS PURE

ALL PRODUCTS MANUFACTURED BY INLET & PIPE PROTECTION, INC
A DIVISION OF ADS, INC.
WWW.INLETFILTERS.COM
(866) 287-8655 PH
(630) 355-3477 FX
INFO@INLETFILTERS.COM

SIZE	FRAME TYPE	DWG NO	REV
C	HD4	HD4-62SHD-FX	A
SCALE		SHEET 1 OF 1	

6.0 Installation Into Standard Grated Drainage Structures:

6.1 Remove the grate from the casting or concrete drainage structure. Clean the ledge (lip) of the casting frame or drainage structure to ensure it is free of stone and dirt. Drop in the FLEXSTORM Inlet Filter through the clear opening and be sure the suspension hangers rest firmly on the inside ledge (lip) of the casting. Replace the grate and confirm it is elevated no more than 1/8", which is the thickness of the steel hangers. For Curb Box Inlet Filters: Insert FLEXSTORM CATCH IT Inlet Filter as described above, pull the rear curb guard flap up and over the open curb box until tight, align magnets to ensure firm attachment to the top portion of the curb box casting. If the curb back opening is not magnetic, slide a typical rock sack or 2 x 4 through the 2-ply rear curb box flap to create a dam which will direct runoff into the sediment bag.




7.0 Maintenance Guidelines: The frequency of maintenance will vary depending on the application (during construction, post construction, or industrial use), the area of installation (relative to grade and runoff exposure), and the time of year relative to the geographic location (infrequent rain, year round rain, rain and snow conditions). The FLEXSTORM Operation & Maintenance Plan (as shown in 7.5) or other maintenance log should be kept on file.

7.1 Frequency of Inspections: Construction site inspection should occur following each ½" or more rain event. Post Construction inspections should occur three times per year (every four months) in areas with year round rainfall and three times per year (every three months) in areas with rainy seasons before and after snowfall season. Industrial application site inspections (loading ramps, wash racks, maintenance facilities) should occur on a regularly scheduled basis no less than three times per year.

7.2 General Maintenance for standard sediment bags: Upon inspection, the FLEXSTORM Inlet Filter should be emptied if the sediment bag is more than half filled with sediment and debris, or as directed by the Engineer. Remove the grate, engage the lifting bars or handles with the FLEXSTORM Removal Tool, and lift the FLEXSTORM Inlet Filter from the drainage structure. Machine assistance is not required. Dispose of the sediment or debris as directed by the Engineer. As an alternative, an industrial vacuum may be used to collect the accumulated sediment if available. Remove any caked on silt from the sediment bag and reverse flush the bag for optimal filtration. Replace the bag if the geotextile is torn or punctured to ½" diameter or greater on the lower half of the bag. If properly maintained, the Woven sediment bag will last a minimum of 4 years in the field.

7.3 Inspection and Handling of the FLEXSTORM PC / PC+ post construction sediment bag: The PC+ sediment bags will collect oil until saturated. Both the Adsorb-it filter liner and the skimmer pouch will retain oil. The volume of oils retained will depend on sediment bag size. Unlike other passive oil sorbent products, Adsorb-it filter fabric has the ability to remove hydrocarbons at high flow rates while retaining 10- 20 times its weight in oil (weight of fabric is 12.8 oz / sq yd). The average 2' x 2' PC Bag contains approx .8 sq yds, or 10 oz of fabric. At 50% saturation, the average Adsorb-it lined PC filter will retain approximately 75 oz (4.2 lbs) of oil. Once the bag has become saturated with oils, it can be centrifuged or passed through a wringer to recover the oils, and the fabric reused with 85% to 90% efficacy. If it is determined, per Maintenance Contracts or Engineering Instructions, that the saturated PC sediment bags will be completely replaced, it is the responsibility of the service technician to place the filter medium and associated debris in an approved container and dispose of in accordance with EPA regulations. Spent Adsorb-it can be recycled for its fuel value through waste to energy incineration with a higher BTU per pound value than coal. The oil skimmers start white in color and will gradually turn brown/black as they become saturated, indicating time for replacement. The average skimmer pouch will absorb approximately 62 oz (4 lbs) of oil before requiring replacement. To remove the pouch simply unclip it from the swivel strap sewn to the bottom of the bag. Dispose of all oil contaminated products in accordance to EPA guidelines. The ClearTec Rubberizer media used in the pouch, since a solidifier, will not leach under pressure and can be disposed of in most landfills, recycled for industrial applications, or burned as fuel.

7.4 Sediment Bag Replacement: When replacing a Sediment Bag, remove the bag by loosening or cutting off the clamping band. Take the new sediment bag, which is equipped with a stainless steel worm drive clamping band, and use a drill or screw driver to tighten the bag around the frame channel. Ensure the bag is secure and that there is no slack around the perimeter of the band. For Oil absorbent boom bags, simply replace the oil boom or pouch when saturated by sliding it through the mesh support sleeve.

7.5 Operation & Maintenance Plan. (Download at www.inletfilters.com or www.ads-pipe.com)

FLEXSTORM OPERATION AND MAINTENANCE PLAN

OPERATION & MAINTENANCE PLAN

Installation Instructions:

1. Remove grate from the drainage structure
2. Clean stone and dirt from ledge (lip) of drainage structure
3. Drop the FLEXSTORM inlet filter through the clear opening such that the hangers rest firmly on the lip of the structure.
4. Replace the grate and confirm it is not elevated more than 1/8", the thickness of the steel hangers.

Frequency of Inspections:

1. Inspection should occur following any rain event >½".
2. Post construction inspections should occur 4 times per year. In snowfall affected regions additional inspections should take place before and after snowfall season.
3. Industrial application site inspections (loading ramps, wash racks, maintenance facilities) should occur on a regularly scheduled basis no less than 3 times/year.

Maintenance Guidelines:

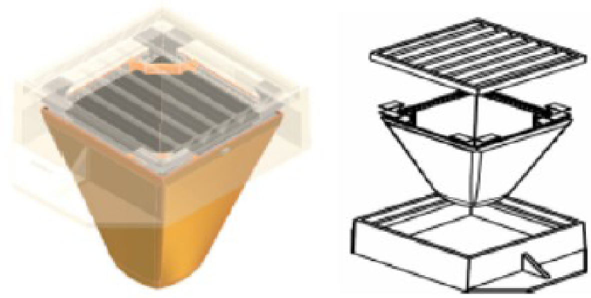
1. Empty the sediment bag if more than half filled with sediment and debris, or as directed.
2. Remove the grate, engage the lifting bars with the FLEXSTORM Removal Tool, and lift from drainage structure.
3. Dispose of sediment or debris as directed by the Engineer or Maintenance contract.
4. An industrial vacuum can be used to collect sediment.
5. Remove caked on silt from sediment bag and flush with Medium spray with optimal filtration.
6. Replace bag if torn or punctured to >½" diameter on lower half of bag.

Post Construction PC Bag Maintenance:

1. At 50% saturation the average 2'x2' Adsorb-it lined PC filter will retain approximately 75 oz (4.2 lbs) of oil and should be serviced. To recover the oils the filter can be centrifuged or passed through a wringer.
2. Oil skimmer pouches start to turn black when saturated, indicating time for replacement. Each ClearTec Rubberizer pouch will absorb ~62oz (4 lbs) of oil before needing replacement.
3. Dispose of all oil contaminated products in accordance with EPA guidelines. ClearTec Rubberizer, since a solidifier, will not leach under pressure and can be disposed of in most landfills, recycled for industrial applications, or burned as fuel.

Sediment Bag Replacement:

1. Remove the bag by loosening or cutting off clamping bag.
2. Take new sediment bag and secure worm drive clamping band to the frame channel.
3. Ensure Bag is secure and there is no slack around perimeter.



STRUCTURE ID#/LOCATION:

DATE	TASK PERFORMED	INSPECTOR

Non-Stormwater Discharges SC-10

Description

Non-stormwater discharges (NSWDs) are flows that do not consist entirely of stormwater. Some non-stormwater discharges do not include pollutants and may be discharged to the storm drain if local regulations allow. These include uncontaminated groundwater and natural springs. There are also some non-stormwater discharges that typically do not contain pollutants and may be discharged to the storm drain with conditions. These include: potable water sources, fire hydrant flushing, air conditioner condensate, landscape irrigation drainage and landscape watering, emergency firefighting, etc. as discussed in Section 2.

However there are certain non-stormwater discharges that pose an environmental concern. These discharges may originate from illegal dumping of industrial material or wastes and illegal connections such as internal floor drains, appliances, industrial processes, sinks, and toilets that are illegally connected to the nearby storm drainage system through on-site drainage and piping. These unauthorized discharges (examples of which may include: process waste waters, cooling waters, wash waters, and sanitary wastewater) can carry substances such as paint, oil, fuel and other automotive fluids, chemicals and other pollutants into storm drains.

Non-stormwater discharges will need to be addressed through a combination of detection and elimination. The ultimate goal is to effectively eliminate unauthorized non-stormwater discharges to the stormwater drainage system through implementation of measures to detect, correct, and enforce against illicit connections and illegal discharges of

Objectives

- *Cover*
- *Contain*
- *Educate*
- *Reduce/Minimize*
- *Product Substitution*

Targeted Constituents

Sediment	
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered

Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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pollutants on streets and into the storm drain system and downstream water bodies.

Approach

Initially the Discharger must make an assessment of non-stormwater discharges to determine which types must be eliminated or addressed through BMPs. The focus of the following approach is the elimination of unauthorized non-stormwater discharges. See other BMP Fact Sheets for activity-specific pollution prevention procedures.

General Pollution Prevention Protocols

- Implement waste management controls described in SC-34 Waste Handling and Disposal.

- Develop clear protocols and lines of communication for effectively prohibiting non-stormwater discharges, especially those that are not classified as hazardous. These are often not responded to as effectively as they need to be.

- Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" or similar stenciled or demarcated next to them to warn against ignorant or unintentional dumping of pollutants into the storm drainage system.

- Manage and control sources of water such as hose bibs, faucets, wash racks, irrigation heads, etc. Identify hoses and faucets in the SWPPP, and post signage for appropriate use.

Non-Stormwater Discharge Investigation Protocols

Identifying the sources of non-stormwater discharges requires the Discharger to conduct an investigation of the facility at regular intervals. There are several categories of non-stormwater discharges:

- Visible, easily identifiable discharges, typically generated as surface runoff, such as uncontained surface runoff from vehicle or equipment washing; and

- Non-visible, (e.g., subsurface) discharges into the site drainage system through a variety of pathways that are not obvious.

The approach to detecting and eliminating non-stormwater discharges will vary considerably, as discussed below:

Visible and identifiable discharges

- Conduct routine inspections of the facilities and of each major activity area and identify visible evidence of unauthorized non-stormwater discharges. This may include:

    - ✓ Visual observations of actual discharges occurring;

- ✓ Evidence of surface staining, discoloring etc. that indicates that discharges have occurred;
- ✓ Pools of water in low lying areas when a rain event has not occurred; and
- ✓ Discussions with operations personnel to understand practices that may lead to unauthorized discharges.

- ☐ If evidence of non-stormwater discharges is discovered:
  - ✓ Document the location and circumstances using Worksheets 5 and 6 (Section 2 of the manual), including digital photos;
  - ✓ Identify and implement any quick remedy or corrective action (e.g., moving uncovered containers inside or to a proper location); and
  - ✓ Develop a plan to eliminate the discharge. Consult the appropriate activity-specific BMP Fact Sheet for alternative approaches to manage and eliminate the discharge.
- ☐ Consult the appropriate activity-specific BMP Fact Sheet for alternative approaches to manage and eliminate the discharge. Make sure the facility SWPPP is up-to-date and includes applicable BMPs to address the non-stormwater discharge.

Other Illegal Discharges (Non visible)

Illicit Connections

- ☐ Locate discharges from the industrial storm drainage system to the municipal storm drain system through review of "as-built" piping schematics.
- ☐ Isolate problem areas and plug illicit discharge points.
- ☐ Locate and evaluate discharges to the storm drain system.
- ☐ Visual Inspection and Inventory:
  - ✓ Inventory and inspect each discharge point during dry weather.
  - ✓ Keep in mind that drainage from a storm event can continue for a day or two following the end of a storm and groundwater may infiltrate the underground stormwater collection system.
  - ✓ Non-stormwater discharges are often intermittent and may require periodic inspections.

Review Infield Piping

- ☐ A review of the "as-built" piping schematic is a way to determine if there are any connections to the stormwater collection system.

- Inspect the path of loading/unloading area drain inlets and floor drains in older buildings.

- Never assume storm drains are connected to the sanitary sewer system.

Monitoring for investigation/detection of illegal discharges

- If a suspected illegal or unknown discharge is detected, monitoring of the discharge may help identify the content and/or suggest the source. This may be done with a field screening analysis, flow meter measurements, or by collecting a sample for laboratory analysis. Section 5 and Appendix D describe the necessary field equipment and procedures for field investigations.

- Investigative monitoring may be conducted over time. For example if, a discharge is intermittent, then monitoring might be conducted to determine the timing of the discharge to determine the source.

- Investigative monitoring may be conducted over a spatial area. For example, if a discharge is observed in a pipe, then monitoring might be conducted at accessible upstream locations in order to pinpoint the source of the discharge.

- Generally, investigative monitoring requiring collection of samples and submittal for lab analysis requires proper planning and specially trained staff.

Smoke Testing

Smoke testing of wastewater and stormwater collection systems is used to detect connections between the two piping systems. Smoke testing is generally performed at a downstream location and the smoke is forced upstream using blowers to create positive pressure. The advantage to smoke testing is that it can potentially identify multiple potential discharge sources at once.

- Smoke testing uses a harmless, non-toxic smoke cartridges developed specifically for this purpose.

- Smoke testing requires specialized equipment (e.g., cartridges, blowers) and is generally only appropriate for specially trained staff.

- A Standard Operating Procedure (SOP) for smoke testing is highly desirable. The SOP should address the following elements:

  - ✓ Proper planning and notification of nearby residents and emergency services is necessary since introducing smoke into the system may result in false alarms;

  - ✓ During dry weather, the stormwater collection system is filled with smoke and then traced back to sources;

- ✓ Temporary isolation of segments of pipe using sand bags is often needed to force the smoke into leaking pipes; and

- ✓ The appearance of smoke in a waste vent pipe, at a sewer manhole, or even the base of a toilet indicates that there may be a connection between the sanitary and storm water systems.

- ☐ Most municipal wastewater agencies will have necessary staff and equipment to conduct smoke testing and they should be contacted if cross connections with the sanitary sewer are suspected. See SC-44 Drainage System Maintenance for more information.

Dye Testing

- ☐ Dye testing is typically performed when there is a suspected specific pollutant source and location (i.e., leaking sanitary sewer) and there is evidence of dry weather flows in the stormwater collection system.

- ☐ Dye is released at a probable upstream source location, either the facility's sanitary or process wastewater system. The dye must be released with a sufficient volume of water to flush the system.

- ☐ Operators then visually examine the downstream discharge points from the stormwater collection system for the presence of the dye.

- ☐ Dye testing can be performed informally using commercially available products in order to conduct an initial investigation for fairly obvious cross-connections.

- ☐ More detailed dye testing should be performed by properly trained staff and follow SOPs. Specialized equipment such as fluorometers may be necessary to detect low concentrations of dye.

- ☐ Most municipal wastewater agencies will have necessary staff and equipment to conduct dye testing and they should be contacted if cross connections with the sanitary sewer are suspected.

TV Inspection of Drainage System

- ☐ Closed Circuit Television (CCTV) can be employed to visually identify illicit connections to the industrial storm drainage system. Two types of CCTV systems are available: (1) a small specially designed camera that can be manually pushed on a stiff cable through storm drains to observe the interior of the piping, or (2) a larger remote operated video camera on treads or wheels that can be guided through storm drains to view the interior of the pipe.

- ☐ CCTV systems often include a high-pressure water jet and camera on a flexible cable. The water jet cleans debris and biofilm off the inside of pipes so the camera can take video images of the pipe condition.

- CCTV units can detect large cracks and other defects such as offsets in pipe ends caused by root intrusions or shifting substrate.

- CCTV can also be used to detect dye introduced into the sanitary sewer.

- CCTV inspections require specialized equipment and properly trained staff and are generally best left to specialized contractors or municipal public works staff.

Illegal Dumping

- Substances illegally dumped on streets and into the storm drain systems and creeks may include paints, used oil and other automotive fluids, construction debris, chemicals, fresh concrete, leaves, grass clippings, and pet wastes. These wastes can cause stormwater and receiving water quality problems as well as clog the storm drain system itself.

- Establish a system for tracking incidents. The system should be designed to identify the following:

  - ✓ Illegal dumping hot spots;

  - ✓ Types and quantities (in some cases) of wastes;

  - ✓ Patterns in time of occurrence (time of day/night, month, or year);

  - ✓ Mode of dumping (abandoned containers, “midnight dumping” from moving vehicles, direct dumping of materials, accidents/spills);

  - ✓ An anonymous tip/reporting mechanism; and

  - ✓ Evidence of responsible parties (e.g., tagging, encampments, etc.).

- One of the keys to success of reducing or eliminating illegal dumping is increasing the number of people at the facility who are aware of the problem and who have the tools to at least identify the incident, if not correct it. Therefore, train field staff to recognize and report the incidents.

Once a site has been cleaned:

- Post “No Dumping” signs with a phone number for reporting dumping and disposal.

- Landscaping and beautification efforts of hot spots may also discourage future dumping, as well as provide open space and increase property values.

- Lighting or barriers may also be needed to discourage future dumping.

- See fact sheet SC-11 Spill Prevention, Control, and Cleanup.

Inspection

- Regularly inspect and clean up hot spots and other storm drainage areas where illegal dumping and disposal occurs.

- Conduct field investigations of the industrial storm drain system for potential sources of non-stormwater discharges.

- Pro-actively conduct investigations of high priority areas. Based on historical data, prioritize specific geographic areas and/or incident type for pro-active investigations.

Spill and Leak Prevention and Response

- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.

- Never hose down or bury dry material spills. Sweep up the material and dispose of properly.

- Use adsorbent materials on small spills rather than hosing down the spill. Remove the adsorbent materials promptly and dispose of properly.

- For larger spills, a private spill cleanup company or Hazmat team may be necessary.

- See SC-11 Spill Prevention Control and Cleanup.

Employee Training Program

- Training of technical staff in identifying and documenting illegal dumping incidents is required. The frequency of training must be presented in the SWPPP, and depends on site-specific industrial materials and activities.

- Consider posting a quick reference table near storm drains to reinforce training.

- Train employees to identify non-stormwater discharges and report discharges to the appropriate departments.

- Educate employees about spill prevention and cleanup.

- Well-trained employees can reduce human errors that lead to accidental releases or spills. The employee should have the tools and knowledge to immediately begin cleaning up a spill should one occur. Employees should be familiar with the Spill Prevention Control and Countermeasure Plan. Employees should be able to identify work/jobs with high potential for spills and suggest methods to reduce possibility.

- Determine and implement appropriate outreach efforts to reduce non-permissible non-stormwater discharges.

- Conduct spill response drills annually (if no events occurred) in order to evaluate the effectiveness of the plan.

- When a responsible party is identified, educate the party on the impacts of his or her actions.

Quality Assurance and Record Keeping

Performance Evaluation

- Annually review internal investigation results; assess whether goals were met and what changes or improvements are necessary.

- Obtain feedback from personnel assigned to respond to, or inspect for, illicit connections and illegal dumping incidents.

- Develop document and data management procedures.

- A database is useful for defining and tracking the magnitude and location of the problem.

- Report prohibited non-stormwater discharges observed during the course of normal daily activities so they can be investigated, contained, and cleaned up or eliminated.

- Document that non-stormwater discharges have been eliminated by recording tests performed, methods used, dates of testing, and any on-site drainage points observed.

- Annually document and report the results of the program.

- Maintain documentation of illicit connection and illegal dumping incidents, including significant conditionally exempt discharges that are not properly managed.

- Document training activities.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- Many facilities do not have accurate, up-to-date 'as-built' plans or drawings which may be necessary in order to conduct non-stormwater discharge assessments.

  - ✓ Online tools such as Google Earth™ can provide an aerial view of the facility and may be useful in understanding drainage patterns and potential sources of non-stormwater discharges

  - ✓ Local municipal jurisdictions may have useful drainage systems maps.

- Video surveillance cameras are commonly used to secure the perimeter of industrial facilities against break-ins and theft. These surveillance systems may also be useful for capturing illegal dumping activities. Minor, temporary adjustments to the field of view of existing surveillance camera systems to target known or suspected problem areas may be a cost-effective way of capturing illegal dumping activities and identifying the perpetrators.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital facility cost requirements may be minimal unless cross-connections to storm drains are detected.

- Indoor floor drains may require re-plumbing if cross-connections are detected.

- Leaky sanitary sewers will require repair or replacement which can have significant costs depending on the size and industrial activity at the facility.

Maintenance (including administrative and staffing)

- The primary effort is for staff time and depends on how aggressively a program is implemented.

- Costs for containment, and disposal of any leak or discharge is borne by the Discharger.

- Illicit connections can be difficult to locate especially if there is groundwater infiltration.

- Illegal dumping and illicit connection violations requires technical staff to detect and investigate them.

Supplemental Information

Permit Requirements

The IGP authorizes certain Non-Storm Water Discharges (NSWDs) provided BMPs are included in the SWPPP and implemented to:

- Reduce or prevent the contact of authorized NSWDs with materials or equipment that are potential sources of pollutants;

- Reduce, to the extent practicable, the flow or volume of authorized NSWDs;

- Ensure that authorized NSWDs do not contain quantities of pollutants that cause or contribute to an exceedance of a water quality standards (WQS); and,

- Reduce or prevent discharges of pollutants in authorized NSWDs in a manner that reflects best industry practice considering technological availability and economic practicability and achievability."

References and Resources

Center for Watershed Protection, 2004. *Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments*, EPA Cooperative Agreement X-82907801-0.

Dublin San Ramon Sanitation District. http://www.dsrsd.com/wwrw/smoketest.html.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Sacramento Stormwater Management Program, *Best Management Practices for Industrial Storm Water Pollution Control*, Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp.org.

Southern California Coastal Water Research Project, 2013. *The California Microbial Source Identification Manual: A Tiered Approach to Identifying Fecal Pollution Sources to Beaches,* Technical Report 804.

The Storm Water Managers Resource Center, http://www.stormwatercenter.net/.

US EPA. National Pollutant Discharge Elimination System. Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=111.

WEF Press Alexandria, Virginia, 2009.Existing Sewer Evaluation and Rehabilitation: *WEF Manual of Practice No. FD-6 ASCE/EWRI Manuals and Reports on Engineering Practice No. 62, Third Edition.*

Outdoor Loading/Unloading SC-30

Description

The loading/unloading of materials usually takes place outside on docks or terminals; therefore, materials spilled, leaked, or lost during loading/unloading may collect in the soil or on other surfaces and have the potential to be carried away by wind, stormwater runoff or when the area is cleaned. Additionally, rainfall may wash pollutants from machinery used to unload or move materials. Implementation of the following protocols will prevent or reduce the discharge of pollutants to stormwater from outdoor loading/unloading of materials.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Park tank trucks or delivery vehicles in designated areas so that spills or leaks can be contained.
- ☐ Limit exposure of material to rainfall whenever possible.
- ☐ Prevent stormwater run-on.
- ☐ Check equipment regularly for leaks.

Good Housekeeping

- ☐ Develop an operations plan that describes procedures for loading and/or unloading.
- ☐ Conduct loading and unloading in dry weather if possible.

Objectives

- *Cover*
- *Contain*
- *Educate*
- *Reduce/Minimize*
- *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Cover designated loading/unloading areas to reduce exposure of materials to rain.
- Consider placing a seal or door skirt between delivery vehicles and building to prevent exposure to rain.
- Design loading/unloading area to prevent stormwater run-on, which would include grading or berming the area, and position roof downspouts so they direct stormwater away from the loading/unloading areas.
- Have employees load and unload all materials and equipment in covered areas such as building overhangs at loading docks if feasible.
- Load/unload only at designated loading areas.
- Use drip pans underneath hose and pipe connections and other leak-prone spots during liquid transfer operations, and when making and breaking connections. Several drip pans should be stored in a covered location near the liquid transfer area so that they are always available, yet protected from precipitation when not in use. Drip pans can be made specifically for railroad tracks. Drip pans must be cleaned periodically, and drip collected materials must be disposed of properly.
- Pave loading areas with concrete instead of asphalt.
- Avoid placing storm drains inlets in the area.
- Grade and/or berm the loading/unloading area with drainage to sump; regularly remove materials accumulated in sump.

Spill Response and Prevention Procedures

- Keep your spill prevention and control plan up-to-date or have an emergency spill cleanup plan readily available, as applicable.
- Contain leaks during transfer.
- Store and maintain appropriate spill cleanup materials in a location that is readily accessible and known to all employees.
- Ensure that employees are familiar with the site's spill control plan and proper spill cleanup procedures.
- Use drip pans or comparable devices when transferring oils, solvents, and paints.

Material Handling and Waste Management

- Spot clean leaks and drips routinely to prevent runoff of spillage.
- Do not pour liquid wastes into floor drains, sinks, outdoor storm drain inlets, or other storm drains or sewer connections.

- Do not put used or leftover cleaning solutions, solvents, and automotive fluids in the storm drain or sanitary sewer.

- Collect leaking or dripping fluids in drip pans or containers. Fluids are easier to recycle if kept separate.

- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave drip pans or other open containers lying around.

- Minimize the possibility of stormwater pollution from outside waste receptacles by doing at least one of the following:

    - ✓ Use only watertight waste receptacle(s) and keep the lid(s) closed.

    - ✓ Grade and pave the waste receptacle area to prevent run-on of stormwater.

    - ✓ Install a roof over the waste receptacle area.

    - ✓ Install a low containment berm around the waste receptacle area.

    - ✓ Use and maintain drip pans under waste receptacles.

- Post “no littering” signs.

- Perform work area clean-up and dry sweep after daily operations.

Employee Training Program

- Train employees (e.g., fork lift operators) and contractors on proper spill containment and cleanup.

- Have employees trained in spill containment and cleanup present during loading/unloading.

- Train employees in proper handling techniques during liquid transfers to avoid spills.

- Make sure forklift operators are properly trained on loading and unloading procedures.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document activities performed, quantities of materials removed, and improvement actions.

- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.

- Establish procedures to complete logs and file them in the central office.

- Keep accurate logs of daily clean-up operations.

Potential Limitations and Work-Arounds

Some facilities may have space constraints, limited staffing and time limitations that may preclude implementation of BMPs. Provided below are typical limitations and recommended "work-arounds."

- Space and time limitations may preclude all transfers from being performed indoors or under cover.
  - ✓ Designate specific areas for outdoor loading and unloading.
  - ✓ Require employees to understand and follow spill and leak prevention BMPs.
- It may not be possible to conduct transfers only during dry weather.
  - ✓ Limit materials and equipment rainfall exposure to all extents practicable.
  - ✓ Require employees to understand and follow spill and leak prevention BMPs.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

Many facilities will already have indoor or covered areas where loading/unloading takes place and will require no additional capital expenditures.

If outdoor activities are required, construction of berms or other means to retain spills and leaks may require appropriate constructed systems for containment. These containment areas may require significant new capital investment.

Capital investments will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

Most of the operations and maintenance activities associated with implementing this BMP are integrally linked to routine operations as previously described. Therefore additional O&M is not required.

- Conduct regular inspections and make repairs and improvements as necessary.
- Check loading and unloading equipment regularly for leaks.
- Conduct regular broom dry-sweeping of area. Do not wash with water.

Supplemental Information

Loading and Unloading of Liquids

- Loading or unloading of liquids should occur in the manufacturing building so that any spills that are not completely retained can be discharged to the sanitary sewer, treatment plant, or treated in a manner consistent with local sewer authorities and permit requirements.

- For loading and unloading tank trucks to above and below ground storage tanks, the following procedures should be used:

  - ✓ The area where the transfer takes place should be paved. If the liquid is reactive with the asphalt, Portland cement should be used to pave the area.

  - ✓ The transfer area should be designed to prevent run-on of stormwater from adjacent areas. Sloping the pad and using a curb, like a speed bump, around the uphill side of the transfer area should reduce run-on.

  - ✓ The transfer area should be designed to prevent runoff of spilled liquids from the area. Sloping the area to a drain should prevent runoff. The drain should be connected to a dead-end sump or to the sanitary sewer. A positive control valve should be installed on the drain.

- For transfer from rail cars to storage tanks that must occur outside, use the following procedures:

  - ✓ Drip pans should be placed at locations where spillage may occur, such as hose connections, hose reels, and filler nozzles. Use drip pans when making and breaking connections.

  - ✓ Drip pan systems should be installed between the rails to collect spillage from tank cars.

References and Resources

Minnesota Pollution Control Agency, *Industrial Stormwater Best Management Practices Guidebook BMP 26 Fueling and Liquid Loading/Unloading Operations*. Available online at: http://www.pca.state.mn.us/index.php/view-document.html?gid=10557.

New Jersey Department of Environmental Protection, 2013. *Basic Industrial Stormwater General Permit Guidance Document NJPDES General Permit No NJ0088315*. Available online at: http://www.nj.gov/dep/dwq/pdf/5G2_guidance_color.pdf.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Oregon Department of Environmental Quality, 2013. *Industrial Stormwater Best Management Practices Manual- BMP 26 Fueling and Liquid Loading/Unloading Operations*. Available online at: http://www.deq.state.or.us/wq/wqpermit/docs/IndBMP021413.pdf.

Sacramento Stormwater Management Program, *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

Sacramento County Environmental Management Stormwater Program: *Best Management Practices*. Available online at: http://www.emd.saccounty.net/EnvHealth/Stormwater/Stormwater-BMPs.html.

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp-w2k.com/.

US EPA. National Pollutant Discharge Elimination System – Industrial Fact Sheet Series for Activities Covered by EPA's Multi Sector General Permit. Available online at: http://cfpub.epa.gov/npdes/stormwater/swsectors.cfm.

Waste Handling & Disposal SC-34

Description

Improper storage and handling of solid wastes can allow toxic compounds, oils and greases, heavy metals, nutrients, suspended solids, and other pollutants to enter stormwater runoff. The discharge of pollutants to stormwater from waste handling and disposal can be prevented and reduced by tracking waste generation, storage, and disposal; reducing waste generation and disposal through source reduction, reuse, and recycling; and preventing run-on and runoff.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Accomplish reduction in the amount of waste generated using the following source controls:
  - ✓ Production planning and sequencing;
  - ✓ Process or equipment modification;
  - ✓ Raw material substitution or elimination;
  - ✓ Loss prevention and housekeeping;
  - ✓ Waste segregation and separation; and
  - ✓ Close loop recycling.
- ☐ Establish a material tracking system to increase awareness about material usage. This may reduce spills and minimize contamination, thus reducing the amount of waste produced.
- ☐ Recycle materials whenever possible.

Objectives

- *Cover*
- *Contain*
- *Educate*
- *Reduce/Minimize*
- *Product Substitution*

Targeted Constituents	
Sediment	
Nutrients	
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- Use the entire product before disposing of the container.

- To the extent possible, store wastes under cover or indoors after ensuring all safety concerns such as fire hazard and ventilation are addressed.

- Provide containers for each waste stream at each work station. Allow time after shift to clean area.

Good Housekeeping

- Cover storage containers with leak proof lids or some other means. If waste is not in containers, cover all waste piles (plastic tarps are acceptable coverage) and prevent stormwater run-on and runoff with a berm. The waste containers or piles must be covered except when in use.

- Use drip pans or absorbent materials whenever grease containers are emptied by vacuum trucks or other means. Grease cannot be left on the ground. Collected grease must be properly disposed of as garbage.

- Dispose of rinse and wash water from cleaning waste containers into a sanitary sewer if allowed by the local sewer authority. Do not discharge wash water to the street or storm drain. Clean in a designated wash area that drains to a clarifier.

- Transfer waste from damaged containers into safe containers.

- Take special care when loading or unloading wastes to minimize losses. Loading systems can be used to minimize spills and fugitive emission losses such as dust or mist. Vacuum transfer systems can minimize waste loss.

- Keep the waste management area clean at all times by sweeping and cleaning up spills immediately.

- Use dry methods when possible (e.g., sweeping, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.

- Stencil or demarcate storm drains on the facility's property with prohibitive message regarding waste disposal.

- Cover waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropylene or hypalon.

- If possible, move the activity indoor after ensuring all safety concerns such as fire hazard and ventilation are addressed.

Preventative Maintenance

- Prevent stormwater run-on from entering the waste management area by enclosing the area or building a berm around the area.

- Prevent waste materials from directly contacting rain.

- Cover waste piles with temporary covering material such as reinforced tarpaulin, polyethylene, polyurethane, polypropylene or hypalon.

- Cover the area with a permanent roof if feasible.

- Cover dumpsters to prevent rain from washing waste out of holes or cracks in the bottom of the dumpster.

- Check waste containers weekly for leaks and to ensure that lids are on tightly. Replace any that are leaking, corroded, or otherwise deteriorating.

- Sweep and clean the waste management area regularly. Use dry methods when possible (e.g., sweeping, vacuuming, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.

- Inspect and replace faulty pumps or hoses regularly to minimize the potential of releases and spills.

- Repair leaking equipment including valves, lines, seals, or pumps promptly.

Spill Response and Prevention Procedures

- Keep your spill prevention and plan up-to-date.

- Have an emergency plan, equipment and trained personnel ready at all times to deal immediately with major spills.

- Collect all spilled liquids and properly dispose of them.

- Store and maintain appropriate spill cleanup materials in a location known to all near the designated wash area.

- Ensure that vehicles transporting waste have spill prevention equipment that can prevent spills during transport. Spill prevention equipment includes:

  - ✓ Vehicles equipped with baffles for liquid waste; and

  - ✓ Trucks with sealed gates and spill guards for solid waste.

Material Handling and Waste Management

Litter Control

- Post “No Littering” signs and enforce anti-litter laws.

- Provide a sufficient number of litter receptacles for the facility.

- Clean out and cover litter receptacles frequently to prevent spillage.

Waste Collection

- Keep waste collection areas clean.

- Inspect solid waste containers for structural damage regularly. Repair or replace damaged containers as necessary.
- Secure solid waste containers; containers must be closed tightly when not in use.
- Do not fill waste containers with washout water or any other liquid.
- Ensure that only appropriate solid wastes are added to the solid waste container. Certain wastes such as hazardous wastes, appliances, fluorescent lamps, pesticides, etc., may not be disposed of in solid waste containers (see chemical/ hazardous waste collection section below).
- Do not mix wastes; this can cause chemical reactions, make recycling impossible, and complicate disposal. Affix labels to all waste containers.

Chemical/Hazardous Wastes

- Select designated hazardous waste collection areas on-site.
- Store hazardous materials and wastes in covered containers and protect them from vandalism.
- Place hazardous waste containers in secondary containment.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Hazardous waste cannot be reused or recycled; it must be disposed of by a licensed hazardous waste hauler.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees how to properly handle and dispose of waste using the source control BMPs described above.
- Train employees and subcontractors in proper hazardous waste management.
- Use a training log or similar method to document training.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for waste handling and disposal, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.

- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital costs will vary substantially depending on the size of the facility and the types of waste handled. Significant capital costs may be associated with reducing wastes by modifying processes or implementing closed-loop recycling.

- Many facilities will already have indoor covered areas where waste materials will be stored and will require no additional capital expenditures for providing cover.

- If outdoor storage of wastes is required, construction of berms or other means to prevent stormwater run-on and runoff may require appropriate constructed systems for containment.

- Capital investments will likely be required at some sites if adequate cover and containment facilities do not exist and can vary significantly depending upon site conditions.

Maintenance

- Check waste containers weekly for leaks and to ensure that lids are on tightly. Replace any that are leaking, corroded, or otherwise deteriorating.

- Sweep and clean the waste management area regularly. Use dry methods when possible (e.g., sweeping, use of absorbents) when cleaning around restaurant/food handling dumpster areas. If water must be used after sweeping/using absorbents, collect water and discharge through grease interceptor to the sewer.

- Inspect and replace faulty pumps or hoses regularly to minimize the potential of releases and spills.

- Repair leaking equipment including valves, lines, seals, or pumps promptly.

References and Resources

Minnesota Pollution Control Agency, *Industrial Stormwater Best Management Practices Guidebook*. Available online at: http://www.pca.state.mn.us/index.php/view-document.html?gid=10557.

New Jersey Department of Environmental Protection, 2013. *Basic Industrial Stormwater General Permit Guidance Document NJPDES General Permit No NJ0088315,* Revised. Available online at: http://www.nj.gov/dep/dwq/pdf/5G2_guidance_color.pdf.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities

Oregon Department of Environmental Quality, 2013. *Industrial Stormwater Best Management Practices Manual- BMP 26 Fueling and Liquid Loading/Unloading Operations*. Available online at: http://www.deq.state.or.us/wq/wqpermit/docs/IndBMP021413.pdf.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at: http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

Sacramento County Environmental Management Stormwater Program: Best Management Practices. Available online at: http://www.emd.saccounty.net/EnvHealth/Stormwater/Stormwater-BMPs.html.

Santa Clara Valley Urban Runoff Pollution Prevention Program. http://www.scvurppp-w2k.com/

US EPA. National Pollutant Discharge Elimination System – Industrial Fact Sheet Series for Activities Covered by EPA's Multi Sector General Permit. Available online at: http://cfpub.epa.gov/npdes/stormwater/swsectors.cfm.

Building & Grounds Maintenance SC-41

Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- ☐ Switch to non-toxic chemicals for maintenance to the maximum extent possible.
- ☐ Choose cleaning agents that can be recycled.
- ☐ Encourage proper lawn management and landscaping, including use of native vegetation.
- ☐ Encourage use of Integrated Pest Management techniques for pest control.
- ☐ Encourage proper onsite recycling of yard trimmings.
- ☐ Recycle residual paints, solvents, lumber, and other material as much as possible.

Objectives

- ■ *Cover*
- ■ *Contain*
- ■ *Educate*
- ■ *Reduce/Minimize*
- ■ *Product Substitution*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	
Metals	✓
Bacteria	✓
Oil and Grease	
Organics	

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	✓
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ☐ Clean work areas at the end of each work shift using dry cleaning methods such as sweeping and vacuuming.

Good Housekeeping

Pressure Washing of Buildings, Rooftops, and Other Large Objects

- ☐ In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.

- ☐ If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.

- ☐ If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

Landscaping Activities

- ☐ Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.

- ☐ Use mulch or other erosion control measures on exposed soils. See also SC-40, Contaminated and Erodible Areas, for more information.

Building Repair, Remodeling, and Construction

- ☐ Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.

- ☐ Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.

- ☐ Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.

- ☐ Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.

- ☐ Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.

- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

Mowing, Trimming, and Planting

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.

- Use mulch or other erosion control measures when soils are exposed.

- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.

- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.

- Use hand weeding where practical.

Fertilizer and Pesticide Management

- Do not use pesticides if rain is expected.

- Do not mix or prepare pesticides for application near storm drains.

- Use the minimum amount needed for the job.

- Calibrate fertilizer distributors to avoid excessive application.

- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.

- Apply pesticides only when wind speeds are low.

- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.

- Irrigate slowly to prevent runoff and then only as much as is needed.

- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.

Inspection

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

Spill Response and Prevention Procedures

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

Material Handling and Waste Management

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Dispose of empty pesticide containers according to the instructions on the container label.
- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

Employee Training Program

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the needs of individual staff.

Quality Assurance and Record Keeping

- Keep accurate logs that document maintenance activities performed and minimum BMP measures implemented.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Additional capital costs are not anticipated for building and grounds maintenance. Implementation of the minimum BMPs described above should be conducted as part of regular site operations.

Maintenance

- Maintenance activities for the BMPs described above will be minimal, and no additional cost is anticipated.

Supplemental Information

Fire Sprinkler Line Flushing

Site fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, poly-phosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual*.

Kennedy/Jenks Consultants, 2007. *The Truckee Meadows Industrial and Commercial Storm Water Best Management Practices Handbook*. Available online at: http://www.cityofsparks.us/sites/default/files/assets/documents/env-control/construction/TM-I-C_BMP_Handbook_2-07-final.pdf.

Orange County Stormwater Program, Best Management Practices for Industrial/Commercial Business Activities. Available online at: http://ocwatersheds.com/documents/bmp/industrialcommercialbusinessesactivities.

Sacramento Stormwater Management Program. *Best Management Practices for Industrial Storm Water Pollution Control*. Available online at:

http://www.msa.saccounty.net/sactostormwater/documents/guides/industrial-BMP-manual.pdf.

US EPA, 1997. *Best Management Practices Handbook for Hazardous Waste Containers*. Available online at: http://www.epa.gov/region6/6en/h/handbk4.pdf.

Ventura Countywide Stormwater Management Program Clean Business Fact Sheets. Available online at: http://www.vcstormwater.org/documents/programs_business/building.pdf.

Drainage System Maintenance SC-44

Description

As a consequence of its function, the stormwater drainage facilities on site convey stormwater that may contain certain pollutants either to the offsite conveyance system that collects and transports urban runoff and stormwater, or directly to receiving waters. The protocols in this fact sheet are intended to reduce pollutants leaving the site to the offsite drainage infrastructure or to receiving waters through proper on-site conveyance system operation and maintenance. The targeted constituents will vary depending on site characteristics and operations.

Approach

Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

General Pollution Prevention Protocols

- Maintain catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

- Develop and follow a site specific drainage system maintenance plan that describes maintenance locations, methods, required equipment, water sources, sediment collection areas, disposal requirements, and any other pertinent information.

Good Housekeeping

Illicit Connections and Discharges

- Look for evidence of illegal discharges or illicit connections during routine maintenance of conveyance system and drainage structures:

Objectives

- *Cover*
- *Contain*
- *Educate*
- *Reduce/Minimize*

Targeted Constituents	
Sediment	✓
Nutrients	✓
Trash	✓
Metals	✓
Bacteria	✓
Oil and Grease	✓
Organics	✓

Minimum BMPs Covered	
Good Housekeeping	✓
Preventative Maintenance	✓
Spill and Leak Prevention and Response	✓
Material Handling & Waste Management	
Erosion and Sediment Controls	
Employee Training Program	✓
Quality Assurance Record Keeping	✓

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- ✓ Identify evidence of spills such as paints, discoloring, odors, etc.
- ✓ Record locations of apparent illegal discharges/illicit connections.
- ✓ Track flows back to potential discharges and conduct aboveground inspections. This can be done through visual inspection of upgradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
- ✓ Eliminate the discharge once the origin of flow is established.

- ☐ Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" or similar stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- ☐ Refer to fact sheet SC-10 Non-Stormwater Discharges for additional information.

Illegal Dumping

- ☐ Inspect and clean up hot spots and other storm drainage areas regularly where illegal dumping and disposal occurs.
- ☐ Establish a system for tracking incidents. The system should be designed to identify the following:
  - ✓ Illegal dumping hot spots;
  - ✓ Types and quantities (in some cases) of wastes;
  - ✓ Patterns in time of occurrence (time of day/night, month, or year);
  - ✓ Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills); and
  - ✓ Responsible parties.
- ☐ Post "No Dumping" signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- ☐ Refer to fact sheet SC-10 Non-Stormwater Discharges for additional information.

Preventative Maintenance

Catch Basins/Inlet Structures

- ☐ Staff should regularly inspect facilities to ensure compliance with the following:
  - ✓ Immediate repair of any deterioration threatening structural integrity.
  - ✓ Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.

- Clean catch basins, storm drain inlets, and other conveyance structures before the wet season to remove sediments and debris accumulated during the summer.

- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Prioritize storm drain inlets; clean and repair as needed.

- Keep accurate logs of the number of catch basins cleaned.

- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.

- Dewater the wastes if necessary with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed. Do not dewater near a storm drain or stream.

Storm Drain Conveyance System

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.

- Collect and pump flushed effluent to the sanitary sewer for treatment whenever possible.

Pump Stations

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.

- Do not allow discharge to reach the storm drain system when cleaning a storm drain pump station or other facility.

- Conduct routine maintenance at each pump station.

- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.

Open Channel

- Modify storm channel characteristics to improve channel hydraulics, increase pollutant removals, and enhance channel/creek aesthetic and habitat value.

- Conduct channel modification/improvement in accordance with existing laws. Any person, government agency, or public utility proposing an activity that will change the natural state of any river, stream, or lake in California, must enter into a Steam or Lake Alteration Agreement with the Department of Fish and Wildlife. The developer-applicant should also contact local governments (city, county, special districts), other state agencies (SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Army Corps of Engineers and USFWS.

Spill Response and Prevention Procedures

- Keep your spill prevention control plan up-to-date.

- Investigate all reports of spills, leaks, and/or illegal dumping promptly.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags) or dig up, remove, and properly dispose of contaminated soil.

Employee Training Program

- Educate employees about pollution prevention measures and goals.
- Train employees how to properly handle and dispose of waste using the source control BMPs described above.
- Train employees and subcontractors in proper hazardous waste management.
- Use a training log or similar method to document training.
- Ensure that employees are familiar with the site's spill control plan and/or proper spill cleanup procedures.
- Have staff involved in detection and removal of illicit connections trained in the following:
  - ✓ OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).
  - ✓ OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).
  - ✓ Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

Quality Assurance and Record Keeping

- Keep accurate maintenance logs that document minimum BMP activities performed for drainage system maintenance, types and quantities of waste disposed of, and any improvement actions.
- Keep accurate logs of spill response actions that document what was spilled, how it was cleaned up, and how the waste was disposed.
- Keep accurate logs of illicit connections, illicit discharges, and illegal dumping into the storm drain system including how wastes were cleaned up and disposed.
- Establish procedures to complete logs and file them in the central office.

Potential Limitations and Work-Arounds

Provided below are typical limitations and recommended "work-arounds" for drainage system maintenance:

- Clean-up activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.

  - ✓ Perform all maintenance onsite and do not flush accumulated material downstream to private property or riparian habitats.

- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, and liquid/sediment disposal.

  - ✓ Develop and follow a site specific drainage system maintenance plan that describes maintenance locations, methods, required equipment, water sources, sediment collection areas, disposal requirements, and any other pertinent information.

- Regulations may include adoption of substantial penalties for illegal dumping and disposal.

  - ✓ Do not dump illegal materials anywhere onsite.
  - ✓ Identify illicit connections, illicit discharge, and illegal dumping.
  - ✓ Cleanup spills immediately and properly dispose of wastes.

- Local municipal codes may include sections prohibiting discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the sanitary sewer system.

  - ✓ Collect all materials and pollutants accumulated in drainage system and dispose of according to local regulations.
  - ✓ Install debris excluders in areas with a trash TMDL.

Potential Capital Facility Costs and Operation & Maintenance Requirements

Facilities

- Capital costs will vary substantially depending on the size of the facility and characteristics of the drainage system. Significant capital costs may be associated with purchasing water trucks, vacuum trucks, and any other necessary cleaning equipment or improving the drainage infrastructure to reduce the potential .

- Developing and implementing a site specific drainage system maintenance plan will require additional capital if a similar program is not already in place.

Maintenance

- Two-person teams may be required to clean catch basins with vactor trucks.
- Teams of at least two people plus administrative personnel are required to identify illicit discharges, depending on the complexity of the storm sewer system.
- Arrangements must be made for proper disposal of collected wastes.
- Technical staff are required to detect and investigate illegal dumping violations.
- Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary.

Supplemental Information

Storm Drain Flushing

Flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in storm drainage systems. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as an open channel, another point where flushing will be initiated, or the sanitary sewer and the treatment facilities, thus preventing re-suspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. Deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, thereby releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce impacts of stormwater pollution, a second inflatable device placed well downstream may be used to recollect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to recollect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75% for organics and 55-65% for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used if allowed or that fire hydrant line flushing coincide with storm sewer flushing.

References and Resources

City of Seattle, Seattle Public Utilities Department of Planning and Development, 2009. *Stormwater Manual Vol. 1 Source Control Technical Requirements Manual*.

Knox County Tennessee *Stormwater Management Manual* Chapter 5 Drainage System Maintenance, 2008. Available online at: http://www.knoxcounty.org/stormwater/manual/Volume%201/knoxco_swmm_v1_chap5_jan2008.pdf.

US EPA. Storm Drain System Cleaning, 2012. Available online at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=102.